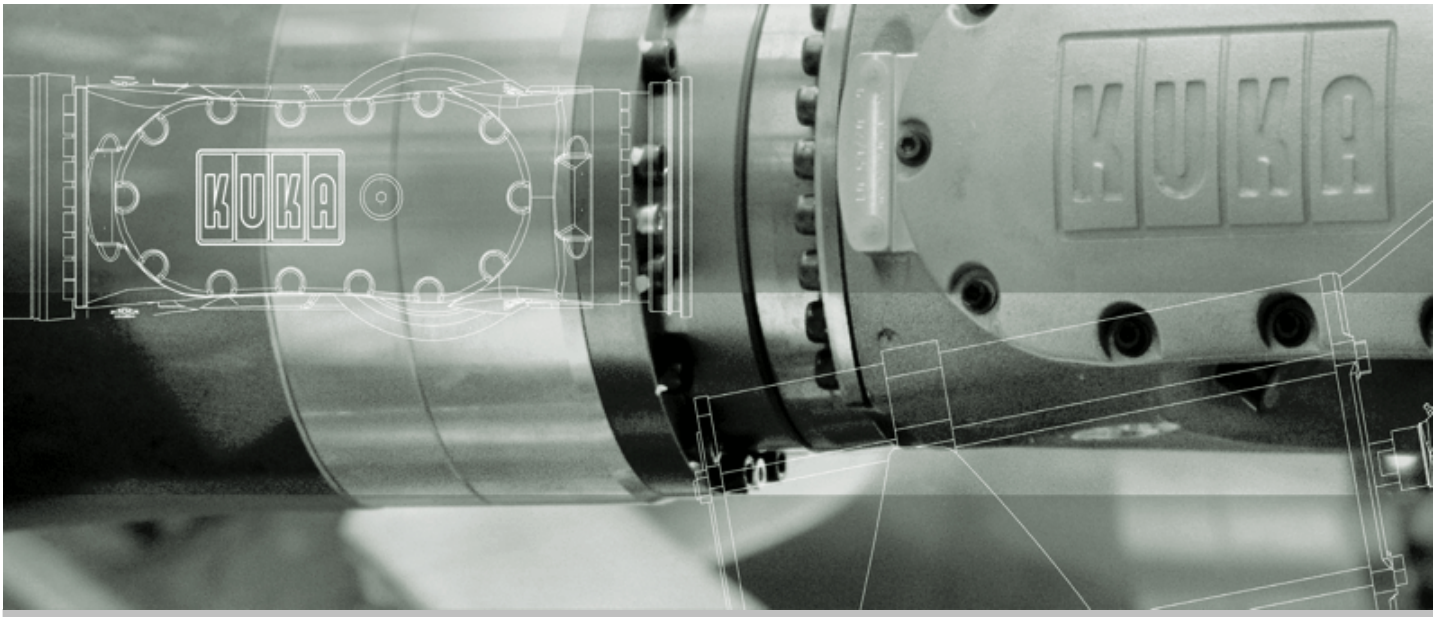


KUKA Robot Group

Controller

KR C2 edition05

Operating Instructions

Issued: 11.07.2007 Version: 3.3

KUKA Roboter GmbH
Zugspitzstraße 140
D-86165 Augsburg
Germany

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

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

Subject to technical alterations without an effect on the function.

KIM-PS4-DOC

Contents

1 Introduction

1.1 Target group

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

- 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.

1.2 Robot system documentation

The robot system documentation consists of the following parts:

- Operating instructions for the robot
- Operating instructions for the robot controller
- Operating and programming instructions for the KUKA System Software
- Documentation relating to options and accessories

Each of these sets of instructions is a separate document.

1.3 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.

1.4 Terms used

Term	Description
DSE	Digital Servo Electronics
EMC	Electromagnetic compatibility

Term	Description
KCP	Teach pendant (KUKA Control Panel)
KRL	KUKA Robot Language
KSS	KUKA System Software
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.
VxWorks	Real-time operating system

2 Product description

2.1 Overview of the robot system

A robot system consists of the following components:

- Robot
- Robot controller
- KCP teach pendant
- Connecting cables
- Software
- Options, accessories

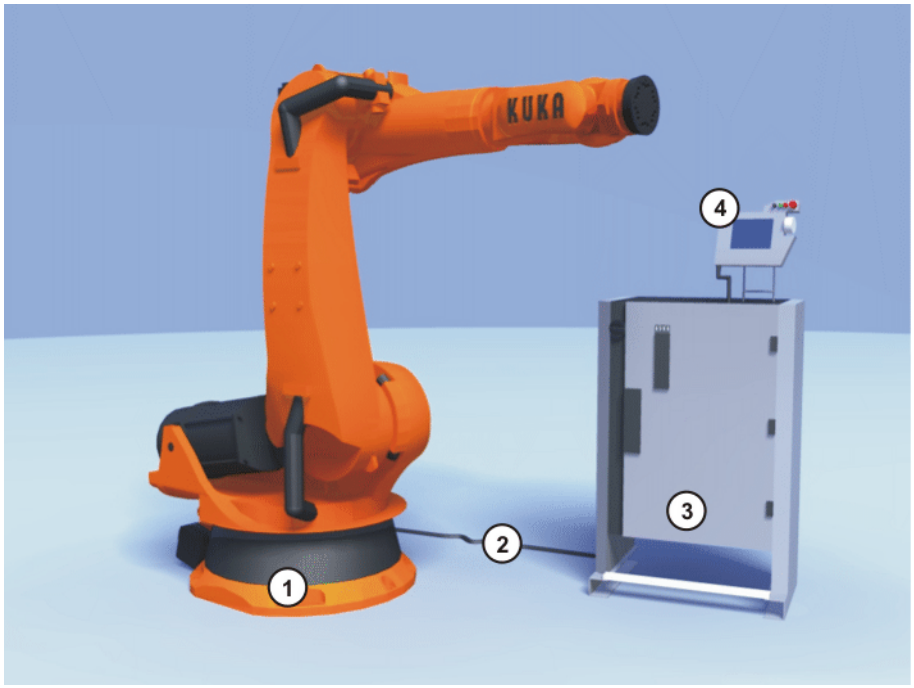


Fig. 2-1: Example of a robot system

1	Robot	3	Robot controller
2	Connecting cables	4	Teach pendant (KCP)

2.2 Overview of the robot controller

The robot controller is used for controlling the following systems:

- KUKA robots
- KMC
- External kinematic system

The robot controller consists of the following components:

- Control PC
- Power unit
- KCP teach pendant
- Safety logic ESC
- Connection panel

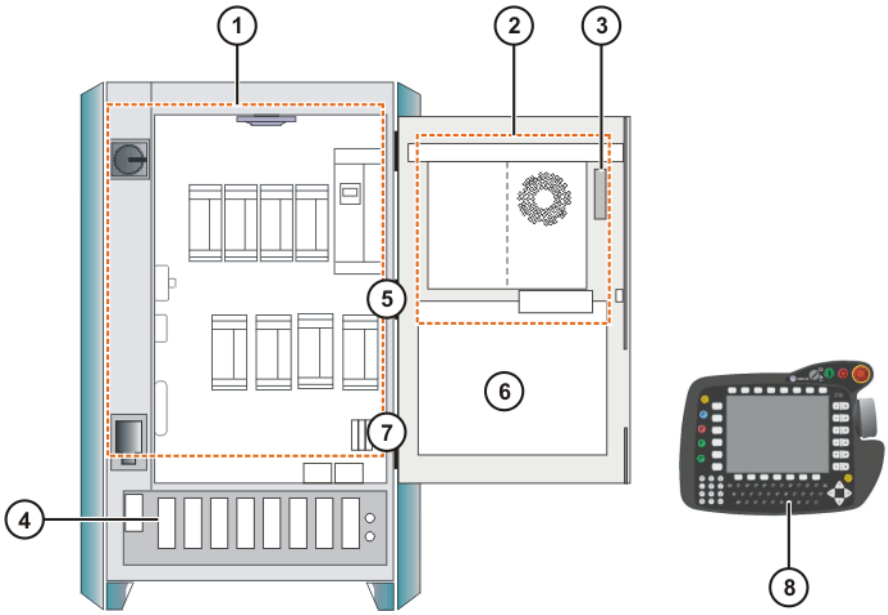


Fig. 2-2: Overview of the robot controller

1	Power unit	4	Connection panel
2	Control PC	5	Mounting plate for customer components
3	Safety logic (ESC)	6	KCP

2.3 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
- Floppy disk drive (optional)
- CD-ROM drive (optional)
- MFC3
- KVGA
- DSE-IBS-C33
- Batteries
- Optional modules, e.g. field bus cards

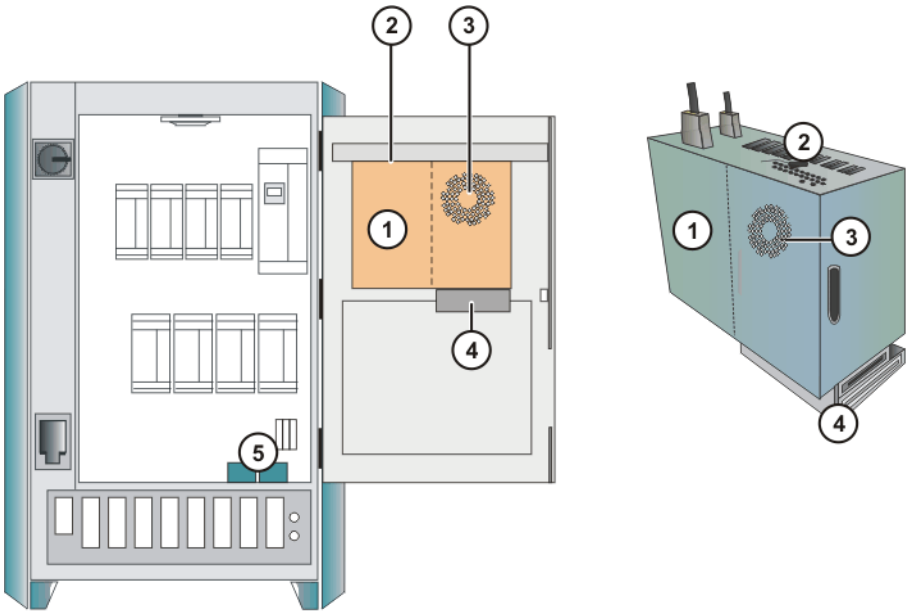


Fig. 2-3: Overview of the control PC

1	PC	4	Drives (optional)
2	PC interfaces	5	Batteries
3	PC fan		

2.3.1 PC interfaces

Overview

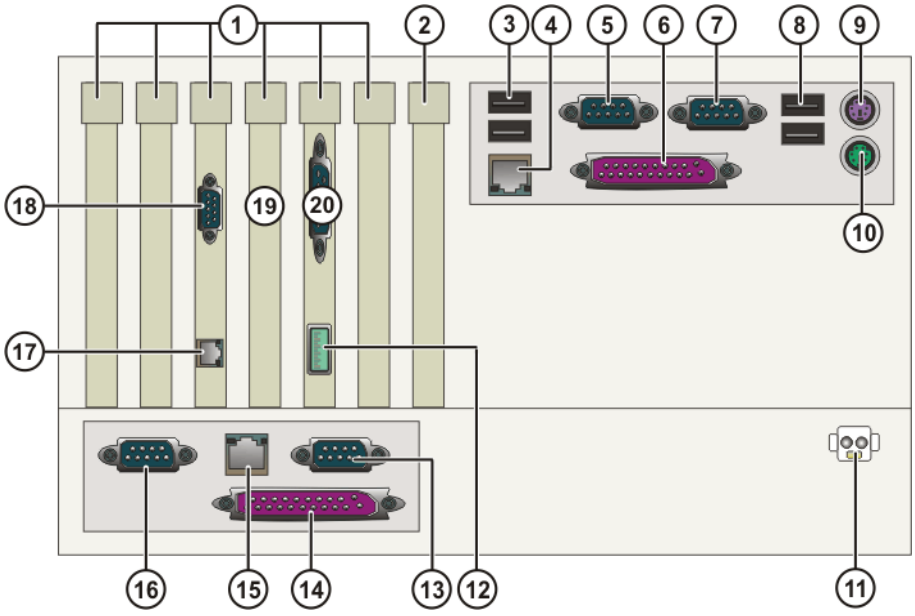


Fig. 2-4: Control PC interfaces

Item	Interface	Item	Interface
1	PCI slots 1 to 6 (>>> 2.3.2 "PC slot assignment" page 14)	11	X961 power supply DC 24 V
2	AGP PRO slot	12	X801 DeviceNet (MFC3)

Item	Interface	Item	Interface
3	USB (2x)	13	ST5 serial real-time interface COM 3
4	X804 Ethernet	14	ST6 ESC/KCP etc.
5	COM 1 serial interface	15	ST3 drive bus to KPS600
6	LPT1 parallel interface	16	ST4 serial RDC interface X21
7	COM 2 serial interface	17	X805 KCP display (KVGA)
8	USB (2x)	18	X821 external monitor (KVGA)
9	Keyboard connection	19	Slot 4 remains unassigned. If a second DSE-IBS-C33 AUX card is plugged into the MFC3, this overlaps slot 4.
10	Mouse connection	20	X2 DC inputs and outputs. SSB interface to the CI3 board.

To activate the USB connections, the following BIOS settings must be made.

1. During the boot procedure, press **F2** to switch to the BIOS.
2. In the **Advanced** menu, select the menu item **Advanced System Configuration**.
3. Activate all menu items except **USB Legacy Support**.

2.3.2 PC slot assignment

Overview

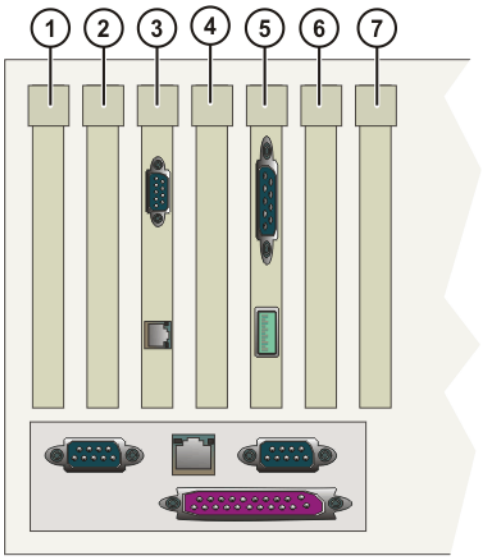


Fig. 2-5: PCI slots

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) ■ LPCN ControlNet 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

2.3.3 Motherboard

Configuration

The following components are located on the motherboard:

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

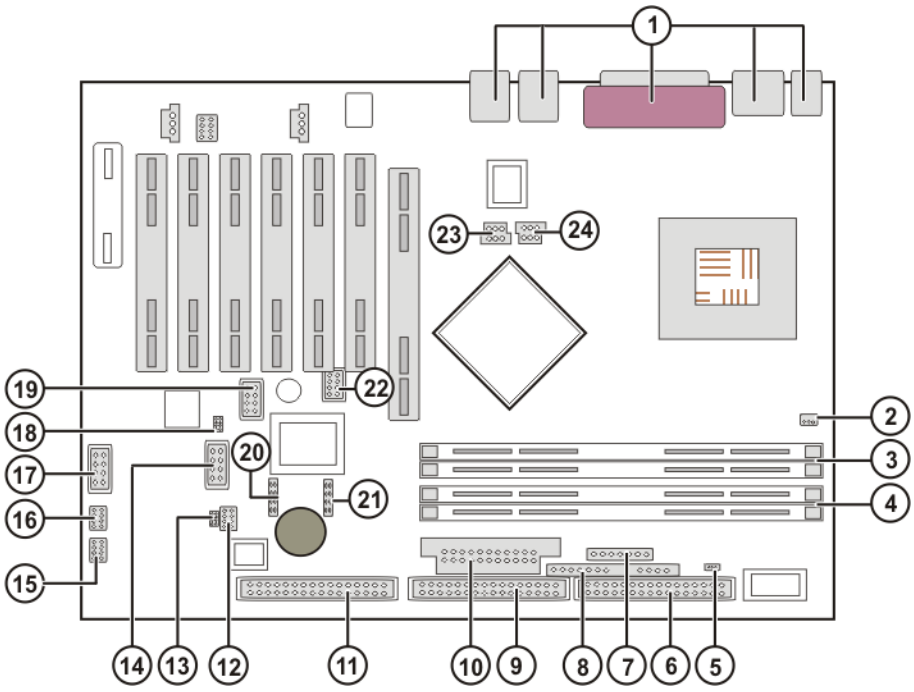


Fig. 2-6: Motherboard

Connections

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

2.3.4 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)

2.3.5 CD-ROM drive (optional)

Description

The CD-ROM drive is a device for reading CDs.

2.3.6 Floppy disk drive (optional)

Description

The floppy disk drive is used for archiving data.

2.3.7 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

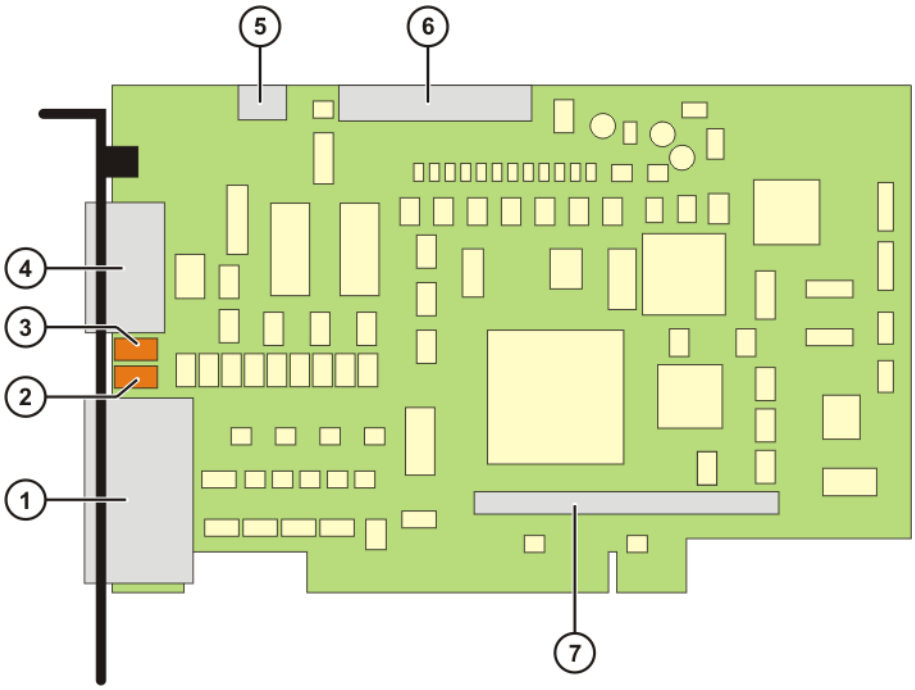


Fig. 2-7: MFC3 card

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

LEDs

Item	LEDs	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)

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

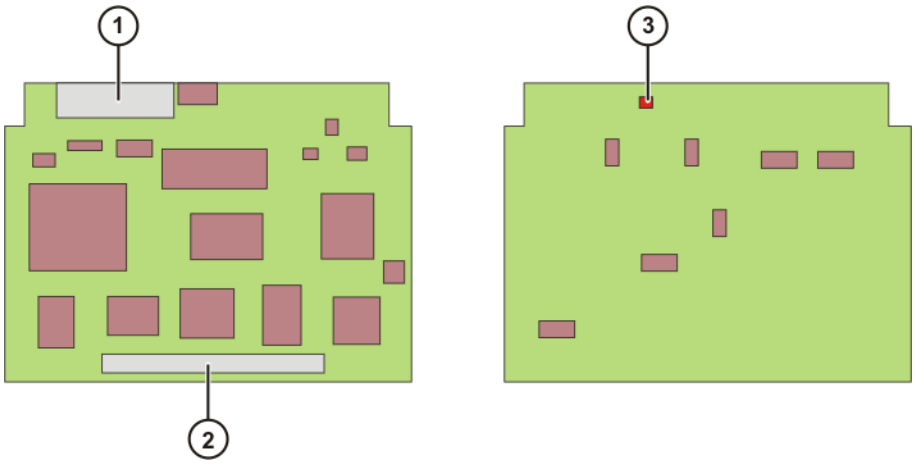
2.3.8 Digital servo-electronics (DSE-IBS-C33)

Description

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

If 2 RDCs are used in the robot system (in the case of more than 8 axes), each RDC must be fitted with a DSE-IBS-C33 board.

Overview



Connections

Item	Connector	Description
1	X4	Connection to the drive servos
2	X810	Connection to the MFC3

LED

Item	LED	Description
3	LED	Flashes when the connection to the MFC3 is established.

2.3.9 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.

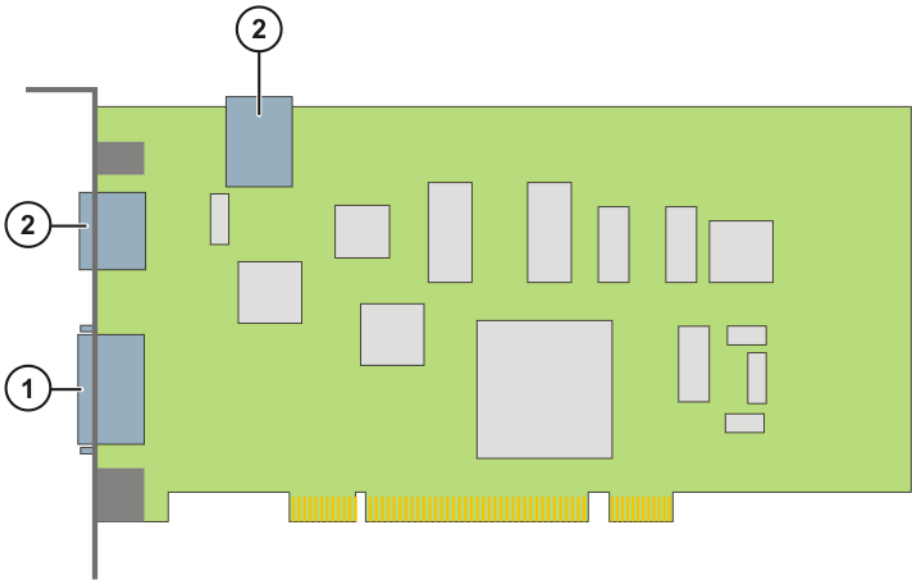


Fig. 2-8: KVGA card

Connections

Item	Connector
1	External monitor connection
2	KCP connection

2.3.10 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.

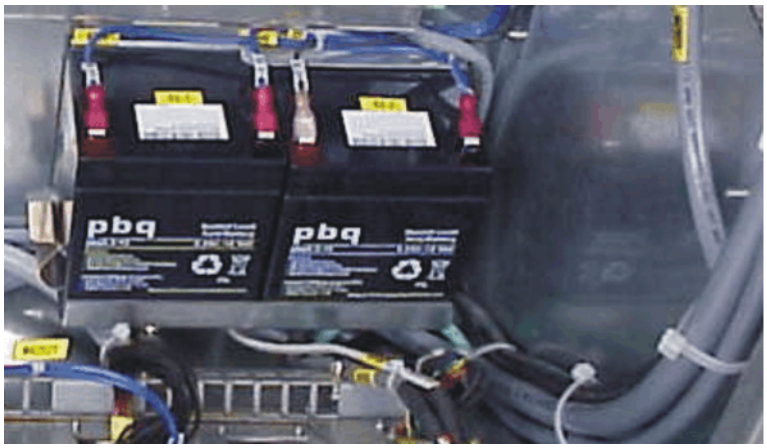


Fig. 2-9: Batteries

2.4 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 functions required for operating and programming the robot system.

2.4.1 Front view

Overview

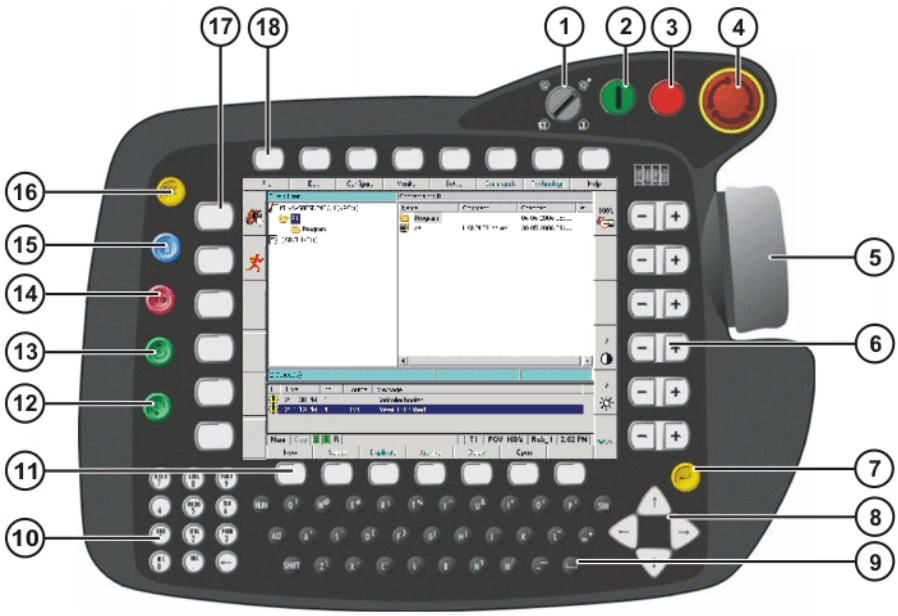


Fig. 2-10: Front view of KCP

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

2.4.2 Rear view

Overview

Fig. 2-11: 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.

2.5 KCP coupler (optional)

Description

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

Overview

Fig. 2-12: KCP coupler LEDs and request button

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

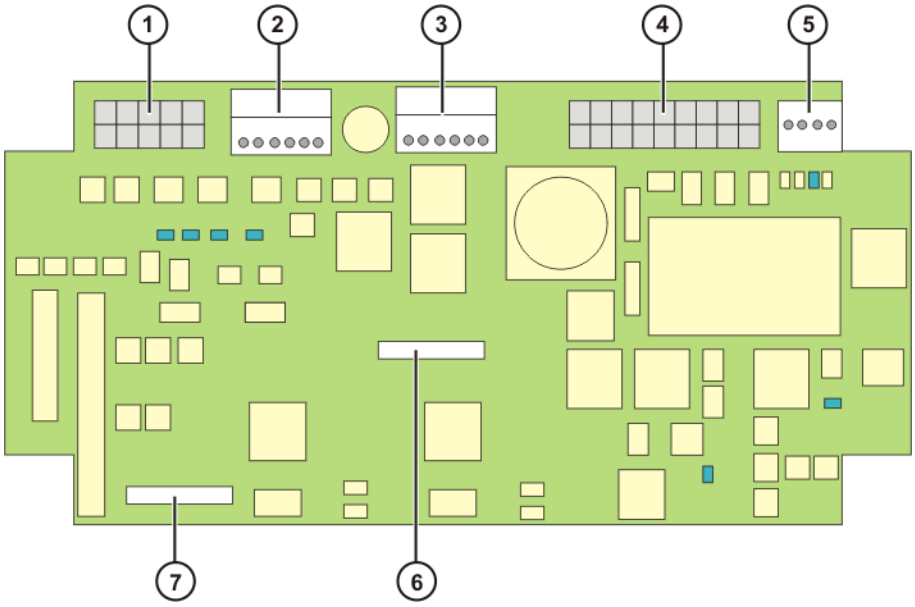


Fig. 2-13: KCP coupler card

Connections

Item	Connector	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.
(>>> 11.10 "KCP coupler LED display (optional)" page 117)

2.6 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

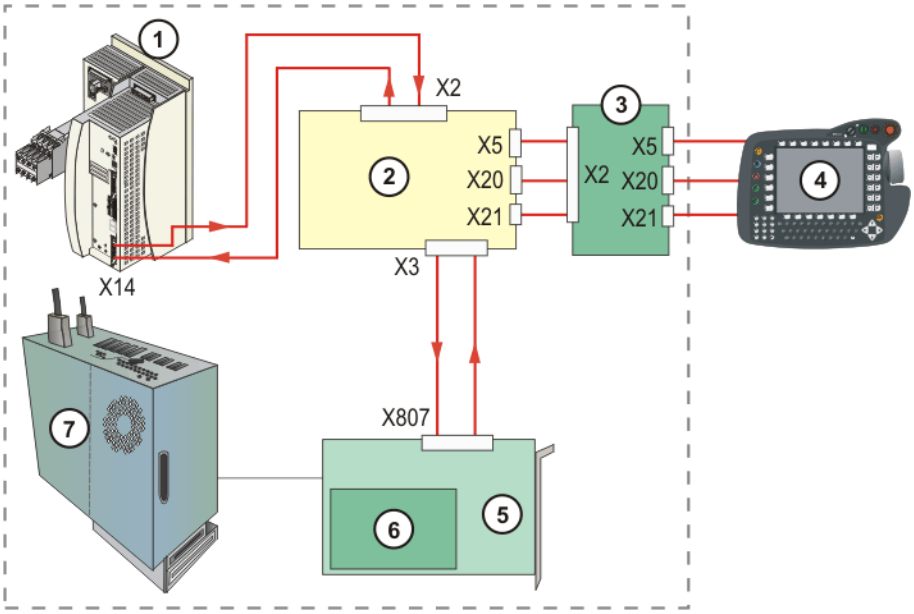


Fig. 2-14: Structure of the ESC circuit

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.

2.6.1 ESC nodes

Configuration

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

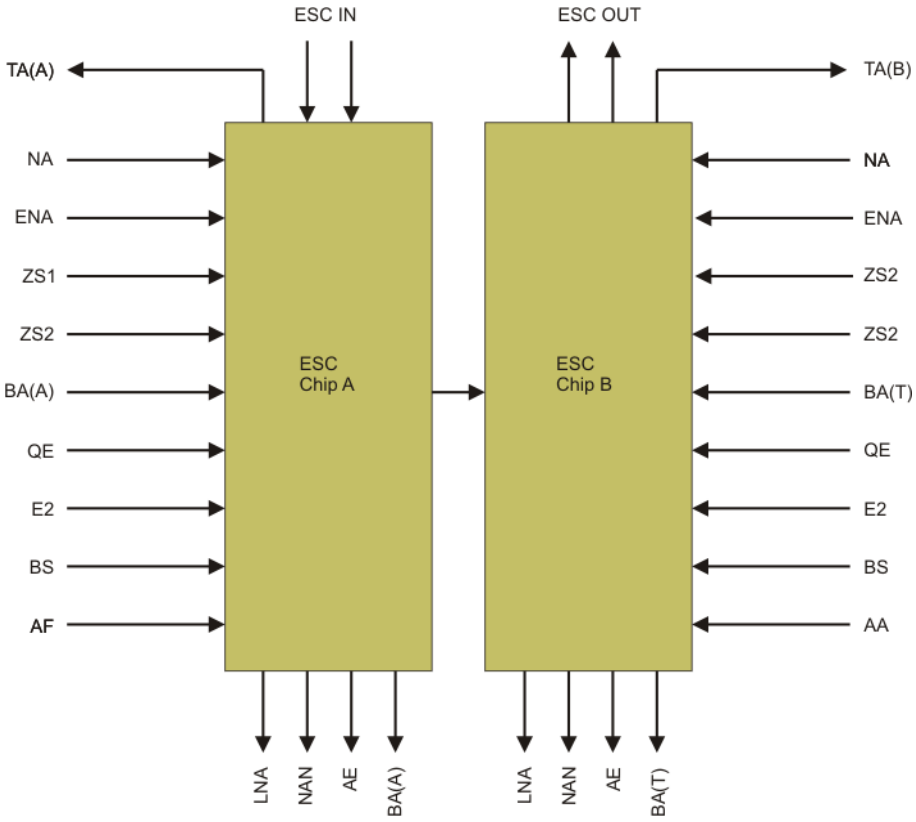


Fig. 2-15: ESC nodes

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	This signal is used for external axes or loading stations. If the signal is interrupted in Test mode, the drives contactor drops out immediately.
E2	Special keyswitch (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.

2.6.2 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 (>>> 2.6.3 "CI3 Standard board" page 26)	No	Indicates the following states: ■ Local E-STOP
CI3 Extended (>>> 2.6.4 "CI3 Extended board" page 28)	Yes	Indicates the following states: ■ Operating modes ■ Local E-STOP ■ Drives ON
CI3 Bus (>>> 2.6.5 "CI3 Bus board" page 29)	No	Connecting board between the ESC circuit and the SafetyBUS p from PILZ
CI3 Tech (>>> 2.6.6 "CI3 Tech board" page 31)	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

2.6.3 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.

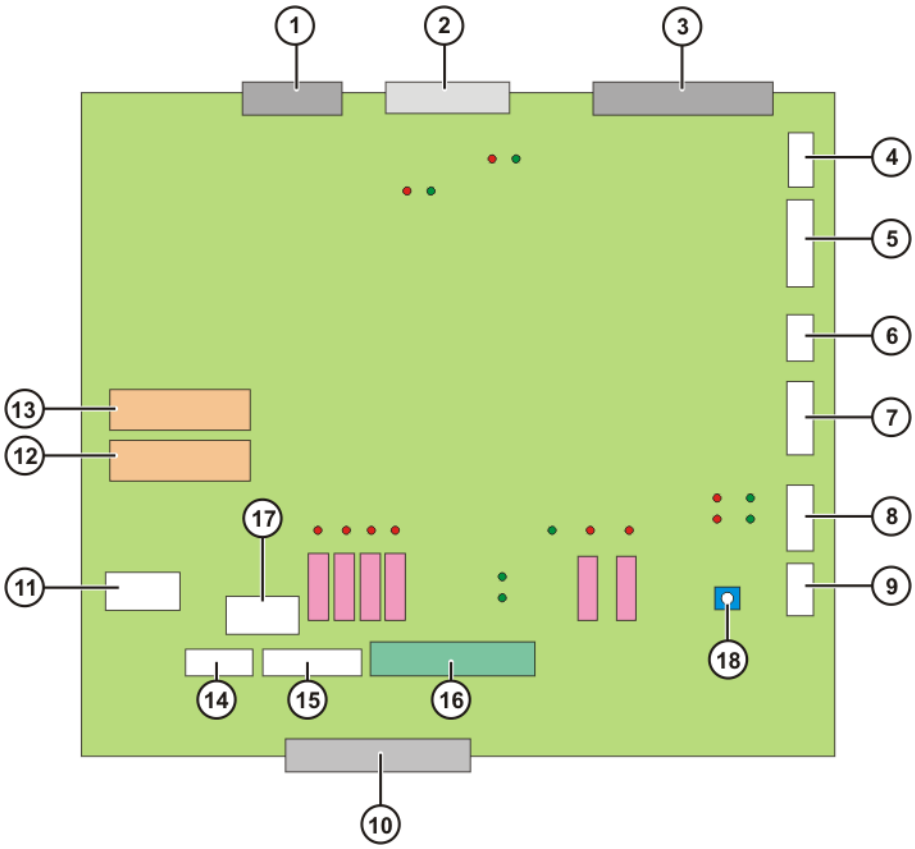


Fig. 2-16: CI3 Standard board connections and relays

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

2.6.4 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.

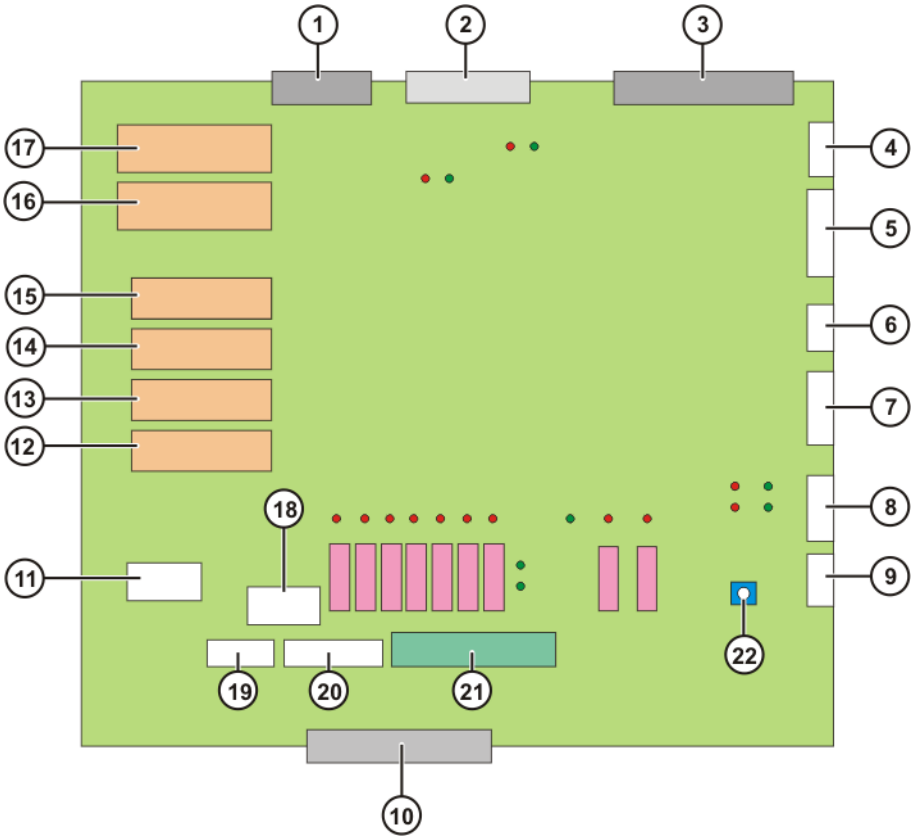


Fig. 2-17: CI3 Extended board connections and relays

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

Item	Designation	Description
9	X21	KCP power supply and KCP CAN
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

2.6.5 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.

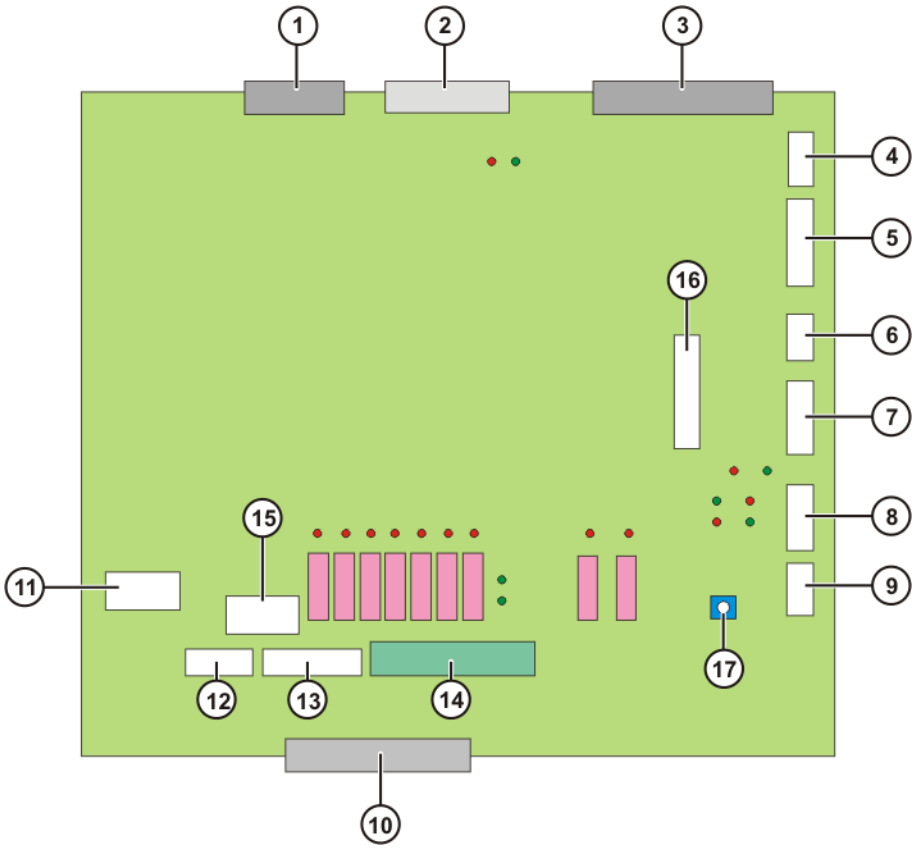


Fig. 2-18: CI3 Bus board connections

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

2.6.6 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.

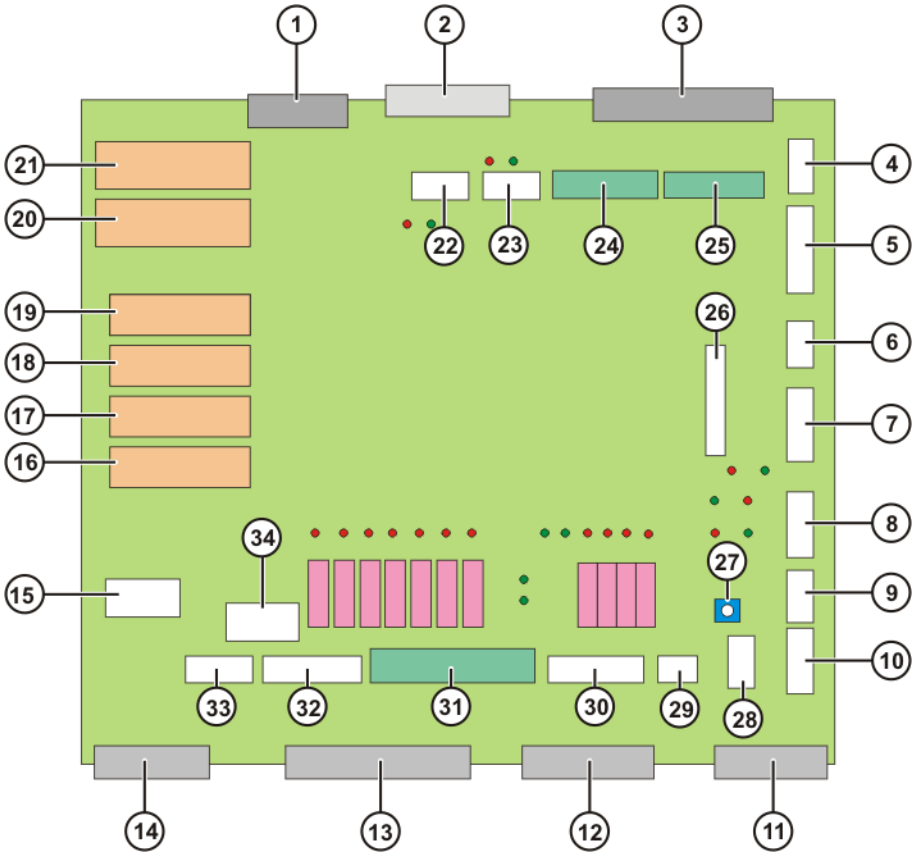


Fig. 2-19: CI3 Tech board connections and relays

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	Interface to selector switch in Shared Pendant (optional)
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

2.7 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

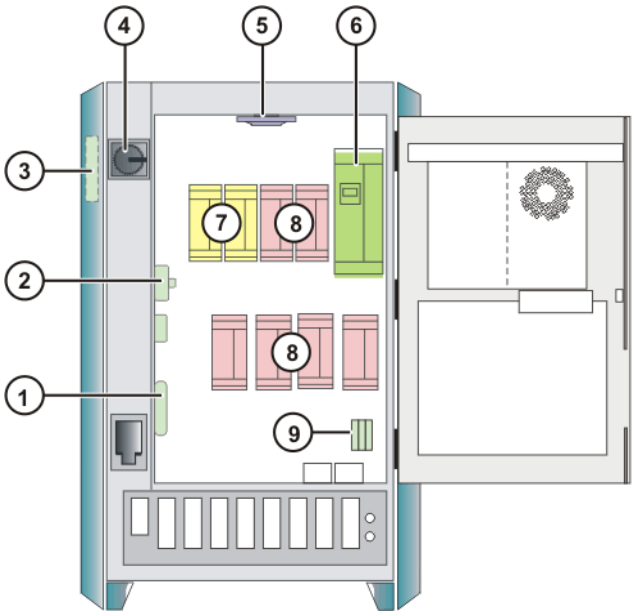


Fig. 2-20: Power unit

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)

2.7.1 Power supply unit KPS 600

Description

Via the drive bus, commands are received from the robot controller and status messages are sent to the robot controller. Communication is monitored by means of a watchdog circuit. In the event of a failure, short-circuit braking is activated.

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 servo drive modules
- 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
- Customer interface
- Control PC
- KSD

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

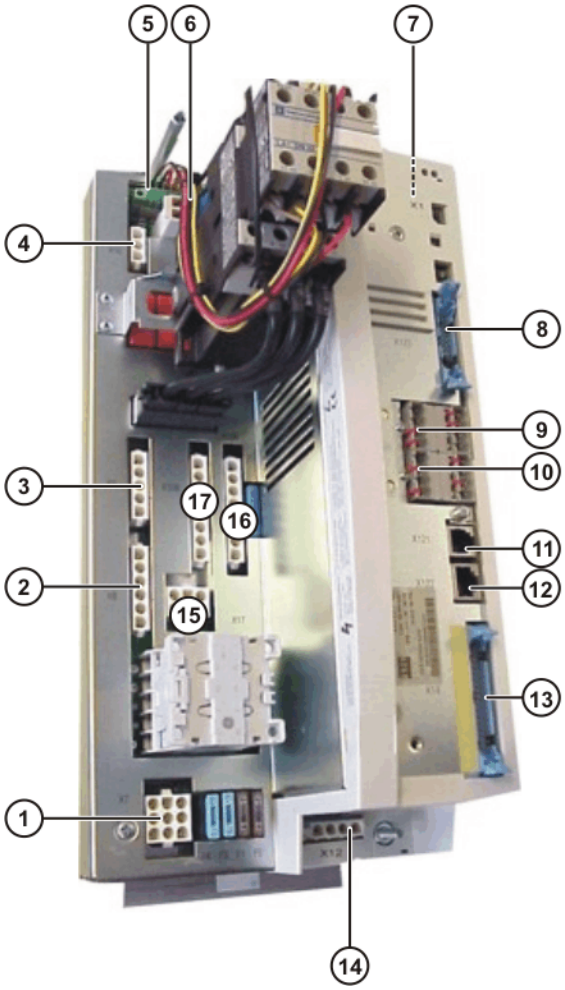


Fig. 2-21: Connections on the KPS 600

Connections

Item	Connector	Description
1	X7	24 V battery, KSD and controller
2	X8	Ballast resistor
3	X9	Energy recovery unit
4	X16	Energy recovery unit

Item	Connector	Description
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 DC 24 V and the batteries. (>>> 11.7 "KPS 600 fuses, messages and error displays" page 112)

LEDs

On the KPS 600 there are 6 LEDs which indicate the state of the safety logic and the brake control. (>>> 11.7 "KPS 600 fuses, messages and error displays" page 112)

2.7.2 Fuses

Overview

The fuses protect the components of the robot controller.

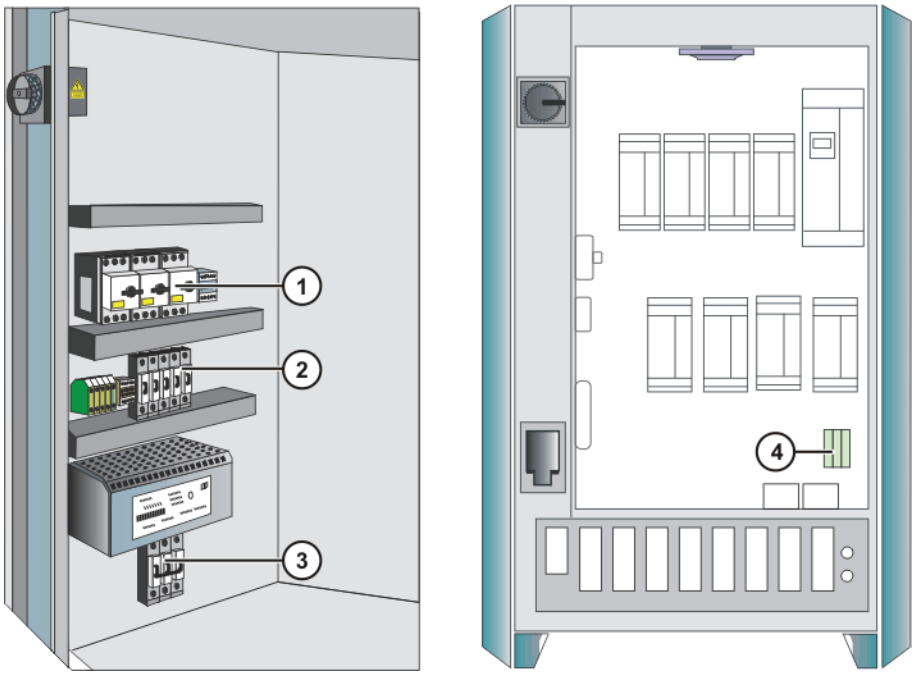


Fig. 2-22: Arrangement of the fuses

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

Values

Item	Fuse	Value in A	Circuit
1	F1	20	KPS600 power supply
	F2	7	KPS-27 power supply
	F3	0. 63	External fan power supply
2	F11	2	24 V DC voltage from KPS-27
	F12	20	24 V DC voltage from KPS-27
	F13	2	Lighting 24 V DC (optional)
	F14	15	CI3 power supply
3	F19	2	Brakes for axes 1 to 6
4	F15	7.5	PC supply
	F16	4	24 V DC supply for: ■ KCP ■ CI3 ■ RDC
	FG3	10	Battery backup

2.7.3 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

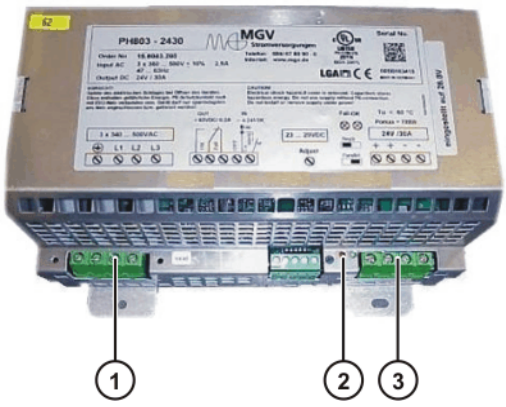


Fig. 2-23: KPS-27 low-voltage power supply

1	Power supply connection	3	24 V DC output
2	LED		

LED

One red and one green LED indicate the operating state of the KPS-27. (>>> 11.8 "KPS-27 error messages" page 115)

2.7.4 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

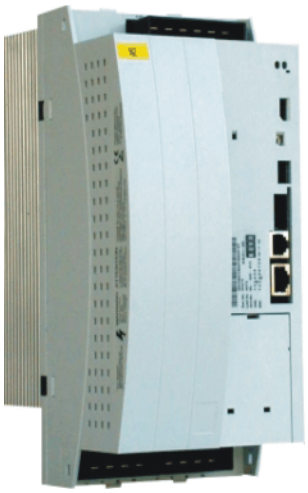


Fig. 2-24: Servo drive module

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

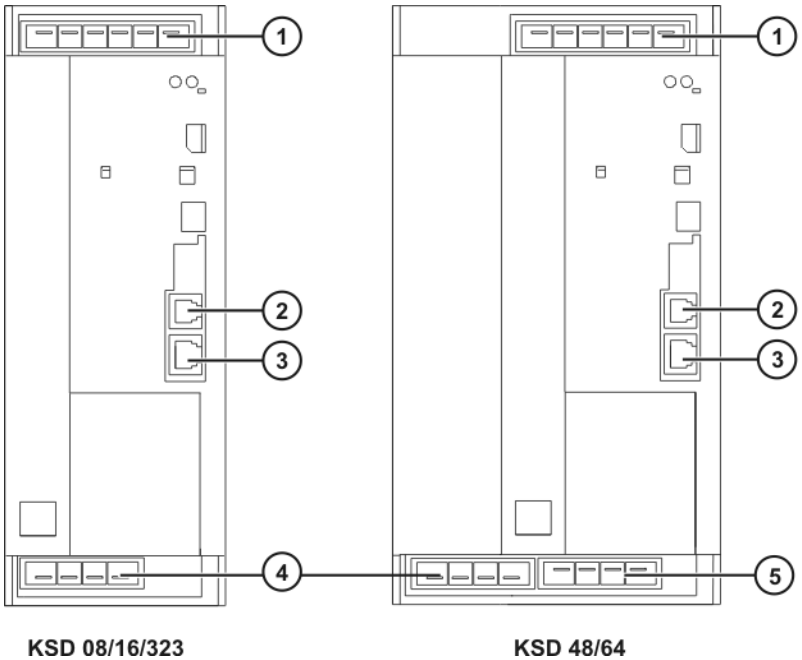


Fig. 2-25: Connections for servo drive modules, size 1 and size 2

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. (>>> 11.9 "Error messages on the KSD" page 115)

2.7.5 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.

2.8 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

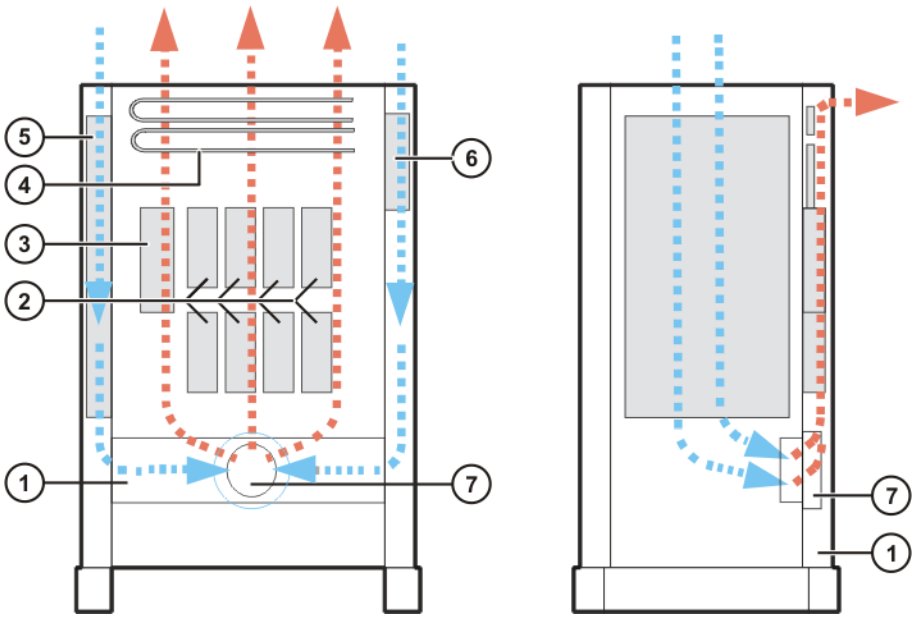


Fig. 2-26: Outer cooling circuit

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		

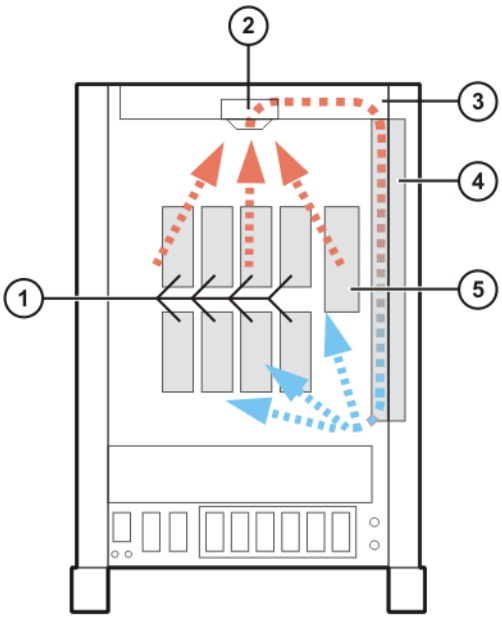


Fig. 2-27: Inner cooling circuit

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.

2.9 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

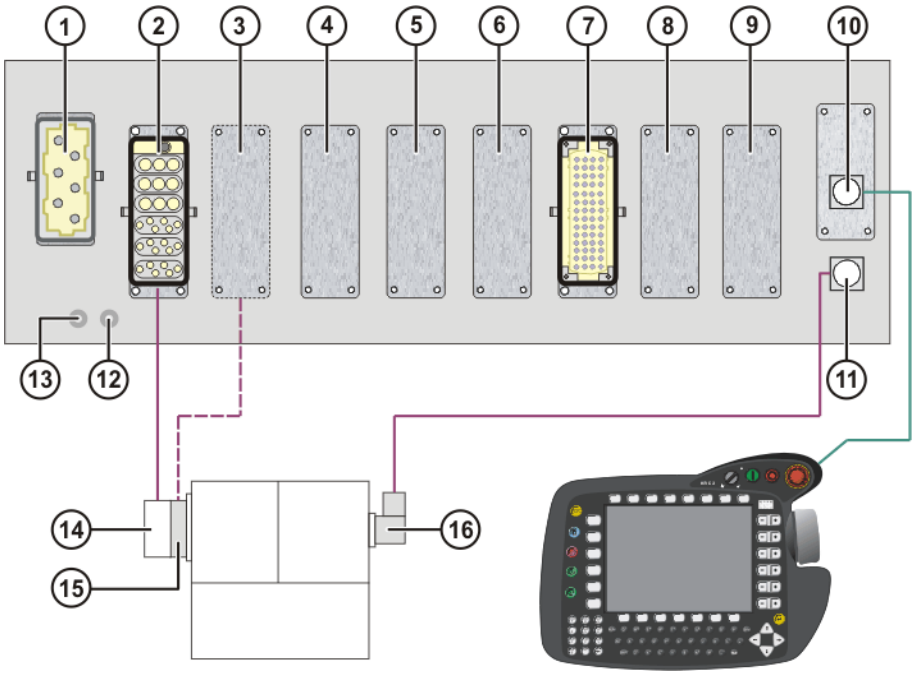


Fig. 2-28: KR C2 ed05 connection panel

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.

2.9.1 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. The robot controller may only be operated with grounded-neutral power supply systems.

Overview

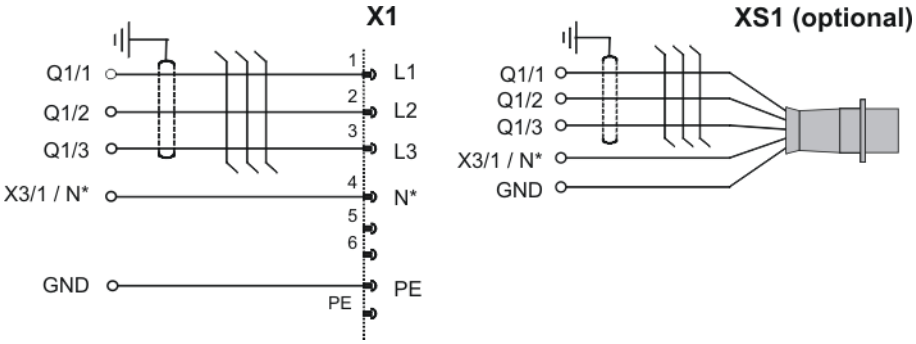


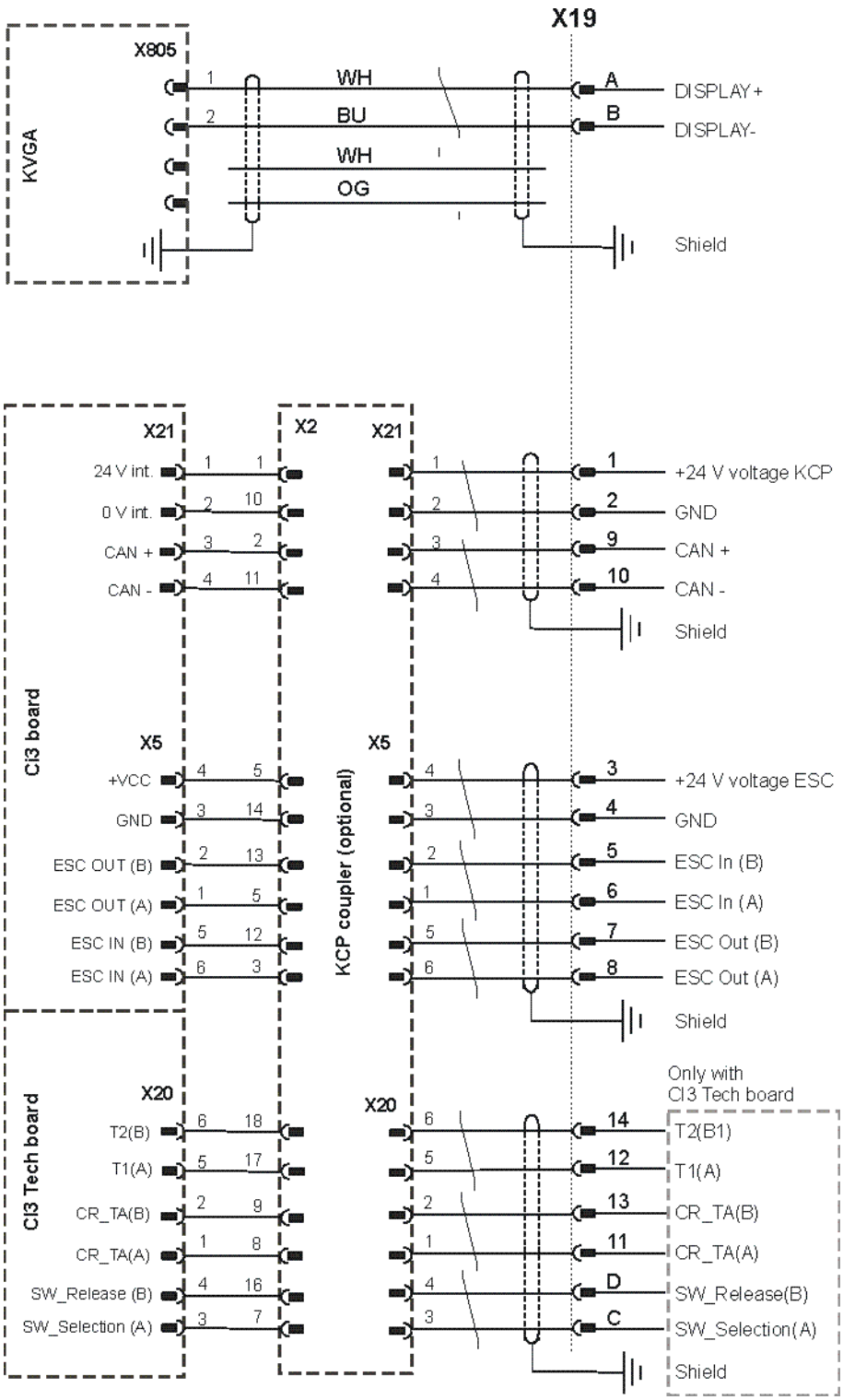
Fig. 2-29: Power supply connection

* 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.

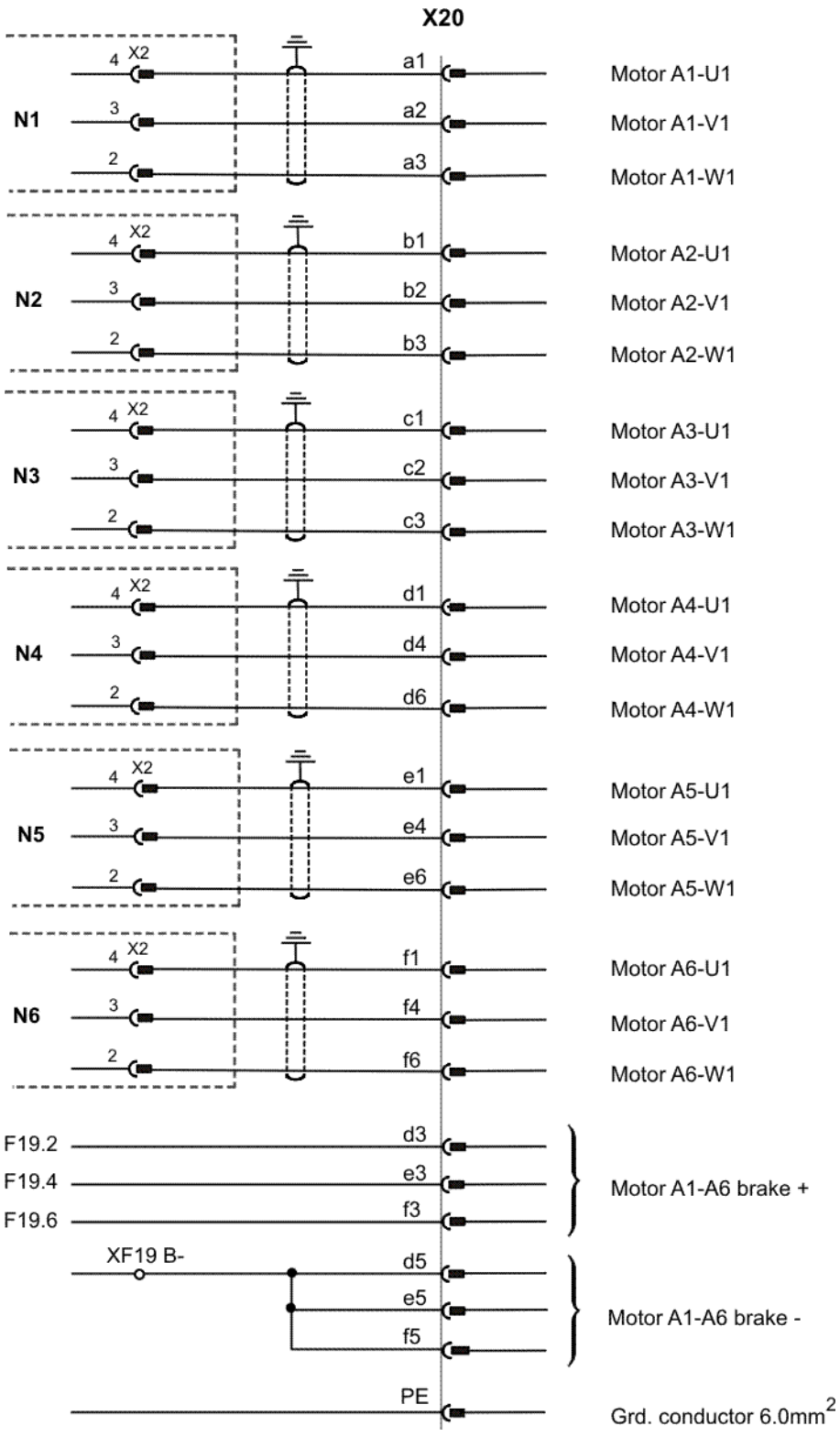
2.9.2 KCP connector X19

Connector pin allocation



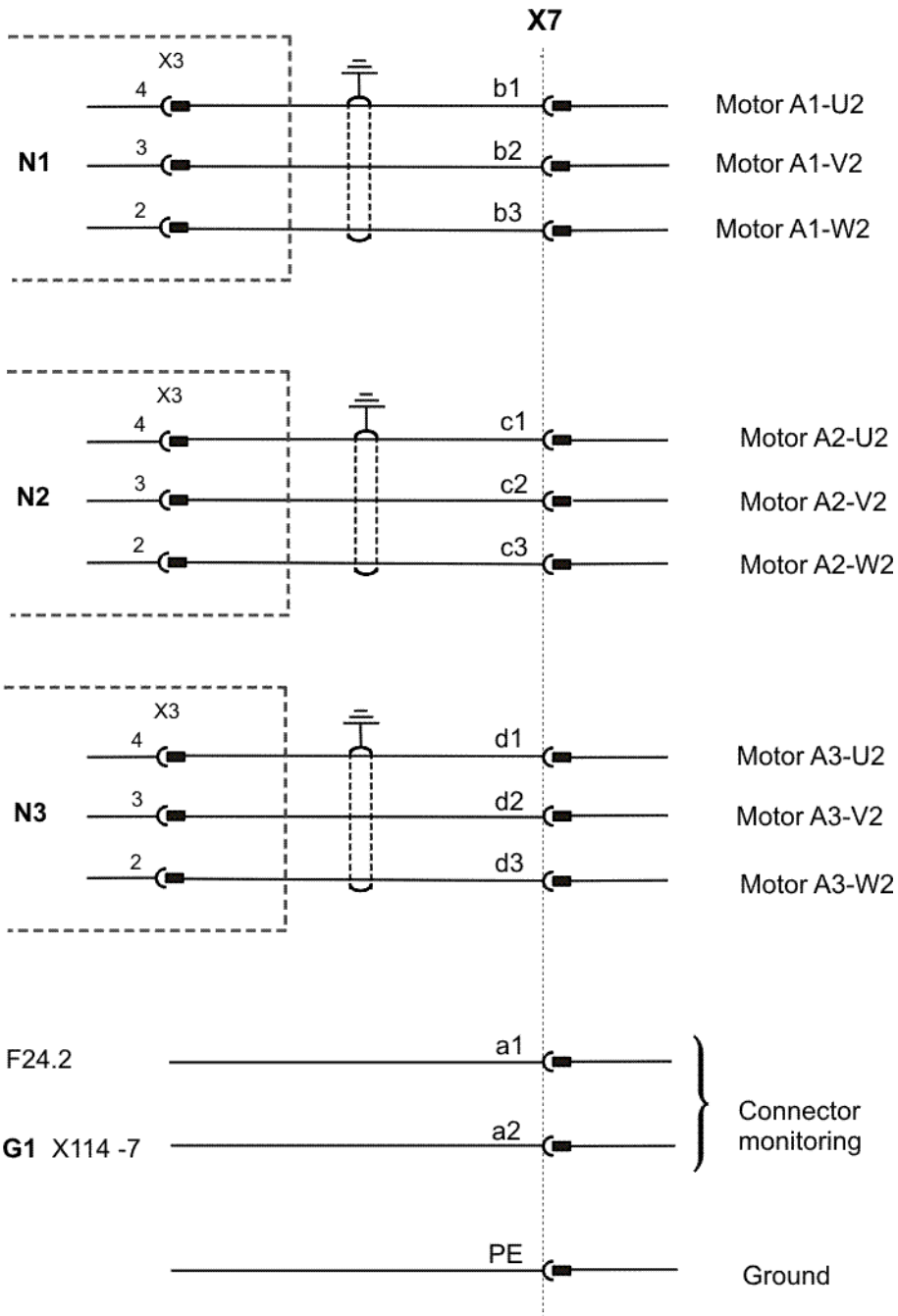
2.9.3 Motor connector X20, axes 1 to 6

Connector pin allocation



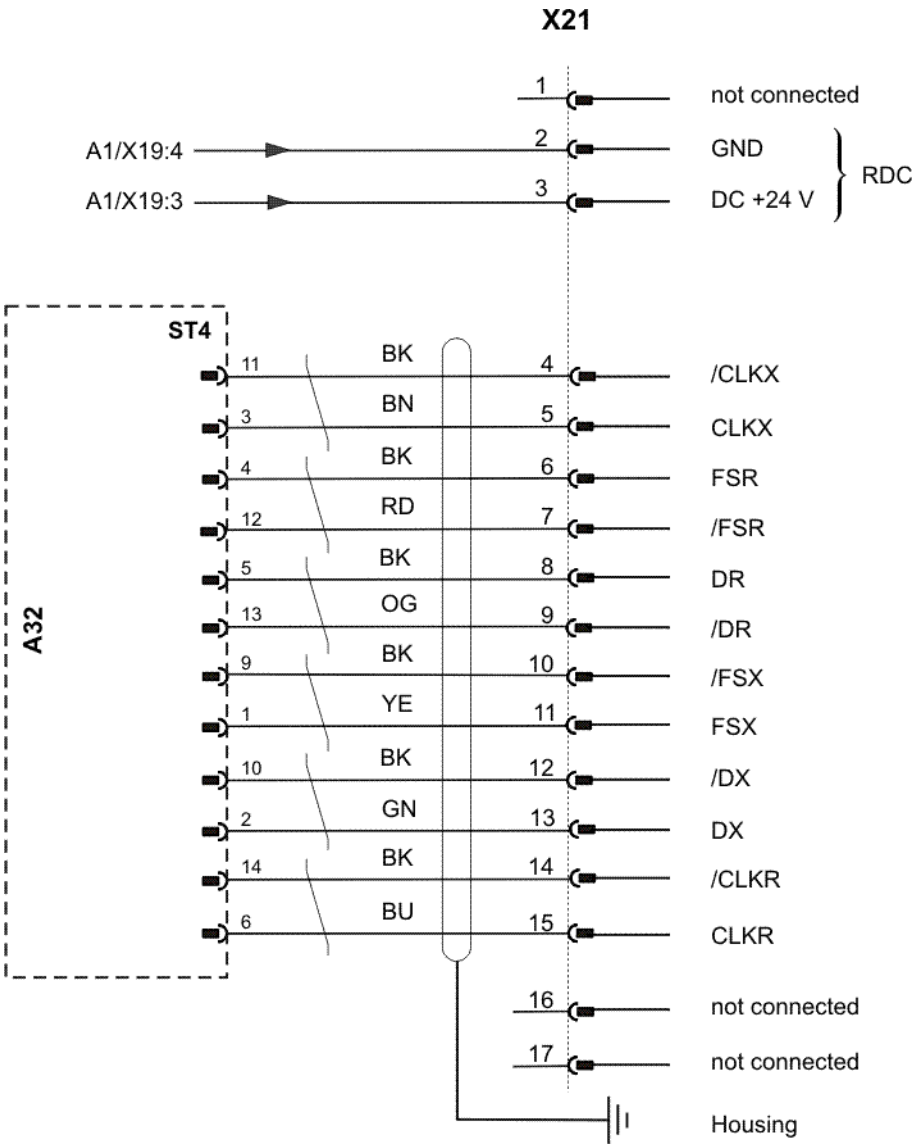
2.9.4 Motor connector X7 (optional)

Connector pin allocation



2.9.5 Data cable X21, axes 1 to 8

Connector pin allocation



2.10 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.

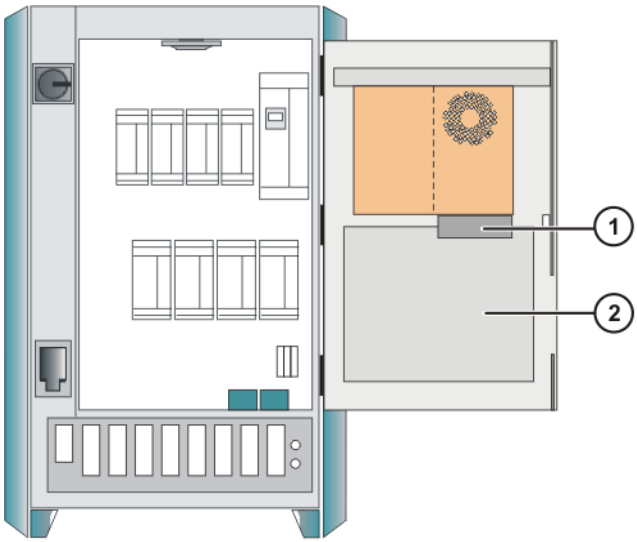


Fig. 2-30: Mounting plate for customer components

1 Drives (optional)
2 Mounting plate for customer components

The drives project into the installation area of the mounting plate.

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

3 Technical data

3.1 Basic data

Basic data

Control cabinet type	KR C2 edition05
Number of axes	max. 8
Weight	approx. 185 kg
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

Standard rated supply voltage acc. to DIN/IEC 38	AC 3x400 V...AC 3x415 V
Permissible tolerance of rated voltage	400 V -10%...415 V +10%
Mains frequency	49...61 Hz
Rated power input ■ Standard	7.3 kVA, see rating plate
Rated power input ■ Heavy-duty robot ■ Palletizer ■ 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
RCCB 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

Environmental conditions

Ambient temperature during operation without cooling unit	+5 °C to 45 °C
Ambient temperature during operation with cooling unit	+5 °C to 55 °C
Ambient temperature during storage/transportation with batteries	-25 °C to +30 °C
Ambient temperature during storage/transportation without batteries	-25 °C to +70 °C
Temperature change	max. 1.1 K/min

Humidity class acc. to EN 60204/ 4.4.4	F
Altitude class according to DIN 40040	N

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	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	Half-sine/11 ms

If more severe mechanical stress is expected, the control cabinet must be fitted with anti-vibration mounts.

Control unit

Supply voltage	26.8 V DC

Control PC

Main processor	See shipping version
DIMM memory modules	at least 256 MB
Hard disk, floppy disk drive, CD-ROM drive	See shipping version

KUKA Control Panel

Supply voltage	26.8 V DC
Dimensions (WxHxD)	approx. 33x26x8 cm^3
VGA display resolution	640x480 pixels
VGA display size	8"
Weight	1.4 kg
Cable length	10 m

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)	2.9	-

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.

3.2 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

3.3 Dimensions of robot controller

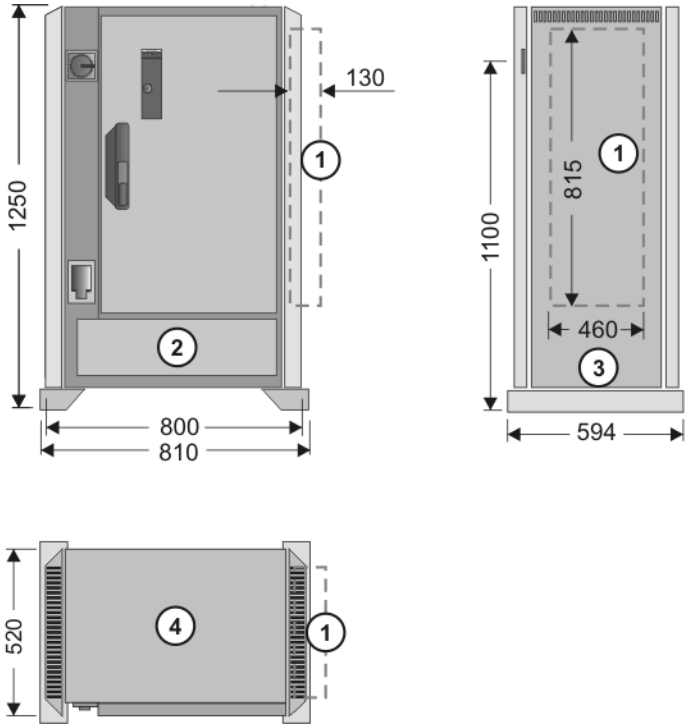


Fig. 3-1: Dimensions (in mm)

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

3.4 Minimum clearances, robot controller

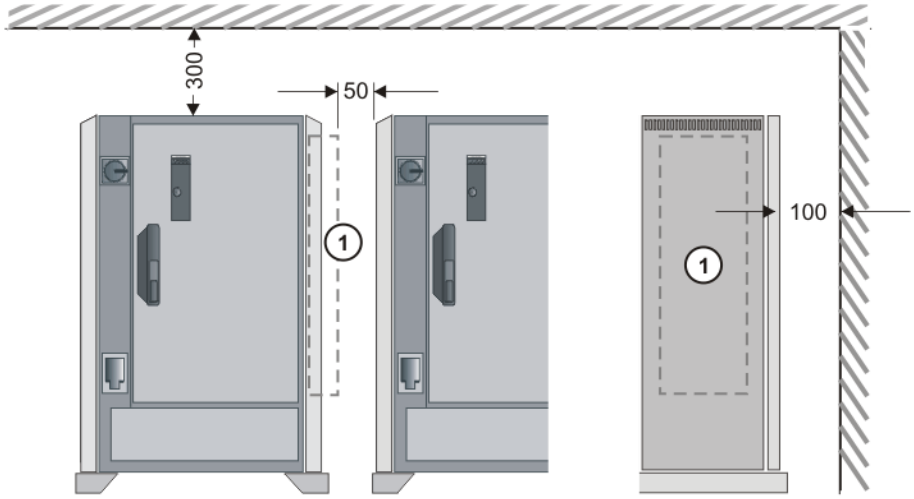


Fig. 3-2: Minimum clearances (dimensions in mm)

1 Cooling unit (optional)

3.5 Minimum clearances, top-mounted / technology cabinet

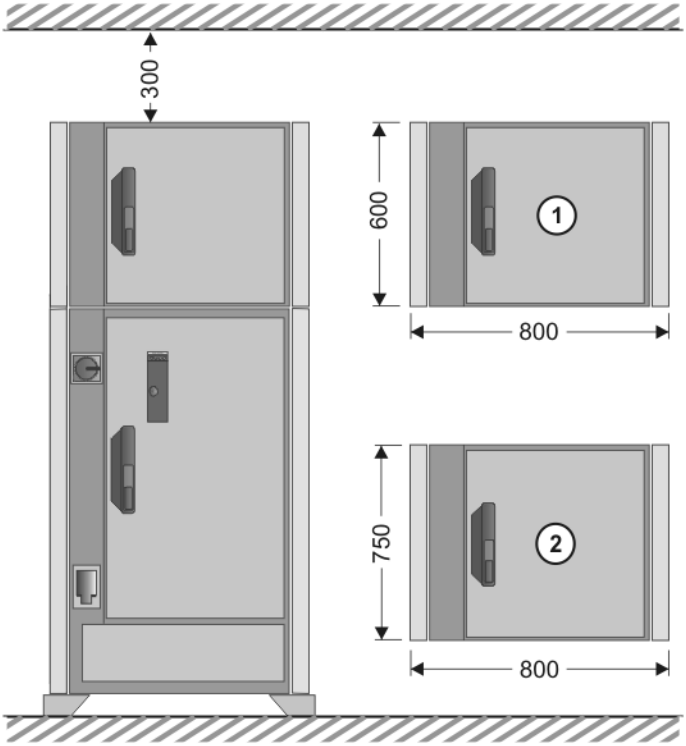
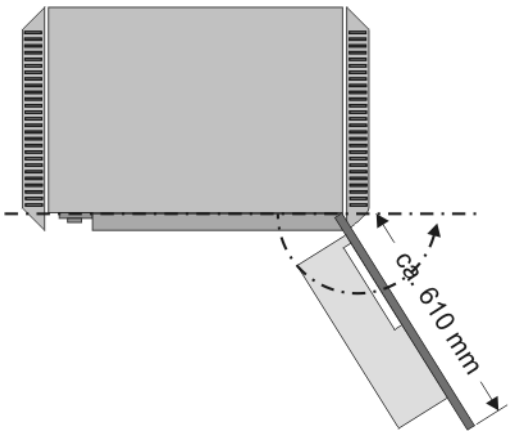


Fig. 3-3: Minimum clearances with top-mounted / technology cabinet

1 Top-mounted cabinet
2 Technology cabinet

3.6 Swing range for cabinet door



Swing range, standalone cabinet:

- Door with computer frame approx. 180°

Swing range, butt-mounted cabinets:

- Door approx. 155°

3.7 Plates and labels

Overview The following plates and labels are attached to the control cabinet.

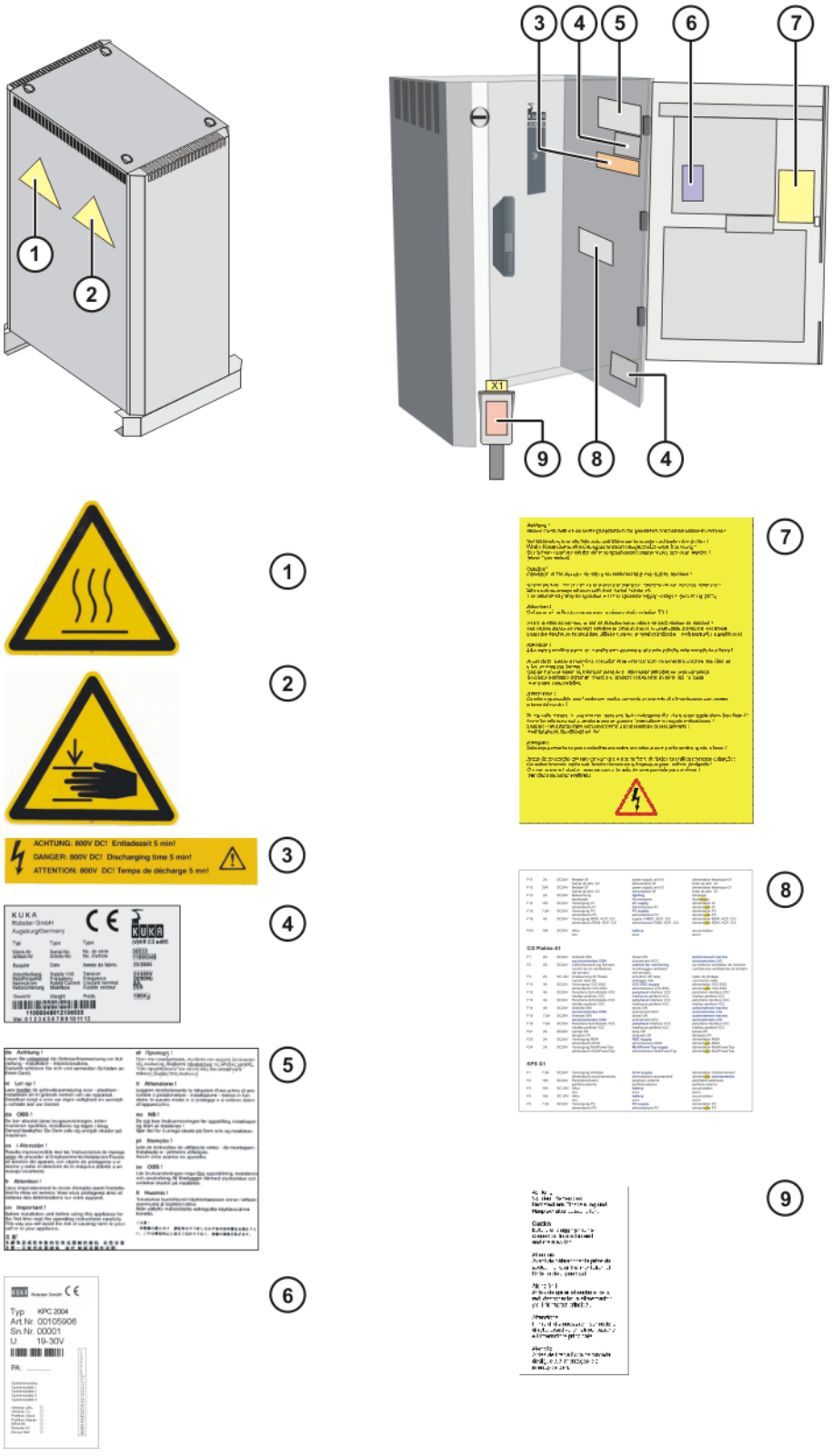


Fig. 3-4: Plates and labels

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	Discharging time warning
4	KR C2 ed05 rating plate
5	Reference to operating instructions
6	PC rating plate
7	Start-up warnings on the door ■ Grounded neutral ■ Check for tight fit of screws and terminals ■ White cables ■ Supply voltage warning
8	Fuse ratings
9	Power plug warning

4 Safety

4.1 System planning

4.1.1 EC declaration of conformity and declaration of incorporation

EC declaration of conformity

The system integrator must issue a declaration of conformity for the overall system in accordance with Directive 98/37/EC (Machinery Directive). The declaration of conformity forms the basis for the CE mark for the system. The robot system must be operated in accordance with the applicable national laws, regulations and standards.

The robot controller has a CE mark in accordance with Directive 89/336/EEC (EMC Directive) and Directive 73/23/EEC (Low Voltage Directive).

Declaration of incorporation

A declaration of incorporation is provided for the robot system. This declaration of incorporation contains the stipulation that the robot system must not be commissioned until it complies with the provisions of 98/37/EC (Machinery Directive).

4.1.2 Installation site

Robot

When planning the system, it must be ensured that the installation site (floor, wall, ceiling) has the required grade of concrete and load-bearing capacity. The principal loads acting on the mounting base are indicated in the specifications.

Further information is contained in the robot operating instructions.

Robot controller

It is imperative to comply with the minimum clearances of the robot controller from walls, cabinets and other system components.

Further information is contained in the robot controller operating instructions.

4.1.3 External safeguards

EMERGENCY STOP

Additional Emergency Stop devices can be connected via interface X11 or linked together by means of higher-level controllers (e.g. PLC).

The input/output signals and any necessary external power supplies must ensure a safe state in the case of an Emergency Stop.

Further information is contained in the robot controller operating instructions.

Safety fences

Requirements on safety fences are:

- Safety fences must withstand all forces that are likely to occur in the course of operation, whether from inside or outside the enclosure.
- Safety fences must not, themselves, constitute a hazard.
- It is imperative to comply with the minimum clearances from the danger zone.

Further information is contained in the corresponding standards and regulations.

Safety gates

Requirements on safety gates are:

- The number of safety gates in the fencing must be kept to a minimum.
- All safety gates must be safeguarded by means of an operator safety system (interface X11).
- Automatic mode must be prevented until all safety gates are closed.
- In Automatic mode, the safety gate can be mechanically locked by means of a safety system.
- If the safety gate is opened in Automatic mode, it must trigger an Emergency Stop function.
- If the safety gate is closed, the robot cannot be started immediately in Automatic mode. The message on the control panel must be acknowledged.

Further information is contained in the corresponding standards and regulations.

Other safety equipment

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

4.1.4 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 danger zone consists of the workspace and the braking distances of the robot. It must be safeguarded by means of protective barriers to prevent danger to persons or the risk of material damage.

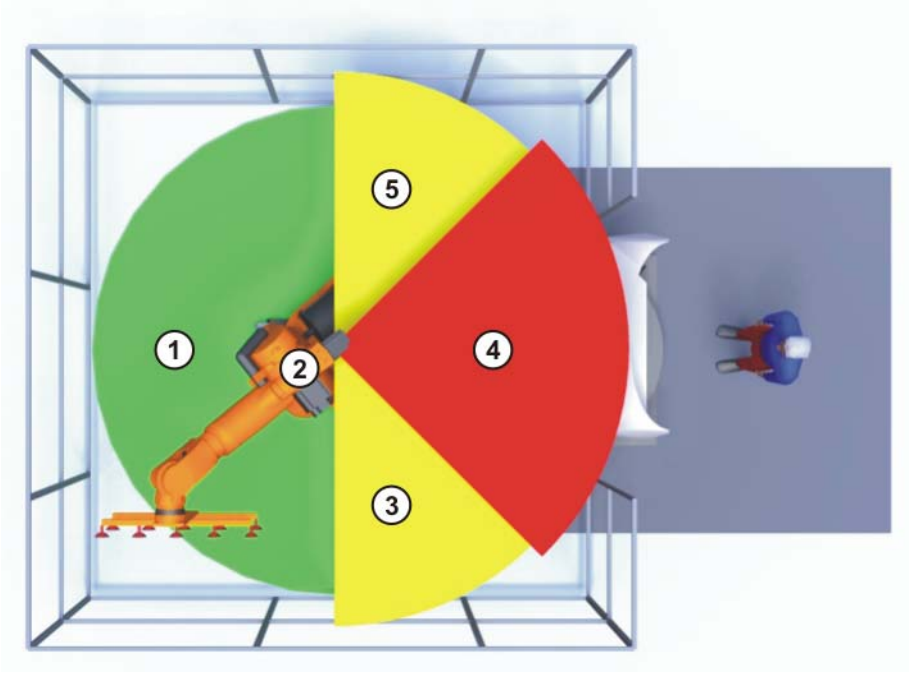


Fig. 4-1: Example of axis range A1

1	Workspace	4	Safety zone

2 Robot
3 Braking distance
5 Braking distance

4.2 Description

4.2.1 Category of the safety-oriented circuits

The following circuits correspond to Category 3 in accordance with EN 954-1:

- EMERGENCY STOP systems
- Enabling switches
- Operator safety
- Operating modes
- Qualifying inputs

4.2.2 Stop reactions

Stop reactions of the robot system 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 EN 60204.

Trigger	T1, T2	AUT, AUT EXT
EMERGENCY STOP pressed	Path-oriented braking (STOP 0)	Path-maintaining braking (STOP 1)
Start key released	Ramp-down braking (STOP 2)	-
Enabling switch released	Path-oriented braking (STOP 0)	-
Safety gate opened	-	Path-maintaining braking (STOP 1)
"Drives OFF" key pressed	Path-oriented braking (STOP 0)	
Change operating mode	Path-oriented braking (STOP 0)	
Encoder error (DSE-RDC connection broken)	Short-circuit braking (STOP 0)	
Motion enable canceled	Ramp-down braking (STOP 2)	
STOP key pressed	Ramp-down braking (STOP 2)	
Robot controller switched off Power failure	Short-circuit braking (STOP 0)	

Stop reaction	Drives	Brakes	Software
Ramp-down braking (STOP 2)	Drives remain on.	Brakes remain open.	Normal ramp which is used for acceleration and deceleration.
Path-maintaining braking (STOP 1)	Drives are switched off after 1 second hardware delay.	Brakes are applied after 1 s at latest.	In this time the controller brakes the robot on the path using a steeper stop ramp.
Path-oriented braking (STOP 0)	Drives are switched off immediately.	Brakes are applied immediately.	The controller attempts to brake the robot on the path with the remaining energy. If the voltage is not sufficient, the robot leaves the programmed path.
Short-circuit braking (STOP 0)	Drives are switched off immediately.	Brakes are applied immediately.	-

4.2.3 Labeling on the robot system

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

Labeling on the robot system consists of:

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

4.2.4 Safety information

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

No modifications may be carried out to the robot system without the authorization of the KUKA Robot Group. Additional components (tools, software, etc.), not supplied by KUKA Robot Group, may be integrated into the robot system. The user is liable for any damage these components may cause to the robot system.

4.3 Safety features

4.3.1 Overview of the safety features

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

Safety features	T1	T2	AUT	AUT EXT
Operator safety	-	-	active	active
Emergency Stop button (STOP 0)	active	active	-	-
Emergency Stop button (STOP 1)	-	-	active	active
Enabling switch	active	active	-	-
Reduced velocity	active	-	-	-
Jog mode	active	active	-	-
Software limit switches	active	active	active	active

Danger!
In the absence of functional safety equipment, the robot can cause personal injury or material damage. No safety equipment may be dismantled or deactivated while the robot is in operation.

4.3.2 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 robot system to a standstill.

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

Further information is contained in the robot controller operating instructions.

4.3.3 Operator safety input

The operator safety input is used for interlocking fixed guards. 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 possible. Operator safety is not active for test modes T1 and T2.

In the event of a loss of signal during Automatic operation (e.g. safety gate is opened), the drives are deactivated after 1 s and the robot stops with a STOP 1. Once the signal is active at the input again (e.g. safety gate closed and signal acknowledged), Automatic operation can be resumed.

Operator safety can be connected via interface X11.

Further information is contained in the robot controller operating instructions.

4.3.4 EMERGENCY STOP button

The EMERGENCY STOP button for the robot system is located on the KCP. If the EMERGENCY STOP button is pressed, the drives are deactivated immediately in operating modes T1 and T2 and the robot stops with a STOP 0. In the Automatic operating modes, the drives are deactivated after 1 s and the robot stops with a STOP 1. The EMERGENCY STOP button must be pressed as soon as persons or equipment are endangered. Before operation can be resumed, the EMERGENCY STOP button must be turned to release it and the error message must be acknowledged.

Fig. 4-2: EMERGENCY STOP button on the KCP

1 EMERGENCY STOP button

4.3.5 Enabling switches

There are 3 enabling switches installed on the KCP. These 3-position enabling switches can be used to switch on the drives in modes T1 and T2.

In the test modes, the robot 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 robot stops with a STOP 0.

Fig. 4-3: Enabling switches on the KCP

1 - 3 Enabling switches

4.3.6 Jog mode

In modes T1 and T2, the robot can only be moved in jog mode. For this, an enabling switch and the Start key must be kept held down. If the enabling switch is released or pressed fully down (panic position), the drives are deactivated immediately and the robot stops with a STOP 0. Releasing the Start key causes the robot to be stopped with a STOP 2.

4.3.7 Mechanical end stops

The axis ranges of main axes A 1 to A 3 and wrist axis A 5 are limited by means of mechanical limit stops with a buffer.

Danger!
If the robot hits an obstruction or a buffer on the mechanical end stop or axis range limitation, this can result in material damage to the robot. The KUKA Robot Group must be consulted before the robot is put back into operation (>>> 13 "KUKA Service" page 147). The affected buffer must immediately be replaced with a new one. If a robot collides with a buffer at more than 250 mm/s, the robot must be exchanged or recommissioning must be carried out by the KUKA Robot Group.

4.3.8 Mechanical axis range limitation (option)

Most robots can be fitted with mechanical axis range limitation in main axes A1 to A3. The adjustable axis range limitation systems restrict the working range to the required minimum. This increases personal safety and protection of the system.

This option can be retrofitted.

Further information is contained in the working range limitation operating instructions.

4.3.9 Axis range monitoring (option)

Most robots can be fitted with dual-channel axis range monitoring systems in main axes A1 to A3. 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 can be retrofitted.

Further information is contained in the working range monitoring operating instructions.

4.3.10 Software limit switches

The axis ranges of all robot 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 robot cannot hit the mechanical limit stops.

Further information is contained in the operating and programming instructions.

4.3.11 Release device (option)

Description

The release device can be used to move the robot mechanically 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). After use of the release device, the affected motors must be exchanged.

Caution!
The motors reach temperatures during operation which can cause burns to the skin. Appropriate safety precautions must be taken.

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.
4. Exchange the motor.
5. Remaster all robot axes.

4.3.12 KUKA.SafeRobot (option)

KUKA.SafeRobot is an option with software and hardware components.

This option may only be retrofitted after consultation with the KUKA Robot Group.

Properties

- Connection to an external safety logic
- Monitoring that can be activated using safe inputs
- Freely definable axis-specific monitoring
- Safe monitoring of axis-specific and Cartesian velocities and accelerations
- Safe standstill monitoring
- Safe stop via Electronic Safety Circuit (ESC) with safe disconnection of the drives
- Monitoring of the mastering
- Brake test

Functional principle

The robot moves within the limits that have been configured and activated. The actual position is continuously calculated and monitored against the safety parameters that have been set.

The SafeRDC monitors the robot system by means of the safety parameters that have been set. If the robot violates a monitoring limit or a safety parameter, it is stopped.

The safe inputs and outputs of the SafeRDC are of a redundant design and LOW active.

Further information is contained in the KUKA System Technology **KUKA.SafeRobot** documentation.

4.4 Personnel

User

The user of a robot system is responsible for its use. The user must ensure that it can be operated in complete safety and define all safety measures for personnel.

System integrator

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

The system integrator is responsible for the following tasks:

- Installing the robot system
- Connecting the robot system
- Implementing the required facilities
- Issuing the declaration of conformity
- Attaching the CE mark

Operator

The operator must meet the following preconditions:

- The operator must have read and understood the robot system documentation, including the safety chapter.
- The operator must be trained for the work to be carried out.
- Work on the robot system 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 dangers.

Example

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

Tasks	Operator	Programmer	Maintenance technician
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 robot		x	x
Configuration		x	x
Programming		x	x
Start-up			x
Maintenance			x
Repair			x
Shut-down			x
Transportation			x

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

4.5 Safety measures

4.5.1 General safety measures

The robot system may only be used in perfect technical condition in accordance with its designated 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 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 robot to sag. If work is to be carried out on a switched-off robot, the robot must first be moved into a position in which it is unable to move on its own, whether the payload is mounted or not. If this is not possible, the robot must be secured by appropriate means.

KCP

The KCP must be removed from the system if it is not connected, as the EMERGENCY STOP button is not functional in such a case.

If there are several KCPs in a system, it must be ensured that they are not mixed up.

No mouse or keyboard may be connected to the robot controller.

Faults

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

- 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.
- Keep a record of the faults.
- Eliminate the fault and carry out a function test.

4.5.2 Transportation

Robot

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

Further information is contained in the robot operating instructions.

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.

Further information is contained in the robot controller operating instructions.

4.5.3 Start-up

The robot controller must not be put into operation until the internal temperature of the cabinet has adjusted to the ambient temperature. Otherwise, condensation could cause damage to electrical components.

Function test

It must be ensured that no persons or objects are present within the danger zone of the robot during the function test.

The following must be checked during the function test:

- The robot system is installed and connected. There are no foreign bodies or destroyed, loose parts on the robot or in the robot controller.
- All safety devices and protective measures are complete and fully functional.
- All electrical connections are correct.
- The peripheral devices are correctly connected.
- The external environment corresponds to the permissible values indicated in the operating instructions.

Further information is contained in the robot operating instructions and in the robot controller operating instructions.

Setting

It must be ensured that the ratings plate on the robot controller has the same machine data as those entered in the declaration of incorporation. The machine data on the ratings plate of the robot must be entered during start-up.

The robot must not be moved unless the correct machine data are not loaded. Otherwise, damage to property could occur.

Further information is contained in the operating and programming instructions.

4.5.4 Programming

The following safety measures must be carried out during programming:

- It must be ensured that no persons are present within the danger zone of the robot during programming.
- New or modified programs must always be tested first in operating mode T1.
- If the drives are not required, they must be switched off to prevent the robot from being moved unintentionally.
- The motors reach temperatures during operation which can cause burns to the skin. Contact should be avoided if at all possible. If necessary, appropriate protective equipment must be used.
- The robot and its tooling must never touch or project beyond the safety fence.
- Components, tooling and other objects must not become jammed as a result of the robot motion, nor must they lead to short-circuits or be liable to fall off.

The following safety measures must be carried out if programming in the danger zone of the robot:

- The robot must only be moved at reduced velocity (max. 250 mm/s). In this way, persons have enough time to move out of the way of hazardous robot motions or to stop the robot.
- To prevent other persons from being able to move the robot, the KCP must be kept within reach of the programmer.
- If two or more persons are working in the system at the same time, they must all use an enabling switch. While the robot is being moved, all persons must remain in constant visual contact and have an unrestricted view of the robot system.

4.5.5 Automatic mode

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

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

If the robot comes to a standstill for no apparent reason, the danger zone must not be entered until the EMERGENCY STOP function has been triggered.

5 Planning

5.1 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)	(>>> 5.2 "Electromagnetic compatibility (EMC)" page 65)
2	Installation conditions for robot controller	(>>> 5.3 "Installation conditions" page 66)
3	Connection conditions	(>>> 5.4 "Connection conditions" page 67)
4	Power supply connection	(>>> 5.5 "Power supply connection" page 68)
5	E-STOP circuit and safeguard	(>>> 5.6 "EMERGENCY STOP circuit and safeguard" page 70)
6	Configuration of interface X11	(>>> 5.7 "Interface X11" page 71)
7	Equipotential bonding	(>>> 5.8 "PE equipotential bonding" page 74)
8	KCP coupler (optional)	(>>> 5.9 "Planning the KCP coupler option" page 75)

5.2 Electromagnetic compatibility (EMC)

Description

If connecting cables (e.g. DeviceNet, 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).

5.3 Installation conditions

Dimensions

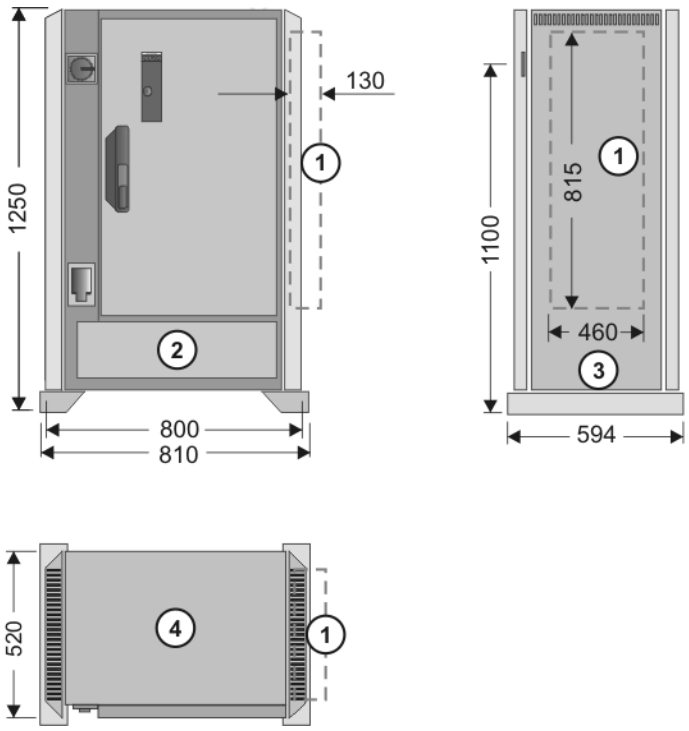


Fig. 5-1: Dimensions (in mm)

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

Minimum clearances

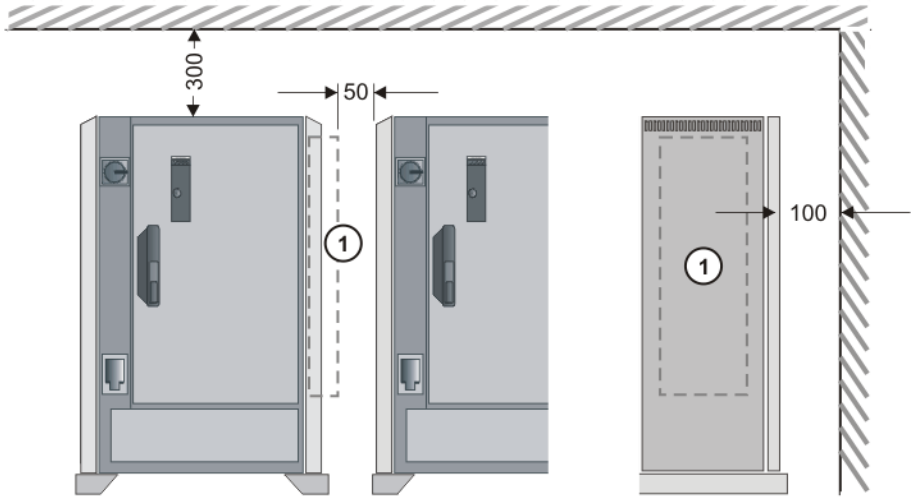


Fig. 5-2: Minimum clearances (dimensions in mm)

Minimum clearances with top-mounted cabinet

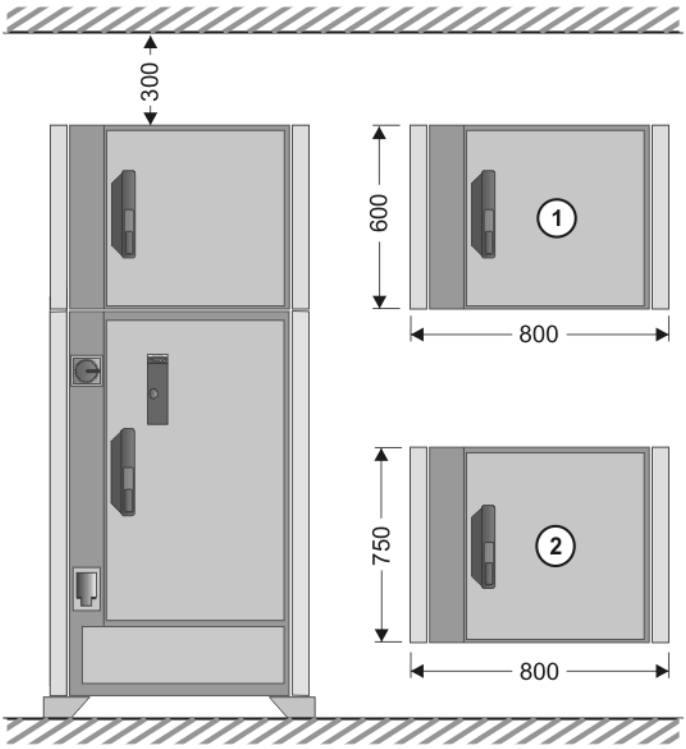
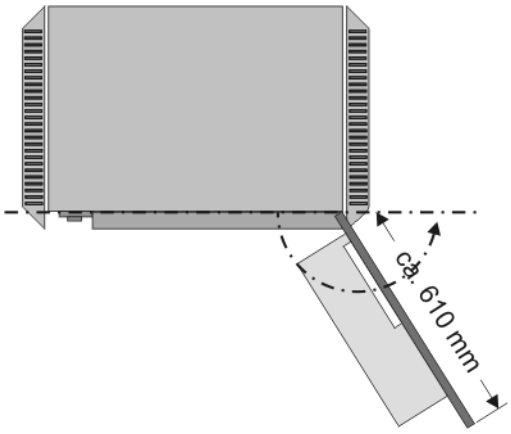


Fig. 5-3: Minimum clearances with top-mounted / technology cabinet

1	Top-mounted cabinet	2	Technology cabinet

Swing range for door



Swing range, standalone cabinet:

- Door with computer frame approx. 180°

Swing range, butt-mounted cabinets:

- Door approx. 155°

5.4 Connection conditions

Power supply connection

Standard rated supply voltage acc. to DIN/IEC 38	AC 3x400 V...AC 3x415 V
Permissible tolerance of rated voltage	400 V -10%...415 V +10%
Mains frequency	49...61 Hz

Rated power input ■ Standard	7.3 kVA, see rating plate
Rated power input ■ Heavy-duty robot ■ Palletizer ■ 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
RCCB 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 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. The robot controller may only be operated with grounded-neutral power supply systems.

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)	2.9	-

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.

5.5 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

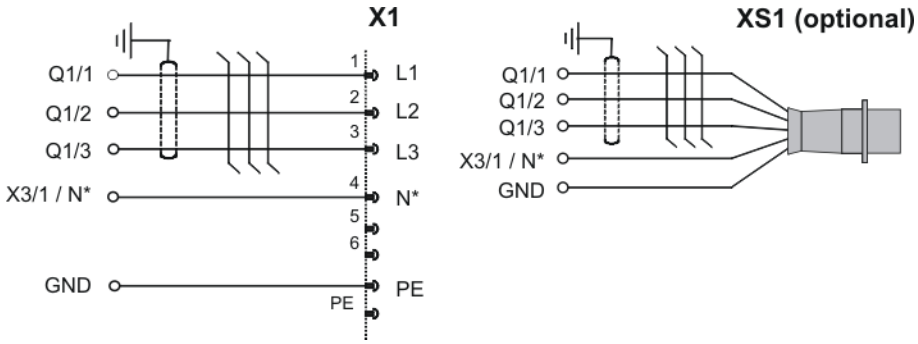


Fig. 5-4: Power supply connection

* 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.

5.5.1 Power supply connection via X1 Harting connector

Description

A Harting connector bypack (1) is supplied with the robot controller. The customer can use this to establish a connection between X1 (2) on the robot controller and the power supply.

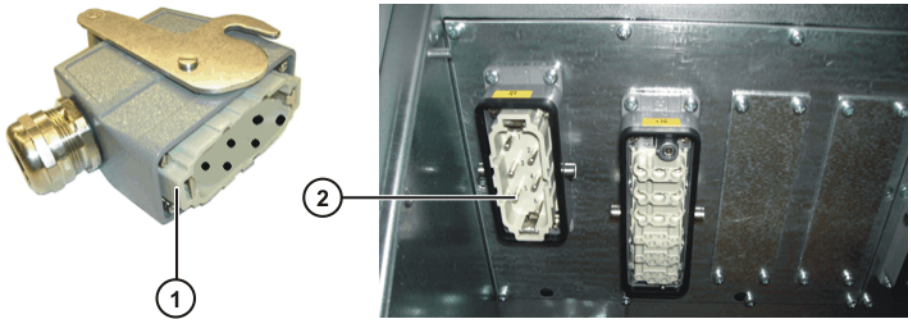


Fig. 5-5: Power supply connection X1

5.5.2 Power supply connection via CEE connector XS1

Description

With this option, the robot controller is connected to the power supply via a CEE connector (2). The cable is approx. 2.9 m long and is routed to the main switch via a cable gland (1).

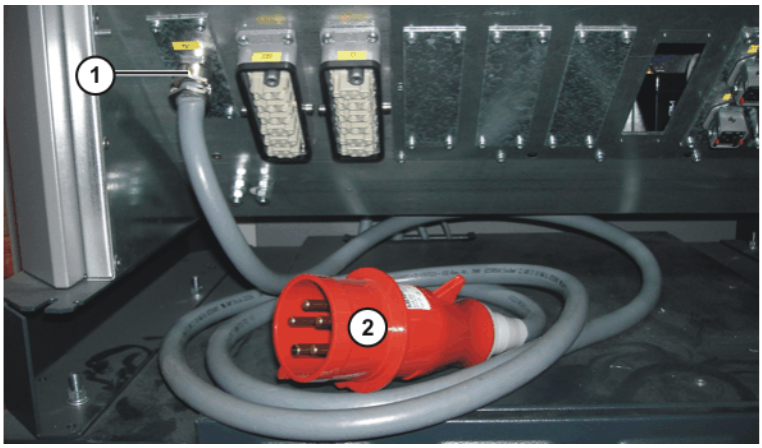


Fig. 5-6: Power supply connection XS1

5.6 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

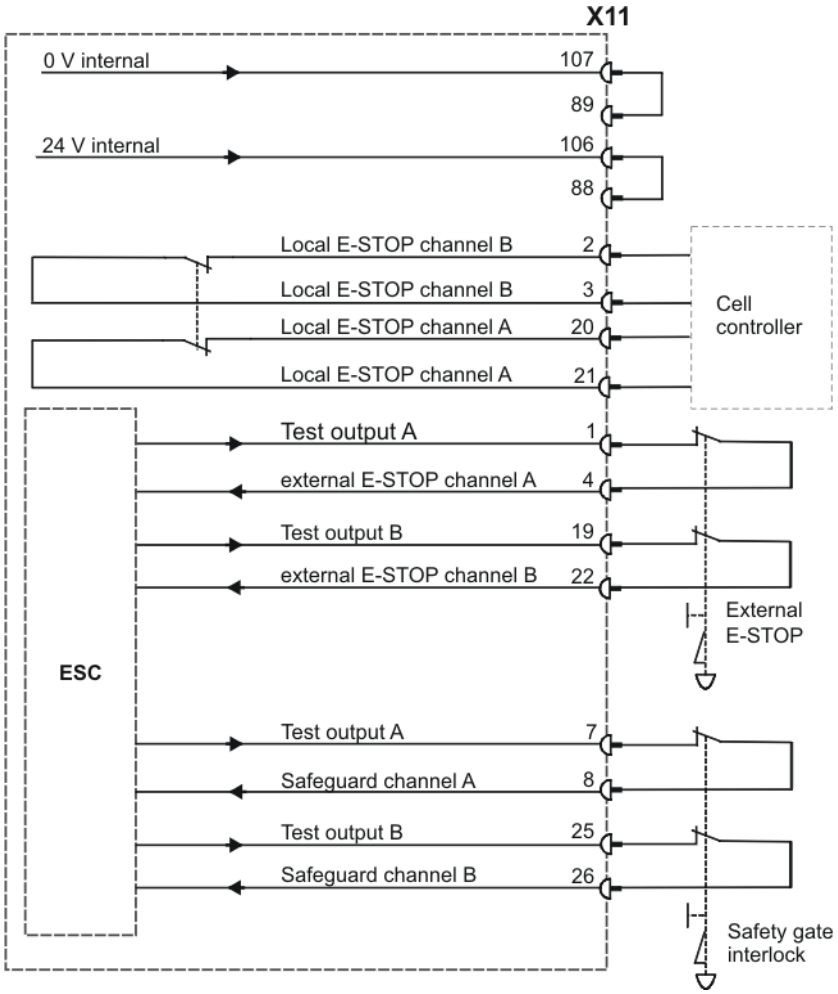


Fig. 5-7: Robot with periphery

Example

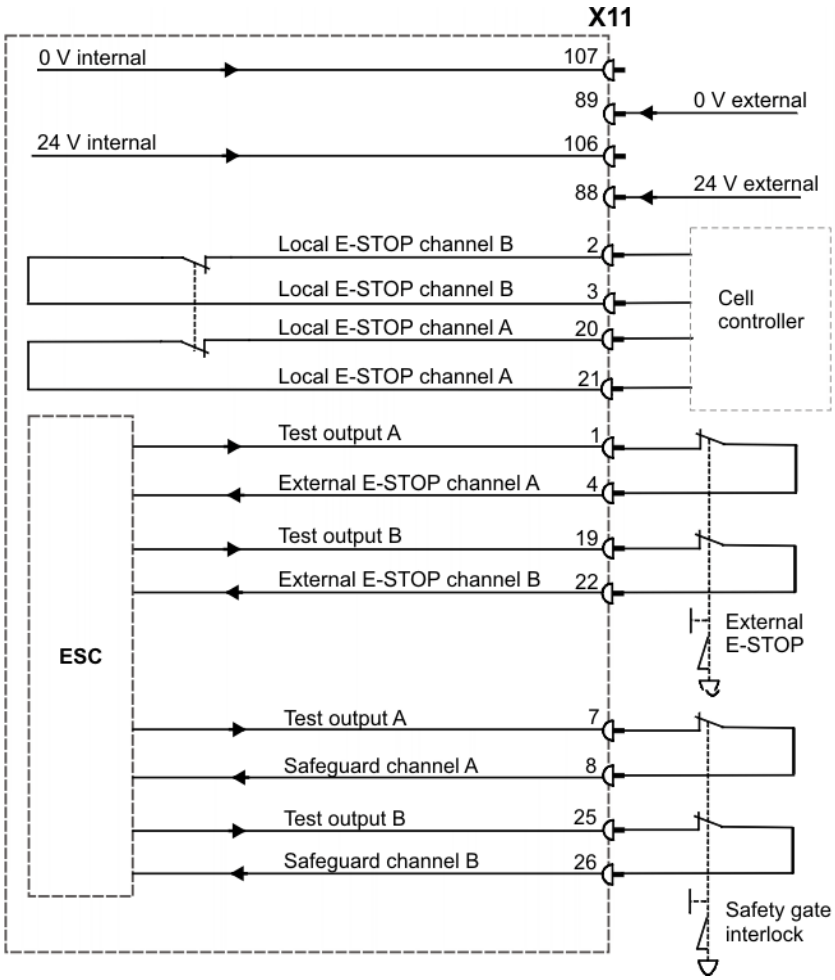


Fig. 5-8: Robot with periphery and external power supply

5.7 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

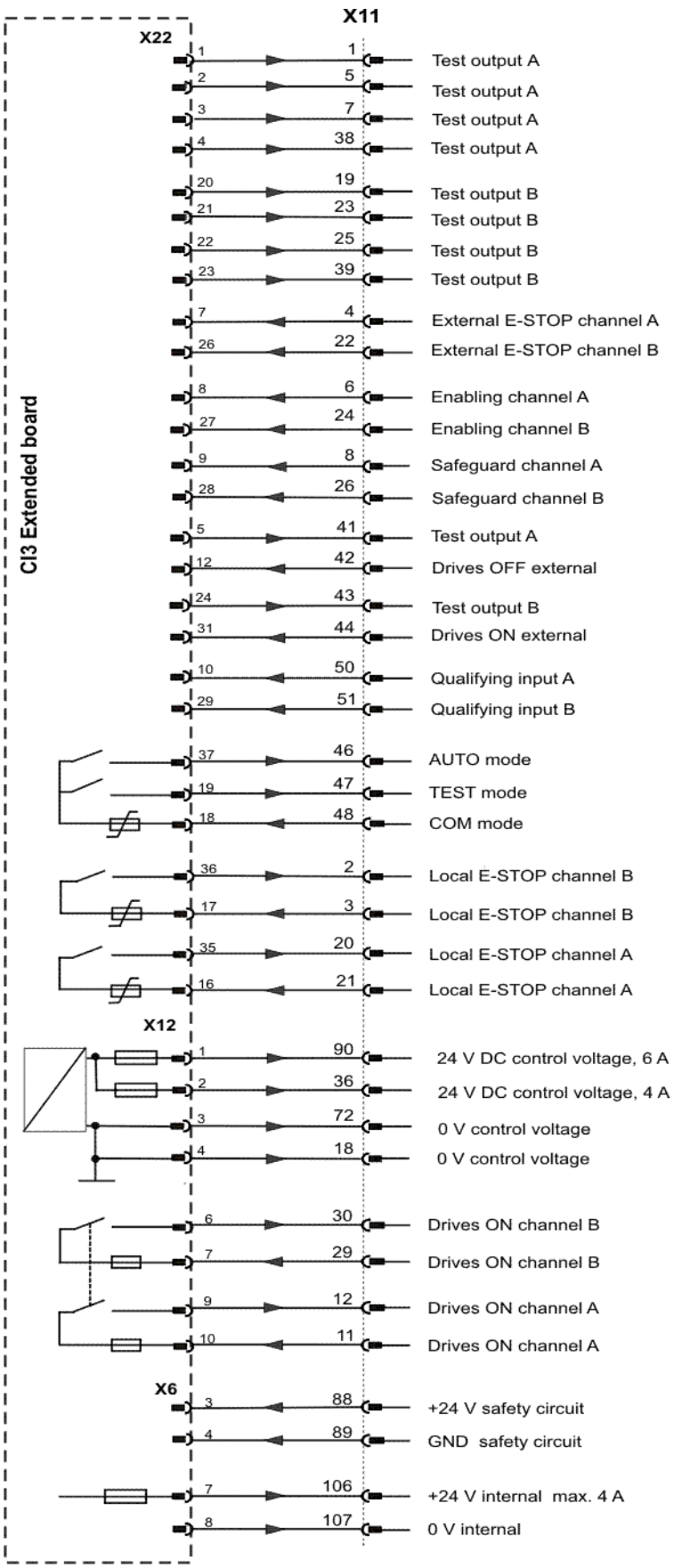
Take the following points into consideration when wiring interface X11:

- System concept
- Safety concept

Various signals and functions are available, depending on the specific CI3 board. (>>> 2.6.2 "Overview of CI3 boards" page 25)

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



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

5.8 PE equipotential bonding

Description

A 16 mm^2 cable must be used as equipotential bonding between the robot and the robot controller.

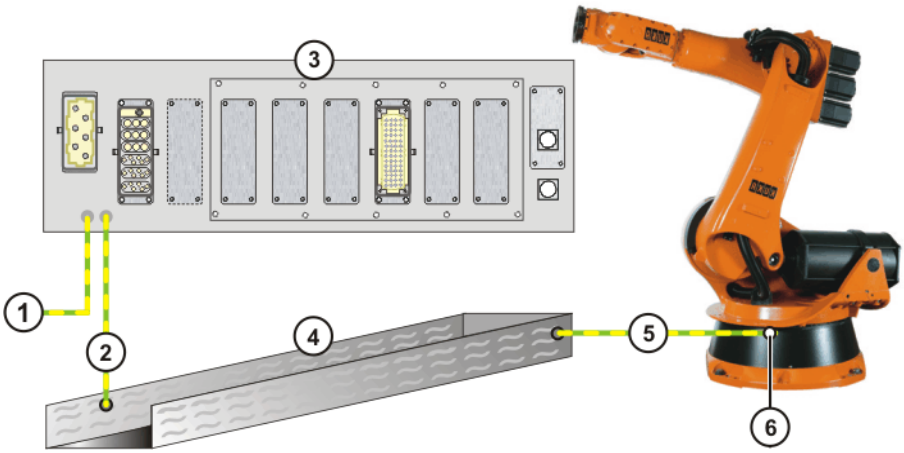


Fig. 5-9: Equipotential bonding, from controller to robot, with cable duct

1	Equipotential bonding to KR C2 ed05	4	Cable duct
2	Equipotential bonding from the connection panel to the cable duct	5	Equipotential bonding from the cable duct to the robot
3	Connection panel, KR C2 ed05	6	Equipotential bonding connection on the robot

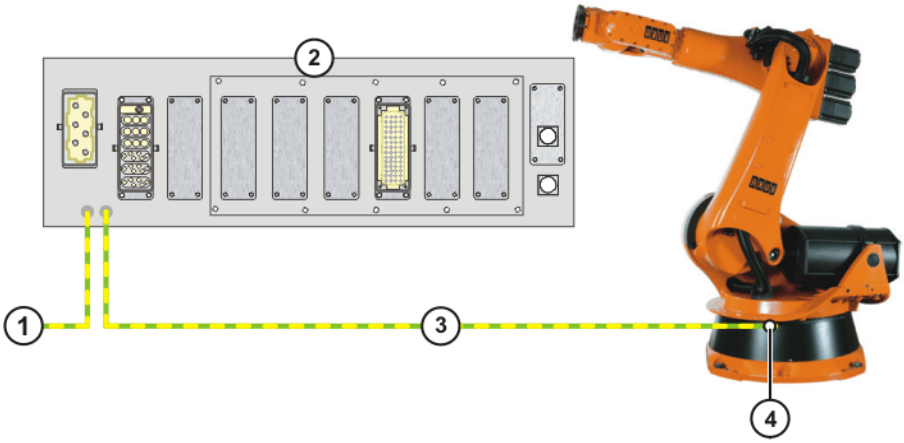


Fig. 5-10: Equipotential bonding, from controller to robot

1	Equipotential bonding to KR C2 ed05	3	Equipotential bonding from the connection panel to the robot
2	Connection panel, KR C2 ed05	4	Equipotential bonding connection on the robot

5.9 Planning the KCP coupler option

Visualization

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

- $Mode_T1 (T1 mode)
- $Mode_T2 (T2 mode)
- $Mode_Ext (External mode)
- $Mode_Aut (Automatic mode)
- $Notaus (Emergency 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 E-STOP button on the KCP. An external E-STOP must be connected to interface X11 to prevent personal injury and material damage.

6 Transportation

6.1 Transportation using lifting tackle

Preconditions

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

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 eyebolts on the control cabinet.

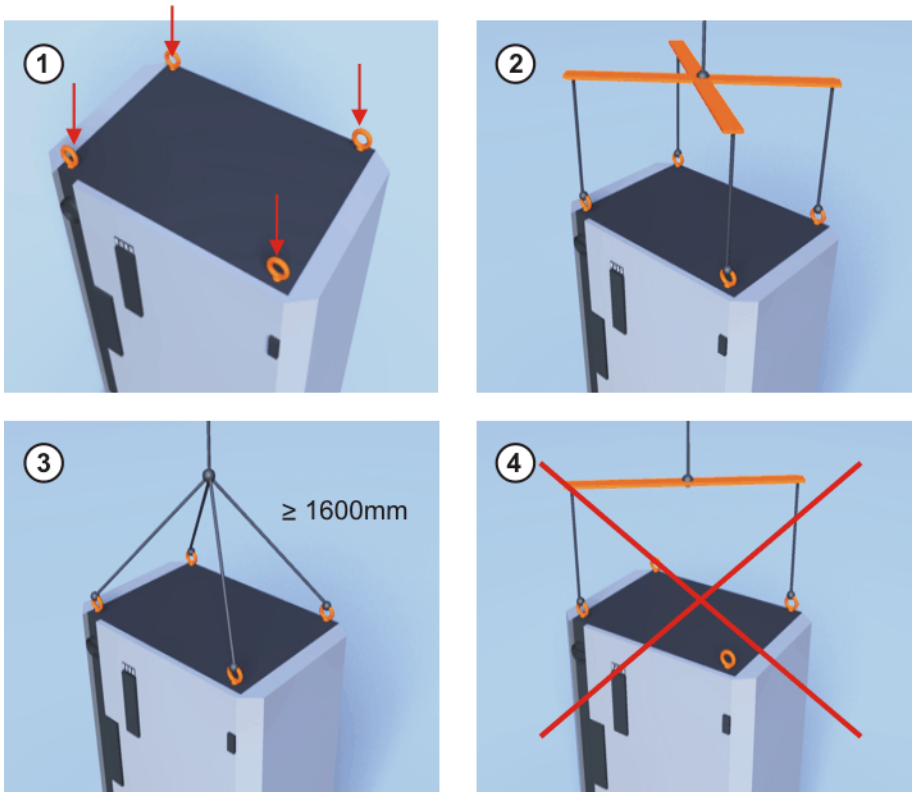


Fig. 6-1: Transportation using lifting tackle

1	Transport eyebolts on the control cabinet
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 control cabinet is transported too quickly, it may swing and cause injury or damage. Transport the control cabinet slowly.

3. Slowly lift and transport the control cabinet.
4. Slowly lower the control cabinet at its destination.
5. Detach the lifting tackle from the control cabinet.

6.2 Transportation by pallet truck

Preconditions

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

Procedure

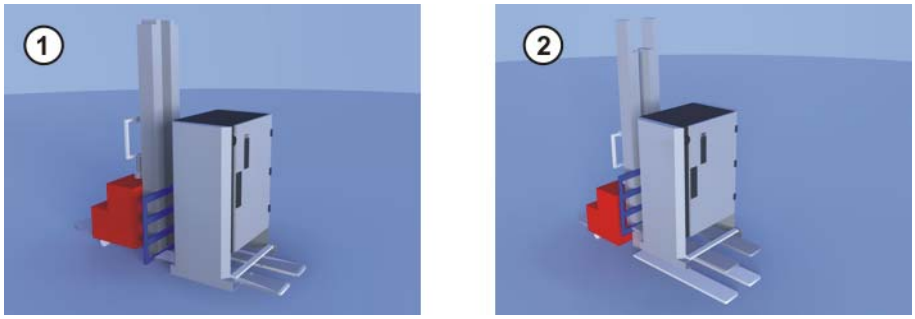


Fig. 6-2: Transportation by pallet truck

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

6.3 Transportation by fork lift truck

Preconditions

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

Procedure

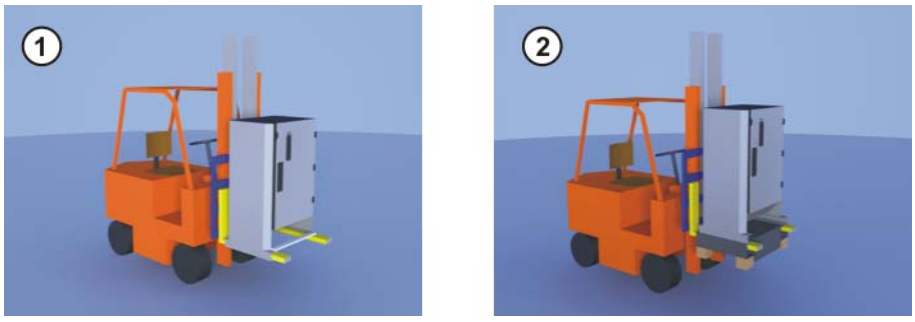


Fig. 6-3: Transportation by fork lift truck

1 Control cabinet with fork slots
2 Control cabinet with transformer installation kit

7 Start-up

7.1 Start-up overview

This is an overview of the most important steps during start-up. The precise sequence depends on the application, the robot type, the technology packages used and other customer-specific circumstances.
This overview refers to the start-up of the robot system. The start-up of the overall system is not within the scope of this documentation.

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

Robot

Step	Description	Information
1	Carry out a visual inspection of the robot.	Detailed information is contained in the robot operating instructions, in the chapter “Start-up”.
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.	(>>> 7.2 "Installing the robot controller" page 80)
7	Connect the connecting cables.	(>>> 7.3 "Connecting the connecting cables" page 80)
8	Connect the KCP.	(>>> 7.4 "Connecting the KCP" page 81)
9	Establish the equipotential bonding between the robot and the robot controller.	(>>> 7.5 "Connecting the PE equipotential bonding" page 81)
10	Connect the robot controller to the power supply.	(>>> 2.9.1 "Power supply connection X1/XS1" page 40)
11	Reverse the battery discharge protection measures.	(>>> 7.7 "Reversing the battery discharge protection measures" page 82)
12	Configure and connect interface X11. **Note:** If interface X11 has not been wired, the robot cannot be jogged.	(>>> 5.7 "Interface X11" page 71)
13	Switch the robot controller on.	(>>> 7.10 "Switching on the robot controller" page 82)
14	Check the direction of rotation of the fans.	(>>> 7.11 "Checking the direction of rotation of the external fan" page 83)
15	Check the safety equipment.	Detailed information is contained in the robot operating instructions, 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 machine data.	Detailed information is contained in the operating and programming instructions.
18	Master the robot without a load.	
19	Mount the tool and master the robot with a load.	
20	Check the software limit switches and adapt them if required.	
21	Calibrate the tool. In the case of a fixed tool: calibrate external TCP.	
22	Enter load data.	
23	Calibrate base (optional). In the case of a fixed tool: calibrate workpiece (optional).	
24	If the robot is to be controlled from a host computer or PLC: configure Automatic External interface.	Detailed information is contained in the Operating and Programming Instructions for System Integrators.

Long text names of inputs/outputs, flags, etc., can be saved in a text file and imported after a reinstallation. In this way, the long texts do not need to be re-entered manually for each robot. Furthermore, the long text names can be updated in application programs.

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 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.	

7.2 Installing the robot controller

Procedure

1. Install the robot controller. The minimum clearances to walls, other cabinets, etc. must be observed. (>>> 5.3 "Installation conditions" page 66)
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.

7.3 Connecting the connecting cables

Overview

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

- Motor cable to the robot

- Control cable to the robot

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

Danger!
The robot controller is preconfigured for specific robots. If cables are interchanged, the robot 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.

Procedure

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

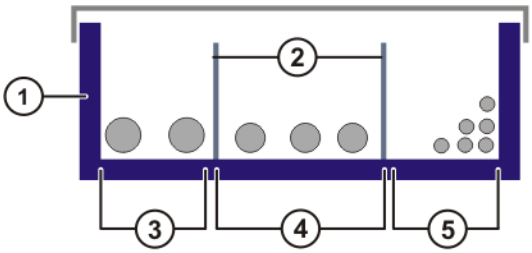


Fig. 7-1: Example: Installing the cables in the cable duct

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

7.4 Connecting the KCP

Procedure

- Connect the KCP to X19 on the robot controller.

7.5 Connecting the PE equipotential bonding

Procedure

1. Route and connect a 16 mm^2 cable as equipotential bonding between the robot and the robot controller. (>>> 5.8 "PE equipotential bonding" page 74)
2. Carry out a ground conductor check for the entire robot system in accordance with DIN EN 60204-1.

7.6 Connecting the robot controller to the power supply

Procedure

- Connect the robot controller to the power supply via X1 or XS1.
  (>>> 5.5.1 "Power supply connection via X1 Harting connector" page 69)
  (>>> 5.5.2 "Power supply connection via CEE connector XS1" page 69)

7.7 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.

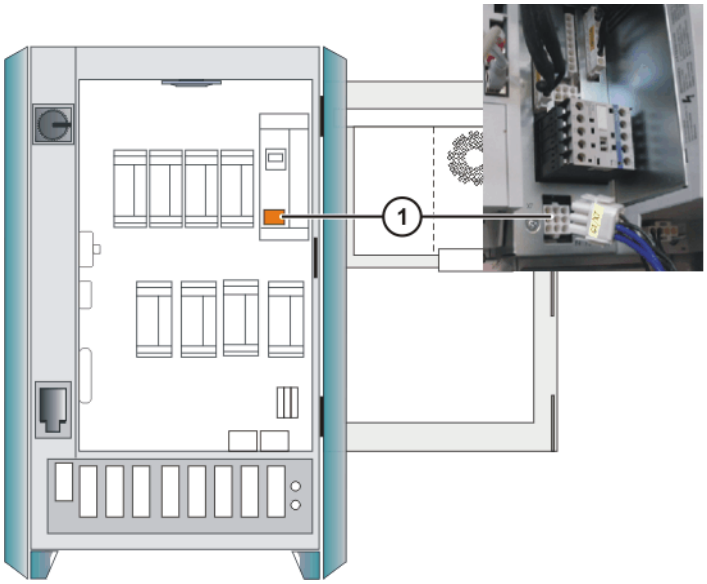


Fig. 7-2: Reversing the battery discharge protection measures

7.8 Connecting the EMERGENCY STOP circuit and safeguard

Procedure

1. Connect the EMERGENCY STOP circuit and safeguard (operator safety) to interface X11. (>>> 5.6 "EMERGENCY STOP circuit and safeguard" page 70)

7.9 Configuring and connecting connector X11

Procedure

1. Configure connector X11 in accordance with the system and safety concepts.
2. Connect interface connector X11 to the robot controller.

7.10 Switching on the robot controller

Precondition

- The door of the control cabinet 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 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).

7.11 Checking the direction of rotation of the external fan

Procedure

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

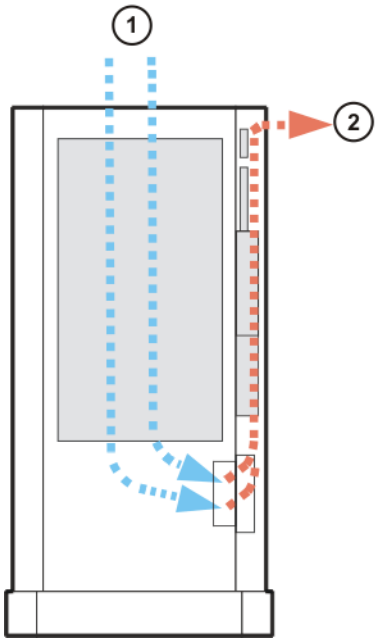


Fig. 7-3: Checking the direction of rotation of the fan

1 Air inlet
2 Air outlet

8 Operation

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

Overview

Fig. 8-1: KCP coupler LEDs and request button

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

8.1.1 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. The KCP must be removed from the system.

Caution!
The KCP must be removed from the system if it is not connected. The EMERGENCY STOP is not operational in this case.

8.1.2 Coupling the KCP

Preconditions

- 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 (>>> 5.9 "Planning the KCP coupler option" page 75)).

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.

8.2 Booting the robot controller from a USB stick

Precondition

- Robot controller is switched off.
- External keyboard.

Procedure

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

Caution!
If a KCP **and** an external keyboard are connected to the robot controller, 2 people can operate the robot system simultaneously. This can result in personal injury and material damage. Take measures to secure the robot system against unauthorized operation and remove the external keyboard from the system immediately completion of the installation process.

9 Maintenance

9.1 Maintenance table

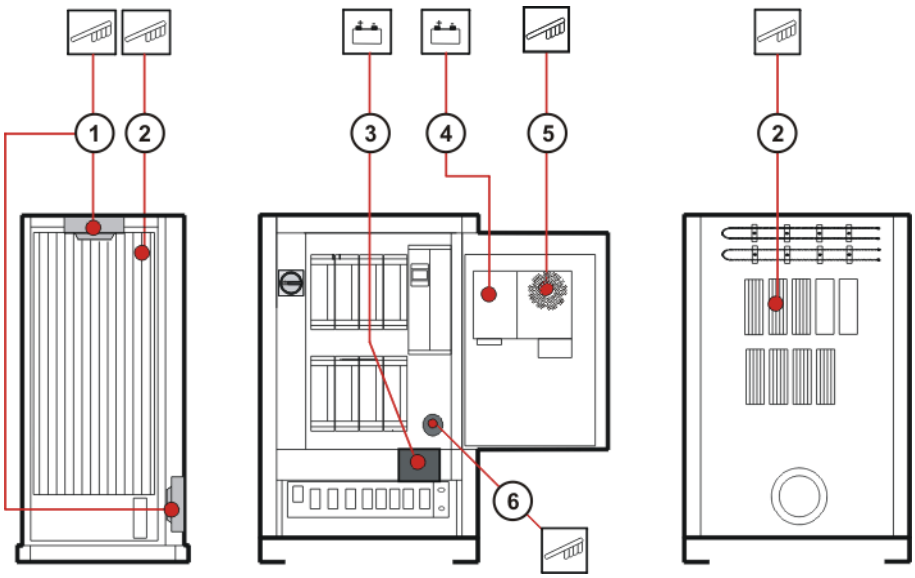


Fig. 9-1: Maintenance points

Maintenance table

Item	Activity	Time required [min]	Maintenance interval
1	Clean fan for inner cooling circuit with brush.	15	Depends on installation conditions and degree of fouling; however, no later than every 2 years
	Clean fan for outer cooling circuit with brush.	15	
2	Clean heat exchanger with brush.	15	
	Clean heat sink with brush and check that it is securely fastened.	15	
1	Exchange fan for inner cooling circuit. (>>> 10.2 "Exchanging the internal fan" page 90)	20	5 years (with 3-shift operation)
	Exchange fan for outer cooling circuit. (>>> 10.3 "Exchanging the external fan" page 91)	20	

Item	Activity	Time required [min]	Maintenance interval
3	Exchange the batteries. (>>> 10.10 "Exchanging the batteries" page 95)	5	2 years
4	Exchange the motherboard battery. (>>> 10.7 "Exchanging the motherboard battery" page 94)	20	5 years
5	Exchange the PC fan. (>>> 10.6 "Exchanging the PC fans" page 93)	2	5 years (with 3-shift operation)
6	Exchange the filter insert. (>>> 10.4 "Exchanging the pressure relief plug" page 91)	1	Depends on installation conditions and degree of fouling. Visual check: change filter insert if discolored (original color: white).

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

- Secure fit of fuses, contactors, plug-in connections and boards.
- PE equipotential bonding connection.
- Damage to cabling.

9.2 Cleaning the robot controller

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Back-up must be completed.
- The power cable must be de-energized.
- Observe the ESD guidelines.

Work regulations

- The manufacturer's instructions must be observed when carrying out cleaning work.
- It must be ensured that no cleaning fluid enters electrical components.
- Do not use compressed air during cleaning work.

Procedure

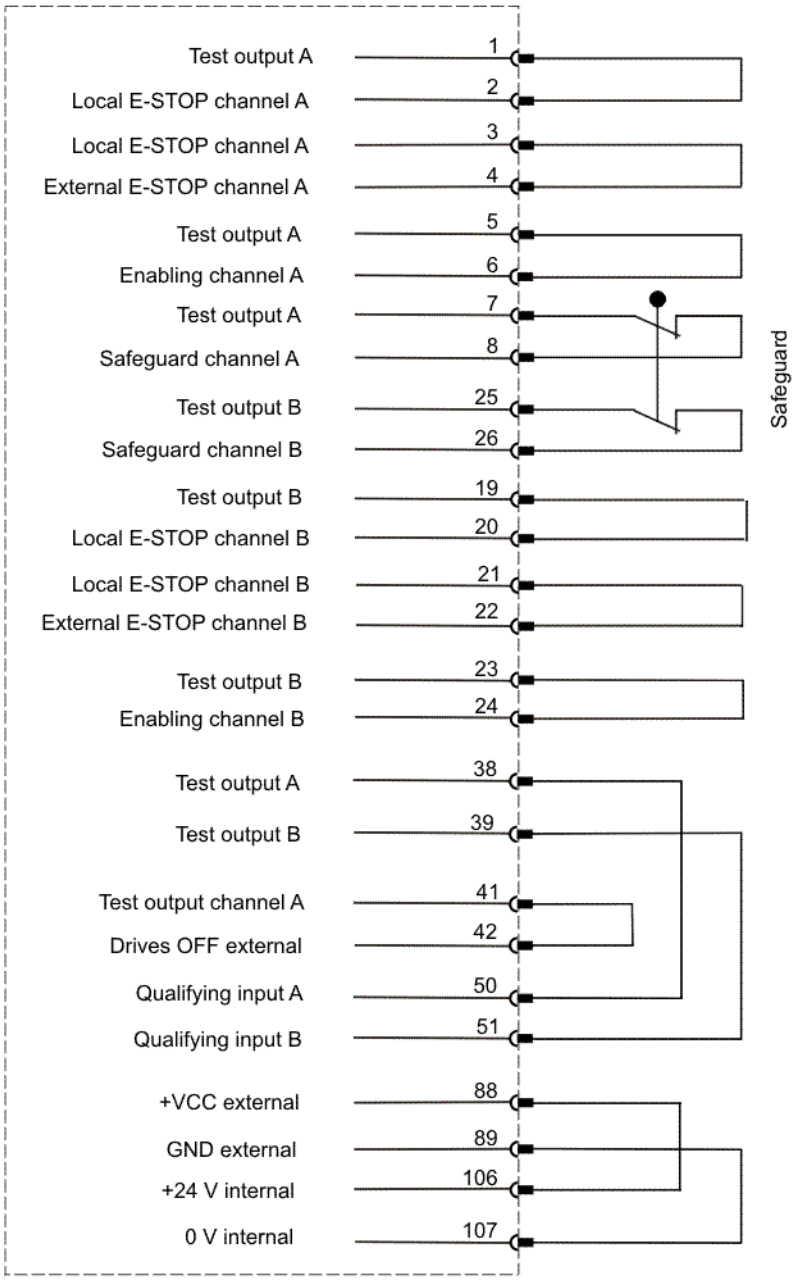
1. Loosen and vacuum up any dust deposits.
2. Clean robot controller with a cloth soaked with a mild cleaning agent.
3. Clean cables, plastic parts and hoses with a solvent-free cleaning agent.
4. Replace damaged, illegible or missing inscriptions, labels and plates.

10 Repair

10.1 Service jumper plug X11

The service jumper plug X11 is a Harting connector with a male insert, type Han 108DD, housing size 24B.

Connector pin allocation



Caution!
The jumper plug is only to be used during start-up and troubleshooting. If the jumper plug is used, the connected safety components are disabled.

10.2 Exchanging the internal fan

Preconditions

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

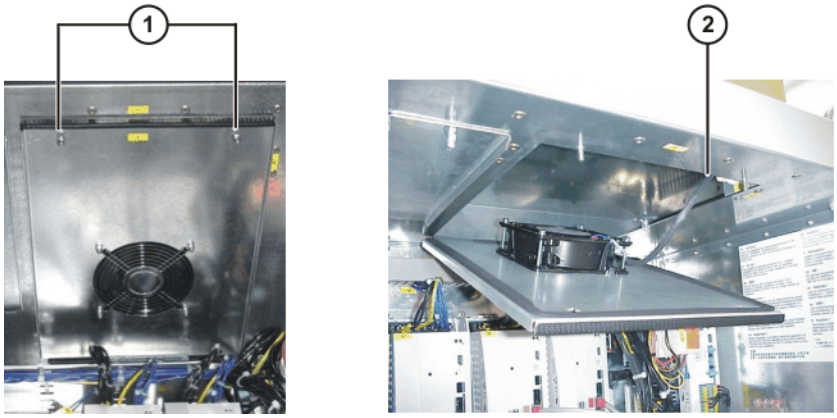
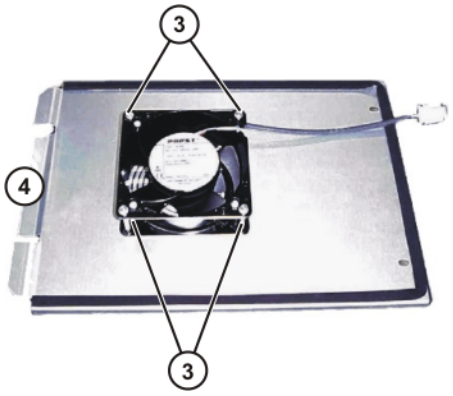


Fig. 10-1: Exchanging the internal fan

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.



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.

10.3 Exchanging the external fan

Preconditions

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

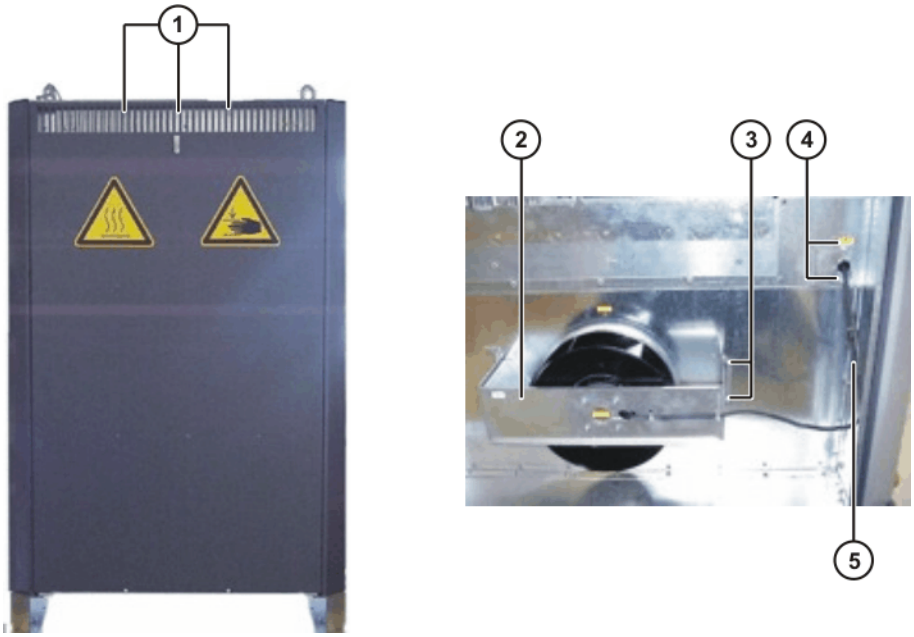


Fig. 10-2: Exchanging the external fan

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

10.4 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.
- Back-up must be completed.
- The power cable must be de-energized.

- 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.

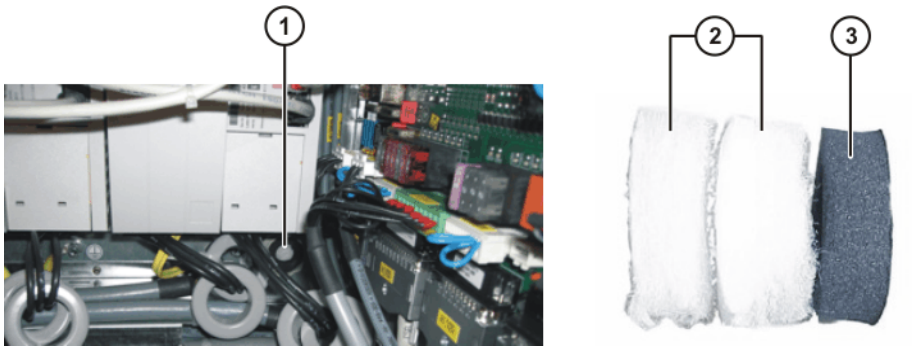


Fig. 10-3: Exchanging the pressure relief plug

1	Pressure relief plug	3	Foam ring
2	Filter insert		

10.5 Exchanging the PC

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Back-up must be completed.
- The power cable must be de-energized.
- Observe the ESD guidelines.

Procedure

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

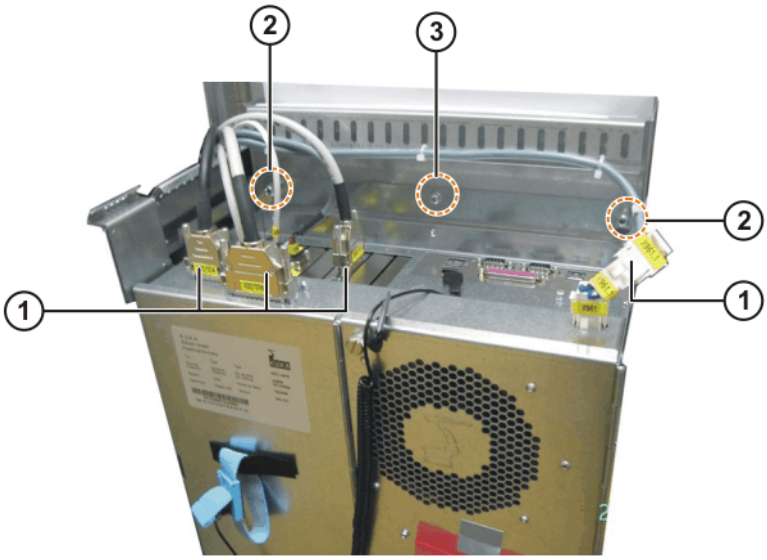


Fig. 10-4: Removing and installing the control PC

1	Plug-in connections on the PC	3	Transport safeguard screw
2	Knurled nut		

10.6 Exchanging the PC fans

Preconditions

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

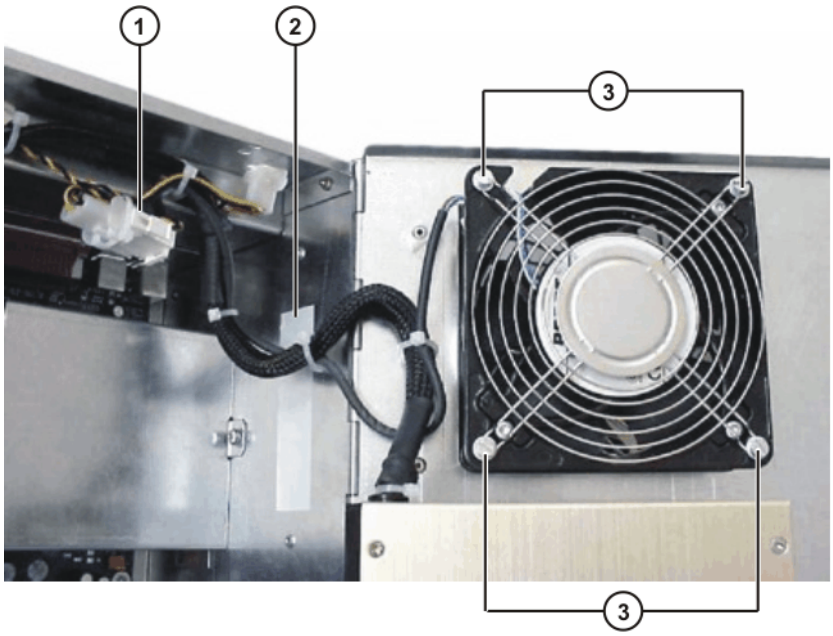


Fig. 10-5: Exchanging the PC fan

1	Fan connector	3	Fan fastening screws
2	Cable strap		

10.7 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.

10.8 Exchanging the motherboard

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

10.9 Exchanging DIMM memory modules

Preconditions

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

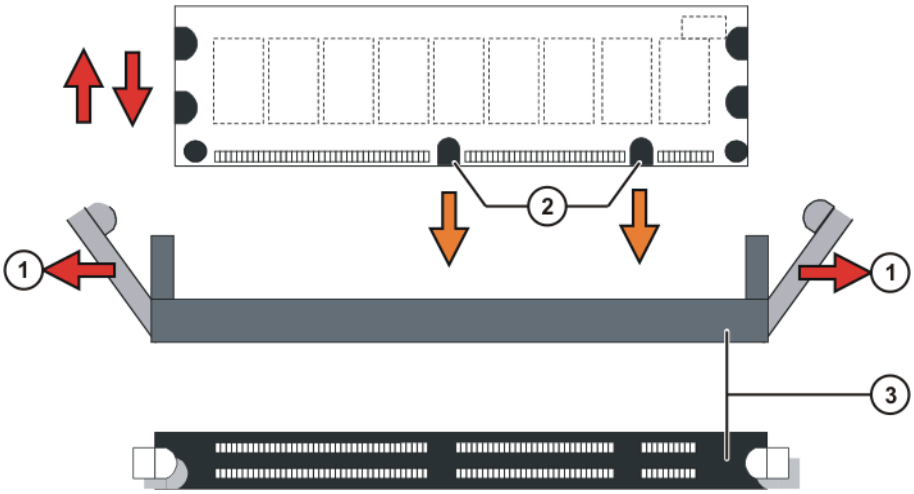


Fig. 10-6: Exchanging DIMM memory modules

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

10.10 Exchanging the batteries

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Back-up must be completed.
- The power cable must be de-energized.
- Observe the ESD guidelines.

Procedure

1. Open the cabinet door.
2. Unplug the battery connection cables.
3. Press the spring clamp 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. 10-7). Installing the batteries in the wrong position or with reversed polarity can damage the batteries, the KPS600 and the low-voltage power supply unit.

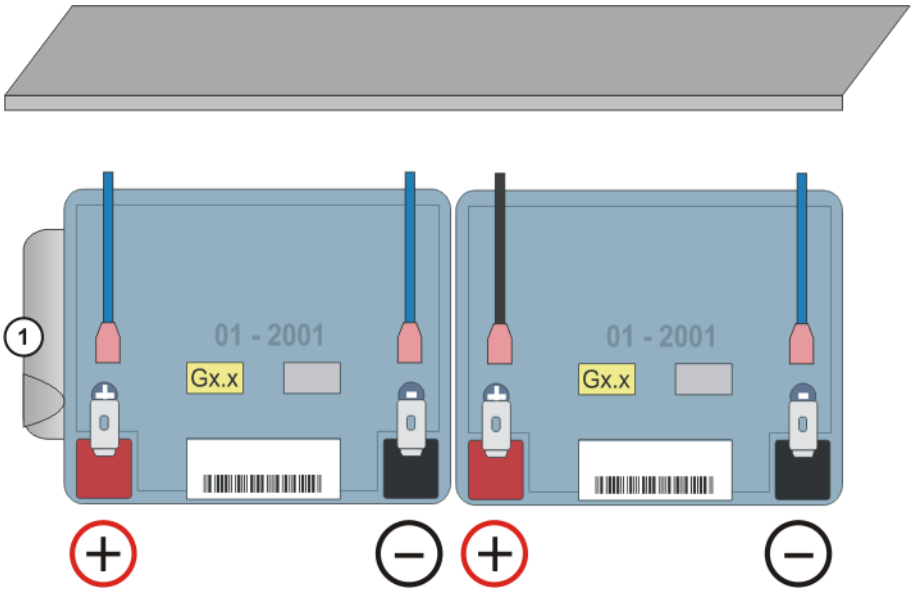


Fig. 10-7: Connection example: Batteries

1 Spring clamp

Storage instruction In case of long-term storage, the batteries must be charged every 6 months to avoid the risk of damage due to self-discharge.

10.11 Removal and installation of the CD-ROM drive (optional)

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Back-up must be completed.
- The power cable must be de-energized.
- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Remove the fastening screw of the drives holder.
3. Push the drives holder out to the left.

Make a note of the number of the pin (pin 1 or pin 40) connected to the side of the 40-strand interface cable marked in red.

4. Disconnect the power supply and data cable.
5. Remove the fastening screws at the side.
6. Push the CD-ROM drive out of the holder.
7. Configure the new CD-ROM drive as "master".

Further information can be found in the manufacturer documentation.

8. Push the CD-ROM drive into the holder and fasten it with 4 screws.
9. Connect the power supply and data cable.
10. Install the drives holder and fasten it with a screw.

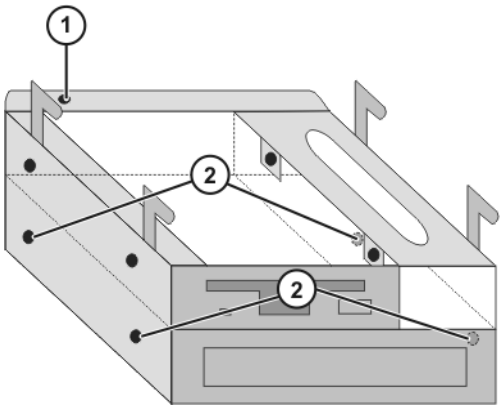


Fig. 10-8: Exchanging the CD-ROM drive

1	Fastening screw of the drives holder	2	Fastening screws of the CD-ROM drive

10.12 Removal and installation of the floppy disk drive (optional)

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Back-up must be completed.
- The power cable must be de-energized.
- Observe the ESD guidelines.

Procedure

1. Open the control cabinet door.
2. Remove the fastening screw of the drives holder.
3. Push the drives holder out to the left.

Make a note of the number of the pin (pin 1 or pin 34) connected to the side of the 34-strand interface cable marked in red.

4. Disconnect the power supply and data cable.
5. Remove the fastening screws at the side.
6. Push the floppy disk drive out of the holder.
7. Push the new floppy disk drive into the holder and fasten it with 4 screws.
8. Connect the power supply and data cable.
9. Install the drives holder and fasten it with the screw.

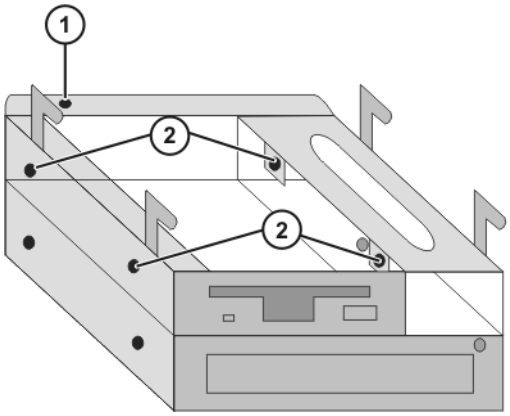


Fig. 10-9: Exchanging the floppy disk drive

1	Fastening screw of the drives holder	2	Fastening screws of the floppy disk drive

10.13 Exchanging the hard drive

Preconditions

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

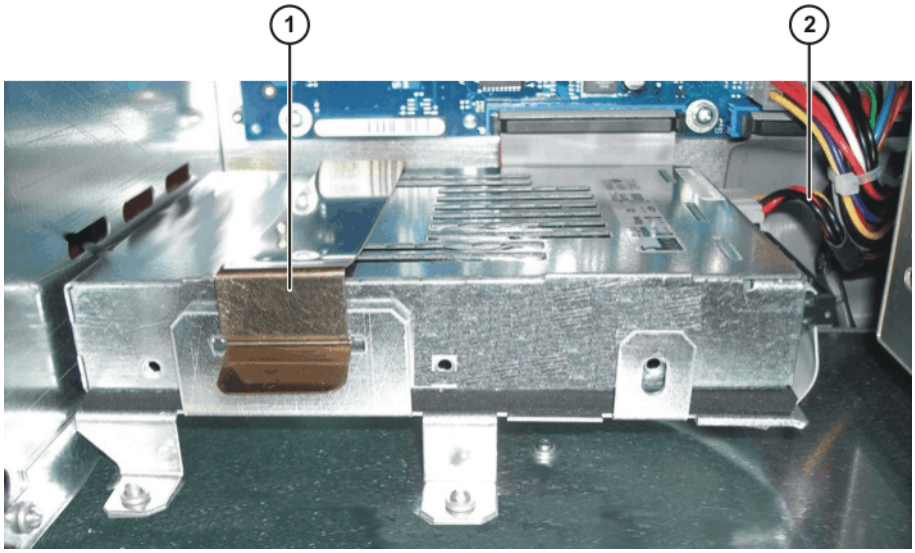


Fig. 10-10: Exchanging the hard drive

1	Retaining clip	2	Interface and power supply cables

10.14 Exchanging the KVGA card

Preconditions

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

10.14.1 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”.

10.15 Exchanging the MFC3 card

Preconditions

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

10.16 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.
- Back-up must be completed.
- The power cable must be de-energized.
- 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.

10.17 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.
- Observe the ESD guidelines.
- Wait 5 minutes until the intermediate circuit has discharged.

Caution!
Voltages in excess of 50 V (up to 600 V) can be present in the KPS, the KSDs and the intermediate-circuit connecting cables up to 5 minutes after the control cabinet has been switched off!

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.

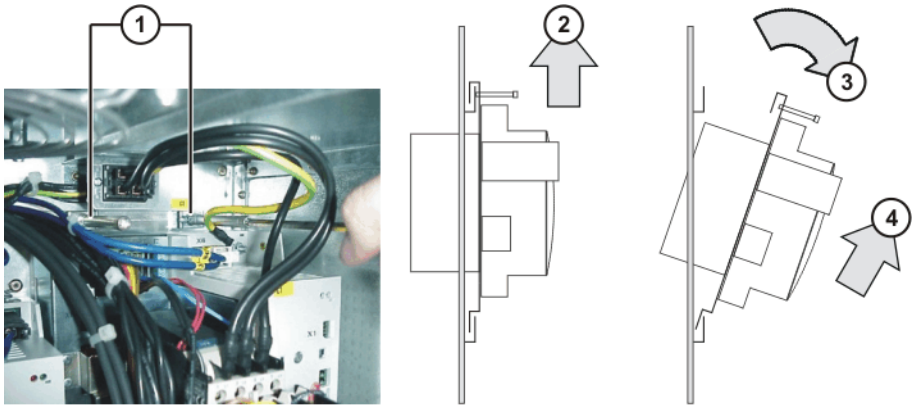


Fig. 10-11: Exchanging the KPS600

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

10.18 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 must be de-energized.
- Observe the ESD guidelines.

- Wait 5 minutes until the intermediate circuit has discharged.

Caution!
Voltages in excess of 50 V (up to 600 V) can be present in the KPS, the KSDs and the intermediate-circuit connecting cables up to 5 minutes after the control cabinet has been switched off!

Procedure

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

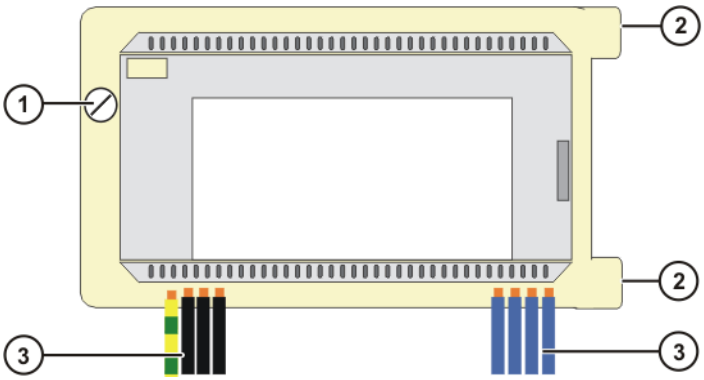


Fig. 10-12: Exchanging the KPS-27

1	Knurled screw	3	Outgoing cables
2	Holders		

10.19 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.
- Observe the ESD guidelines.
- Wait 5 minutes until the intermediate circuit has discharged.

Caution!
Voltages in excess of 50 V (up to 600 V) can be present in the KPS, the KSDs and the intermediate-circuit connecting cables up to 5 minutes after the control cabinet has been switched off!

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.

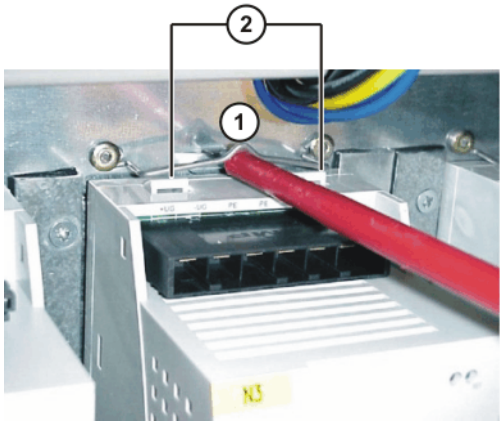


Fig. 10-13: Exchanging the KSD

1	Retaining clip	2	Locking device

10.20 Removal and installation of the KCP coupler

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Back-up must be completed.
- The power cable must be de-energized.
- 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 (1).
4. Install and fasten the new KCP coupler card.
5. Plug in all connectors.

10.21 Installing the KUKA System Software (KSS)

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

11 Troubleshooting

11.1 Repair and procurement of spare parts

Repairs

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 the KUKA Robot Group.

Repairs within modules may only be carried out by specially trained KUKA Robot Group 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.

The KUKA Robot Group 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 the KUKA Robot Group.

A "Robot Repair Card" is supplied with the exchange parts. The Repair Card must be completed and returned to the KUKA Robot Group.

11.2 PC fault profiles

Effects	Causes	Remedy
■ PC does not boot ■ Display is dark	Power supply defective	Disconnect all devices one by one from the power supply unit. Switch on the PC and measure output voltages at the power supply unit.
	Short circuit on the motherboard	
	Short circuit on a connected device	
■ 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)	Snap memory modules correctly into place.
	Memory modules defective	Exchange memory modules.
	Defective motherboard	Exchange the PC
■ PC boots normally ■ Display is dark	KVGA defective	Exchange KVGA
	Cable break in KCP connecting cable	Exchange the KCP connecting cable
■ System crash when booting ■ No keyboard input possible	Defective motherboard	Exchange the PC
The system repeatedly resets itself (reboot).	Memory modules defective	Exchange memory modules
	KVGA defective	Exchange KVGA
	KSD defective	Exchange KSD

Effects	Causes	Remedy
BIOS error message "CMOS Checksum Error"	Undervoltage in lithium battery on the motherboard	Exchange lithium battery
	CMOS memory on motherboard defective	Exchange the PC
BIOS error message "MEMORY 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 connected	Check IDE cable
	Power supply not correctly connected	Check the connector
	Hard drive defective	Exchange the hard drive
	Defective motherboard	Exchange the PC
Cannot access floppy disk drive (FDD)	BIOS settings incorrect	Load KUKA default settings
	Data cable incorrectly connected	Connect data cable correctly
	Power supply cable incorrectly connected	Connect power supply cable correctly
	FDD defective	Exchange FDD
	Defective motherboard	Exchange the PC
CD-ROM drawer does not open	Power supply not correctly connected	Connect power supply correctly
	CD-ROM drive defective	Exchange the CD-ROM drive
CD-ROM drive cannot be read	BIOS fails to detect CD-ROM drive	Load KUKA default settings
	IDE cable incorrectly connected	Connect IDE cable correctly
	CD-ROM drive defective	Exchange the CD-ROM drive
	CD-ROM defective or inserted incorrectly	Exchange CD-ROM or insert it correctly (label upwards!)
Windows operating system crashes with exceptional error (blue screen)	Memory module defective	Exchange memory module
	Defective or lost sectors	Re-install the software
Controller hangs when loading software components	MFC3 not correctly connected	Connect MFC3 correctly
	MFC3 defective	Exchange the MFC3
	Additional PC card (e.g. Interbus)	Remove PC card and run controller up again. Exchange PC card
	Motherboard defective	Exchange the PC
KUKA.HMI does not boot, and is aborted with a General Protection fault	Defective files in the software installation	Reinstall control software
	Settings in CMOS setup incorrect	Check settings in CMOS setup
	Defective memory module(s)	Exchange memory module(s)

11.3 MFC3 error messages

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
	PC card (e.g. Interbus) interfering with functioning of MFC3	Exchange the MFC3
	PCI bus on motherboard faulty	Exchange motherboard
KCP control panel does not work	CAN controller on the MFC defective	Exchange the MFC3
	KCP cable or connector faulty	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
	Motherboard defective	Exchange motherboard
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

11.4 KCP error messages

Effects	Causes	Remedy
No display on the LCD	Connecting cable defective	Exchange KCP with connecting cable
	KVGA defective	Exchange KVGA
	KCP defective	Replace KCP
Drives cannot be switched on	Connecting cable defective	Exchange KCP with connecting cable
	Enabling switch jammed	Replace KCP
	KCP defective	Replace KCP
	CI3 board is defective	Exchange CI3 board
No entries can be made via KCP	Connecting cable defective	Exchange the connecting cable
	MFC3 defective	Exchange the MFC3
	KCP defective	Replace KCP
EMERGENCY STOP cannot be acknowledged	EMERGENCY STOP button defective	Replace KCP
	Connecting cable defective	Exchange KCP with connecting cable
Space Mouse does not work	Connecting cable defective	Exchange KCP with connecting cable
	Space Mouse defective	Replace KCP
	MFC3 defective (CAN bus)	Exchange the MFC3

11.5 Field bus communication error messages

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	Interbus filter defective or not correctly connected	Exchange Interbus filter (if fiber-optic cable)
	External power supply input on IBS card defective	Exchange Interbus card

11.6 Fuses and LED indicators on the CI3 board

11.6.1 CI3 Standard board

Overview

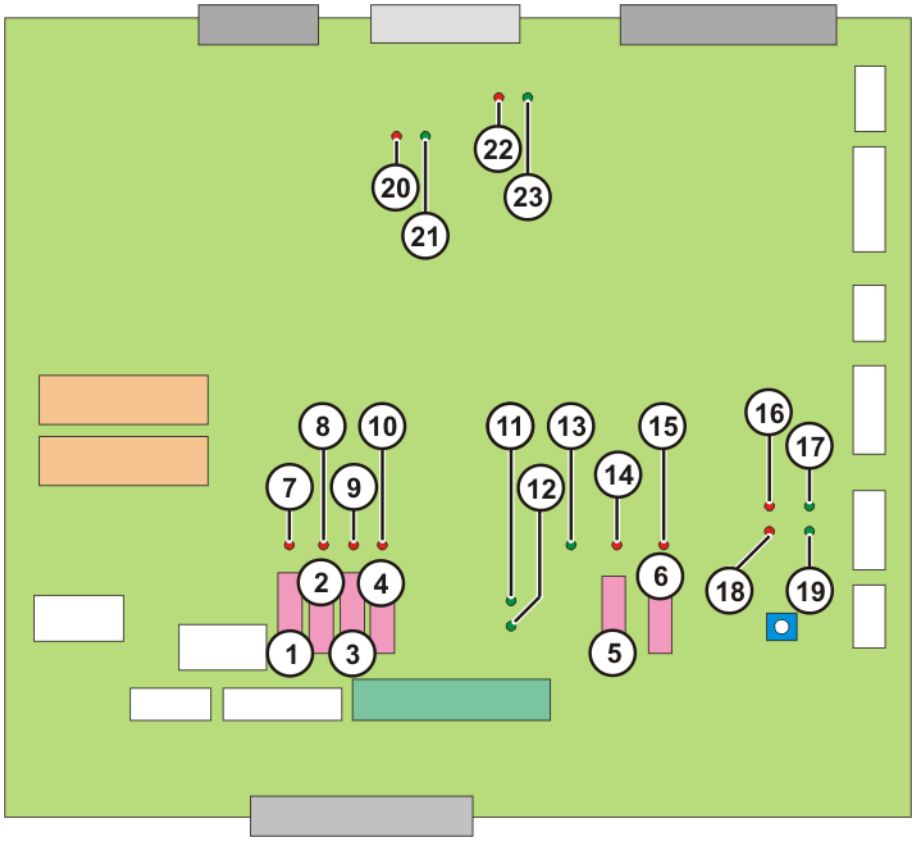


Fig. 11-1: CI3 Standard board fuses and LEDs

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
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

11.6.2 CI3 Extended board

Overview

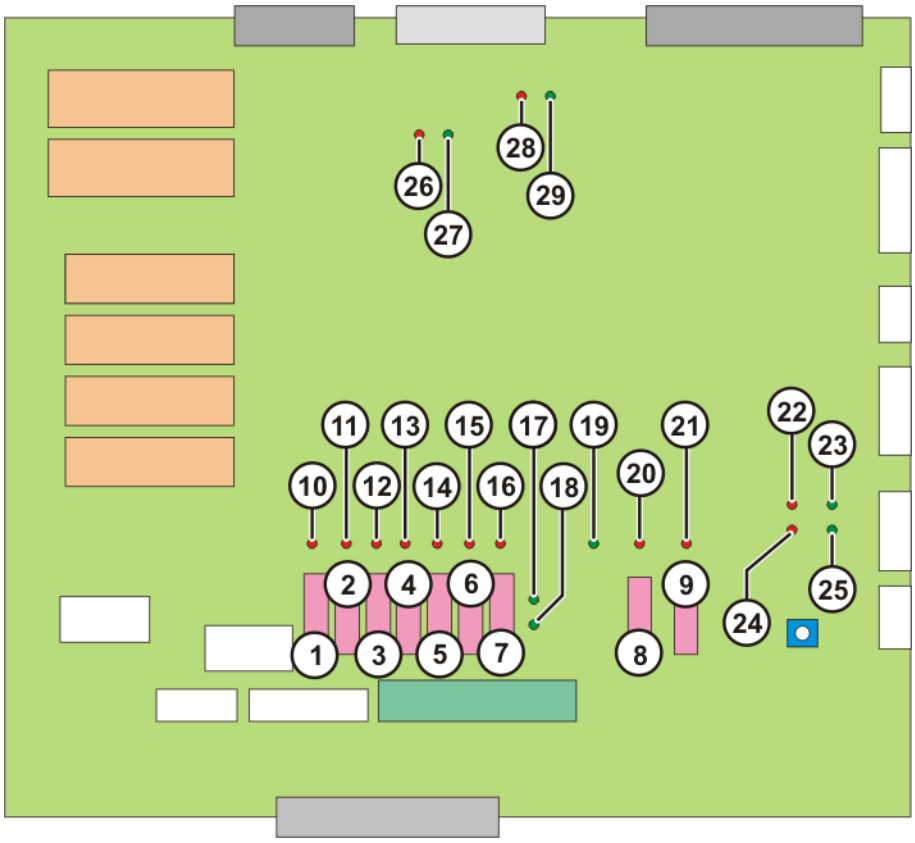


Fig. 11-2: CI3 Extended board fuses and LEDs

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
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

Item	Designation	Description
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

11.6.3 CI3 Bus board

Overview

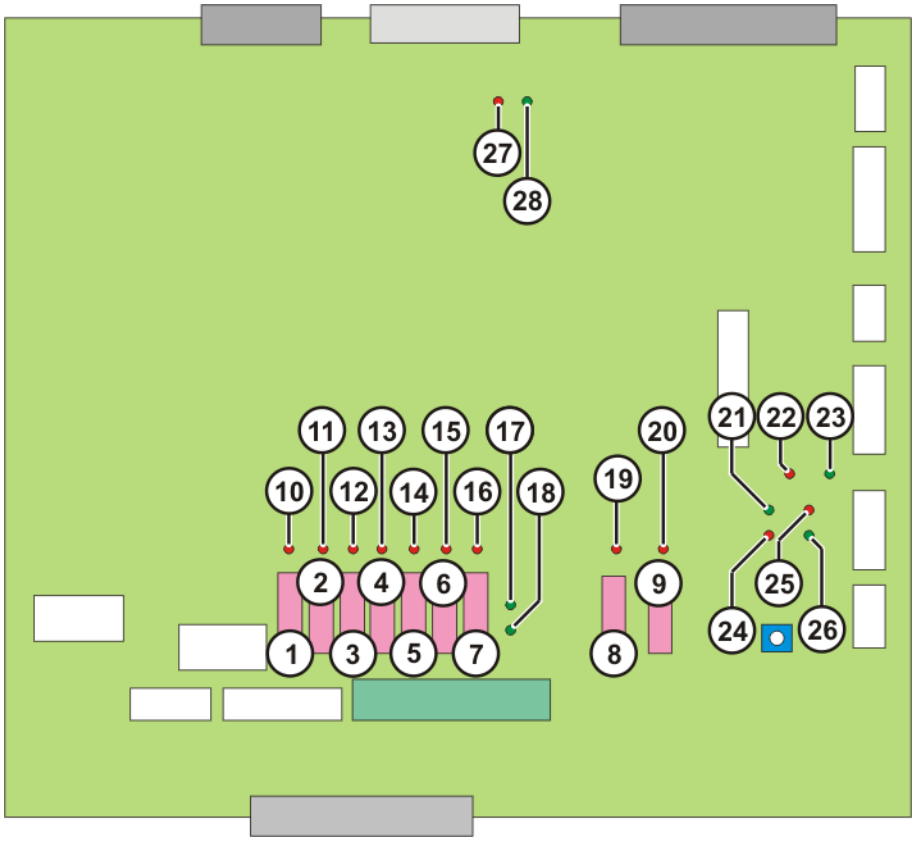


Fig. 11-3: CI3 Bus board fuses and LEDs

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
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

11.6.4 CI3 Tech board

Overview

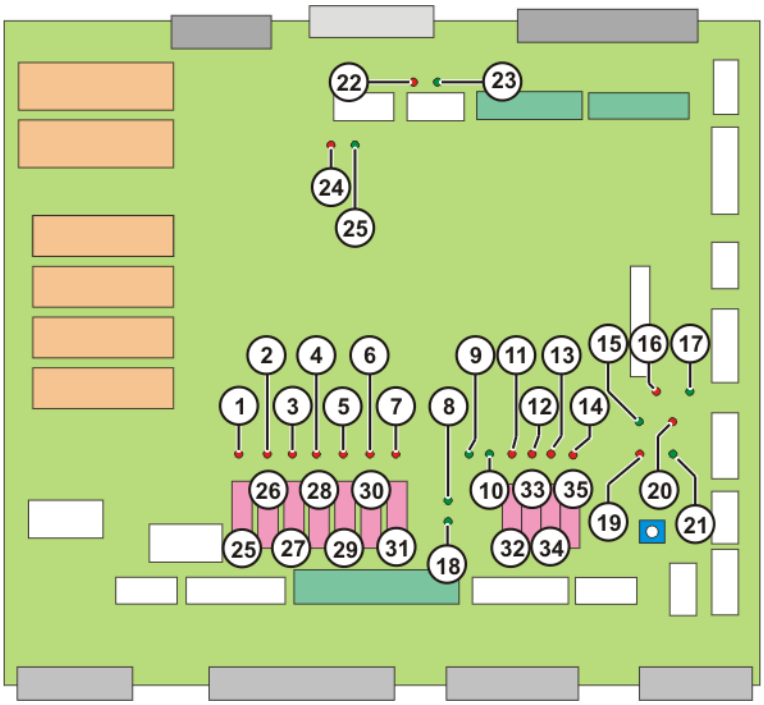


Fig. 11-4: CI3 Tech board fuses and LEDs

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

Item	Designation	Value in A	Description
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

11.7 KPS 600 fuses, messages and error displays

Overview

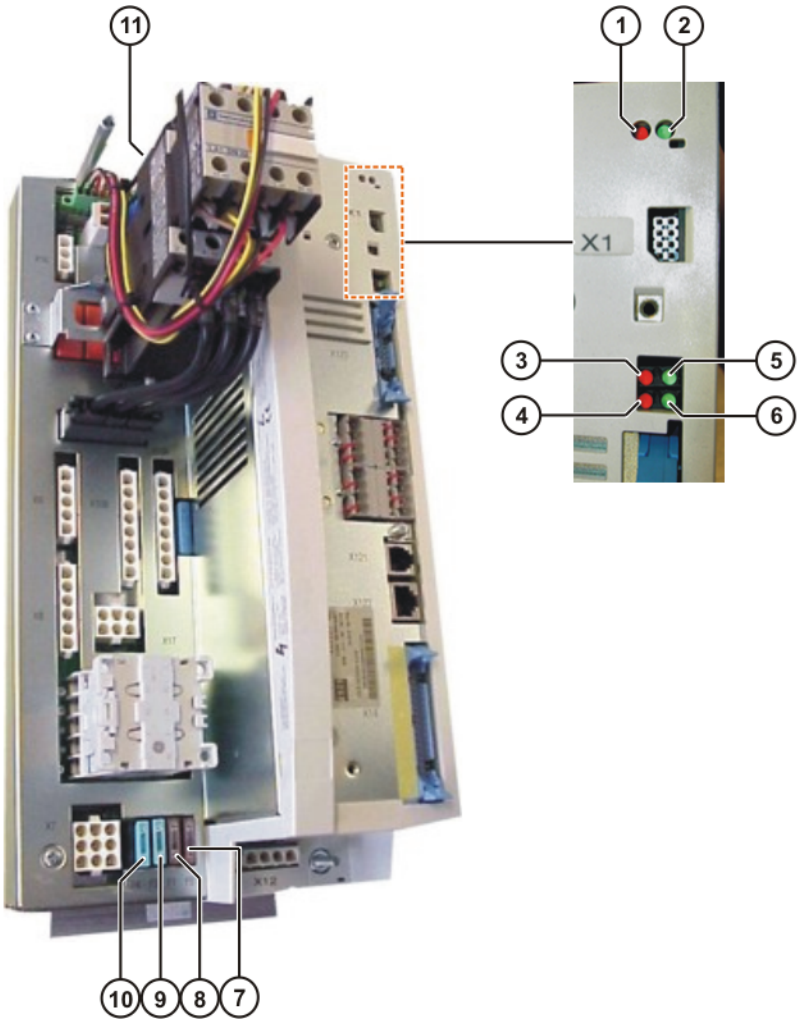


Fig. 11-5: KPS 600 LED display and fuses

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)		

Fuses

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

LEDs 1 and 2

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
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.

LEDs 3 and 4

LED 3	LED 4	Meaning
On	Off	External E-STOP activated
On	On	Local EMERGENCY STOP activated
Off	On	Internal ESC fault

LED 5

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

LED 6

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

KCP display

The following KSD error messages are 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; use energy recovery unit
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

Display in message window	Meaning / cause	Remedy
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
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

11.8 KPS-27 error messages

Overview

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

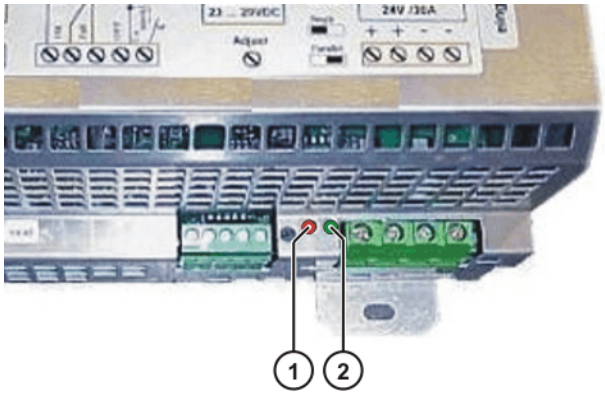


Fig. 11-6: KPS-27 LED display

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

LED

LED	State	Meaning
LED 2 (OK)	Lit	Normal operation
LED 1 (overload)	Lit	Overload operation
	Flashes slowly	Short-circuit operation

11.9 Error messages on the KSD

Overview

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

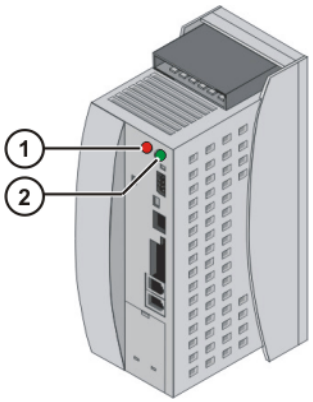


Fig. 11-7: KSD error display

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

LED

LED 1	LED 2	Meaning
Off	Off	No 24 V
On	Off	Undefined state
Flashes quickly	Flashes quickly ($U_{IC} > U_{limit}$)	Fault is present
Flashes slowly	Flashes slowly ($U_{IC} < U_{limit}$)	Message is present (except in case of undervoltage U_{IC}), default value = 250 V
	Flashes quickly ($U_{IC} > U_{limit}$)	
Off	Flashes slowly	$U_{IC} < U_{limit}$
Off	Flashes quickly	$U_{IC} > U_{limit}$
Off	On	Servo enable, $U_{IC} > U_{limit}$

U_{IC}: Intermediate circuit voltage

U_{limit}: Intermediate circuit voltage = 250 V

KCP

The following KSD error messages are 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 detailed error message which is also displayed.
OVERCURRENT Ax	■ Overloading of the axis ■ I^2t overload ■ KSD defective	■ Reduce load on axis (reduce OVR, $ACC_AXIS) ■ Exchange KSD
SYNCHRONISATION ERROR DRIVE MODULE Ax	■ Max. permissible number of communication errors with the servo bus exceeded ■ Too many consecutive toggle bit errors; causes short-circuit braking.	■ Check Interbus cable between DSE, KPS and KSD

Display in message window	Meaning / cause	Remedy
HEAT SINK TEMPERATURE Ax	Heat sink overtemperature	■ Check control cabinet fans / cooling circuit ■ Reduce load on axis (reduce OVR, $VEL_AXIS or $ACC_AXIS)
Parameter error Ax PR1	Checksum error in parameter set 1	■ Check the KSD ■ Restart ■ Exchange the KSD
Motor cable Ax	■ Power unit overcurrent (short-circuit or ground fault) ■ Hardware monitoring ■ 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.: 105	Checksum error in the control unit device set	■ Check the KSD ■ Restart ■ Exchange the KSD
Drives error Ax no.: 71	Microcontroller crash	■ Check the KSD ■ Restart ■ Exchange the KSD
Drives error Ax no.: 79	Communication error with the EEPROM in the control unit	■ Check the KSD ■ Restart ■ Exchange the KSD
Drives error Ax no.: 80	Communication error with the EEPROM in the power unit	■ Check the KSD ■ Restart ■ Exchange the KSD
Drives error Ax no.: 106	Checksum error in the power unit device set	■ Check the KSD ■ Restart ■ Exchange the KSD

11.10 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)

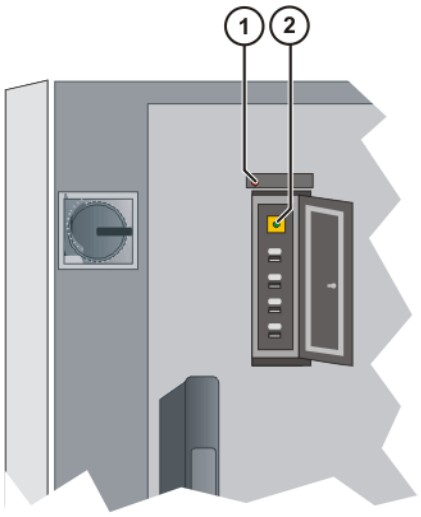


Fig. 11-8: KCP coupler LEDs and request button

LED 1 (red)

Item	State	Meaning
1	On	Internal error in KCP coupler.
	Off	No error
	Flashes slowly (approx. 1 Hz)	Internal ESC communications error
	Flashes quickly (approx. 10 Hz)	ESC protocol timeout from KCP

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

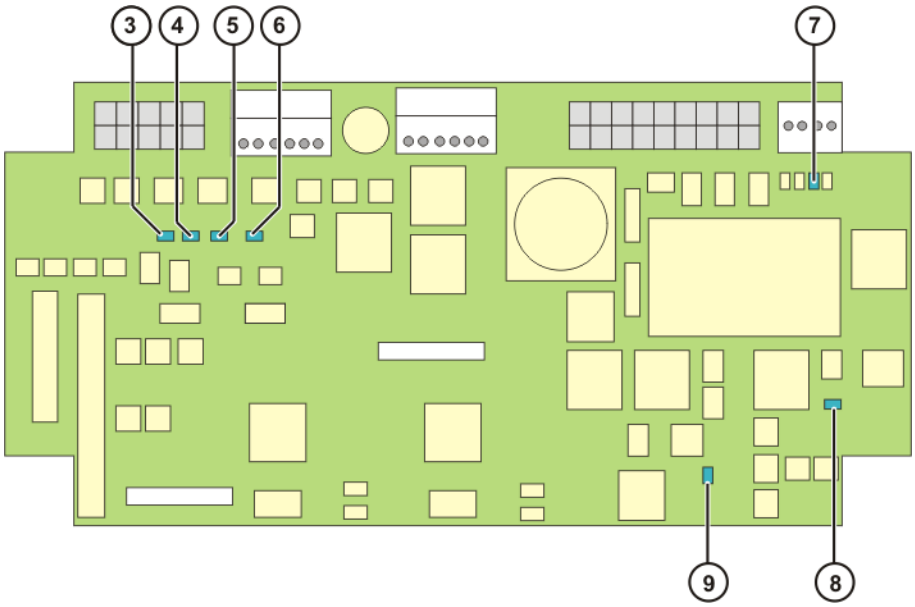


Fig. 11-9: LEDs on the KCP coupler card

Item	LED	State	Meaning
3	H10	On	24 V ESC
4	H9	On	Switched 24 V ESC
5	H6	On	Test output channel B
6	H5	On	Test output channel A
7	H7	On	Switched 24 V KCP
8	H8	On	24 V KCP
9	H11	On	5 V KCP coupler

11.11 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. (>>> 8.1.1 "Uncoupling the KCP" page 85) (>>> 8.1.2 "Coupling the KCP" page 85)
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	

11.12 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.

11.12.1 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:

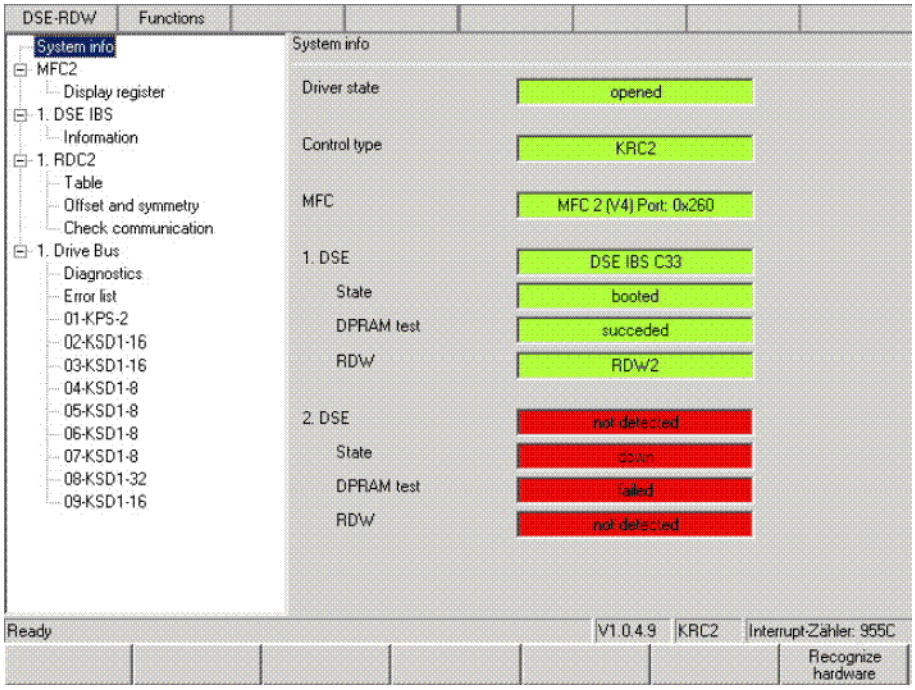


Fig. 11-10: DSE-RDW user interface

Parameter	Description
Driver state:	Driver program is being executed
Control type	Type of controller (KR C2ed05, KR C3)
MFC	Version of the MFC module used
■ 1.DSE ▫ State ▫ DPRAM test ▫ RDW	■ 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

11.12.2 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**.

11.12.3 MFC3 register display

Procedure

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

Description

The following parameters are displayed:

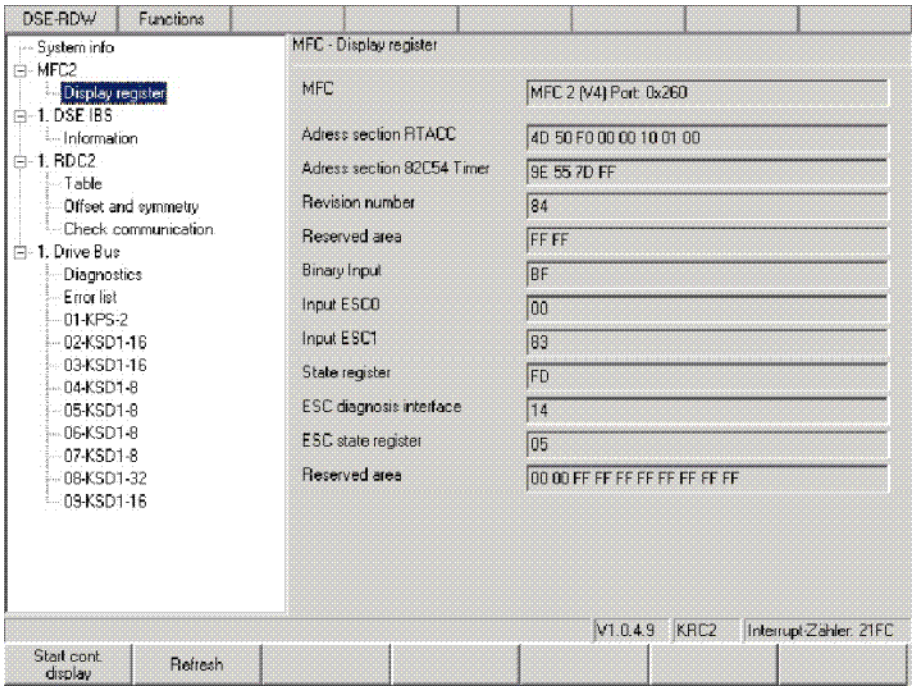


Fig. 11-11: MFC register display

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

11.12.4 DSE IBS information

Procedure

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

Description

The following parameters are displayed:

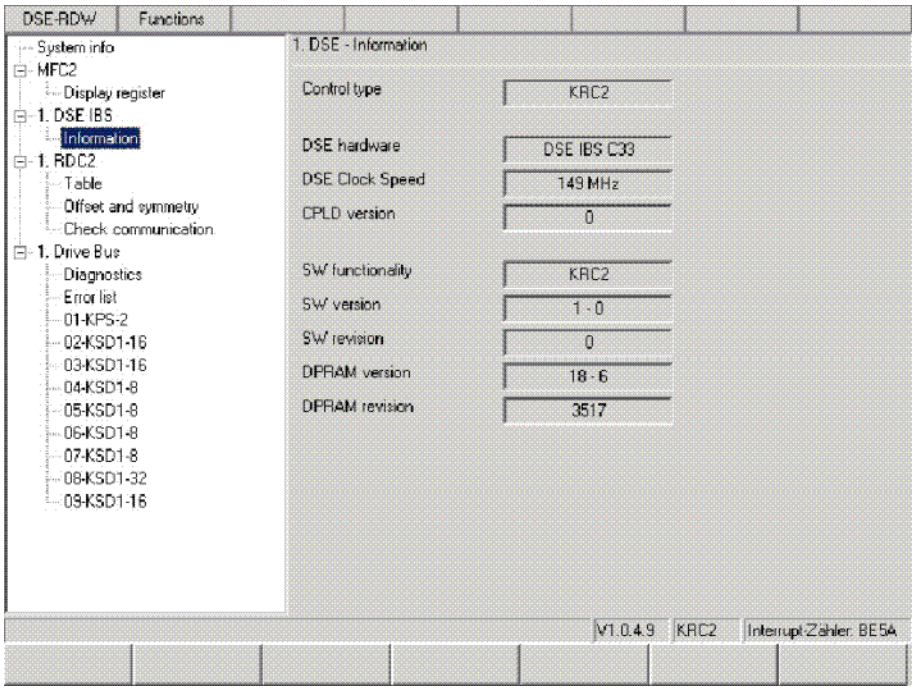


Fig. 11-12: DSE IBS information

Parameter	Description
Control type	Type of controller (KR C2ed05, KR C3)
DSE hardware	Hardware version of the DSE
DSE Clock Speed	Clock frequency of the DSE used
CPLD version	Internal version numbers
SW functionality	
SW version	
DPRAM version	
DPRAM revision	

11.12.5 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.

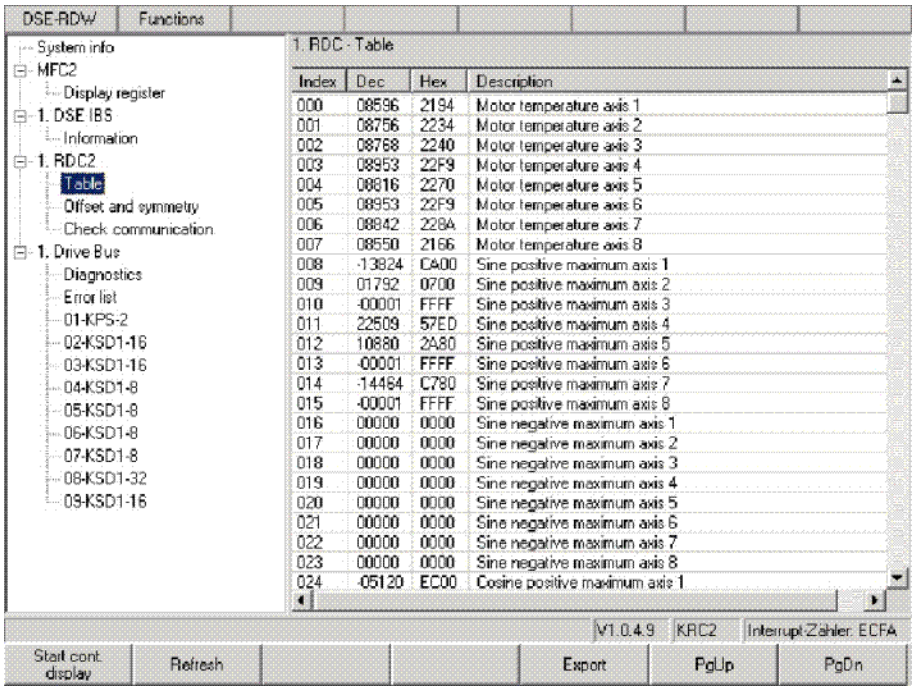


Fig. 11-13: RDC table

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

11.12.6 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:

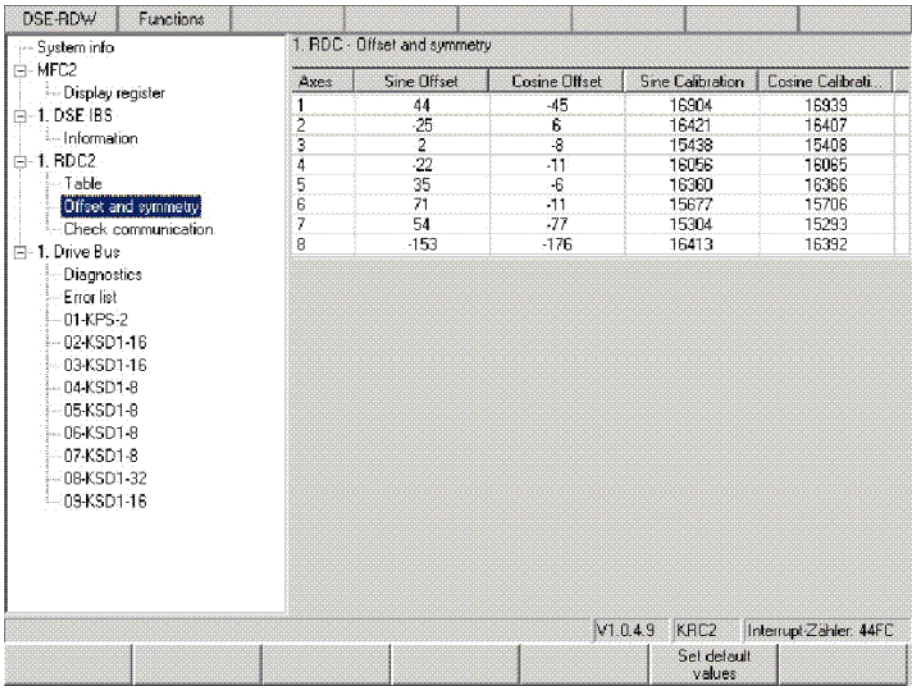


Fig. 11-14: RDC offset and symmetry

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

11.12.7 Check RDC-DSE communication

Procedure

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

Description

The following parameters are displayed:

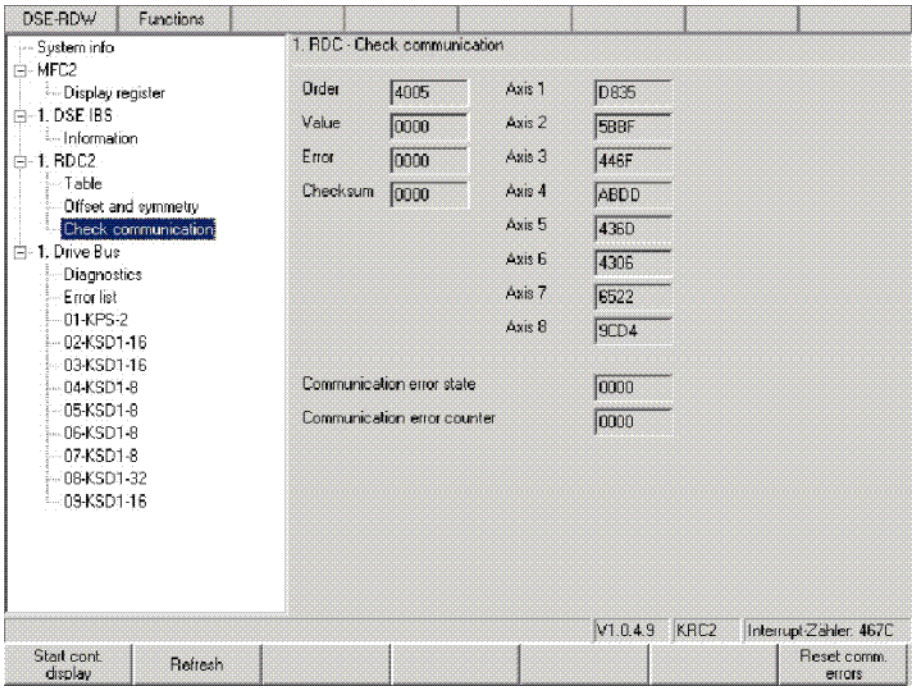


Fig. 11-15: Check communication

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. 11-16: Encoded display of the encoder error bits and EMT signals

Softkeys

Softkey	Description
Rest comm. errors	Sets errors to 0

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

11.12.8 Drive bus diagnostics

Procedure

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

Description

The following parameters are displayed:

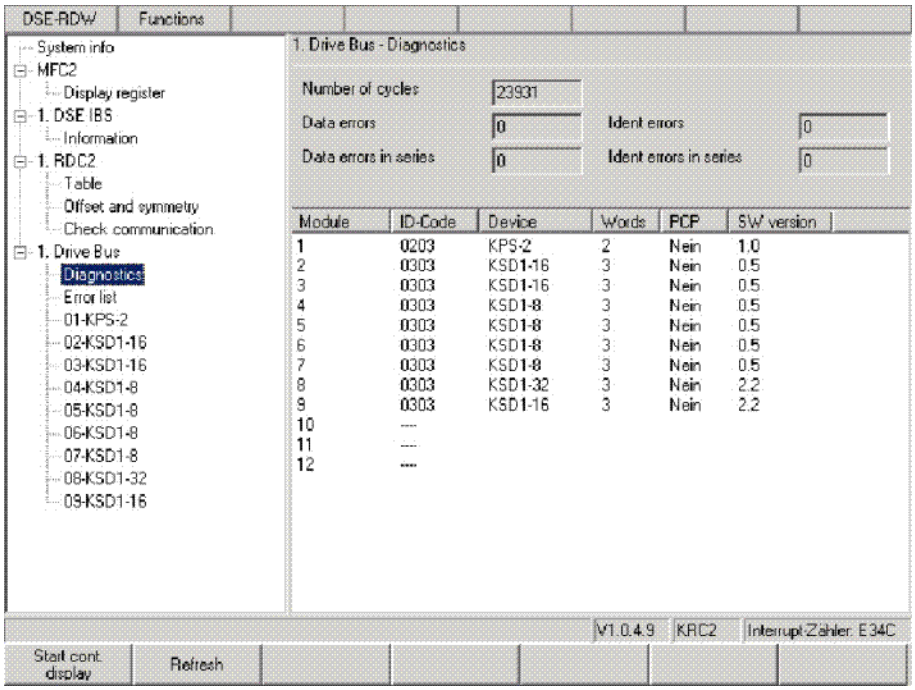


Fig. 11-17: Drive bus diagnostics

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

11.12.9 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.

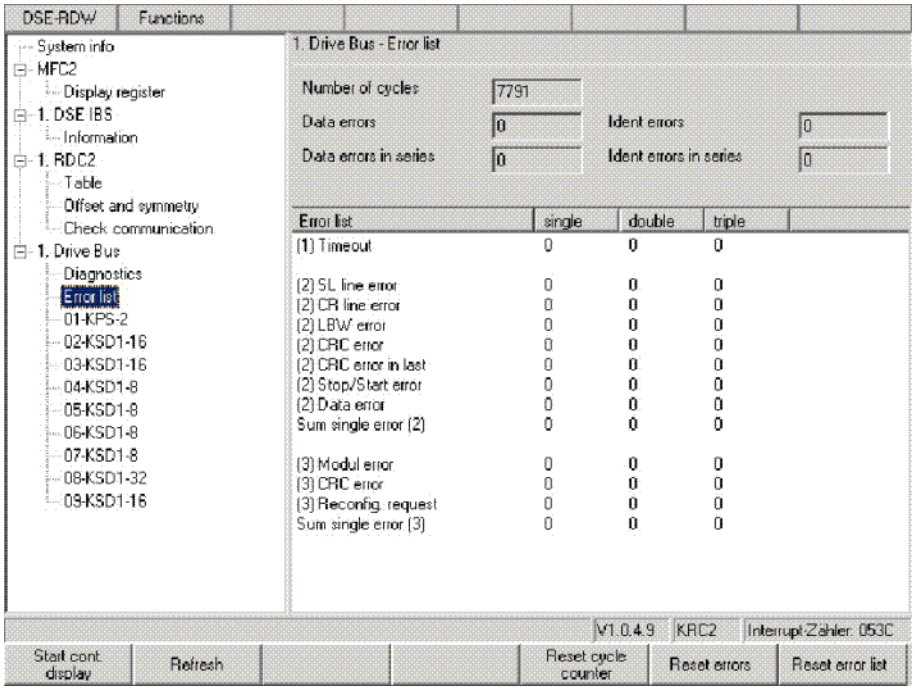


Fig. 11-18: Drive bus error list

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

11.12.10 Drive bus - KPS

Procedure

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

Description

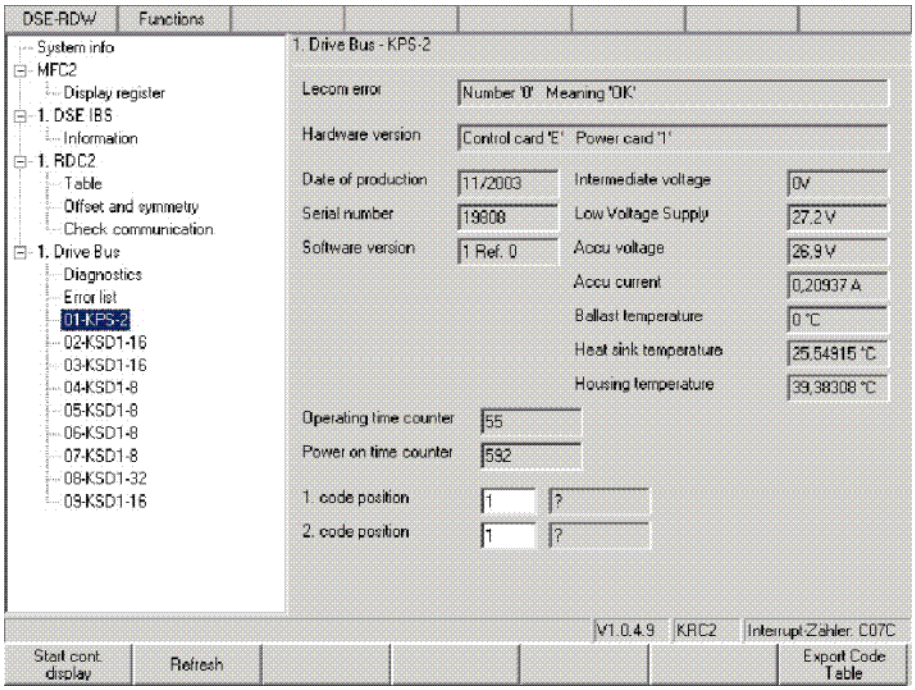


Fig. 11-19: Drive bus - KPS

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)

11.12.11Drive bus - KSD-16

Procedure

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

Description

The following parameters are displayed:

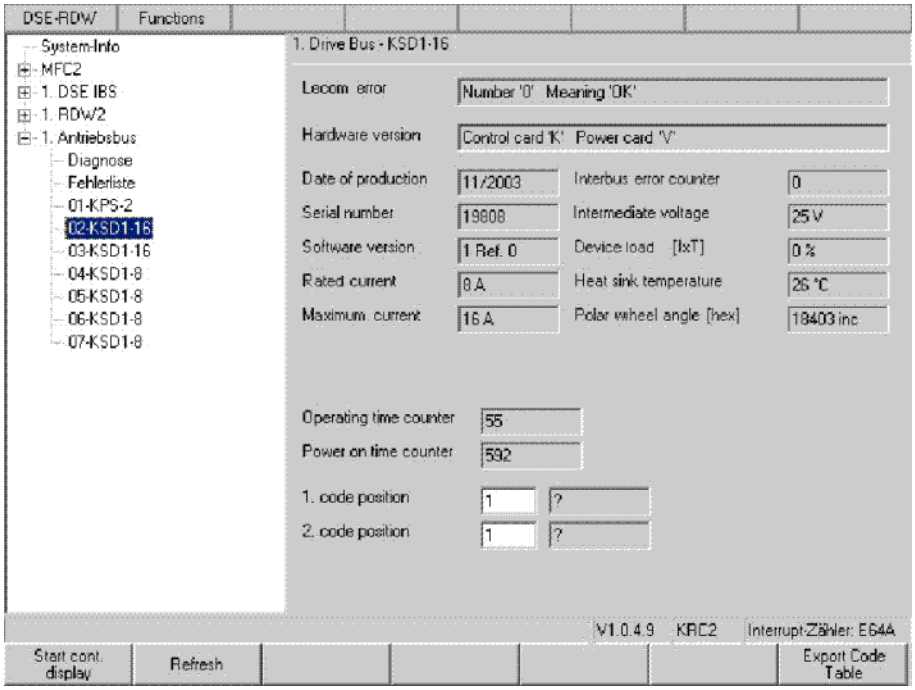


Fig. 11-20: Drive bus - KSD

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)

11.12.12KPS600 error messages

IBS trip number	Lecom error number	Message text	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 EEP-ROM 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

11.12.13KSD error messages

Valid from Firmware V0.3 onwards

IBS trip number	Lecom error number	Message text	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

11.13 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.

11.13.1 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.

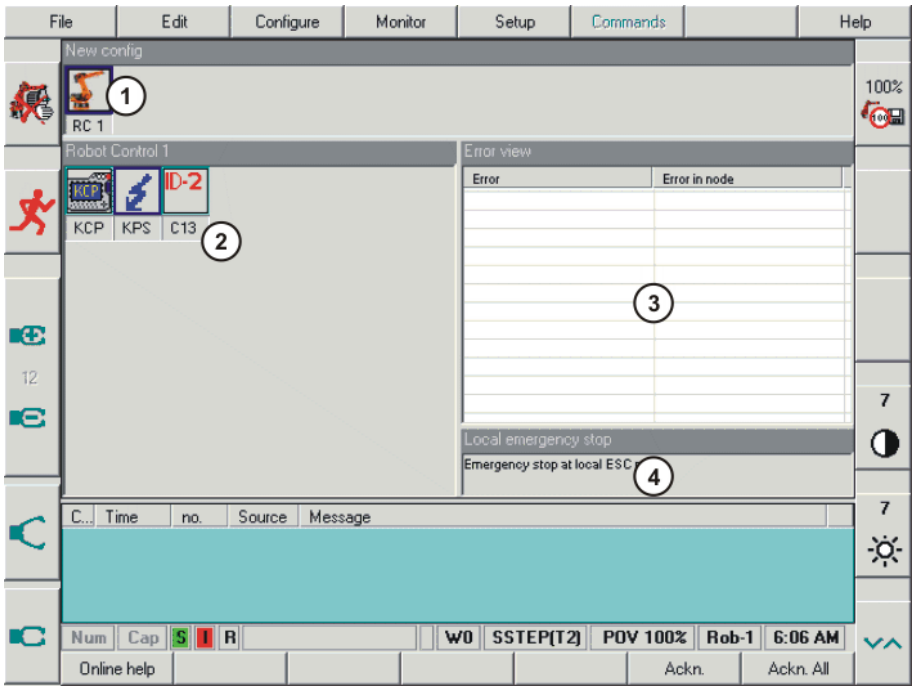


Fig. 11-21: Example: a controller with three ESC nodes

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.

11.13.2 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.

11.13.3 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.

11.13.4 Terminating ESC diagnosis

Procedure

- Terminate ESC diagnosis by pressing the **Close** softkey.

11.13.5 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.

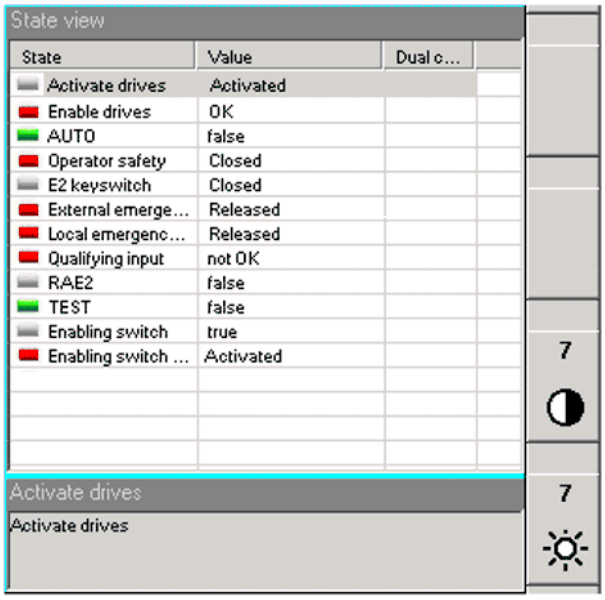


Fig. 11-22: State display (example)

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	Level 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 E-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 activat-ed	Drives ON key	Activate drives
Green	Pressed		

11.13.6 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

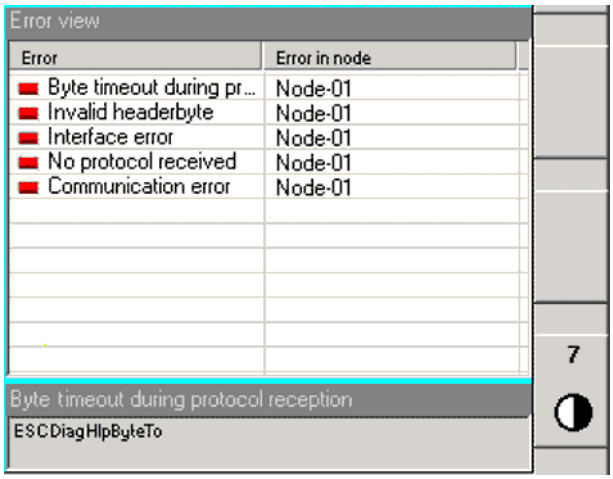


Fig. 11-23: Error display (example)

The following errors can be displayed in the table:

Error	Error in node
Byte timeout during protocol recep-tion	Node XX
CRC error in protocol	Node XX
Invalid header byte	Node XX
Interface error	Node XX
Operating mode error	Node XX
No log received	Node XX

Error	Error in node
CCC_Error	Node XX
Initialization error	Node XX
Configuration error	Node XX
Hardware error	Node XX
Communication error	Node XX
Software error	Node XX
IO monitoring error	Node XX
Error protocol received	Node XX
Crossed connection error	Node XX
RAM error	Node XX
Output error	Node XX
Output error: operating mode	Node XX
Drives contactor auxiliary contact error	Node XX
Output error: local emergency stop	Node XX
Output error, external E-STOP	Node XX
Output error: AE coil	Node XX
Crossed connection error	Local E-STOP
Crossed connection error	External E-STOP
Crossed connection error	Operator safety
Crossed connection error	Qualifying input
Crossed connection error	Enabling switch 1
Crossed connection error	E2 keyswitch
Crossed connection error	Panic position
Crossed connection error	Activate drives or enable drives

11.13.7 Displaying all status bits

Procedure

- The states of the status bits of all connected controllers 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.

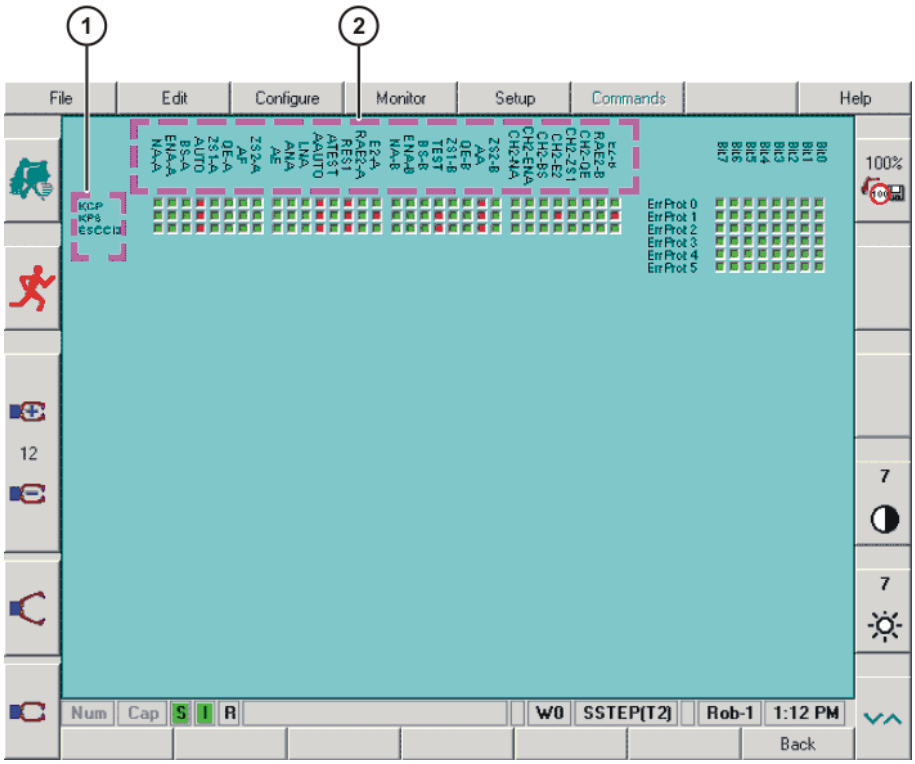


Fig. 11-24: State of the status bits in the ESC circuit

11.13.8 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.

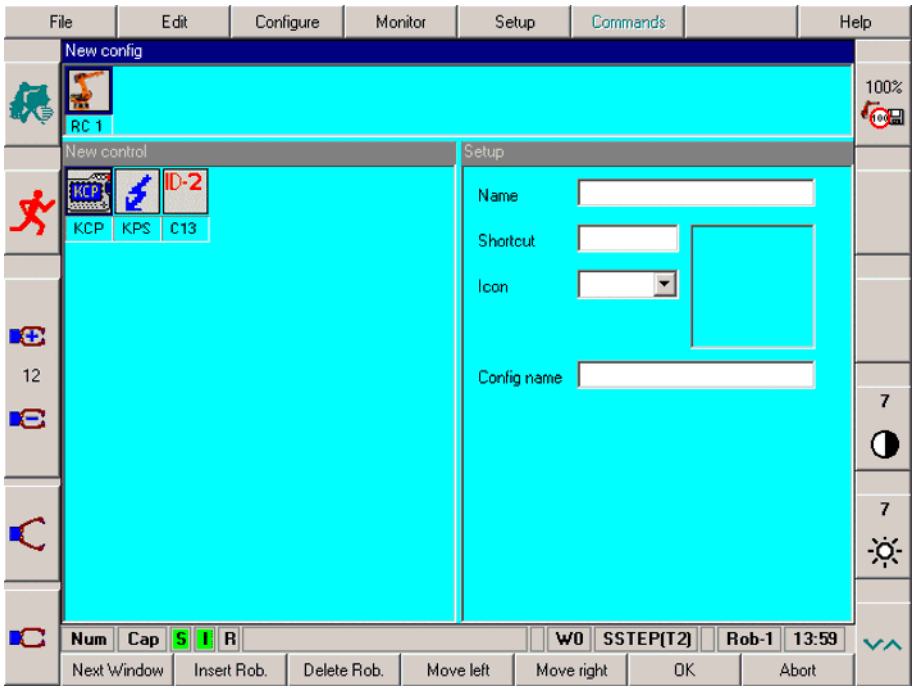


Fig. 11-25: Controller configuration menu

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.

11.13.9 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.

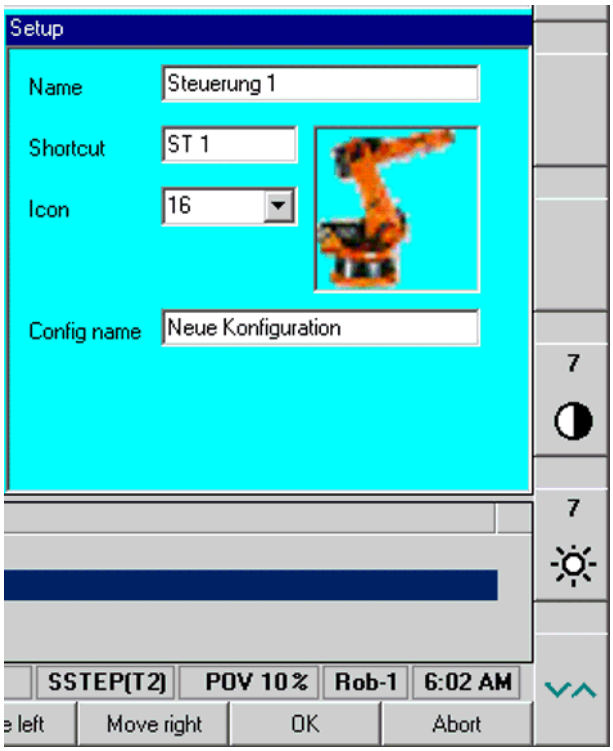


Fig. 11-26: Example: robot property boxes

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.

11.13.10Configuring ESC nodes

Precondition

- A node must be highlighted.

Description

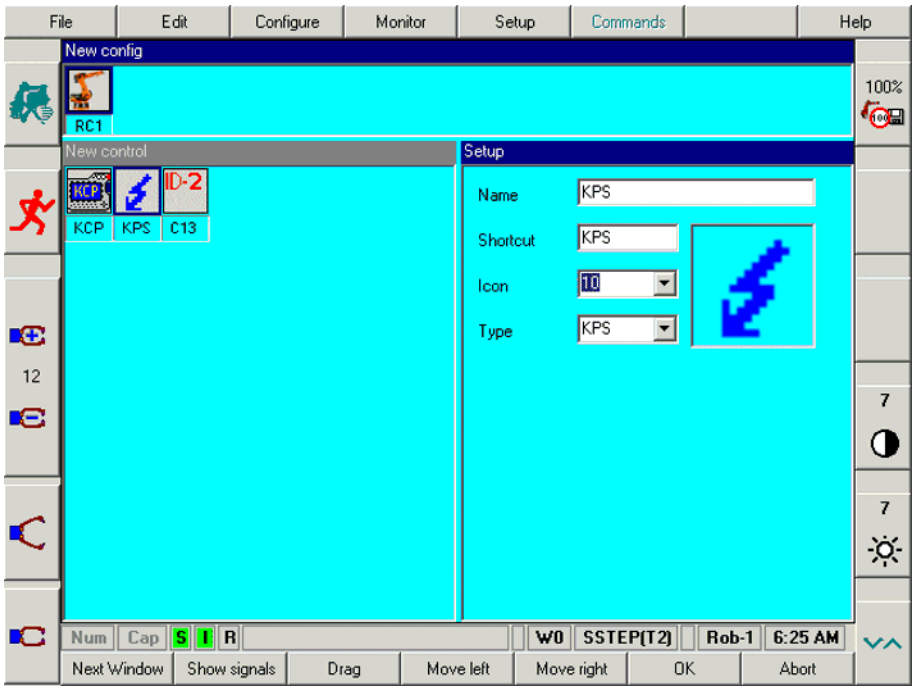


Fig. 11-27: Configuring ESC nodes

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.

11.13.11 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.

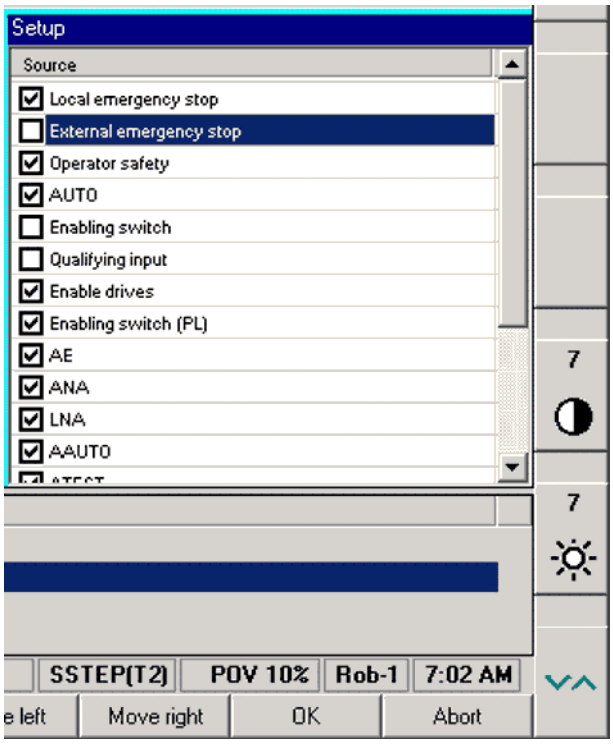


Fig. 11-28: Example: signals of a KCP ESC node

11.13.12Selecting 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.

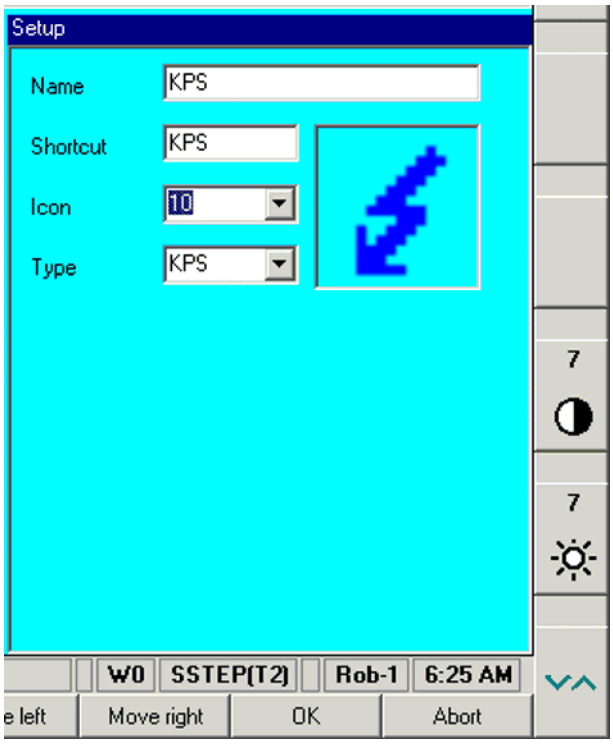


Fig. 11-29: Example: KPS property boxes

Parameter	Description
Name	Name of the node
Shortcut	Short designation of the node
Icon	Node icon
Config name	Name of the current configuration set

11.13.13Assigning 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.

11.13.14Error messages and troubleshooting

Message text	Cause	Troubleshooting
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.
CRC error in protocol	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	Troubleshooting
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 error	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.
Drives contactor auxiliary contact error	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 emergency 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).

Message text	Cause	Troubleshooting
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: Operating mode 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.	Verdrahtung der Eingänge Antriebe aktivieren (AA) und Antriebsfreigabe (AF) überprüfen.

12 Appendix

Name	Definition	Edition
73/23/EEC	Low Voltage Directive: Council Directive of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits	1993
89/336/EEC	EMC Directive: Council Directive of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility	1993
97/23/EC	Pressure Equipment Directive: Directive 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
98/37/EC	Machinery Directive: Directive of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery	1998
EN 418	Safety of machinery: EMERGENCY STOP equipment, functional aspects; principles for design	1993
EN 563	Safety of machinery: Temperatures of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces	2000
EN 614-1	Safety of machinery: Ergonomic design principles – Part 1: Terms and general principles	1995
EN 775	Industrial robots: Safety	1993
EN 954-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles for design	1997
EN 55011	Industrial, scientific and medical (ISM) radio-frequency equipment – Radio disturbance characteristics – Limits and methods of measurement	2003
EN 60204-1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	1998

Name	Definition	Edition
EN 61000-4-4	Electromagnetic compatibility (EMC): Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	2002
EN 61000-4-5	Electromagnetic compatibility (EMC): Part 4-5: Testing and measurement techniques; Surge immunity test	2001
EN 61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards - Immunity for industrial environments	2002
EN 61000-6-4	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments	2002
EN 61800-3	Adjustable speed electrical power drive systems: Part 3: EMC product standard including specific test methods	2001
EN ISO 12100-1	Safety of machinery: Basic concepts, general principles for design - Part 1: Basic terminology, methodology	2004
EN ISO 12100-2	Safety of machinery: Basic concepts, general principles for design - Part 2: Technical principles	2004

13 KUKA Service

13.1 Requesting support

Introduction

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

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

Information

The following information is required for processing a support request:

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

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

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

Australia

Marand Precision Engineering Pty. Ltd. (Agency)
153 Keys Road
Moorabbin
Victoria 31 89
Australia
Tel. +61 3 8552-0600
Fax +61 3 8552-0605
robotics@marand.com.au

Austria

KUKA Roboter GmbH
Vertriebsbüro Österreich
Regensburger Strasse 9/1
4020 Linz
Austria
Tel. +43 732 784752
Fax +43 732 793880
office@kuka-roboter.at
www.kuka-roboter.at

Belgium

KUKA Automatisering + Robots N.V.
Centrum Zuid 1031
3530 Houthalen
Belgium
Tel. +32 11 516160
Fax +32 11 526794
info@kuka.be
www.kuka.be

Brazil

KUKA Roboter do Brasil Ltda.
Avenida Franz Liszt, 80
Parque Novo Mundo
Jd. Guançã
CEP 02151 900 São Paulo
SP Brazil
Tel. +55 11 69844900
Fax +55 11 62017883
info@kuka-roboter.com.br

Chile

Robotec S.A. (Agency)
Santiago de Chile
Chile
Tel. +56 2 331-5951
Fax +56 2 331-5952
robotec@robotec.cl
www.robotec.cl

China

KUKA Flexible Manufacturing Equipment (Shanghai) Co., Ltd.
Shanghai Qingpu Industrial Zone
No. 502 Tianying Rd.
201712 Shanghai
P.R. China
Tel. +86 21 5922-8652
Fax +86 21 5922-8538
Franz.Poeckl@kuka-sha.com.cn
www.kuka.cn

France

KUKA Automatisme + Robotique SAS
Techvallée
6 Avenue du Parc
91140 Villebon s/Yvette
France
Tel. +33 1 6931-6600
Fax +33 1 6931-6601
commercial@kuka.fr
www.kuka.fr

Germany

KUKA Roboter GmbH
Blücherstr. 144
86165 Augsburg
Germany
Tel. +49 821 797-4000
Fax +49 821 797-1616
info@kuka-roboter.de
www.kuka-roboter.de

Hungary

KUKA Robotics Hungaria Kft.
Fö út 140
2335 Taksony
Hungary
Tel. +36 24 501609
Fax +36 24 477031
info@kuka-robotics.hu

India

KUKA Robotics, Private Limited
621 Galleria Towers
DLF Phase IV
122 002 Gurgaon
Haryana
India
Tel. +91 124 4148574
info@kuka.in
www.kuka.in

Italy

KUKA Roboter Italia S.p.A.
Via Pavia 9/a - int.6
10098 Rivoli (TO)
Italy
Tel. +39 011 959-5013
Fax +39 011 959-5141
kuka@kuka.it
www.kuka.it

Korea

KUKA Robot Automation Korea Co. Ltd.
4 Ba 806 Sihwa Ind. Complex
Sung-Gok Dong, Ansan City
Kyunggi Do
425-110
Korea
Tel. +82 31 496-9937 or -9938
Fax +82 31 496-9939
info@kukakorea.com

Malaysia

KUKA Robot Automation Sdn Bhd
South East Asia Regional Office
No. 24, Jalan TPP 1/10
Taman Industri Puchong
47100 Puchong
Selangor
Malaysia
Tel. +60 3 8061-0613 or -0614
Fax +60 3 8061-7386
info@kuka.com.my

Mexico

KUKA de Mexico S. de R.L. de C.V.
Rio San Joaquin #339, Local 5
Colonia Pensil Sur
C.P. 11490 Mexico D.F.
Mexico
Tel. +52 55 5203-8407
Fax +52 55 5203-8148
info@kuka.com.mx

Norway

KUKA Sveiseanlegg + Roboter
Bryggeveien 9
2821 Gjövik
Norway
Tel. +47 61 133422
Fax +47 61 186200
geir.ulsrud@kuka.no

Portugal

KUKA Sistemas de Automatización S.A.
Rua do Alto da Guerra n° 50
Armazém 04
2910 011 Setúbal
Portugal
Tel. +351 265 729780
Fax +351 265 729782
kuka@mail.telepac.pt

Russia

KUKA-VAZ Engineering
Jushnoje Chaussee, 36 VAZ, PTO
445633 Togliatti
Russia
Tel. +7 8482 391249 or 370564
Fax +7 8482 736730
Y.Klychkov@VAZ.RU

South Africa

Jendamark Automation LTD (Agency)
76a York Road
North End
6000 Port Elizabeth
South Africa
Tel. +27 41 391 4700
Fax +27 41 373 3869
www.jendamark.co.za

Spain

KUKA Sistemas de Automatización S.A.
Pol. Industrial
Torrent de la Pastera
Carrer del Bages s/n
08800 Vilanova i la Geltrú (Barcelona)
Spain
Tel. +34 93 814-2353
Fax +34 93 814-2950
Comercial@kuka-e.com
www.kuka-e.com

Sweden

KUKA Svetsanläggningar + Robotar AB
A. Odhners gata 15
421 30 Västra Frölunda
Sweden
Tel. +46 31 7266-200
Fax +46 31 7266-201
info@kuka.se

Switzerland

KUKA Roboter Schweiz AG
Riedstr. 7
8953 Dietikon
Switzerland
Tel. +41 44 74490-90
Fax +41 44 74490-91
info@kuka-roboter.ch
www.kuka-roboter.ch

Taiwan

KUKA Robot Automation Taiwan Co. Ltd.
136, Section 2, Huanjung E. Road
Jungli City, Taoyuan
Taiwan 320
Tel. +886 3 4371902
Fax +886 3 2830023
info@kuka.com.tw
www.kuka.com.tw

Thailand

KUKA Robot Automation (M)SdnBhd
Thailand Office
c/o Maccall System Co. Ltd.
49/9-10 Soi Kingkaew 30 Kingkaew Road
Tt. Rachatheva, A. Bangpli
Samutprakarn
10540 Thailand
Tel. +66 2 7502737
Fax +66 2 6612355
atika@ji-net.com
www.kuka-roboter.de

UK

KUKA Automation + Robotics
Hereward Rise
Halesowen
B62 8AN
UK
Tel. +44 121 585-0800
Fax +44 121 585-0900
sales@kuka.co.uk

USA

KUKA Robotics Corp.
22500 Key Drive
Clinton Township
48036 Michigan
USA
Tel. +1 866 8735852
Fax +1 586 5692087
info@kukarobotics.com
www.kukarobotics.com

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