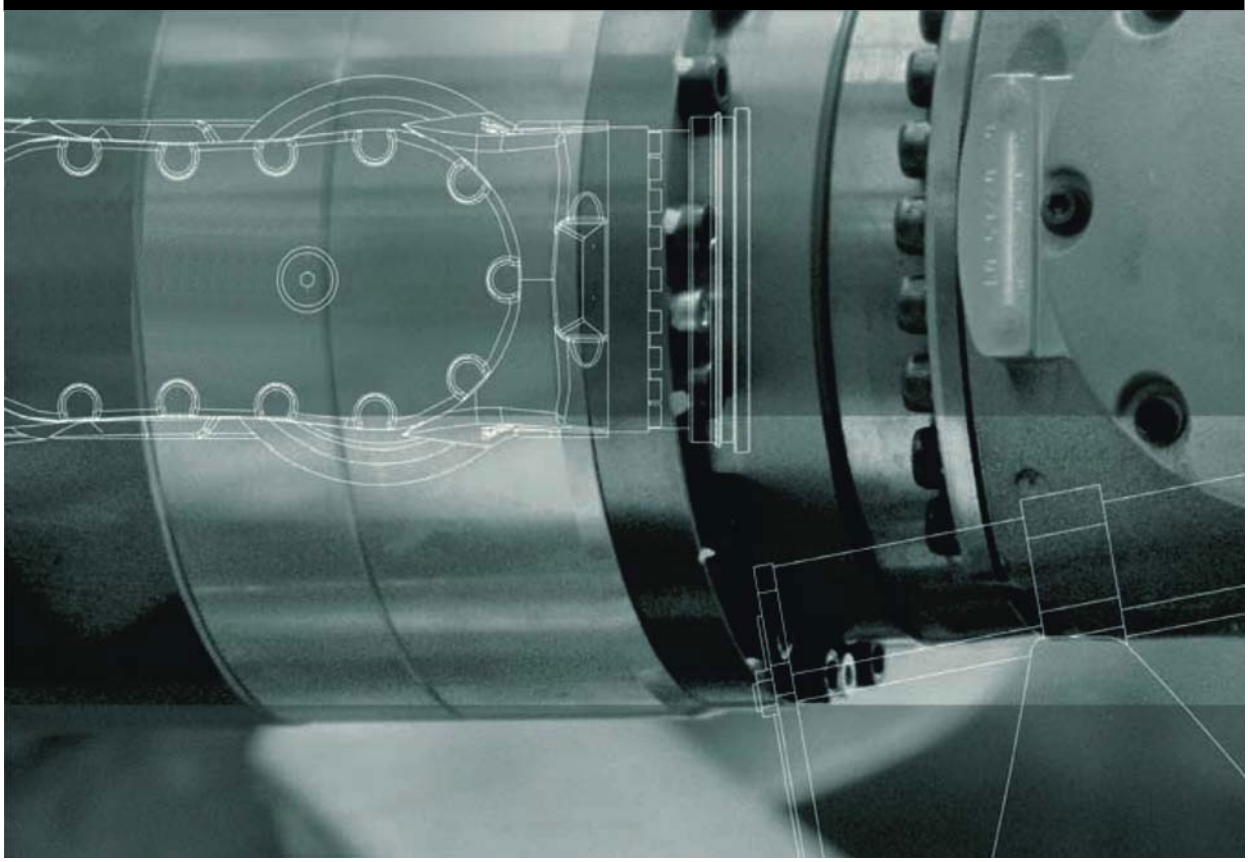
KUKA

Controller

KUKA Laboratories GmbH

KR C2 lr

Operating Instructions



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Contents

1 Introduction

1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:

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

Each of these sets of instructions is a separate document.

1.2 Representation of warnings and notes

Safety

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

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

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

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

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

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

Notes

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

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

1.3 Terms used

Term	Description
EMC	Electromagnetic compatibility
KCP	Teach pendant (KUKA Control Panel)
KSS	KUKA System Software
Motherboard	Main board of the control PC
MFC3	Multi-function card
PLC	Programmable logic controller
USB	Universal Serial Bus. Bus system for connecting additional devices to a computer.

Term	Description
UPS	Uninterruptible power supply
VxWorks	Real-time operating system

2 Purpose

2.1 Target group

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

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

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

2.2 Intended use

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

- KUKA industrial robots

Impermissible misuse

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

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

3 Product description

3.1 Description of the industrial robot

The industrial robot consists of the following components:

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

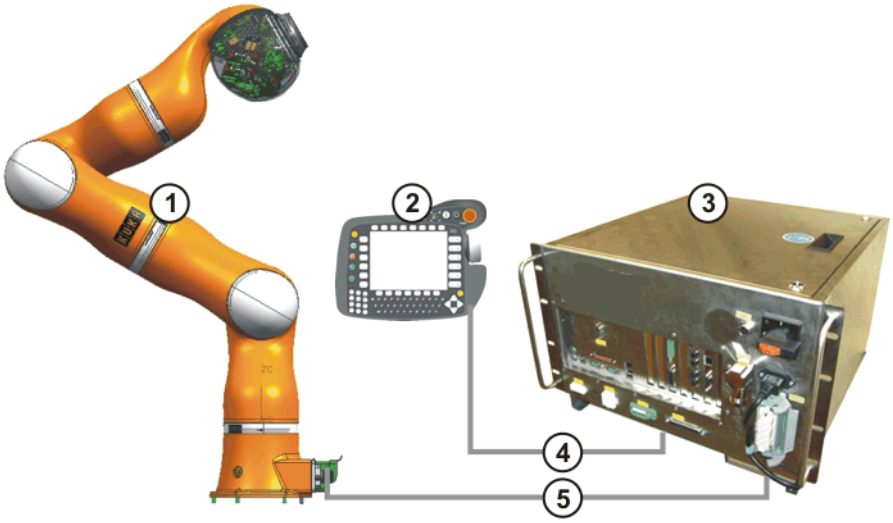

Fig. 3-1: Example of an industrial robot

1	Manipulator	4	Connecting cable/KCP
2	Teach pendant	5	Connecting cable/robot
3	Robot controller		

3.2 Overview of the KR C2 lr robot controller

The robot controller is used for controlling the following systems:

- KUKA robots

The robot controller consists of the following components:

- Control PC
- Power unit
- Safety logic
- Teach pendant (KCP)
- Connection panel

The robot controller can be installed in a 19" rack.

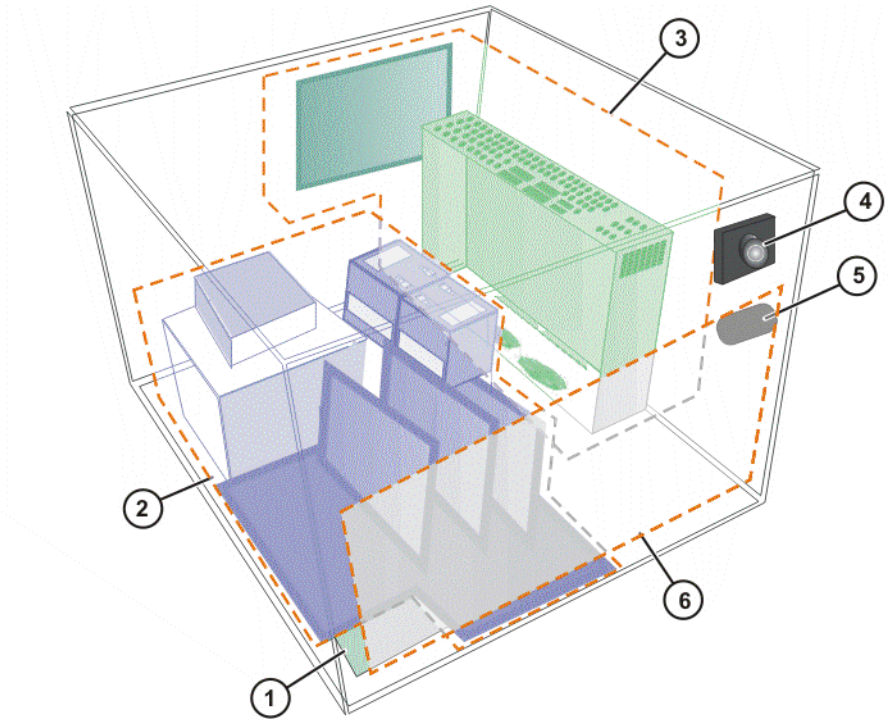

Fig. 3-2: Overview of KR C2 lr

1	Safety logic (ESC)	4	Main switch
2	Control PC	5	Power supply connection
3	Power unit	6	Connection panel

3.3 Description of the control PC

Functions

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

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

Overview

The control PC includes the following components:

- Motherboard with interfaces
- Processor and main memory
- Hard drive
- MFC3
- KVGA
- Sercos
- Batteries

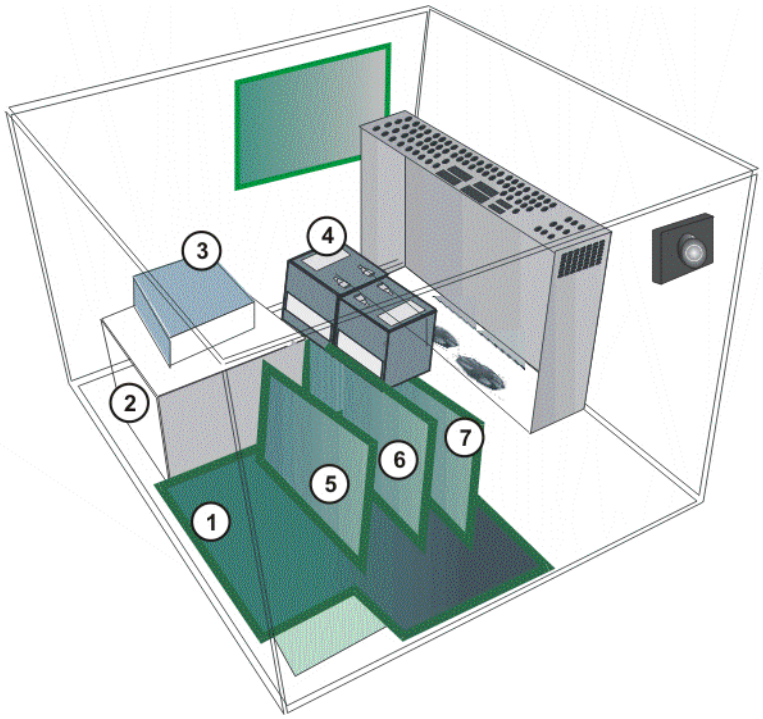

Fig. 3-3: Control PC structure

1	Motherboard	5	MFC3 card
2	PC power supply unit	6	Sercos card
3	Hard drive	7	KVGA card
4	Batteries		

3.3.1 PCI slot assignment

Overview

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

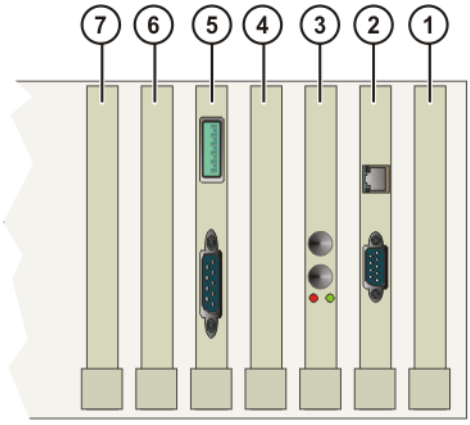

Fig. 3-4: PCI slots

Item	Slot	Plug-in card
1	1	Profibus master/slave card (optional)
2	2	KVGA card
3	3	Sercos FOC card
4	4	free
5	5	MFC3 card

Item	Slot	Plug-in card
6	6	3COM Ethernet (optional)
7	7	free

3.3.2 PC interfaces

Overview

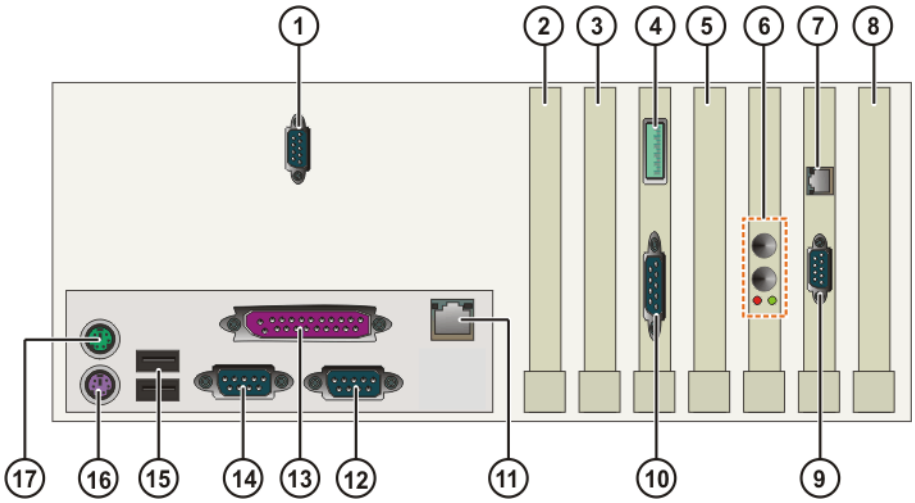

Fig. 3-5: PC interfaces

Item	Interface	Item	Interface
1	ST5 serial real-time interface COM 3	10	X2 DC inputs and outputs. Interface to the CI3 board
2	Not assigned	11	X804 Ethernet
3	PCI slot 6	12	COM 1 serial interface
4	X801 DeviceNet (MFC3)	13	LPT1 parallel interface
5	PCI slot 4	14	COM 2 serial interface
6	Sercos FOC (>>> 3.3.6 "Sercos card" Page 17)	15	USB (2x)
7	X805 KCP display (KVGA)	16	Keyboard connection
8	PCI slot 1	17	Mouse connection
9	X821 external monitor (KVGA)		

3.3.3 Motherboard

Configuration

The following components are located on the motherboard:

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

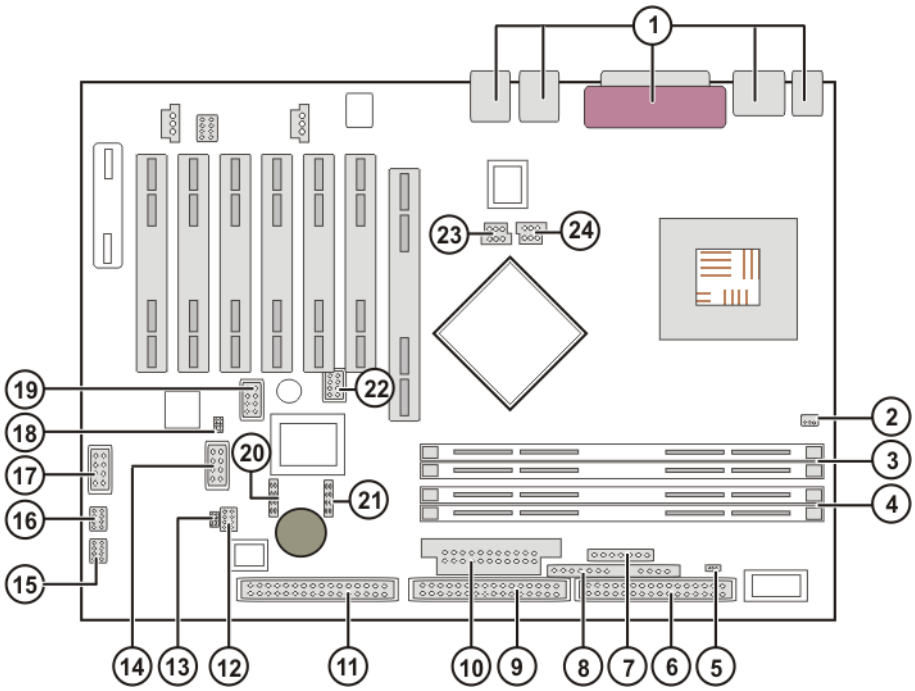

Fig. 3-6: Motherboard

Connections

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

KUKA Roboter GmbH 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 KUKA Roboter GmbH.

3.3.4 Hard drive

Description

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

The following systems are available on the hard drive:

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

3.3.5 Multi-function card (MFC3)

Description

The MFC3-Tech is used in the robot controller:

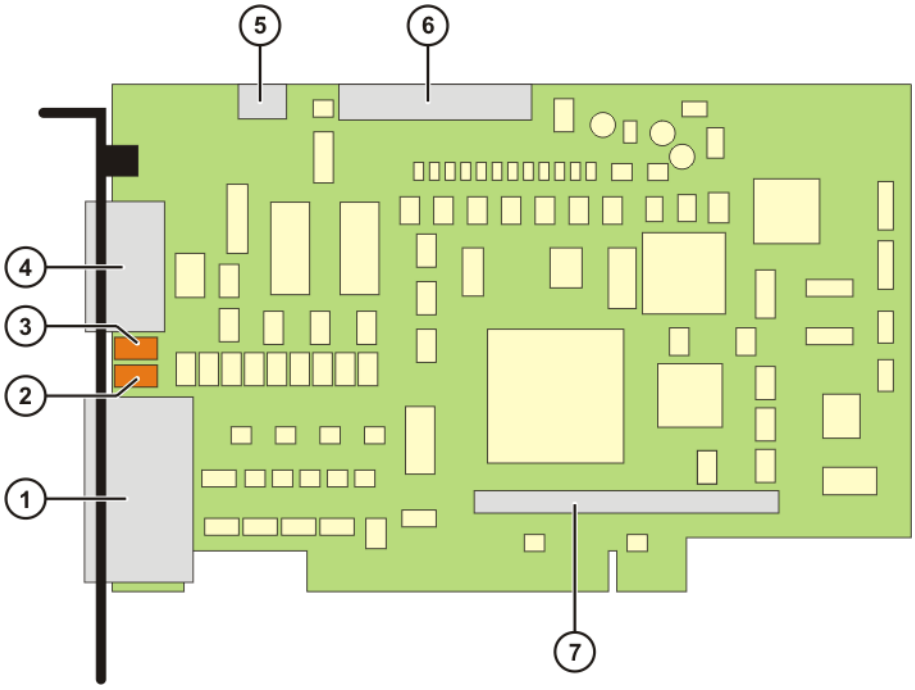

Fig. 3-7: MFC3 card

Connections

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

MFC3 Tech

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

- RTAcc chip for VxWinRT (real-time function).

- DeviceNet connection.
  - Customer-specific interface.
  - As master circuit only.
- Interface to the CI3 safety logic.
- Interface for the CR option (RoboTeam).
- Fan monitoring.

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

3.3.6 Sercos card

Overview

The Sercos card is the digital interface between the robot controller and the drives

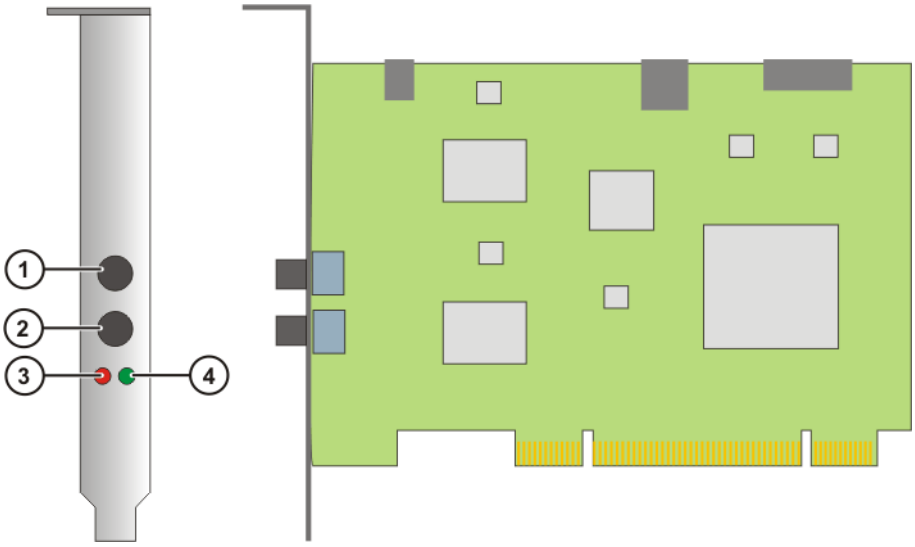

Fig. 3-8: Overview of Sercos card

Connections

Item	Connector	Description
1	FOC Tx	Output
2	FOC Rx	Input

LEDs

Item	LED	Description
3	Red	Sercos ring broken
4	Green	Sercos ring closed

3.3.7 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 (vertical frequency must not exceed 31.5 kHz).

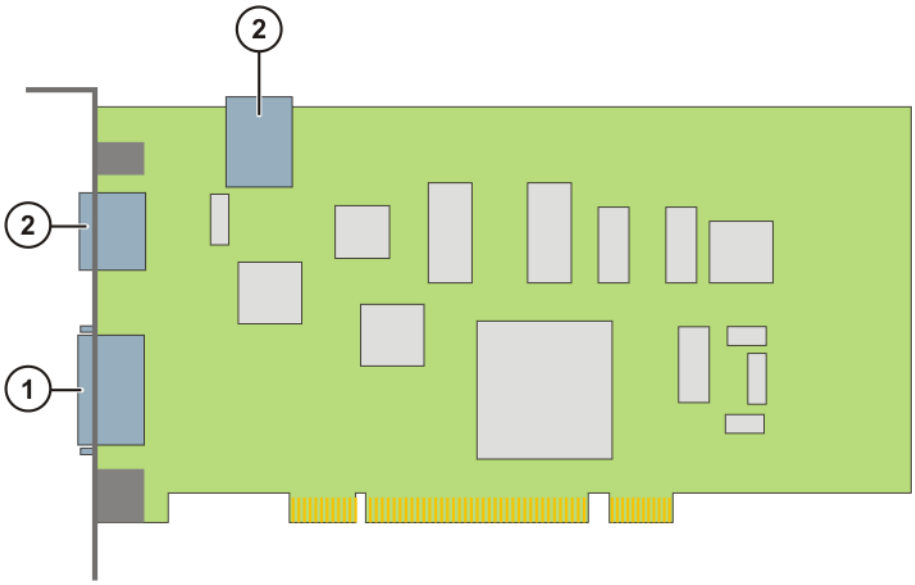

Fig. 3-9: KVGA card

Connections

Item	Connector
1	External monitor connection
2	KCP connection

Only one KCP may be connected.

3.3.8 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 KPS 10-48 which also monitors their state.

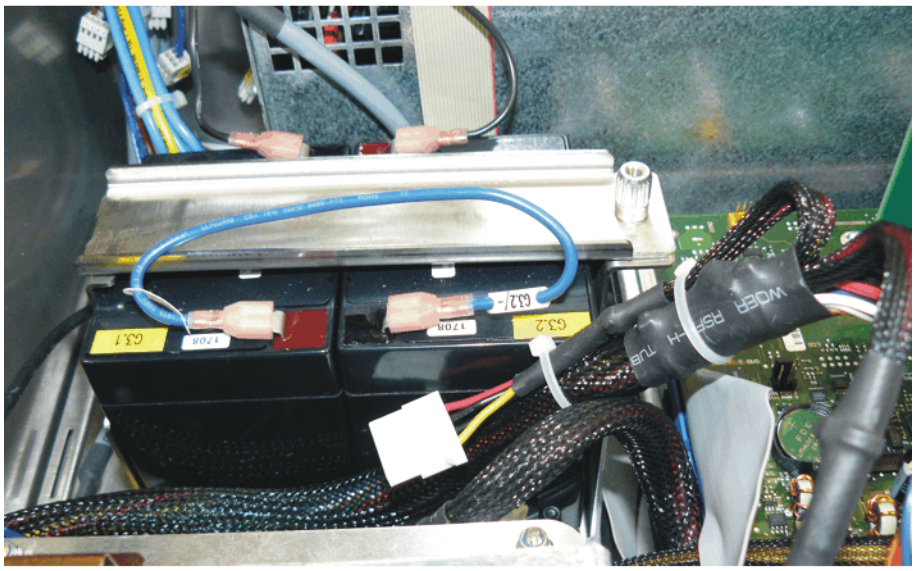

Fig. 3-10: Batteries

3.4 Description of the power unit

Overview

The power unit includes the following components:

- Power supply unit with fan
- Main switch
- Power supply connection with mains filter
- Auxiliary card

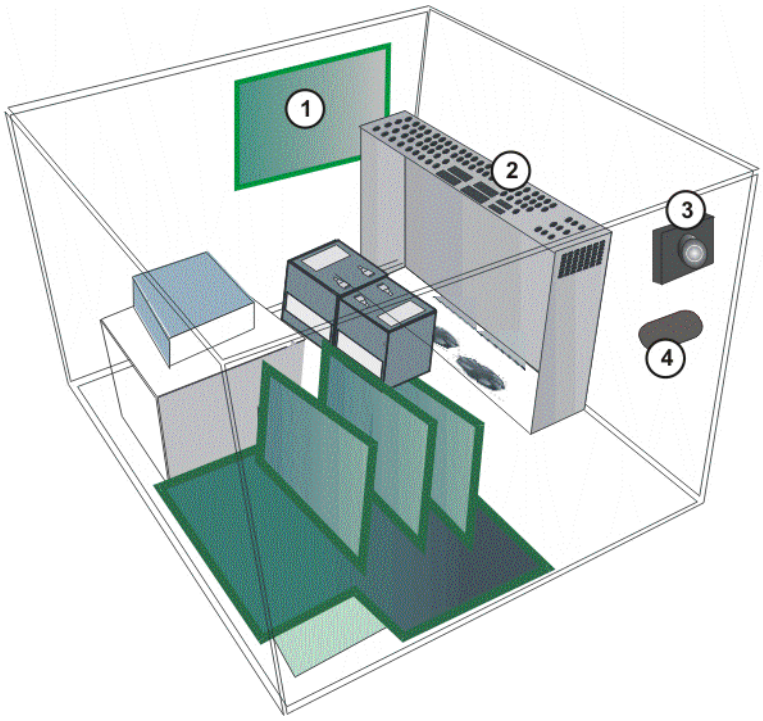

Fig. 3-11: KR C2 lr power unit

1	Auxiliary card	3	Main switch
2	Power supply unit with fan	4	Power supply connection with mains filter

3.4.1 KPS 10-48 power supply unit

Description

The KPS 10-48 has the following functions:

- 48 V DC intermediate circuit voltage to the robot.
- 27 V DC without battery backup for power supply to the ESC circuit.
- 27 V DC with battery backup for the PC power supply and KCP.
- 48 V DC, with battery backup and electrically isolated, for the robot servo drive modules and holding brakes.
- Battery charging and discharging circuit.
- Disconnection of the battery backup max. 5 minutes after PowerOff.

To prevent loss of data, the max. permissible value for the power off reaction time in the variable $POWEROFF_DELYTIME is 180 s.

- Safe cut-off of the 48 V robot supply via the ESC.
- Cooling by means of the intrinsically safe fans with standstill monitoring in the housing.
- Connection from the power unit to the ESC circuit.

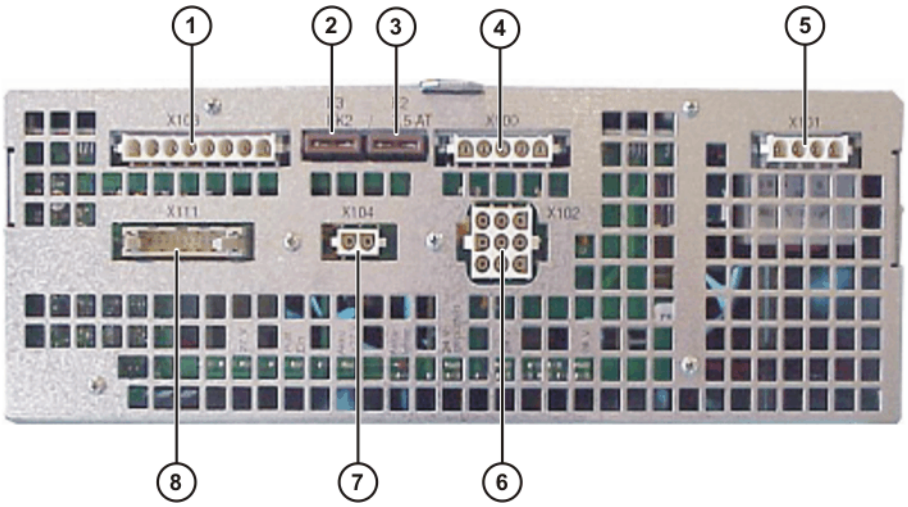

Fig. 3-12: KPS 10-48

Connections

Item	Connector	Description
1	X103	Internal supply 24 V
4	X100	Grounded neutral
5	X101	Infeed 110/230 V
6	X102	Robot supply 48 V
7	X104	PC supply 24 V
8	X111	Control and message signals

Fuses

Item	Fuse	Value in A	Circuit
2	F2	7.5	Battery
3	F3	7.5	Battery

3.4.2 Auxiliary card

Description

The auxiliary card has the following functions:

- 80 W monitoring in manual mode
- Ballast circuit with monitoring functions
- Current loop for switching of the drives in the robot
- Signal level adaptation for fan monitoring
- Brake release voltage

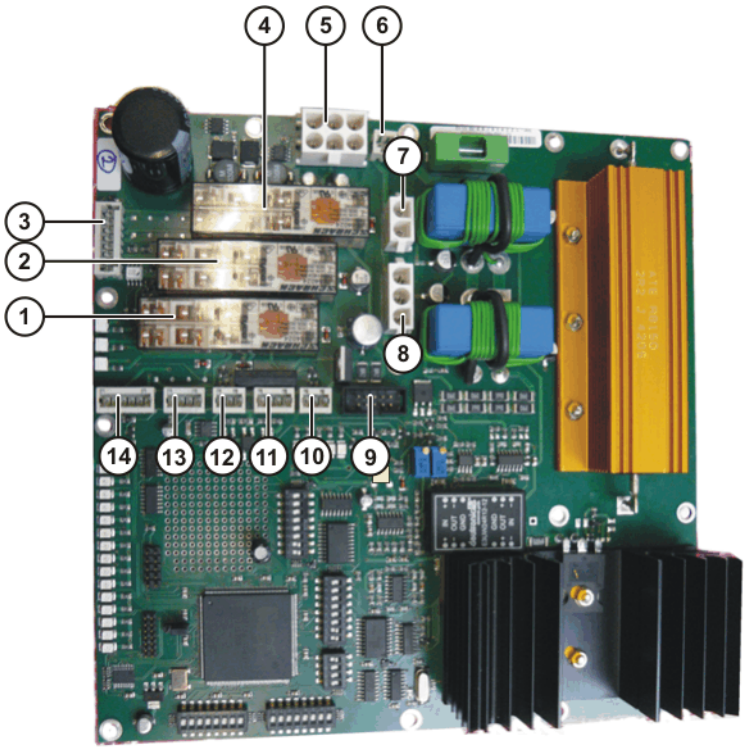

Fig. 3-13: Overview of auxiliary card

Connections

Item	Description	Description
3	X6	Signal connection AUX1-ESC-CI2
5	X1	48 V supply to AUX1 card
6	X10	24 V supply, without battery backup, to AUX1 card
7	X2	48 V supply to motors A1...A2
8	X3	48 V supply to motors A3...A7
9	X18	Signal connection AUX1-ESC-CI2
10	X13	Signal connection AUX1-MFC3-Tech
11	X8	48 V brake release voltage supply A1...A7 (X63)
12	X7	10 mA supply to emergency loop
13	X4	48 V supply to robot electronics
14	X5	Interface X15 power switching

Relay

Item	Description	Description
1	K1	Dual-channel safety circuit
2	K3	Dual-channel safety circuit
4	K2	Dual-channel safety circuit

3.5 Description of the KUKA Control Panel (KCP)

Function

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

3.5.1 Front view

Overview

Fig. 3-14: Front view of KCP

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

3.5.2 Rear view

Overview

Fig. 3-15: Rear view of KCP

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

Description

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

3.6 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:

- CI2 board

- KCP (master)
- KPS 10-80
- 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

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 button
- Enabling switches

The node receives single-channel signals from:

- Drives ON
- AUTO mode, TEST mode

The ESC circuit will only function with the KCP connected. If the KCP is unplugged during operation, the drives are immediately switched off.

Node on the MFC3

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

3.6.1 ESC nodes

Configuration

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

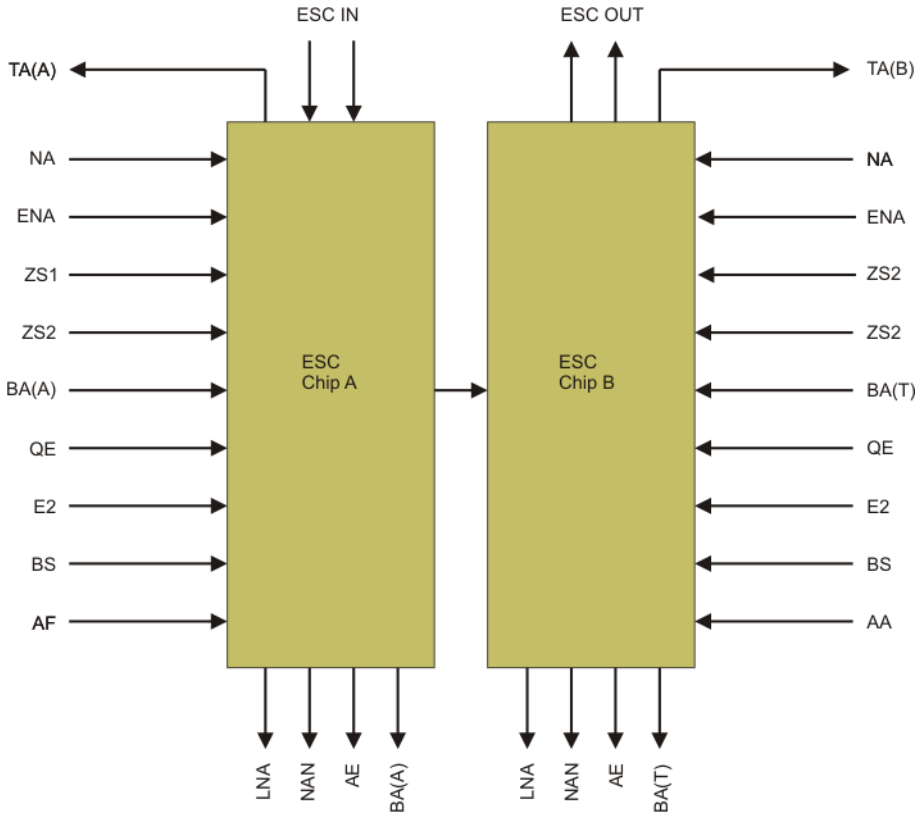

Fig. 3-16: ESC nodes

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.
ZS1	Enabling switches on the KCP	Input for external enabling switch (dual-channel, 1-step). If the signal is interrupted in Test mode, the drives contactor drops out immediately.
ZS2	Enabling switches, panic position	
BA	Operating mode (A=Automatic, T=Test)	Inputs for external mode selector switch (single-channel). If the Automatic and Test modes are activated simultaneously, the drives contactor drops out immediately.
AE	Drives ON output	Output for the drives contactor (dual-channel). The contactor is activated/deactivated by setting the voltage to 24 V/0 V.
AF	Drives enable	Input for external drives enable (single-channel). If the signal is interrupted, the drives contactor drops out immediately.
QE	Qualifying input	0 signal causes a category 0 STOP in all operating modes.
E2	Special key-switch (customer-specific)	-

Signal name	Meaning	Description
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.
AAU-TO/ ATEST BA	Operating mode	Output (single-channel). The corresponding output is set depending on the operating mode. With the relay variant, the contact is closed if the corresponding operating mode has been selected.

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

3.6.2 CI2 board

Description

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

- Operating modes
- Drives ON
- Local E-STOP

The ESC circuit can be reset using the reset button.

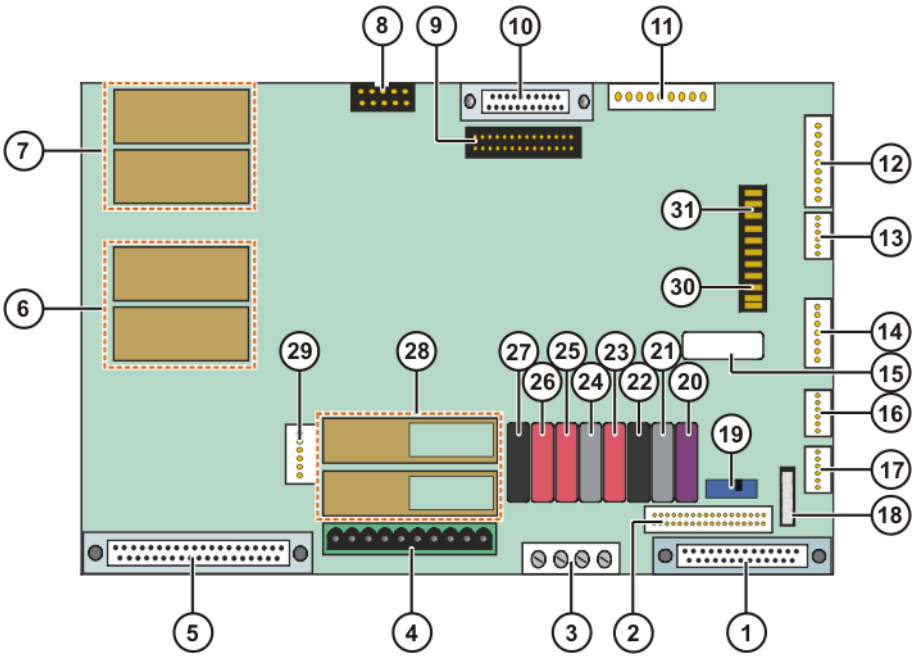

Fig. 3-17

Connections

Item	Designation	Description
1	X3	Not assigned
2	X9	MFC3 inputs/outputs
3	X1	27 V supply voltage infeed
4	X2	Peripheral interface X12 (optional)
5	X24	Peripheral interface X11
8	X18	DSE TTL I/O connection
9	X2	Connection to KPS 8-80
10	X22	Peripheral interface for inputs and outputs
11	X16	Not assigned
12	X4	24 V MFC3 inputs and BA input
13	X7	CAN I/O module connection
14	X6	External ESC bus (power supply)
16	X5	KCP connection
17	X21	KCP power supply and CAN
18	X10	RS 232 from MFC3 (optional)
29	X8	E-STOP / Servo Disconnect (optional)
30	X14	Jumper plug for X13
31	X13	Not assigned

Relays

Item	Designation	Description
6	Relay	Message: Local E-STOP
7	Relay	Message: Operating mode Auto/Test
28	Relay	Message: Drives ON

Fuses

Item	Designation	Value in A	Description
15	F2	2	Node supply
20	F10	3	ESC safety circuit
21	F3	2	Contactor control
22	F15	7.5	Periphery X12

Item	Designation	Value in A	Description
23	F14	4	Periphery X12
24	F1	2	Periphery X12
25	F13	3	27 V without battery backup
26	F12	4	Periphery X12
27	F16	7.5	Periphery X12

Reset

Item	Designation	Description
19	KY1	ESC Reset button

3.7 Description of interfaces

Overview

The connection panel of the robot controller consists as standard of connections for the following cables:

- Power supply cable
- Motor/data cable
- KCP cable
- Peripheral cables

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

Connection panel

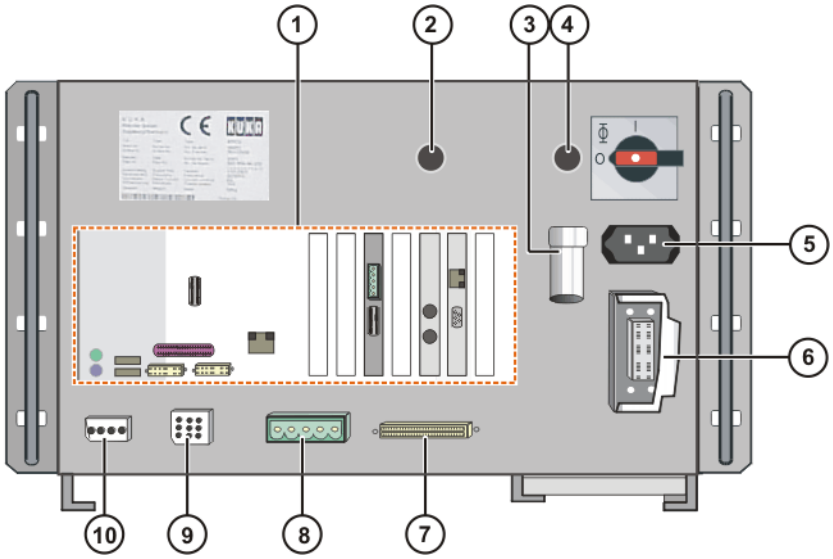

Fig. 3-18: KR C2 lr interfaces

Item	Interface	Item	Interface
1	PC interfaces (>>> 3.3.2 "PC interfaces" Page 14)	6	X20 Motor connection
2	Cable gland for FOC	7	X11 interface
3	X19 KCP connection	8	X12 customer interface
4	X63 brake release	9	X15 power switching
5	X1 power supply connection	10	X14 ESC power supply

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

3.7.1 Power supply connection X1

Description

The robot controller is connected to the mains via a 3-pole socket for non-heating apparatus.

Connector pin allocation

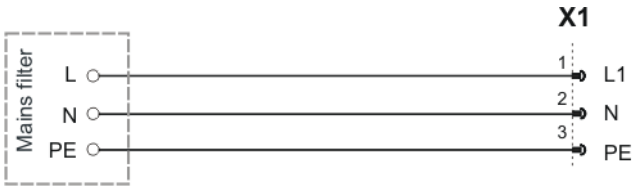

Fig. 3-19: Connector pin allocation X1

Infeed

- 230 V 50/60 Hz

Fusing

- 2x 10 A slow-blowing, type C

3.7.2 Interface X12

Description

The relay contacts on the CI2 board are closed in the case of Drives ON.

Connector pin allocation

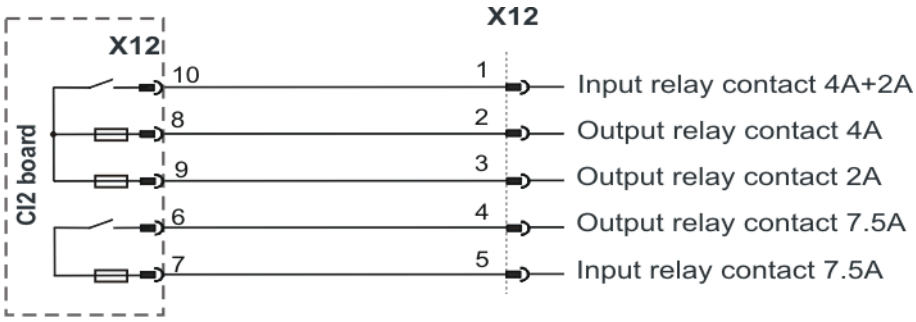

Fig. 3-20: Interface X12

3.7.3 External ESC supply X14

Description

An external ESC voltage supply (24 V ±10%) can be connected via connector X14. In the case of external ESC voltage supply, jumpers 1/3 and 2/4 must be removed from connector X14.

Connector pin allocation

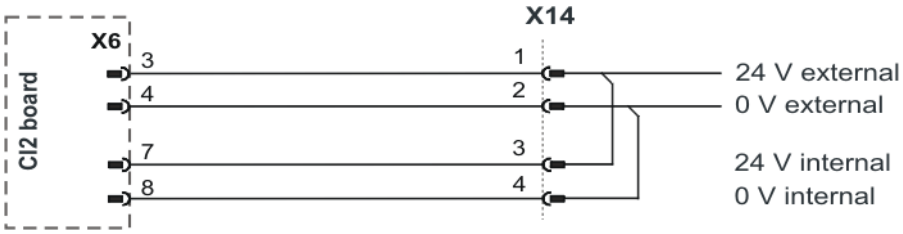

Fig. 3-21: External ESC supply via X14

3.7.4 Power limitation X15

Description

This interface is used to reduce the robot power to 80 W. External operator safety components (light barriers, gate switches, etc.) can be connected to this. If the robot moves into a defined zone, the robot drive power is limited to 80 W (e.g. for manual guidance). When the robot leaves this zone, the power limitation is deactivated again without acknowledgement (normal operation).

3.7.5 KCP connector X19

Connector pin allocation

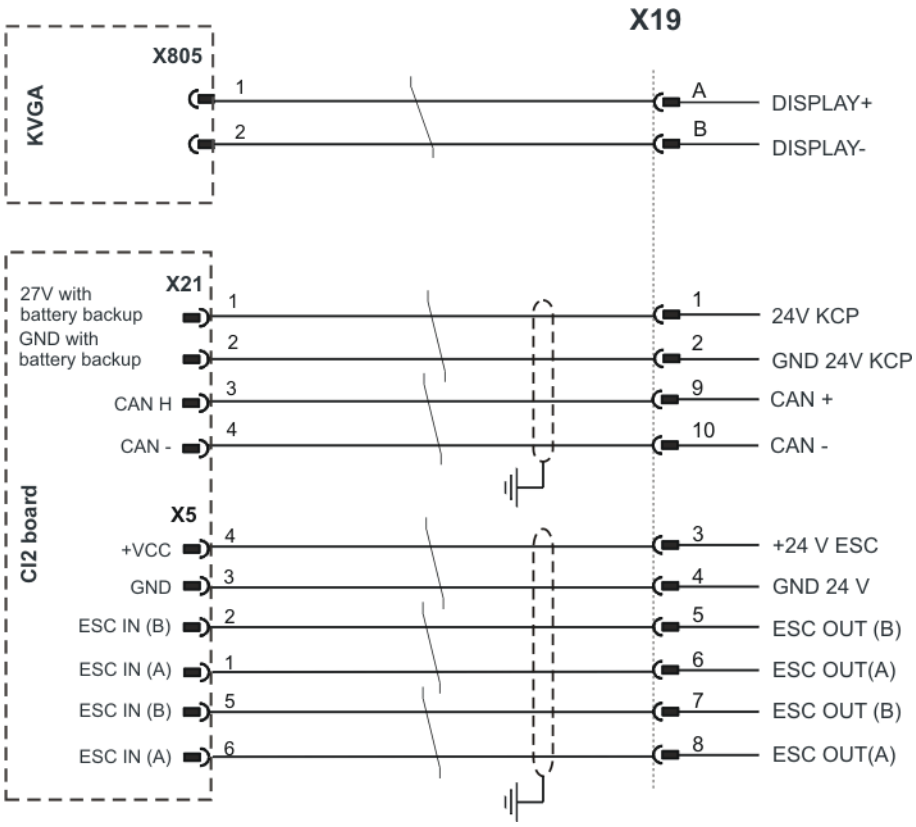

Fig. 3-22

3.7.6 Motor connector X20

Connector pin allocation

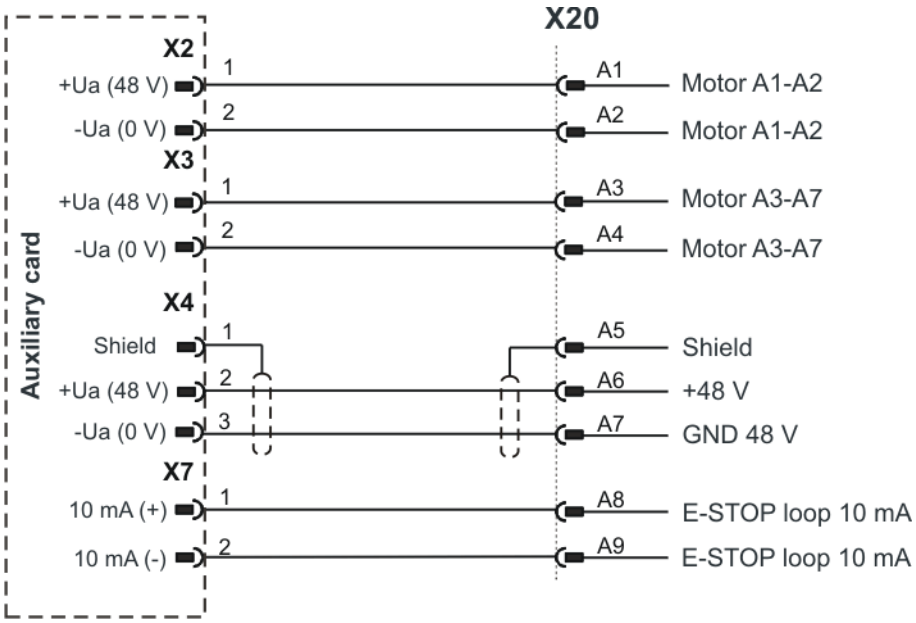

Fig. 3-23: Motor connector X20

3.7.7 Brake connector X63

Description A voltage can be tapped at connector X63 to release the motor brakes.

Connector pin allocation

Fig. 3-24: Connector pin allocation X63

3.7.8 COM3 interface

Connector pin allocation

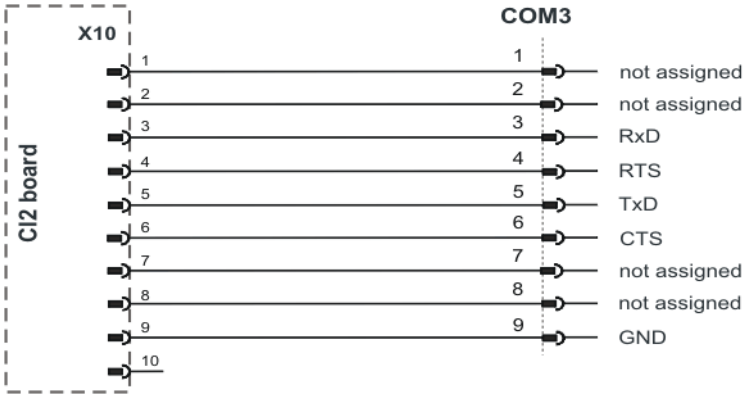

Fig. 3-25

3.8 Cooling of the robot controller

Description

The external air is drawn in by the two fans in the KPS 10-80. The air is distributed by means of deflector plates so that it can cool the individual components. The air exits the controller via openings in the housing at the PC power supply, hard drive and CPU.

Configuration

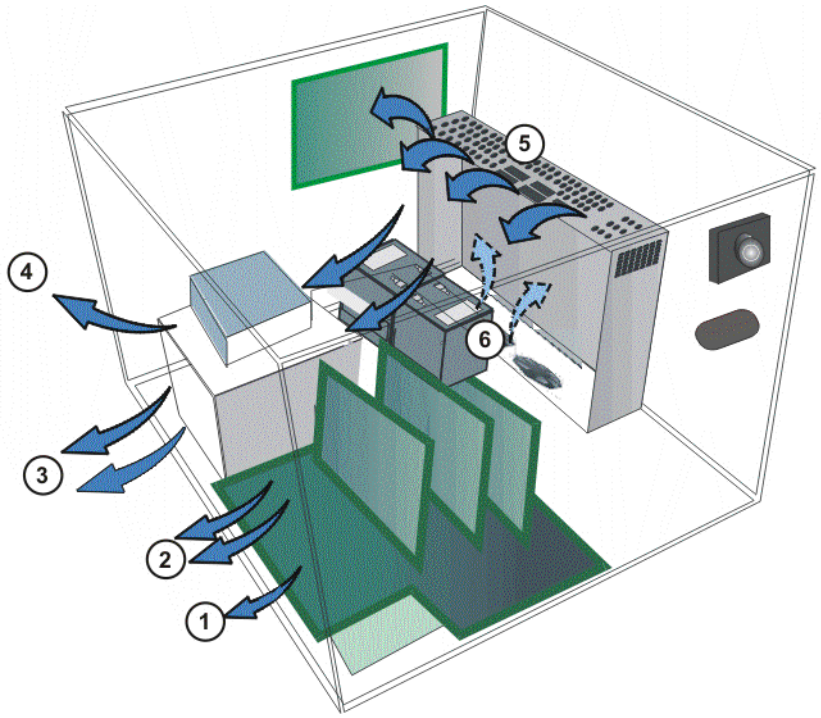

Fig. 3-26: Cooling

1	CI2 board cooling air outlet	4	Hard drive cooling air outlet
2	CPU cooling air outlet	5	KPS 10-80 cooling air outlet
3	PC power supply unit cooling air outlet	6	Air intake on underside of KPS 10-80

3.9 Category of the safety-oriented circuits

The following circuits conform to the requirements of Performance Level d and Category 3 according to EN ISO 13849-1:

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

4 Technical data

Basic data

Control cabinet type	KR C2 lr, 19" rack
Housing material	Stainless steel
Number of axes	max. 7
Weight	approx. 34 kg
Protection classification	IP 20
Max. power dissipation	350 W

Power supply connection

Rated supply voltage	115/230 V AC, single-phase, automatic switching between 115/230 V
Permissible tolerance of rated voltage	115/230 V +/-10%
Mains frequency	49 ... 61 Hz
Rated power input	1.1 kVA
Mains-side fusing	2x 10 A slow-blowing, type C

Environmental conditions

Ambient temperature during operation	+10 °C to +40 °C (283 K to 313 K)
Ambient temperature during storage/transportation without batteries	-25 °C to +70 °C (248 K to 343 K)
Ambient temperature during storage/transportation with batteries	-25 °C to +40 °C (248 K to 313 K)
Temperature change	max. 1.1 K/min
Humidity class	3k3 acc. to DIN EN 60721-3-3; 1995
Altitude	■ up to 1000 m above mean sea level with no reduction in power ■ 1000 to 4000 m above mean sea level with a reduction in power of 5%/1000 m

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

Vibration resistance

Vibration test in accordance with:	ASTM D4728-91
Shock test in accordance with:	EN 60068-2-27

KUKA Control Panel

Dimensions (W x H x D)	approx. 33x26x8 cm^3
VGA display resolution	640x480 pixels
VGA display size	8"
Weight	1.4 kg

Cable lengths

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

Cable	Standard length in m	Optional length in m
Power supply cable	3	-
Motor/data cable	3	-
KCP cable	10	20

4.1 Housing dimensions

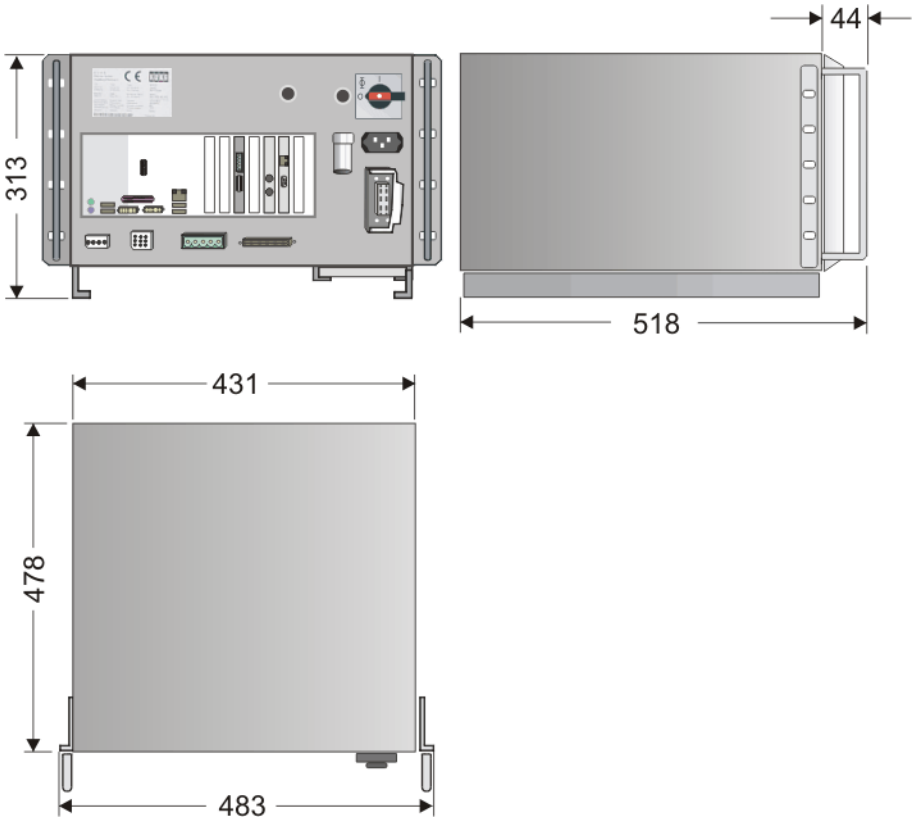

Fig. 4-1: Housing dimensions (in mm)

4.2 Handle dimensions

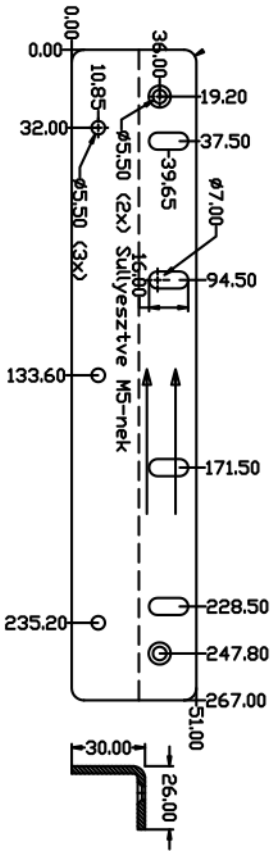

Fig. 4-2: Handle dimensions (in mm)

4.3 Plates and labels

Overview The following plates and labels are attached to the housing.

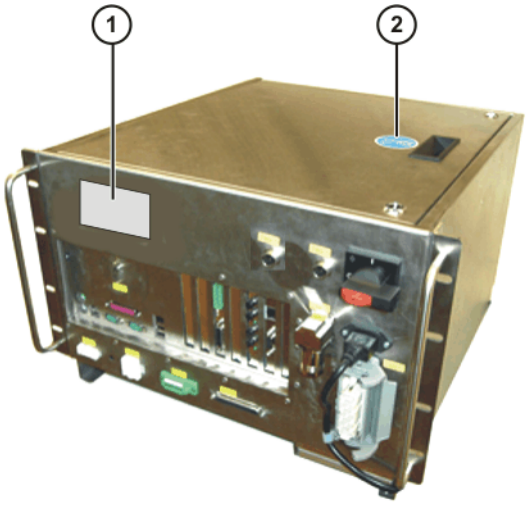

Fig. 4-3: Plates and labels

The plates may vary slightly from those illustrated as a result of updates.

Designations

Plate no.	Designation
1	Identification plate
2	Note: Unplug mains connector before opening the housing.

5 Safety

5.1 General

5.1.1 Liability

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

Components of the industrial robot:

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

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

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

Safety information

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

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

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

5.1.2 Intended use of the industrial robot

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

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

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

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

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

Misuse

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

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

5.1.3 EC declaration of conformity and declaration of incorporation

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

- The industrial robot is integrated into a complete system.

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

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

Declaration of conformity

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

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

Declaration of incorporation

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

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

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

5.1.4 Terms used

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

5.2 Personnel

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

- User
- Personnel

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

User

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

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

Personnel

Personnel must be instructed, before any work is commenced, in the type of work involved and what exactly it entails as well as any hazards which may exist. Instruction must be carried out regularly. Instruction is also required after particular incidents or technical modifications.

Personnel includes:

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

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

System integrator

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

The system integrator is responsible for the following tasks:

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

Operator

The operator must meet the following preconditions:

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

Example

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

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

Tasks	Operator	Programmer	System integrator
Maintenance			x
Repair			x
Decommissioning			x
Transportation			x

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

5.3 Workspace, safety zone and danger zone

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

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

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

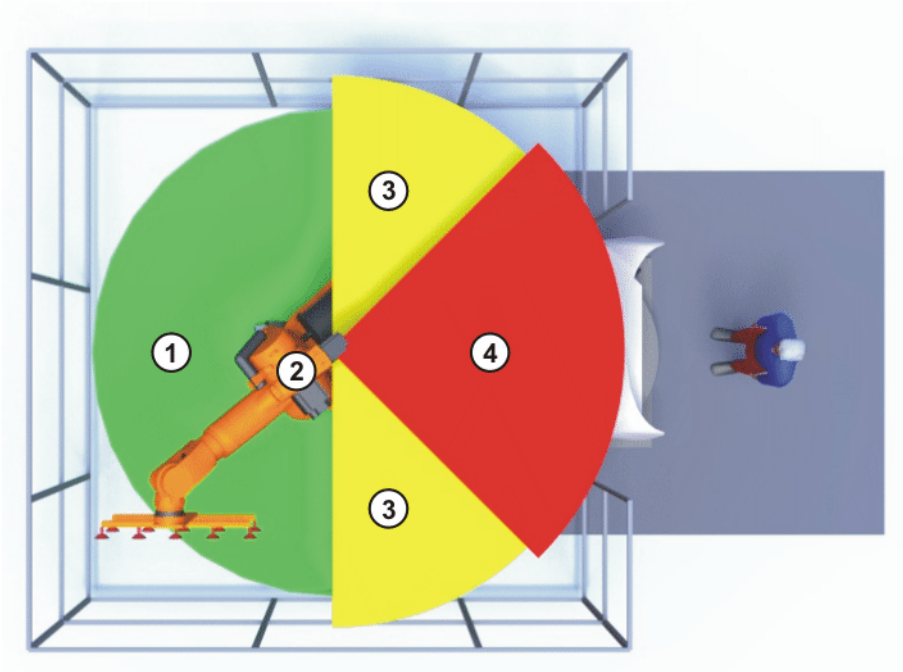

Fig. 5-1: Example of axis range A1

1	Workspace	3	Stopping distance
2	Manipulator	4	Safety zone

5.4 Triggers for stop reactions

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

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

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

5.5 Safety functions

5.5.1 Overview of safety functions

Safety functions:

- Mode selection
- Operator safety (= connection for the guard interlock)
- Local EMERGENCY STOP device (= EMERGENCY STOP button on the KCP)
- External EMERGENCY STOP device
- Enabling device

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

- The EMERGENCY STOP is not triggered more than once a day on average.
- The operating mode is not changed more than 10 times a day on average.
- Number of switching cycles of the main contactors:
  - Max. 100 per day
  - At least once every 6 months

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

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

5.5.2 ESC safety logic

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

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

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

The ESC safety logic monitors the following inputs:

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

The ESC safety logic monitors the following outputs:

- Operating mode
- Local E-STOP

5.5.3 Mode selector switch

The industrial robot can be operated in the following modes:

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

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

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

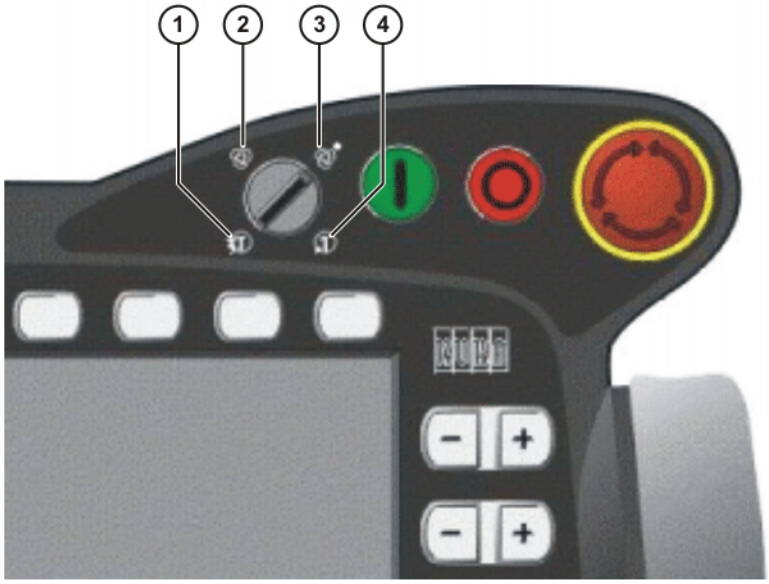

Fig. 5-2: Mode selector switch

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

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

5.5.4 Operator safety

The operator safety input is used for interlocking physical safeguards. Safety equipment, such as safety gates, can be connected to the dual-channel input. If nothing is connected to this input, operation in Automatic mode is not possible. Operator safety is not active in the test modes T1 (Manual Reduced Velocity) and T2 (Manual High Velocity).

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

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

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

5.5.5 EMERGENCY STOP device

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

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

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

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

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

1 EMERGENCY STOP button

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

5.5.6 External EMERGENCY STOP device

There must be EMERGENCY STOP devices available at every operator station that can initiate a robot motion or other potentially hazardous situation. The system integrator is responsible for ensuring this.

There must always be at least one external EMERGENCY STOP device installed. This ensures that an EMERGENCY STOP device is available even when the KCP is disconnected.

External EMERGENCY STOP devices are connected via the customer interface. External EMERGENCY STOP devices are not included in the scope of supply of the industrial robot.

5.5.7 Enabling device

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

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

- Not pressed
- Center position
- Panic position

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

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

Fig. 5-4: Enabling switches on the KCP

1 - 3 Enabling switches

5.6 Additional protective equipment

5.6.1 Jog mode

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

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

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

5.6.2 Software limit switches

The axis ranges of all manipulator and positioner axes are limited by means of adjustable software limit switches. These software limit switches only serve as machine protection and must be adjusted in such a way that the manipulator/ positioner cannot hit the mechanical end stops.

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

Further information is contained in the operating and programming instructions.

5.6.3 Labeling on the industrial robot

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

Labeling on the industrial robot consists of:

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

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

5.6.4 External safeguards

Safeguards

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

Physical safeguards must meet the following requirements:

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

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

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

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

Other safety equipment

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

5.7 Overview of operating modes and safety functions

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

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

5.8 Safety measures

5.8.1 General safety measures

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

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

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

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

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

KCP

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

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

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

External keyboard, external mouse

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

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

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

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

Faults

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

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

Modifications

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

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

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

5.8.2 Testing safety-related controller components

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

Check:

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

Additional checks are required during start-up and recommissioning.

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

5.8.3 Transportation

Manipulator

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

Robot controller

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

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

External axis (optional)

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

5.8.4 Start-up and recommissioning

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

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

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

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

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

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

Function test

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

General test:

It must be ensured that:

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

Test of safety-oriented circuits:

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

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

Test of reduced velocity control:

This test is to be carried out as follows:

1. Program a straight path with the maximum possible velocity.
2. Calculate the length of the path.
3. Execute the path in T1 mode with the override set to 100% and time the motion with a stopwatch.

⚠ WARNING It must be ensured that no persons are present within the danger zone during path execution. Death or severe physical injuries may result.

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

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

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

Machine data

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

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

5.8.5 Virus protection and network security

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

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

5.8.6 Manual mode

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

- Jog mode
- Teaching
- Programming
- Program verification

The following must be taken into consideration in manual mode:

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

  New or modified programs must always be tested first in Manual Reduced Velocity mode (T1).
- The manipulator, tooling or external axes (optional) must never touch or project beyond the safety fence.
- Workpieces, tooling and other objects must not become jammed as a result of the industrial robot motion, nor must they lead to short-circuits or be liable to fall off.
- All setup work must be carried out, where possible, from outside the safeguarded area.

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

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

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

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

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

- This mode may only be used if the application requires a test at a velocity higher than Manual Reduced Velocity.
- Teaching and programming are not permissible in this operating mode.
- Before commencing the test, the operator must ensure that the enabling devices are operational.
- The operator must be positioned outside the danger zone.

- There must be no other persons inside the safeguarded area. It is the responsibility of the operator to ensure this.

5.8.7 Simulation

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

5.8.8 Automatic mode

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

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

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

5.8.9 Maintenance and repair

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

The purpose of maintenance and repair work is to ensure that the system is kept operational or, in the event of a fault, to return the system to an operational state. Repair work includes troubleshooting in addition to the actual repair itself.

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

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

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

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

Robot controller

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

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

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

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

Hazardous substances

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

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

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

5.8.10 Decommissioning, storage and disposal

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

5.8.11 Safety measures for “single point of control”

Overview

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

Components:

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

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

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

Submit interpreter, PLC

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

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

Safety measures:

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

OPC server, remote control tools

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

Safety measures:

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

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

External keyboard/mouse

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

Safety measures:

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

5.9 Applied norms and regulations

Name	Definition	Edition
2006/42/EC	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
2004/108/EC	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC	2004
EN ISO 13850	Safety of machinery: Emergency stop - Principles for design	2008
EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles of design	2008
EN ISO 13849-2	Safety of machinery: Safety-related parts of control systems - Part 2: Validation	2008
EN ISO 12100-1	Safety of machinery: Basic concepts, general principles for design - Part 1: Basic terminology, methodology	2003
EN ISO 12100-2	Safety of machinery: Basic concepts, general principles for design - Part 2: Technical principles	2003

Name	Definition	Edition
EN ISO 10218-1	Industrial robots: Safety	2008
EN 614-1	Safety of machinery: Ergonomic design principles - Part 1: Terms and general principles	2006
EN 61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards; Immunity for industrial environments	2005
EN 61000-6-4	Electromagnetic compatibility (EMC): Part 6-4: Generic standards; Emission standard for industrial environments	2007
EN 60204-1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	2006

6 Planning

6.1 Overview of planning

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

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

Robot controller

Step	Description	Info
1	Electromagnetic compatibility (EMC)	(>>> 6.2 "Electromagnetic compatibility (EMC)" Page 59)
2	Installation conditions for robot controller	(>>> 6.3 "Installation conditions" Page 59)
3	Connection conditions	(>>> 6.4 "Connection conditions" Page 61)
4	Power supply connection	(>>> 6.5 "Power supply connection" Page 61)
5	Connection of the EMERGENCY STOP circuit	(>>> 6.6 "Connecting the EMERGENCY STOP circuit" Page 61)
6	Configuration of interface X11	(>>> 6.7 "Interface X11" Page 61)
7	Configuration of interface X15	(>>> 6.8 "Wiring interface X15" Page 64)
8	Switch on the drives in “Automatic External” mode.	(>>> 6.9 "Switching on the drives in “Automatic External” mode" Page 64)

6.2 Electromagnetic compatibility (EMC)

Description

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

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

6.3 Installation conditions

Dimensions

The robot controller can be installed in a 19" rack.

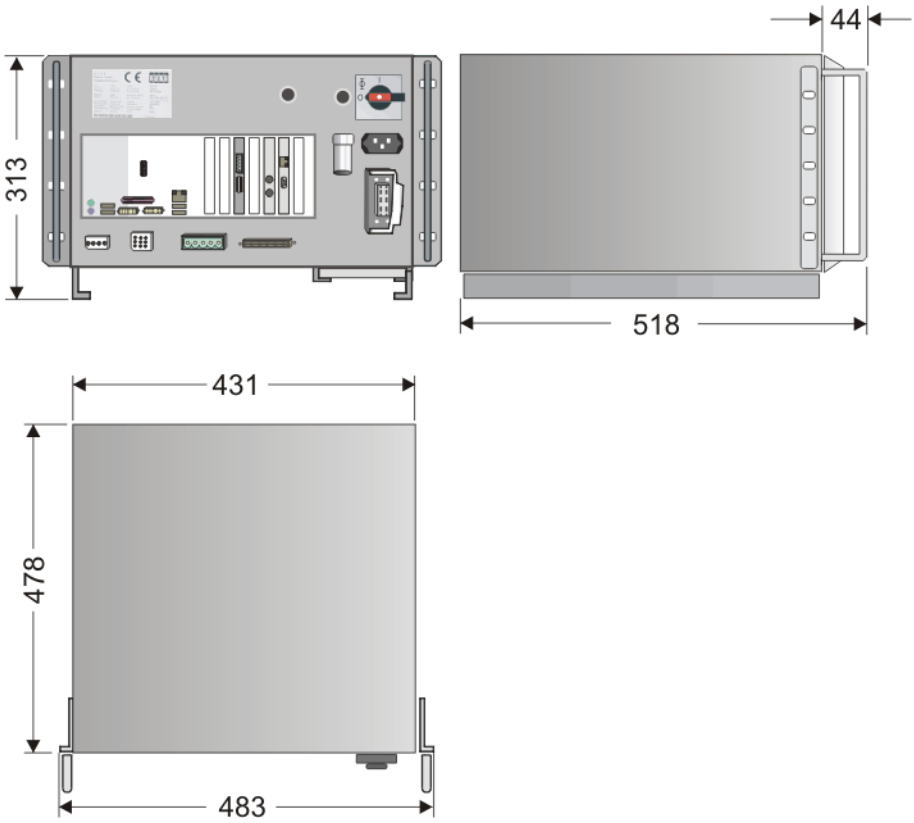

Fig. 6-1: Housing dimensions (in mm)

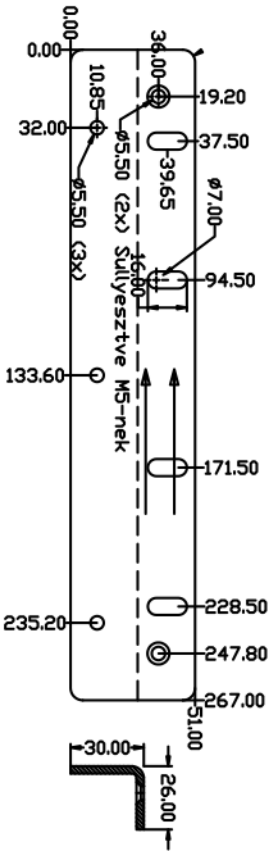

Fig. 6-2: Handle dimensions (in mm)

6.4 Connection conditions

Power supply connection

Rated supply voltage	115/230 V AC, single-phase, automatic switching between 115/230 V
Permissible tolerance of rated voltage	115/230 V +/-10%
Mains frequency	49 ... 61 Hz
Rated power input	1.1 kVA
Mains-side fusing	2x 10 A slow-blowing, type C

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
Power supply cable	3	-
Motor/data cable	3	-
KCP cable	10	20

6.5 Power supply connection

Description

The robot controller is connected to the mains via a 3-pole socket for non-heating apparatus connector.

Infeed

- 230 V 50/60 Hz

Fusing

- 2x 10 A slow-blowing, type C

6.6 Connecting the EMERGENCY STOP circuit

The following example shows how the EMERGENCY STOP circuit of the robot system can be connected to the periphery.

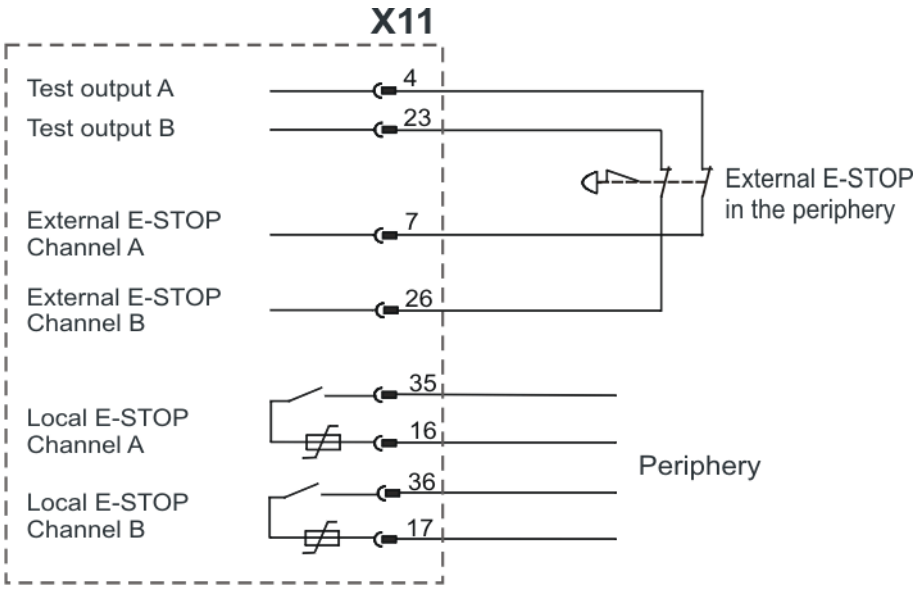

Fig. 6-3: Robot with periphery

6.7 Interface X11

Description

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

Wiring

Take the following points into consideration when wiring interface X11:

- System concept
- Safety concept

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

Connector pin allocation

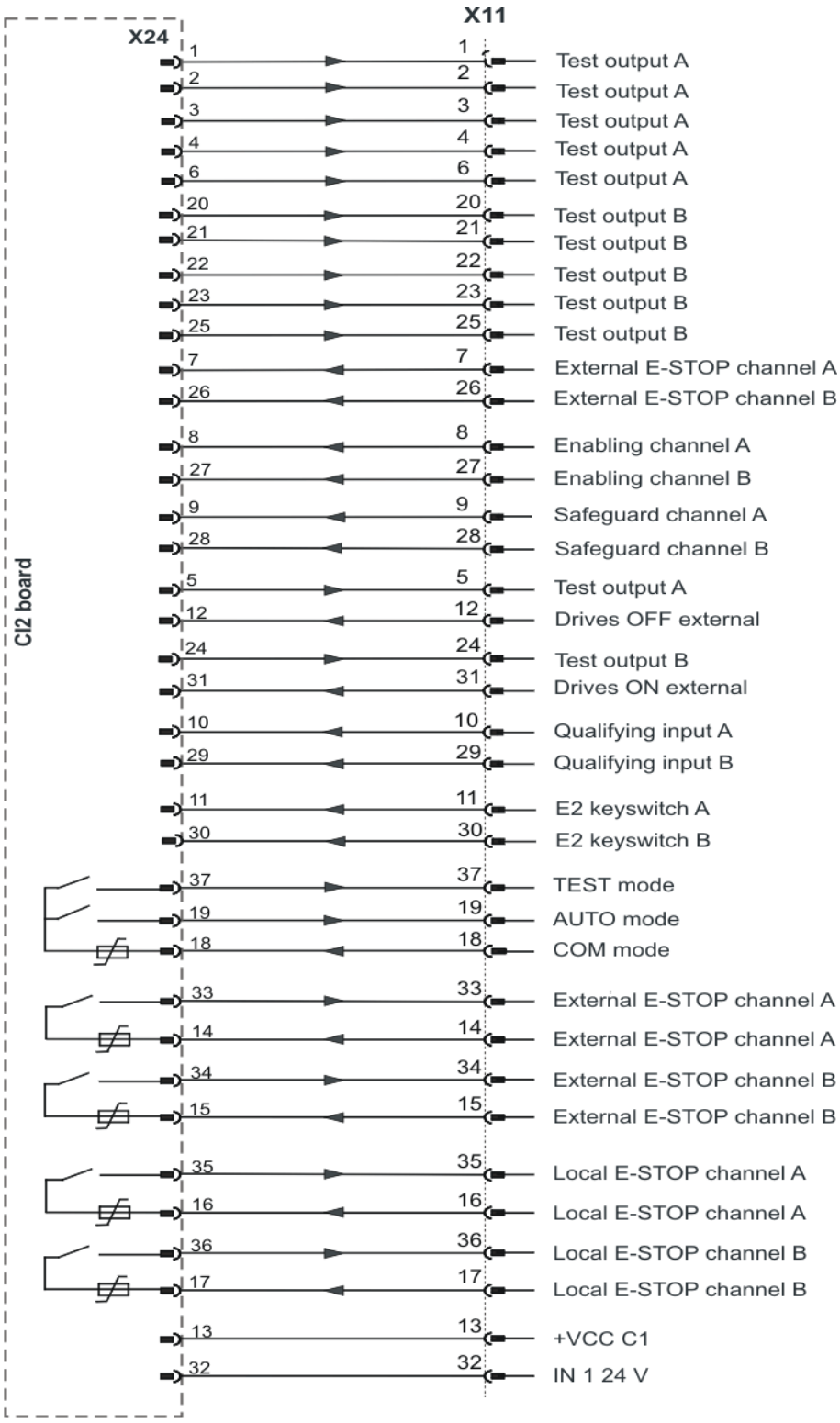

Fig. 6-4: Interface X11

Signal	Pin	Description	Comments
+24 V KCP 0 V KCP	13 32	24 V with the potential of the KCP supply, max. 0.5 A	-
Test output A (test signal)	1 2 3 4 5 6	Makes the pulsed voltage available for the individual interface inputs of channel A.	Connection example: safety gate locking mechanism is connected under channel A to pin 3 (TA_A) and pin 9.
Test output B (test signal)	20 21 22 23 24 25	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 22 (TA_B) and pin 28.
Drives OFF external, channel A (single-channel)	12	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 5 / 12 must be jumpered.
Drives ON external, channel B (single-channel)	31	For connection of a floating contact.	Pulse > 200 ms switches the drives on. Signal must not be permanently active.
Local E-STOP, channel A	16 / 35	Output, floating contacts from internal E-STOP max. 24 V.	In the non-activated state, the contacts are closed.
Local E-STOP, channel B	17 / 36		
External E-STOP, channel A	7	E-STOP, dual-channel input, max. 24 V.	-
External E-STOP, channel B	26		
Safeguard channel A	9	For dual-channel connection of a safety gate locking mechanism, max. 24 V.	Only effective in the AUTOMATIC modes.
Safeguard channel B	28		
Automatic operating mode	18 / 19	Floating contacts signal the operating mode.	-
Test mode	37 / 18		
E2 keyswitch channel A	11	E2 keyswitch, dual-channel, max. 24 V.	The input is at 0 V if keyswitch off.
E2 keyswitch channel B	30		
Qualifying input, channel A	10	0 signal causes a category 0 STOP in all operating modes.	If these inputs are not used, pin 10 must be jumpered to test output 3, and pin 29 to test output 4.
Qualifying input, channel B	29		

6.8 Wiring interface X15

Example If contacts X15 pins 1/3/4 and pins 2/5/6 are closed, the 80 W power limitation is not active.

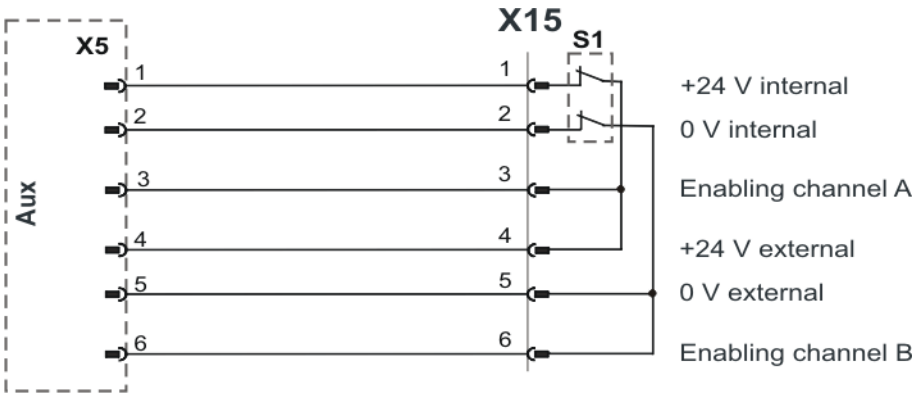

Fig. 6-5: Interface X15 with internal supply

S1 Customer's operator safety device

Example If contacts X15 pins 3/4 and pins 5/6 are closed, the 80 W power limitation is not active.

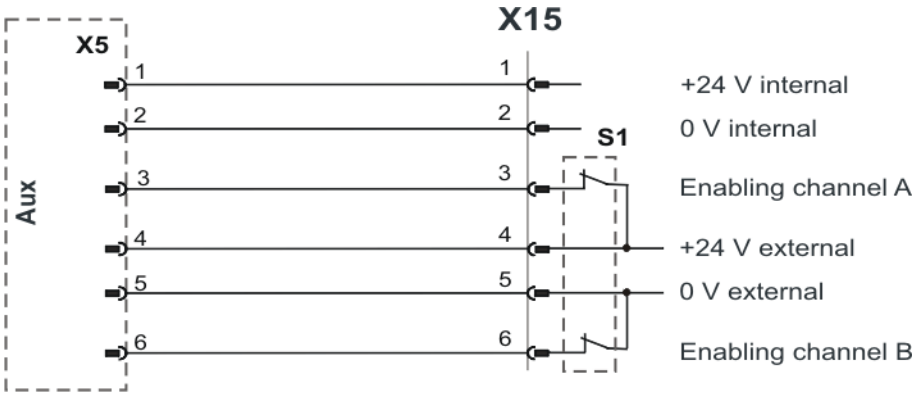

Fig. 6-6: Interface X15 with external supply

S1 Customer's operator safety device

6.9 Switching on the drives in "Automatic External" mode

In order to be able to switch on the drives in Automatic External mode, a relay K1 must be connected between X2 (PC interface), X11 and X14, as shown in the diagram (>>> Fig. 6-7).

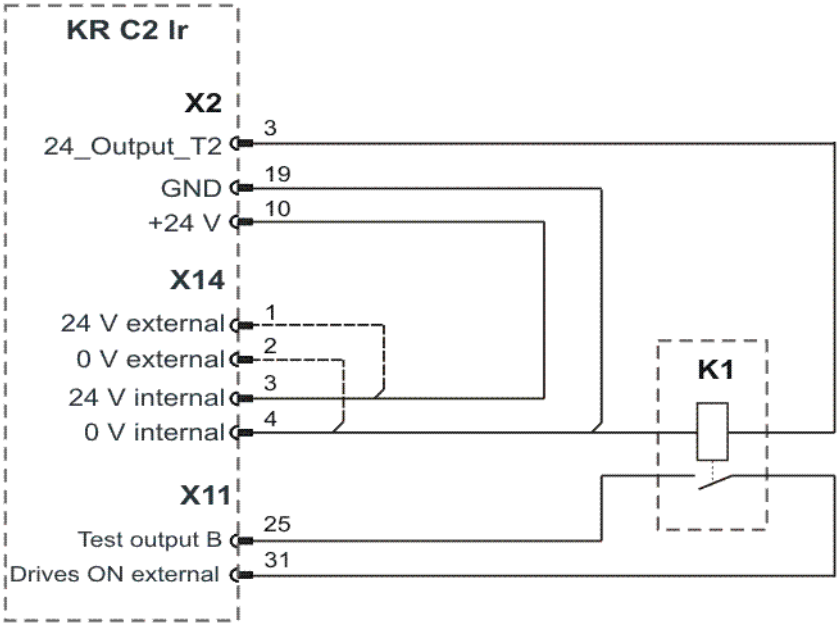

Fig. 6-7: Drives ON in Automatic External

If a jumper plug is used with interface X14, pin 1 must still be jumpered with pin 3, and pin 2 with pin 4.

The variables **UPS_CONTROL_MONITORING** and **MFC_AA_AF_SIGNALS** must be set to 1 in the configuration file Progress.ini.

7 Transportation

7.1 Transporting the robot controller

Preconditions

- The housing of the robot controller must be closed.
- No cables may be connected to the robot controller.
- The robot controller must be transported in a horizontal position.

Procedure

- Transport the robot controller using a pallet truck or a fork lift truck. The robot controller must be laid on a pallet.

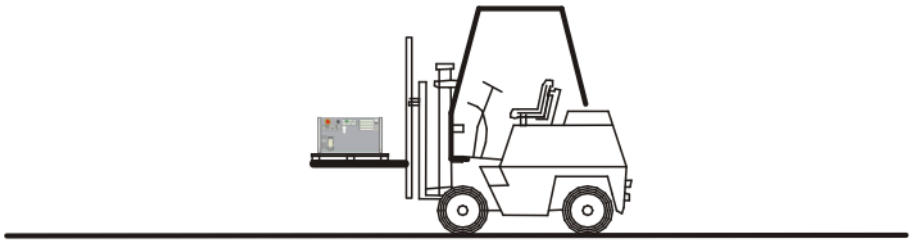

Fig. 7-1: Transport by fork lift truck

If the robot controller is installed in an electrical enclosure during transportation, this may result in vibrations (oscillations). Such vibrations can cause contact problems on the PC plug-in cards.

8 Start-up and recommissioning

8.1 Start-up overview

Step	Description	Info
1	Carry out a visual inspection of the robot controller.	-
2	Make sure that no condensation has formed in the robot controller.	-
3	Install the robot controller.	(>>> 8.2 "Installing the robot controller" Page 69)
4	Connect the connecting cables.	(>>> 8.3 "Connecting the connecting cables" Page 70)
5	Connect the KCP.	(>>> 8.4 "Connecting the KCP" Page 70)
6	Connect the robot controller to the power supply.	(>>> 8.5 "Connecting the robot controller to the power supply" Page 70)
7	Configure and connect interface X11.	(>>> 8.7 "Configuring and connecting connector X11" Page 70)
8	Wire and plug in connector X15.	(>>> 8.8 "Connecting interface X15" Page 71)
9	Switch on the robot controller.	(>>> 8.9 "Switching on the robot controller" Page 71)
10	Check the safety equipment.	Detailed information is contained in the operating instructions for the robot controller, in the chapter “Safety”.
11	Configure the inputs/outputs between the robot controller and the periphery.	Detailed information can be found in the field bus documentation.

8.2 Installing the robot controller

Description The robot controller can be installed in a 19" rack or as a standalone device.

Preconditions
- If the robot controller is to be installed in a 19" rack, the depth must be at least 800 mm.
- Both sides of the robot controller must be accessible to the cooling air. Clearance of 70 mm on each side.

Procedure
1. Only install the robot controller horizontally. (>>> Fig. 8-1)
2. Check the robot controller for any damage caused during transportation.

Fig. 8-1: Installation position of the KR C2 lr

8.3 Connecting the connecting cables

Overview

A cable set is supplied with the robot system. The basic version consists of:

- Motor/data cable
- Power supply connection cable

The following cables may be provided for additional applications:

- Peripheral cables

Preconditions

- Compliance with the connection conditions concerning:
  - Cable cross-section
  - Fusing
  - Voltage
  - Mains frequency
- Compliance with the safety regulations

Procedure

1. Connect the power supply connection cable.
2. Connect the motor/data cable.
3. Connect the interface cable.

8.4 Connecting the KCP

Procedure

- Connect the KCP to X19 on the robot controller.

8.5 Connecting the robot controller to the power supply

Procedure

- Connect the robot controller to the power supply via X1.

8.6 Connecting the EMERGENCY STOP circuit

Procedure

- Connect the EMERGENCY STOP circuit to interface X11.

8.7 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.

8.8 Connecting interface X15

Procedure

- Configure interface X15 and connect it on the robot controller. (>>> 6.8 "Wiring interface X15" Page 64)

8.9 Switching on the robot controller

Preconditions

- The robot has been installed in accordance with the LWR III operating instructions.
- All electrical connections are correct and the energy levels are within the specified limits.
- The housing of the robot controller must be closed.
- The peripheral devices are correctly connected.
- 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 robot controller must have adapted to the ambient temperature.
- The metal filter must be installed.

Procedure

1. Unlock the EMERGENCY STOP button on the KCP.
2. Switch on the main switch. The computer unit begins to run up (load) 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).

9 Maintenance

9.1 Maintenance

Overview

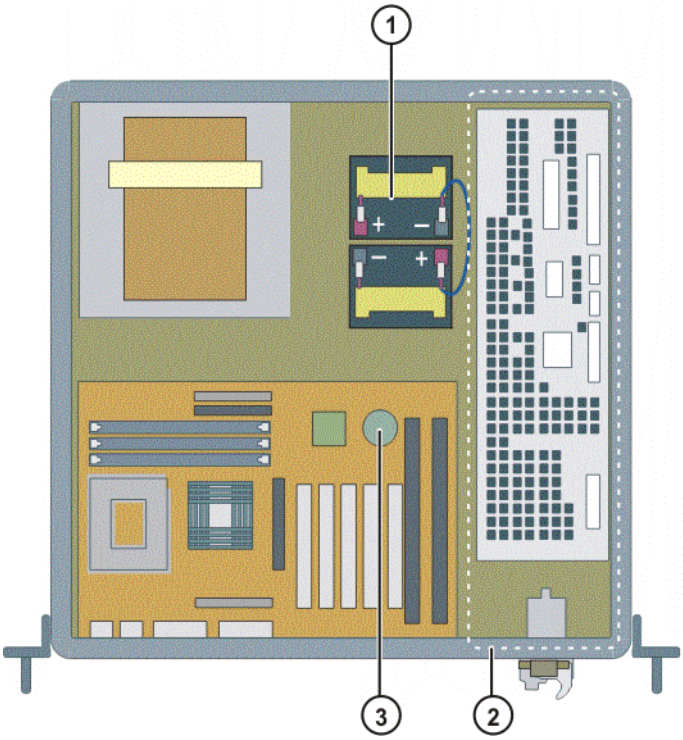

Fig. 9-1: Maintenance points

1 Batteries
2 Metal filter
3 Motherboard battery

Maintenance table

The table provides an overview of the maintenance intervals applying to this robot controller.

Item	Maintenance interval	Activity
1	2 years	Exchange the batteries (>>> 10.5 "Exchanging the batteries" Page 77)
2	Depends on installation conditions and degree of fouling.	Clean the metal filter (>>> 9.2 "Cleaning the metal filter" Page 73)
3	5 years	Exchange the motherboard battery (>>> 10.4 "Exchanging the motherboard battery" Page 77)

9.2 Cleaning the metal filter

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Pull the metal filter out of the holder.
2. Clean the metal filter and rack in warm water.

3. Dry the metal filter and rack.
4. Push the metal filter into the holder and click into place.

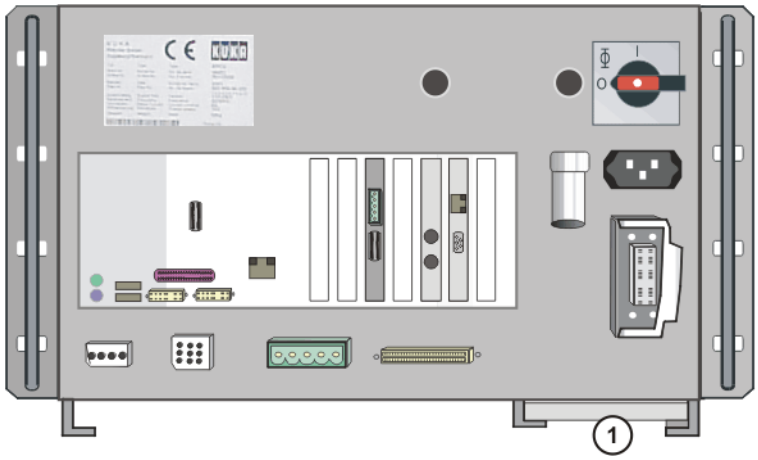

Fig. 9-2: Cleaning the metal filter

1 Metal filter

9.3 Cleaning the robot controller

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Work regulations

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

Procedure

1. Loosen and vacuum up any dust deposits.
2. Clean the housing 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 Wiring example X11

The X11 is a 37-contact Sub D female socket.

Connector pin allocation

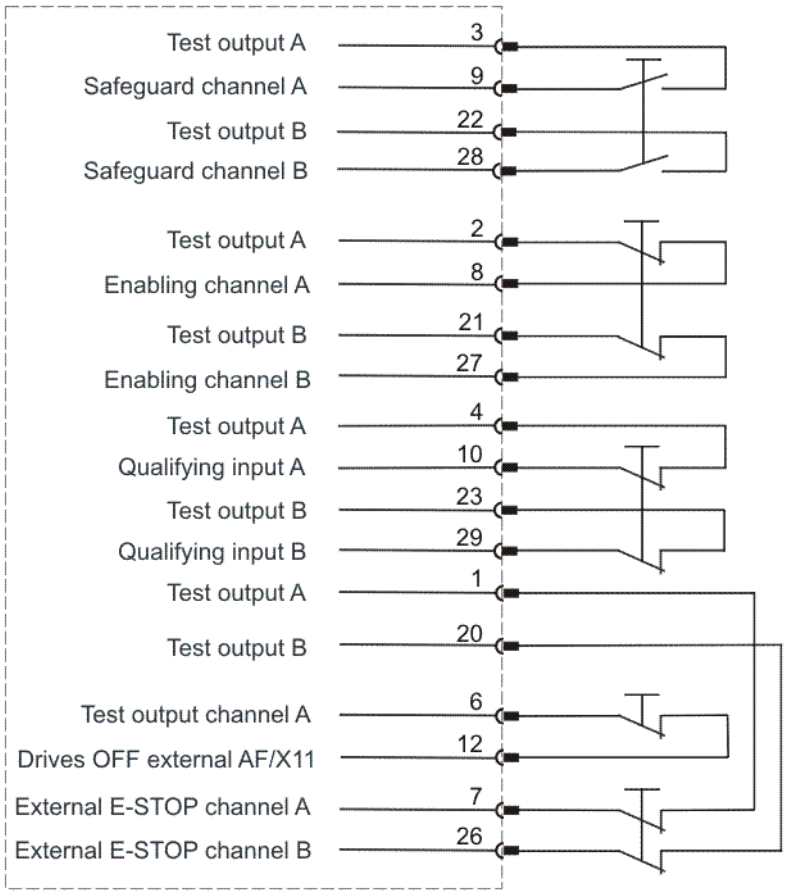

Fig. 10-1: Wiring example X11

WARNING If wiring example X11 is used for start-up or trouble-shooting, the connected safety components of the robot system are disabled.

10.2 Opening the housing cover

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Unscrew the housing cover screws.
2. Take off the housing cover.

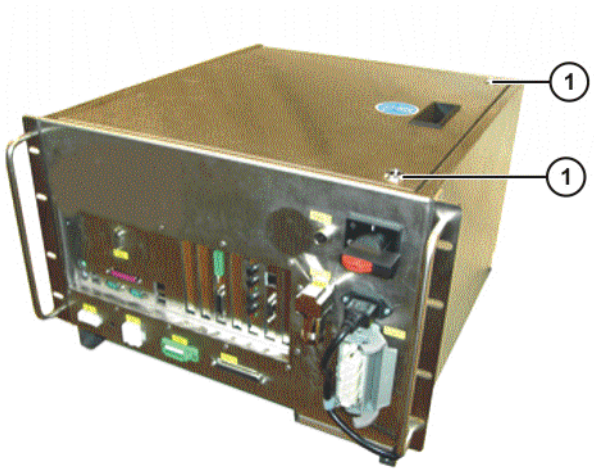

Fig. 10-2: Opening the housing cover

1 Housing cover screws

10.3 Exchanging DIMM memory modules

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Open the housing cover. (>>> 10.2 "Opening the housing cover" Page 75)
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.

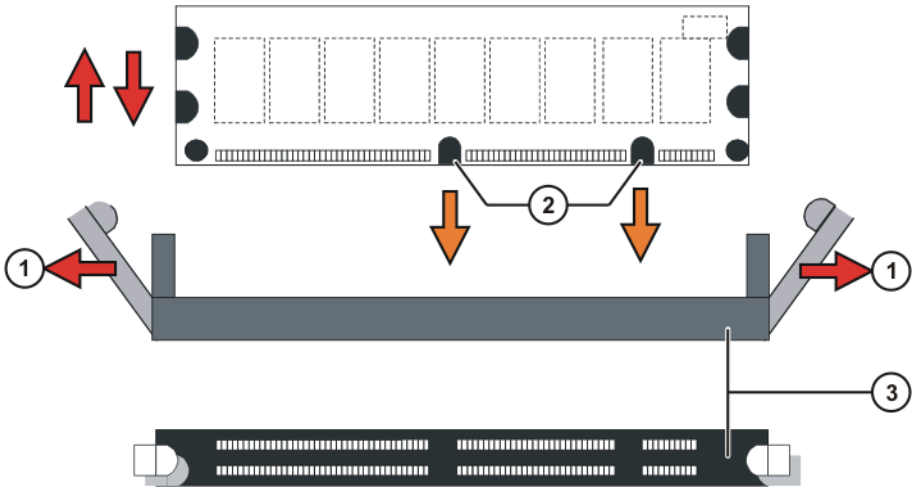

Fig. 10-3: Exchanging DIMM memory modules

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

10.4 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.

10.5 Exchanging the batteries

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Open the housing cover. (>>> 10.2 "Opening the housing cover" Page 75)
2. Remove the knurled screw and swivel up the battery holder.
3. Unplug the battery connection cables.
4. Take out both battery blocks.

> The battery blocks must both be exchanged together.

5. Insert new battery blocks.
6. Insert and screw down the battery holder.
7. Plug in the battery connection cables.
8. Close the housing cover.

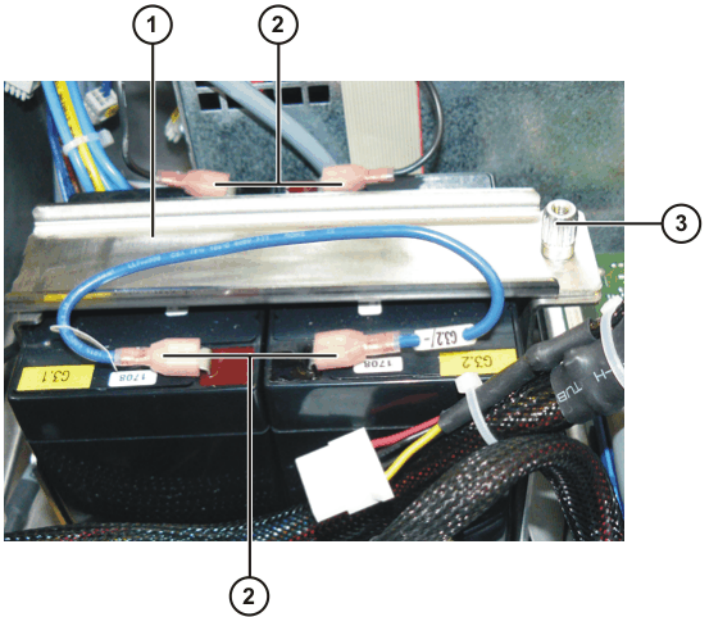

Fig. 10-4: Fastening battery blocks

1	Battery holder
2	Battery connection cables
3	Knurled screw

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.

10.6 Exchanging the auxiliary card

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Open the housing cover. (>>> 10.2 "Opening the housing cover" Page 75)
2. Disconnect all plug-in connections from the auxiliary card.
3. Remove the fastening screw.

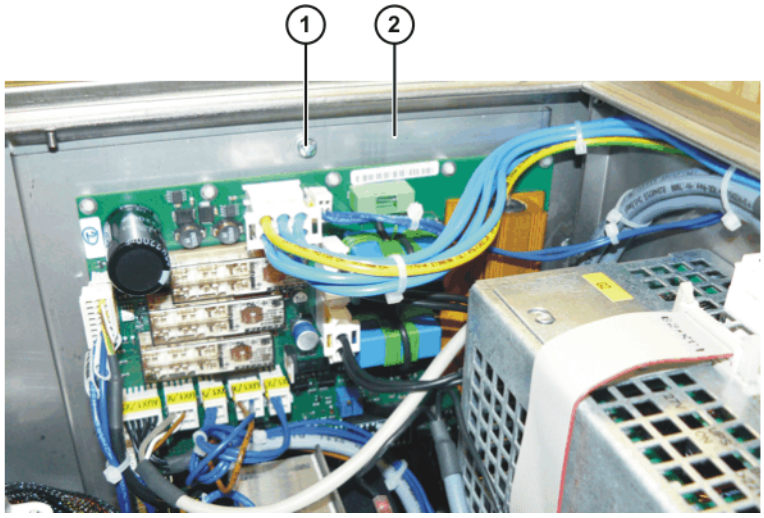

Fig. 10-5: Fastening the auxiliary card

1 Fastening screw
2 Fastening plate

4. Lift out the fastening plate with the auxiliary card.

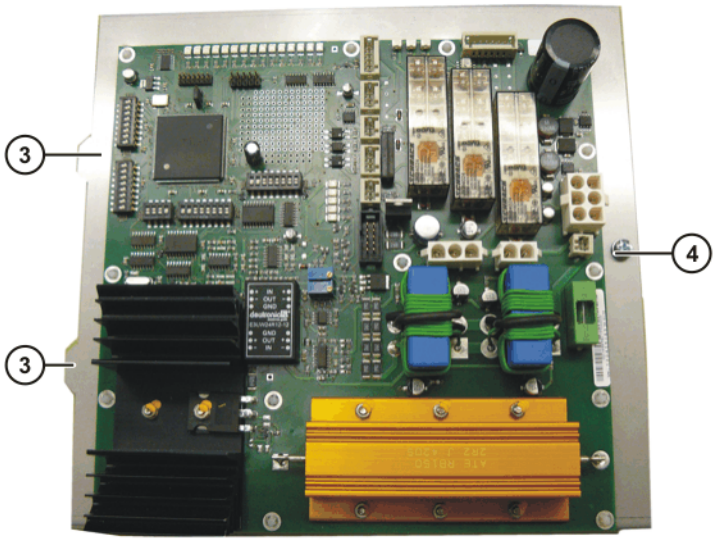

Fig. 10-6: Auxiliary card with fastening plate

3 Push-in tabs
4 Fastening screw

5. Check the new auxiliary card for mechanical damage. Insert the fastening plate with the auxiliary card into the tab slots and screw firmly in place.
6. Plug in the connections to the card.

10.7 Exchanging the hard drive

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Open the housing cover. (>>> 10.2 "Opening the housing cover" Page 75)
2. Disconnect the power supply and data cables.
3. Remove the fastening screws of the hard drive holder.
4. Remove clip.
5. Remove the hard drive.
6. Configure the new hard drive as the master drive.

> Further information is contained in the relevant manufacturer documentation.

7. Fasten the new hard drive to the holder with the screw and clip.
8. Connect power supply and data cables.
9. Close the housing cover.

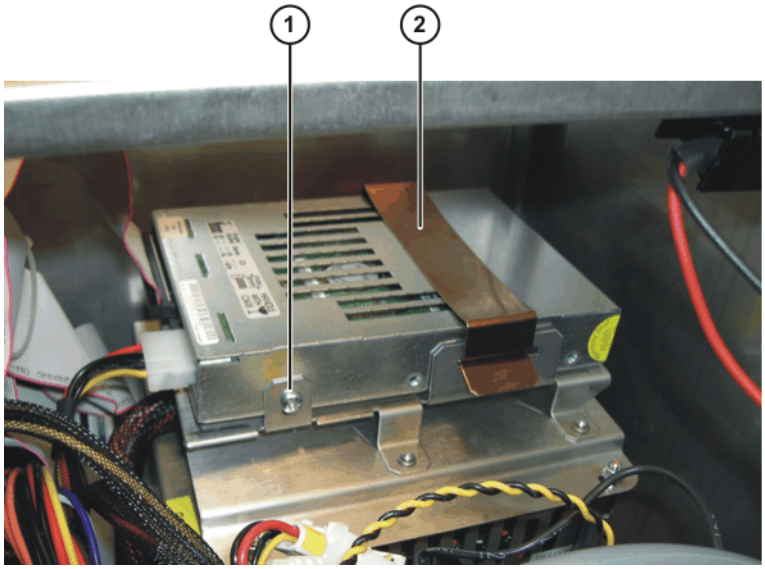

Fig. 10-7: Hard drive fastening

1 Hard drive holder screws
2 Clip

10.8 Exchanging the KVGA card

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Open the housing cover. (>>> 10.2 "Opening the housing cover" Page 75)
2. Release the front plate fastenings of the KVGA card and pull the card out of the slot.
3. Check the new card for mechanical damage, insert it into the slot and tighten the fastening screws.

4. Close the housing cover.

10.9 Exchanging the MFC3 card

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Open the housing cover. (>>> 10.2 "Opening the housing cover" Page 75)
2. Release the front plate fastenings of the MFC3 Tech card and pull the card out of the slot.
3. Check the new MFC3 Tech card for mechanical damage, insert it into the slot and tighten the fastening screws.
4. Close the housing cover.

10.10 Exchanging the CI2 board

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Remove screws on underside of housing cover.

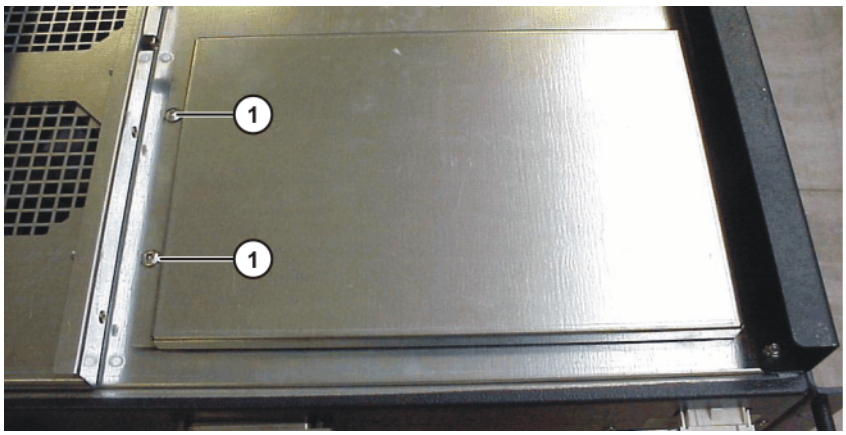

Fig. 10-8: Cover on underside

1 Housing cover screws

2. Disconnect all plug-in connections from the CI2 board.
3. Remove the CI2 board retaining screw.

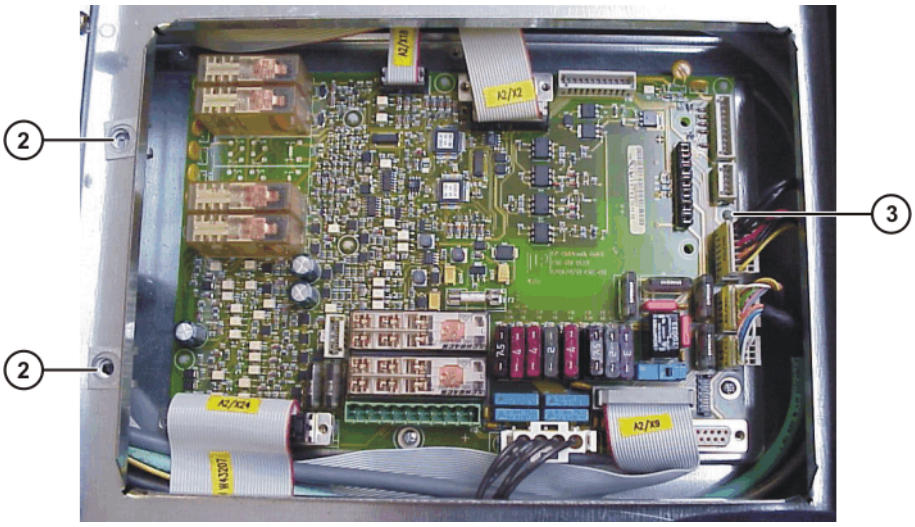

Fig. 10-9: CI2 board with holder plate

2 Housing cover screws
3 CI2 board fastening

4. Remove CI2 board.
5. Install, fasten and connect the new CI2 board.
6. Close the housing cover.

10.11 Exchanging the PC power supply unit

Preconditions

- The robot controller must be switched off and secured to prevent unauthorized persons from switching it on again.
- Power supply lead disconnected.
- Observe the EMC guidelines.

Procedure

1. Open the housing cover. (>>> 10.2 "Opening the housing cover" Page 75)
2. Remove the hard drive. (>>> 10.7 "Exchanging the hard drive" Page 79)
3. Remove the fastening screws of the hard drive holder.

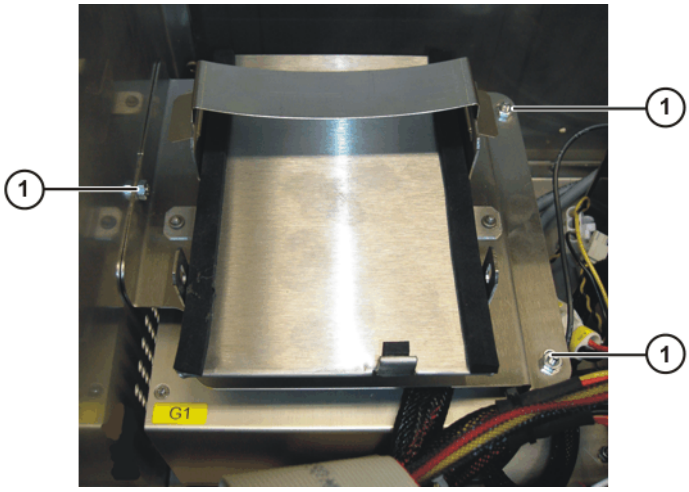

Fig. 10-10: Exchanging the PC power supply

1 Fastening screws of the hard drive holder

4. Disconnect PC power supply.

5. Remove the fastening screws of the PC power supply on the underside of the robot controller.
6. Insert and connect new PC power supply and screw firmly to underside.
7. Insert hard drive holder and screw firmly in place.
8. Install hard drive.
9. Close the housing cover.

11 Troubleshooting

11.1 Repair and procurement of spare parts

Repair

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

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

Procurement of spare parts

The article numbers of the spare parts are listed in the spare parts catalog.

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

- New parts
  Once the new part has been installed, the part that has been removed can be disposed of.
- Exchange parts
  Once the exchange part has been installed, the part that has been removed is returned to KUKA Roboter GmbH.

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

11.2 Control PC errors

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

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

11.3 KCP error messages

Effects	Causes	Remedy
No display on the LCD	Connecting cable defective	Exchange KCP with connect-ing cable
	KVGA defective	Exchange KVGA
	KCP defective	Exchange KCP
Drives cannot be switched on	Connecting cable defective	Exchange KCP with connect-ing cable
	Enabling switch jammed	Exchange KCP
	KCP defective	Exchange 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	Exchange KCP

Effects	Causes	Remedy
EMERGENCY STOP cannot be acknowledged	EMERGENCY STOP push-button defective	Exchange 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	Exchange KCP
	MFC3 defective (CAN bus)	Exchange the MFC3

12 KUKA Service

12.1 Requesting support

Introduction

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

Information

The following information is required for processing a support request:

- Model and serial number of the robot
- Model and serial number of the controller
- Model and serial number of the linear unit (if applicable)
- 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

12.2 KUKA Customer Support

Availability

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

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