KUKA

ROBOT

KR 30, 60-3; KR 30 L16-2 with KR C4

Assembly Instructions

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Translation of the original documentation

Contents

Valid for **KR 30-3**
KR 30 L16-2
KR 60-3
KR 60 L45-3
KR 60 L30-3
with the F variant and with KR C4

1 Introduction

1.1 Robot documentation

The documentation of this robot comprises the following parts:

- KR 30, 60-3, F, KR C4 assembly instructions
- Parts catalog on storage medium

Each of these parts is a separate document that is attached to the robot.

The assembly instructions and parts catalog for the controller are not part of this documentation.

1.2 Representation of warnings and notes

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

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

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

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

Notice!
These warnings mean that damage to property may occur, if no precautions are taken. They contain references to safety-relevant information or general safety measures. These warnings do not refer to individual hazards or individual precautionary measures.

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

2 Purpose

2.1 Intended use

Use

Handling of tools or fixtures for processing or transferring components or products, e.g.

- Handling
- Assembly
- MIG/MAG welding
- YAG laser beam welding

Use is only permitted under the environmental conditions specified in Chapter 4.

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
- Use in underground mining

Notice!

Changing the structure of the manipulator, e.g. by drilling holes, etc., can result in damage to the components. This is considered improper use and leads to loss of guarantee and liability entitlements.

Notice!

Deviations from the operating conditions specified in the technical data or the use of special functions or applications can lead to premature wear. KUKA Roboter GmbH must be consulted.

2.2 Target group

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

- Advanced knowledge of mechanical engineering
- Advanced knowledge of electrical and electronic systems
- Knowledge of the robot controller system

Information!

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.

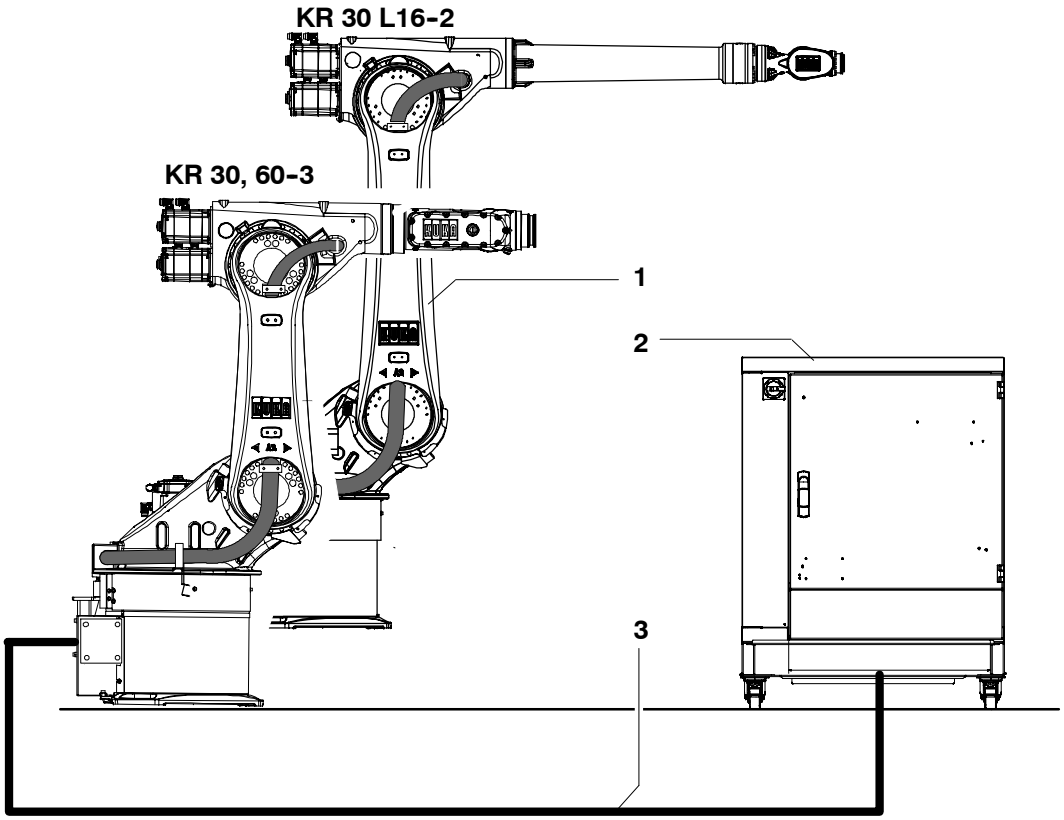
3 Product description

Information!
This description applies analogously to all of the industrial robots listed in Chapter 1, regardless of the variant or model shown in the illustrations.

3.1 General

The industrial robot consists of the manipulator (= robot arm and electrical installations), control cabinet, teach pendant (KUKA smartPAD) and connecting cables (Fig. 1). The manipulator is dealt with in this document.

The control cabinet, teach pendant and connecting cables are described in separate documentation.



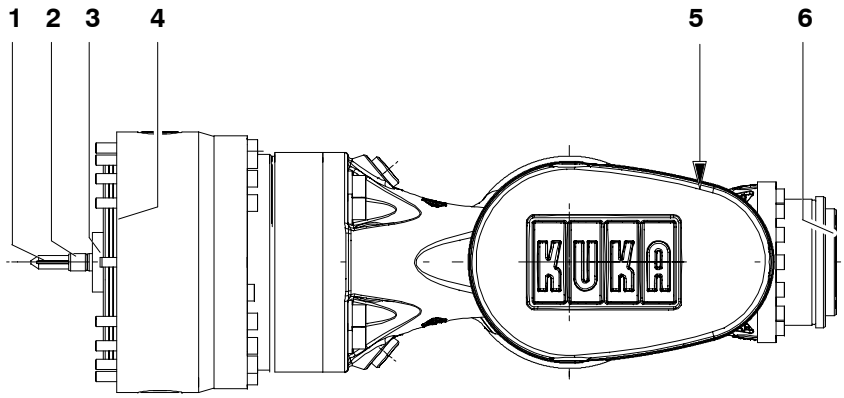
1 Manipulator
2 Control cabinet
3 Connecting cables

Fig. 1 Industrial robot (example: floor-mounted)

This section is subdivided in accordance with the breakdown of the manipulator into its main subassemblies.

3.2 In-line wrist IW 16 II

The robot KR 30 L16 is equipped with a triple-axis in-line wrist (Fig. 3) for a payload of 16 kg (IW 16 Ii). The in-line wrist is screwed to the arm via the flange (4). The wrist axes A4, A5 and A6 are driven by means of the shafts (1, 2, 3). End effectors are attached to the mounting flange (6) of axis 6. Each axis has a measuring device (5), through which the mechanical zero of the respective axis can be checked by means of an electronic probe (accessory) and transferred to the controller. Directions of rotation, axis data and permissible loads can be found in Chapter4, “Technical data”.



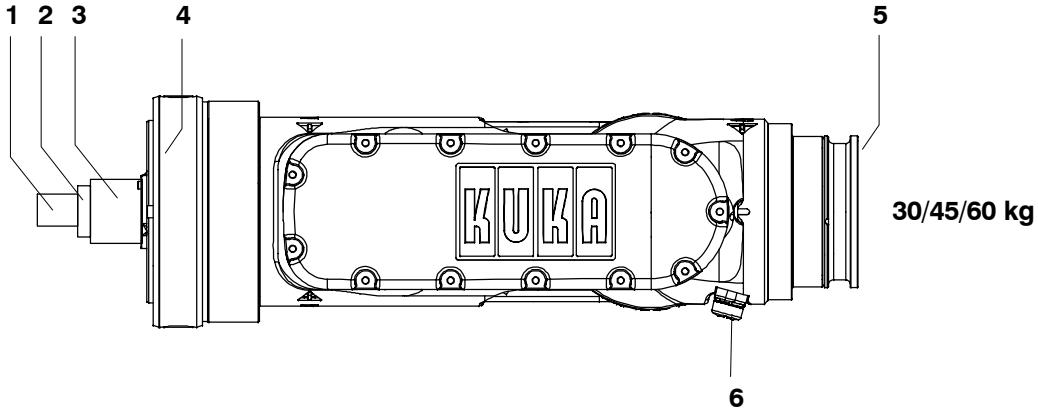
1 Shaft for axis 6
2 Shaft for axis 5
3 Shaft for axis 4
4 Flange (arm-wrist)
5 Measuring device
6 Mounting flange

Fig. 2 In-line wrist IW 6 II

3.3 In-line wrist 30/45/60

The robot variants KR 30, 60-3 are equipped with a triple-axis in-line wrist (Fig. 3) for a payload of 30, 45 or 60 kg, depending on the type. The function and interfaces correspond to IW 16 II. This in-line wrist is equipped with toothed belts for driving axes 5 and 6.

The in-line wrist variant “F” is available for operating conditions involving greater mechanical and thermal stress.



1 Shaft
2 Shaft
3 Shaft
4 Flange
5 Mounting flange
6 Measuring device

Fig. 3 In-line wrist IW 30/45/60

3.4 Arm

The arm assembly (Fig. 4/2) embodies the driven element of axis 3 of the manipulator. The arm is flange-mounted to the side of the link arm (7) through a gear unit with integrated bearings and is driven by main axis motor unit A3 (6). The swivel axis (3) of the arm has been so selected that with the rated payload there is no need for an additional counterweight to balance the masses on the arm.

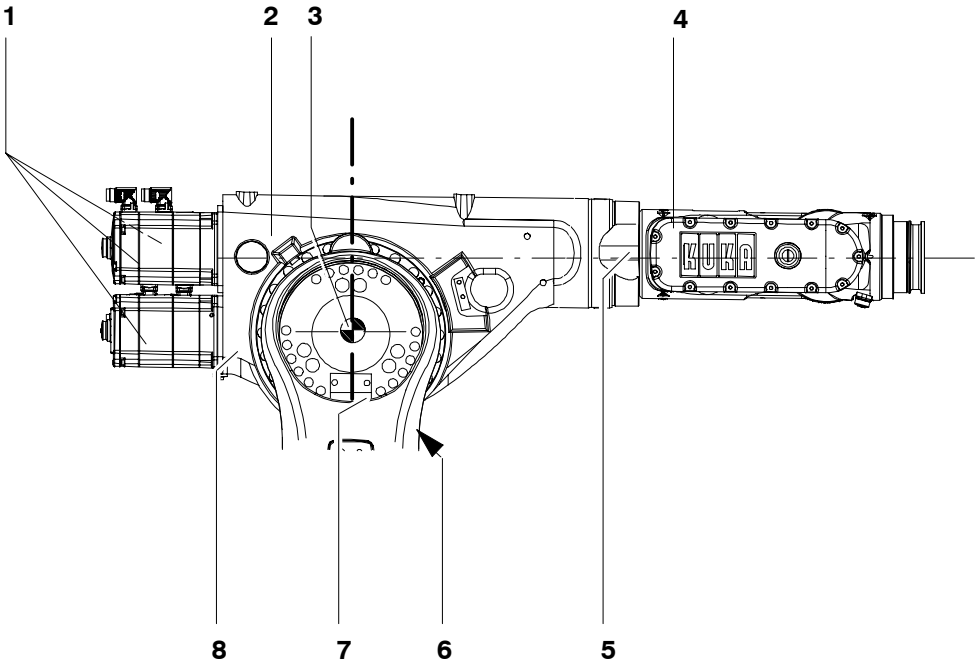
The effective software swivel range extends for all manipulators from +158° to -120°, referred to the electrical zero position of axis 3, which is given when the longitudinal axes of the arm and link arm run parallel. The swivel range is limited by mechanical limit stops with a buffer function in addition to the software limit switches.

Attached to the rear of the arm housing (8) are the motor units for wrist axes 4 to 6. Arm variants are available which are 200 mm (KR 60 L45-3) or 400 mm (KR 60 L30-3) longer than the standard arm. These arm extensions involve a reduction in the rated payloads and the individual axis speeds. The arm length in the case of the KR 30 L16-2 is 624 mm more than for the standard variant.

The arm housing consists - as do the housings of the link arm and rotating column - of a light alloy construction optimized by means of CAD and FEM.

Mounted on the front end of the arm via a standardized interface is the in-line wrist (4), which is driven by the wrist axis motor units (1) through push-on shafts (5) located inside the arm.

With "F" variant robots, the arm is pressurized. It is operated with an internal pressure of 0.1 bar.



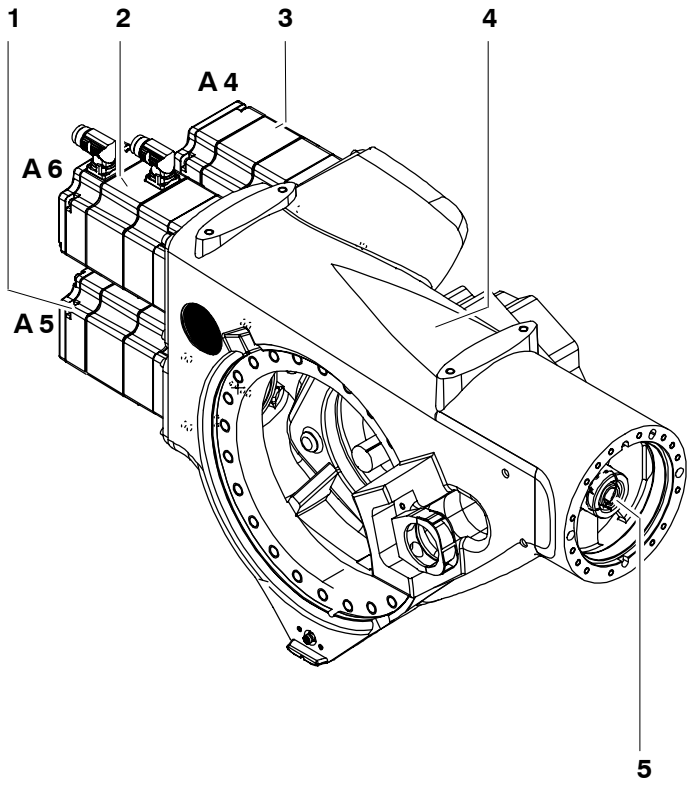
1 Motor units for wrist axes
2 Arm
3 Rotational axis A3
4 In-line wrist
5 Shaft
6 Main axis motor unit A3
7 Link arm
8 Arm housing

Fig. 4 Arm

3.4.1 Wrist axis motor units A4 to A6

The wrist axes are driven by three motor units. These are fastened to the arm (Fig. 5/4) by means of screws. Motor units A4 (3) and A5 (1) are of the same design and drive the respective wrist axes via toothed belts and shafts. Wrist axis A6 is driven directly by motor unit A6 (2) via a push-on shaft (5).

Each motor unit for the wrist axis drives consists of a brushless AC servomotor with a permanent-magnet single-disk brake and a hollow-shaft resolver (both integrated).

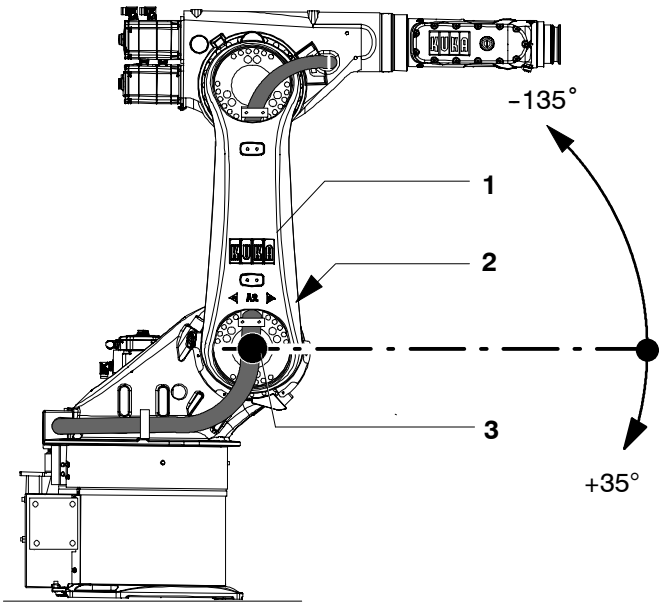


1 Motor unit A5
2 Motor unit A6
3 Motor unit A4
4 Arm
5 Shaft

Fig. 5 Wrist axis motor units A4 to A6

3.5 Link arm

The link arm (Fig. 6/1) is the driven element of axis 2. It pivots about rotational axis 2 (3) through an effective software range from +35° to -135° — referred to the zero position of axis 2, which corresponds to the horizontal position of the link arm in Fig. 6. The effective software swivel range is limited by mechanical limit stops with a buffer function in addition to the software limit switches.

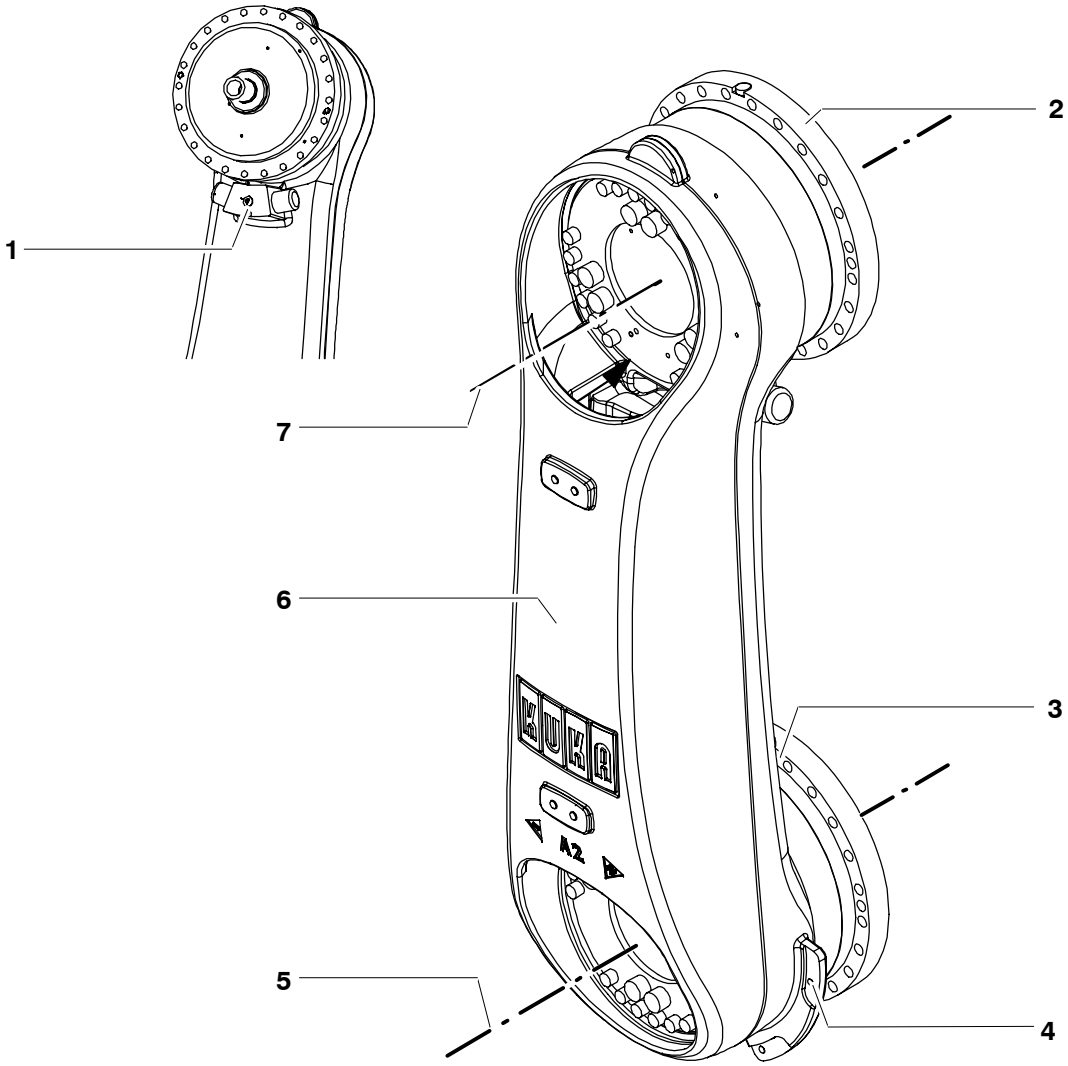


1 Link arm
2 Main axis motor unit A2
3 Rotational axis 2

Fig. 6 Link arm and turning range

The link arm (Fig. 7/6) houses gear unit A3 (2) at its upper end, and gear unit A2 (3) at its lower end. The gear units (2, 3) are used both as drive elements and to support the arm and link arm assemblies. The reference notch (1) and the gauge cartridge (4) are provided to define and locate the mechanical zero position of axes 2 and 3. The cables for energy supply and signal transmission are routed in the interior of the link arm housing from the rotating column to the arm.

The link arm of the KR 30 L16-2 has a center distance from A2 to A3 of 1250 mm, compared with 850 mm for the link arm of the standard variants.



1	Reference notch A3	5	Rotational axis 2
2	Gear unit A3	6	Link arm
3	Gear unit A2	7	Rotational axis 3
4	Gauge cartridge A2		

Fig. 7 Structure of link arm

3.5.1 Main axis motor units A1 to A3

The robot axes 1, 2 and 3 are driven by motor units as shown in Fig. 8. Each motor unit for the main axis drives consists of a brushless AC servomotor (1) with a permanent-magnet single-disk brake and hollow-shaft resolver (2), both integrated. The motor units for axes 1, 2 and 3 are of the same design.

Axis 2 of the KR 60 variants is equipped with a more powerful motor unit.

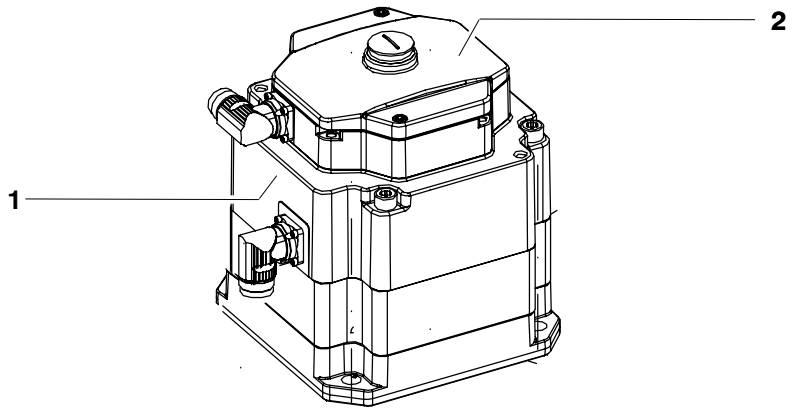
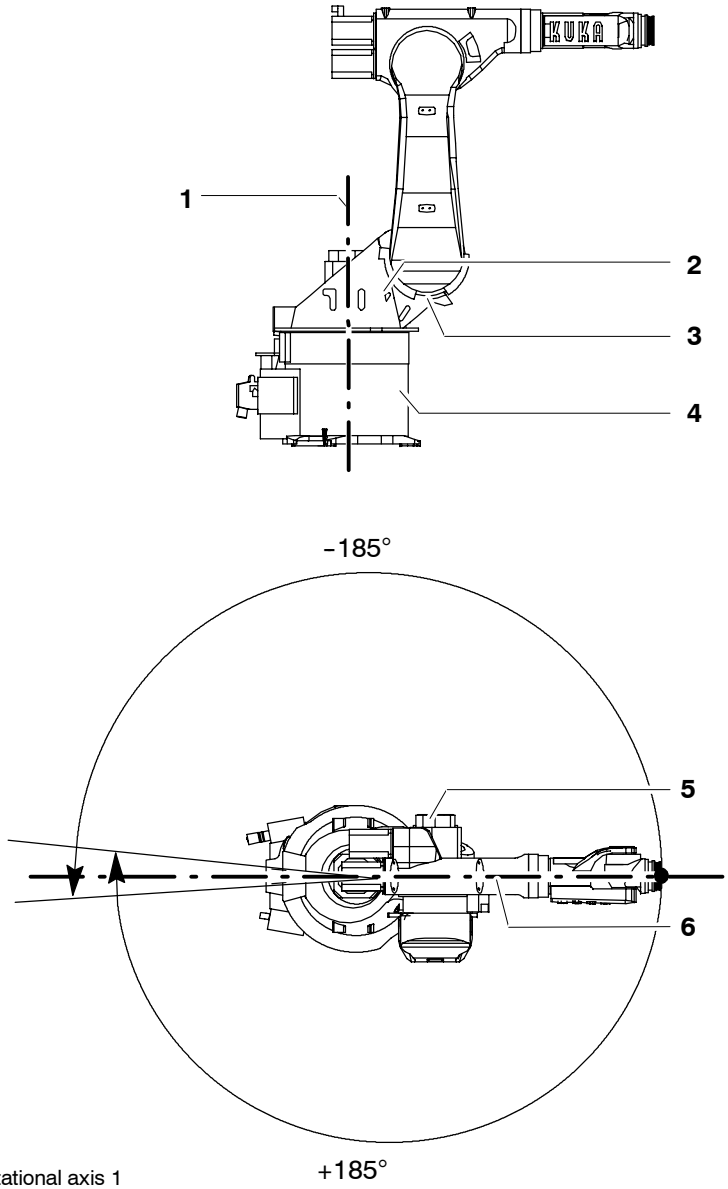


Fig. 8 Motor unit for main axis drive

3.6 Rotating column

The rotating column (Fig. 9/2) is the assembly located between the link arm and the base frame. Screwed to the base frame (4) through a special reduction gear unit (3), which allows it to rotate, it performs movements about rotational axis 1 (1). It has an effective software turning range of 185° in both the (+) and (–) directions, measured from the zero position of axis (6). This range is limited by mechanical limit stops with a buffer function in addition to the software limit switches. This limit stop system operates with a trailing stop acting on both sides, which is installed in the base frame and mechanically limits the large turning range of 185° in both directions.

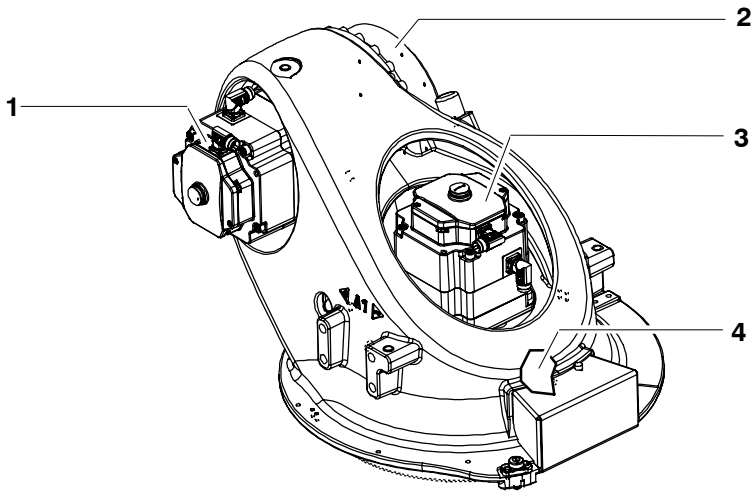


1 Rotational axis 1
2 Rotating column
3 Special reduction gear unit
4 Base frame
5 Main axis motor unit A2
6 Zero position A1

Fig. 9 Rotating column with turning range (shown here: KR 30-3)

The main axis motor unit for axis 1 (Fig. 10/3) is installed in the rotating column with a special reduction gear unit (4), and the main axis motor unit for axis 2 (1) is mounted on the side of the rotating column with its special reduction gear unit (2).

Part of the manipulator electrical installations is routed inside the rotating column.



1 Main axis motor unit A2
2 Special reduction gear unit A2
3 Main axis motor unit A1
4 Special reduction gear unit A1

Fig. 10 Structure of rotating column

3.7 Base frame

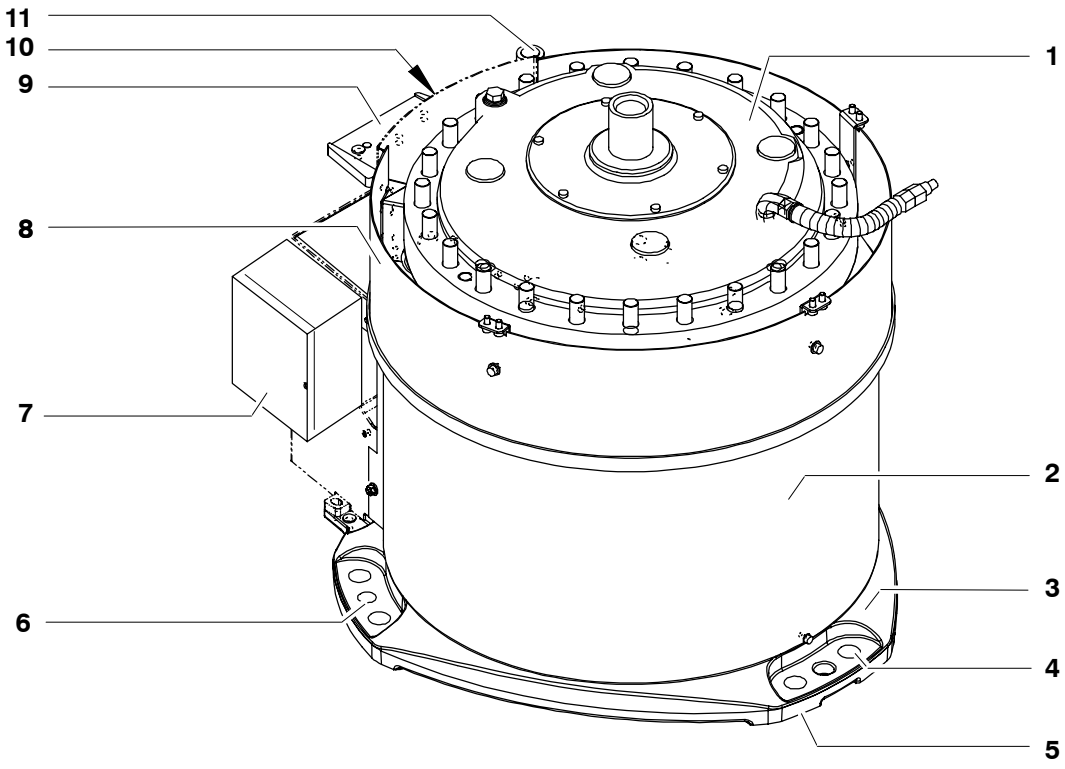
The base frame (Fig. 11) is the stationary part of the manipulator, on which the rotating column turns with the link arm, the arm and the wrist. Its base flange (5) features through-holes (4) for holding the manipulator down and two locating boreholes (6), with which the manipulator can be placed on two locating pins (accessories, see Chapter 7, “Installation”).

Attached to a flange inside the base frame housing (3) is the special reduction gear unit (1) of axis 1. Also integrated into this flange is the double-acting trailing stop, which together with a stop block on the rotating column mechanically safeguards the software-limited movement range of 370° about rotational axis 1.

In the base frame, the installation cables leading to the rotating column are routed stress-free about rotational axis 1 of the manipulator in a flexible tube. The space between the rotating column and the base frame is provided with two detachable, one-piece covers (2, 8).

The sockets for the connecting cables from the manipulator to the control cabinet are located on the RDC box (7) and on the multi-function housing (10).

The reference notch (11) necessary for determining the mechanical zero position is found on the bracket (9).



1 Special reduction gear unit A1
2 Cover
3 Base frame housing
4 Attachment holes (6x)
5 Base flange
6 Locating boreholes (2x)
7 Junction box
8 Cover
9 Bracket
10 MFH, multi-function housing
11 Reference notch

Fig. 11 Structure of the base frame

3.8 Working range limitation for A1 to A3

Mechanical stops for task-related limitation of the respective working range for axes 1 to 3 can be supplied as the “Working range limitation” accessory:

Axis 1: with two supplementary stops:
from +58° to +185° and -58° to -185°, adjustable in steps of 15°.

Axis 2: from +5° to +65° and -5° to -20°, adjustable in steps of 15°.

Axis 3: from +3° and -108° to -153° or -33° to -153°, adjustable in steps of 15°.

The working range limitation system is described in separate documentation.

3.9 Working range monitoring for A1 and A2

Axes 1 and 2 can be equipped with position switches and slotted rings to which adjustable cams are attached (see documentation “Working Range Monitoring”). This allows the position of the manipulator to be continuously monitored.

Up to three sectors of the movement range can be monitored on axis 1, and a maximum of one sector on axis 2.

The working range monitoring is described in separate documentation.

3.10 Energy supply system

For use in certain production technologies, the industrial robot can be equipped with an energy supply system installed between the base frame and axis 6. The energy supply system consists of a dress package (cable and hose bundle) for transmitting the energy and fluids typical for the specific application, and the “Group of holders for energy supply system” required for attaching it to the manipulator. The energy supply system accommodates the cables and hoses and ensures that they are guided with minimum stress throughout the permitted working envelope. The design of the energy supply system is suitable for the majority of applications in terms of reach and resistance to wear. There may, of course, be applications for which this version is of only limited use. A special version is required in such cases, or a corresponding adaptation of the energy supply system.

The energy supply system is described in separate documentation.

4 Technical data

Information!

This description applies analogously to all of the industrial robots listed in Chapter 1, regardless of the variant or model shown in the illustrations.

4.1 General

The industrial robots are six-axis manipulators for installation on the floor or on the ceiling. They are suitable for all continuous-path controlled tasks. The main areas of application are:

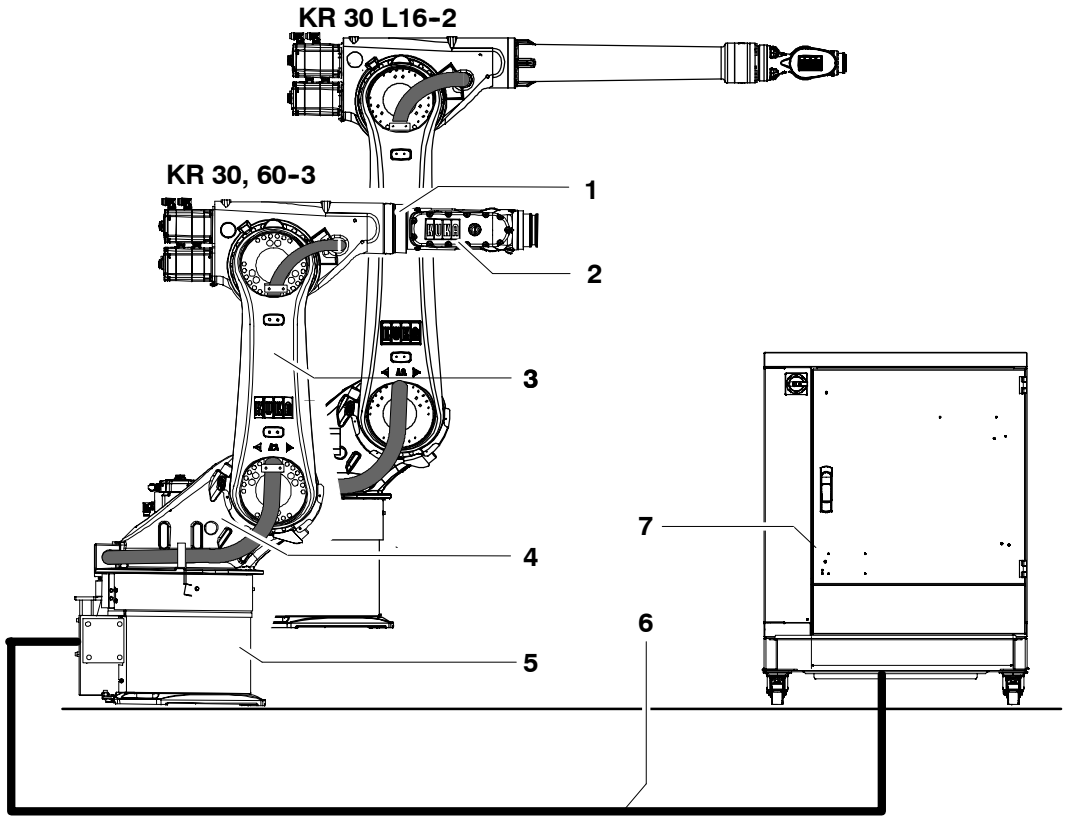
- Machining
- Handling
- Assembly
- MIG/MAG welding
- YAG laser beam welding

Notice!

Using the manipulator for purposes other than those mentioned above is considered contrary to its designated use (see Chapter 2, “Purpose”).

Fig. 12 shows the industrial robot with the manipulator (= robot arm and electrical installations) and the control cabinet.

The following data apply, unless otherwise indicated, to both floor-mounted and ceiling-mounted robots.



1	Arm	5	Base frame
2	In-line wrist	6	Connecting cables
3	Link arm	7	Control cabinet (see separate documentation)
4	Rotating column		

Fig. 12 Main components of the industrial robot

4.2 Principal data

Type

KR 30-3
KR 30 L16-2
KR 60-3
KR 60 L45-3
KR 60 L30-3

Number of axes

6 (Fig. 14)

Load limits

see following table and Fig. 13

Industrial robot type	KR 30-3	KR 30 L16-2	KR 60-3	KR 60 L45-3	KR 60 L30-3
Wrist (IW)[1]	IW 30/45/60[1]	IW 16	IW 30/45/60[1]	IW 30/45/60[1]	IW 30/45/60[1]
Rated payload [kg]	30	16	60	45	30
Suppl. load with rated payload [kg]	35	35	35	35	35
Max. total load [kg]	65	51	95	80	65

[1]IW = in-line wrist

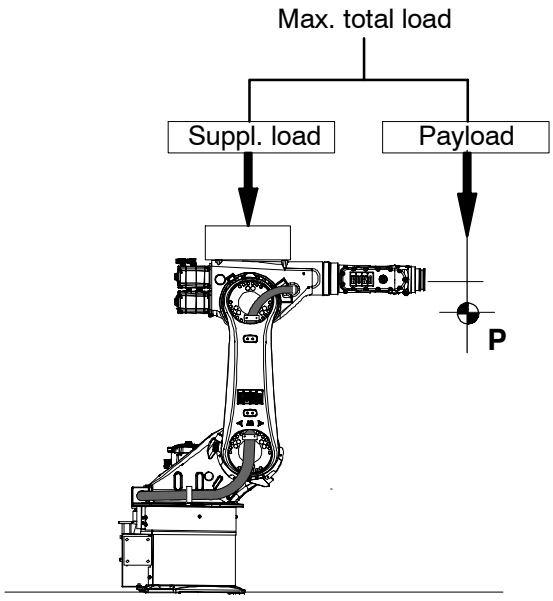


Fig. 13 Load distribution

Axis data

see the following tables.

All specifications in the “Range of motion” column are referred to the electrical zero of the manipulator axis concerned.

KR 30-3

- **In-line wrist, rated payload 30 kg**

Axis	Range of motion, software-limited	Speed
1	±185°	140°/s
2	+35° to -135°	126°/s
3	+158° to -120°	140°/s
4	±350°	260°/s
5	±119°	245°/s
6	±350°	322°/s

KR 30 L16-2

- **In-line wrist, rated payload 16 kg**

Axis	Range of motion, software-limited	Speed
1	±185°	100°/s
2	+35° to -135°	80°/s
3	+158° to -120°	80°/s
4	±350°	230°/s
5	±130°	165°/s
6	±350°	249°/s

KR 60-3

- **In-line wrist, rated payload 60 kg**

Axis	Range of motion, software-limited	Speed
1	±185°	128°/s
2	+35° to -135°	102°/s
3	+158° to -120°	128°/s
4	±350°	260°/s
5	±119°	245°/s
6	±350°	322°/s

KR 60 L45-3

- **In-line wrist, rated payload 45 kg**

Axis	Range of motion, software-limited	Speed
1	±185°	128°/s
2	+35° to -135°	102°/s
3	+158° to -120°	128°/s
4	±350°	260°/s
5	±119°	245°/s
6	±350°	322°/s

KR 60 L30-3

- **In-line wrist, rated payload 30 kg**

Axis	Range of motion, software-limited	Speed
1	±185°	128°/s
2	+35° to -135°	102°/s
3	+158° to -120°	128°/s
4	±350°	260°/s
5	±119°	245°/s
6	±350°	322°/s

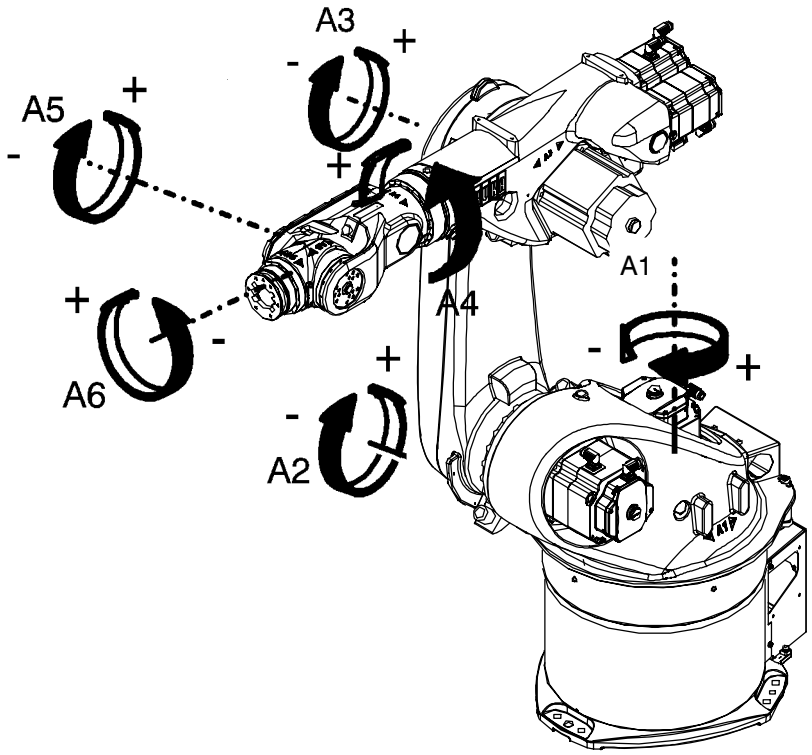


Fig. 14 Rotational axes and their directions of rotation

Pose repeatability (ISO 9283)	KR 30-3	± 0.06 mm
	KR 30 L16-2	± 0.07 mm
	KR 60-3	± 0.06 mm
	KR 60 L45-3	± 0.06 mm
	KR 60 L30-3	± 0.06 mm
Installation location	KR 30, 60-3 CR	Ceiling and floor
	KR 30 L16-2	Floor and ceiling
Principal dimensions	see Fig. 21 to Fig. 23.	
Working envelope	The shape and dimensions of the working envelope may be noted from Fig. 21 to Fig. 23.	

Volume of working envelope	KR 30-3	approx. 27.24 m^3
	KR 30 L16-2	approx. 104.5 m^3
	KR 60-3	approx. 27.24 m^3
	KR 60 L45-3	approx. 36.89 m^3
	KR 60 L30-3	approx. 47.78 m^3
	The reference point is the intersection of axes 4 and 5.	
Load center of gravity P	see Fig. 15 to Fig. 18. For the rated payload, the (nominal) distance of the load center of gravity P is for KR 30, 60-3: 150 mm (horizontal), 180 mm (vertical) for KR 30 L16-2: 150 mm (horizontal), 120 mm (vertical) measured from the face of the mounting flange (rotational axis 6).	
Weight	KR 30-3	approx. 665 kg
	KR 30 L16-2	approx. 700 kg
	KR 60-3	approx. 665 kg
	KR 60 L45-3	approx. 671 kg
	KR 60 L30-3	approx. 679 kg
Principal dynamic loads	See Fig. 25	
Drive system	Electromechanical, with transistor-controlled AC servomotors.	
Installed motor capacity	approx. 14.9 kW	

Protection classification of the manipulator

IP 64
ready for operation, with connecting cables plugged in (according to EN 60529).

Protection classification of the in-line wrist

IP 65 (according to EN 60529)
(standard)

Protection classification of the in-line wrist "F"

IP 67 (according to EN 60529)

Stress limits, in-line wrist "F"

Thermal loading	10 s/min at 453 K (180 °C)
Surface temperature	373 K (100 °C)
Resistant to:	- high ambient dust content - lubricants and coolants * - steam

Special maintenance intervals apply for in-line wrists of type "F"

* after consultation with KUKA

Special features for the "F" variant

Pressurized arm

Overpressure in arm:	0.1 bar
Compressed air:	free of oil and water
Air consumption:	approx. 0.1 m^3/h
Threaded union:	M5
Pressure reducer:	0.1 - 0.7 bar
Pressure gauge:	0 - 1 bar
Filter:	25 - 30 µm

Ambient temperature

during operation:
283 K to 328 K (+10 °C to +55 °C),
during storage/transportation:
233 K to 333 K (-40 °C to +60 °C).
Other temperature limits available on request.

Humidity class

DIN EN 60721-3-3, Class 3K3

Sound level

< 75 dB (A) outside the working envelope
(Fig. 22 and Fig. 23)

Color

Manipulator

Manipulator overall:	KUKA -Orange 2567
Motors:	Black (RAL 9005)
Cover A1	black (RAL 9005)

With "F" variant, additional special paint finish for the entire manipulator.

In-line wrist "F":
Heat-resistant and heat-reflecting
special paint finish in silver.

Plates

see Fig. 26 to Fig. 34.

Special consumables

none

Stopping distances and times

see separate documentation

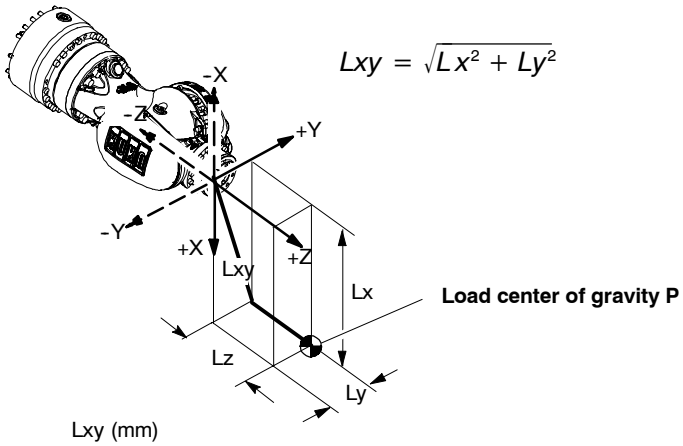
Notice!

The loading curves and the values in the table correspond to the maximum load capacity. Both values (payload and principal moment of inertia) must be checked in all cases. Exceeding this capacity will reduce the service life of the robot and generally overload the motors and the gears; in any such case KUKA must be consulted beforehand.

Information!

The values determined here are necessary for planning the application.
For commissioning the manipulator, additional input data are required in accordance with the KUKA software documentation.

Robot flange coordinate system



$$Lxy = \sqrt{Lx^2 + Ly^2}$$

Load center of gravity P

Permissible mass inertia at the design point
(Lxy = 120 mm,
Lz = 150 mm)
0.36 kgm^2.

CAUTION: The mass inertia must be verified using KUKA Load. It is imperative for the load data to be entered in the controller!

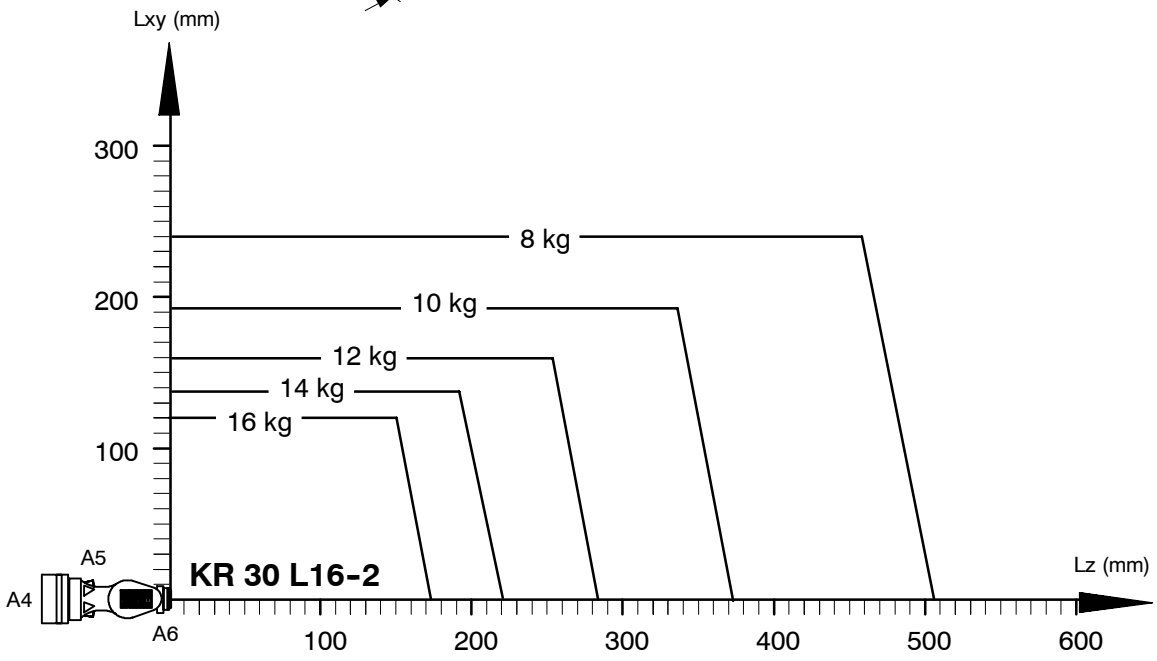


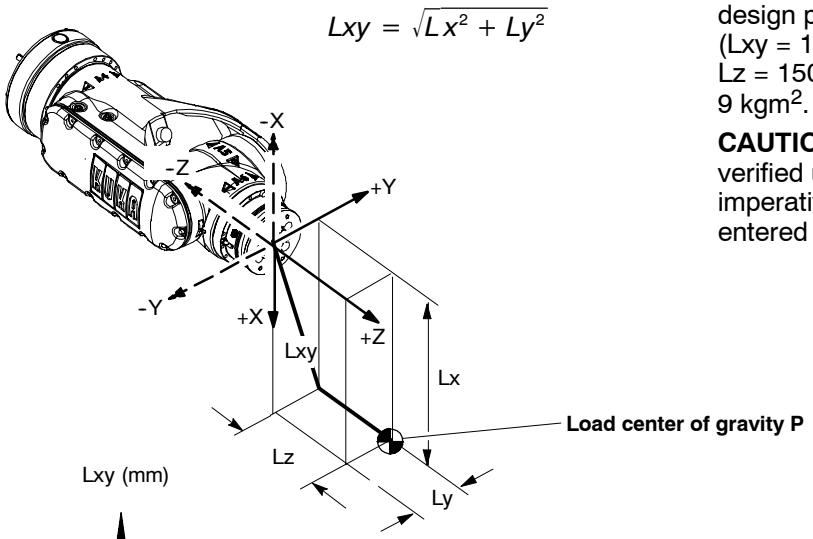
Fig. 15 Load center of gravity P and loading curves for KR 30 L16-2

Information!

The values determined here are necessary for planning the application.
For commissioning the robot, additional input data are required in accordance with the KUKA software documentation.

Robot flange coordinate system

$$Lxy = \sqrt{Lx^2 + Ly^2}$$



Permissible mass inertia at the design point
(Lxy = 180 mm,
Lz = 150 mm)
9 kgm^2.

CAUTION: The mass inertia must be verified using KUKA Load. It is imperative for the load data to be entered in the controller!

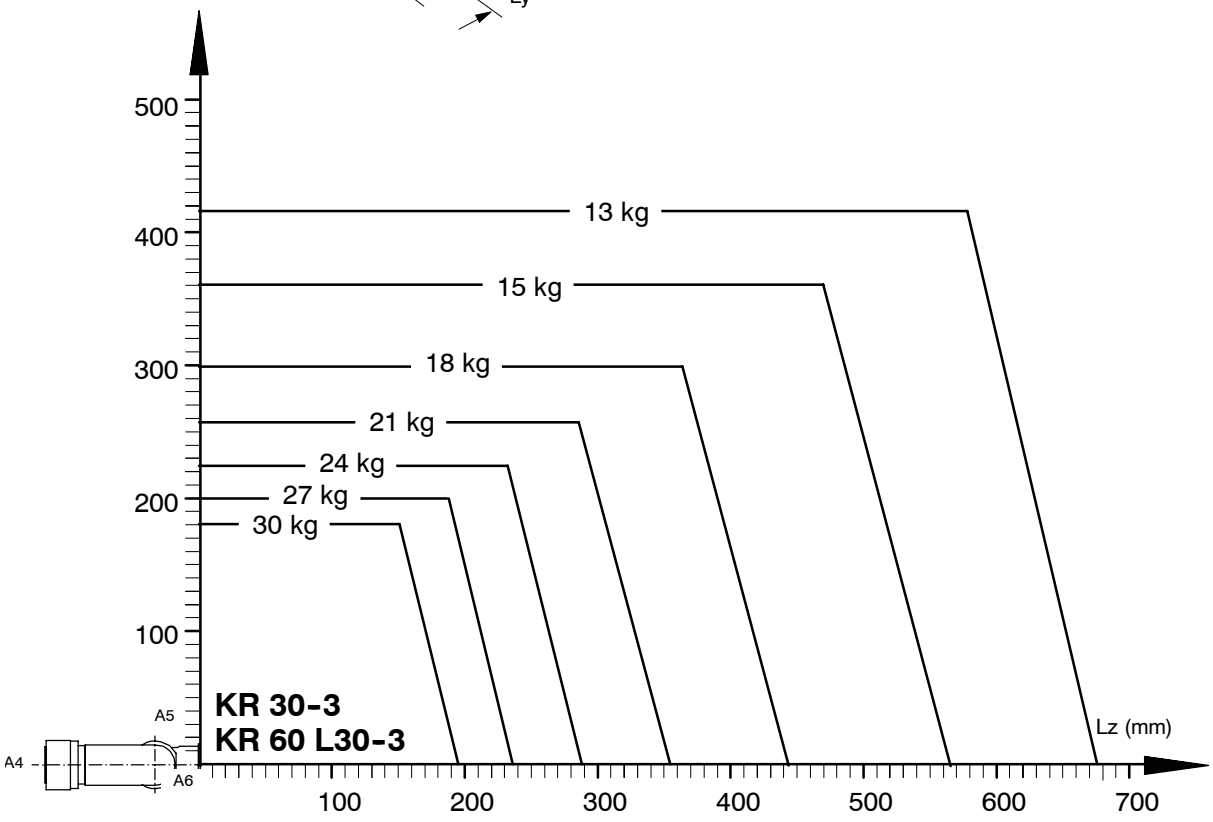
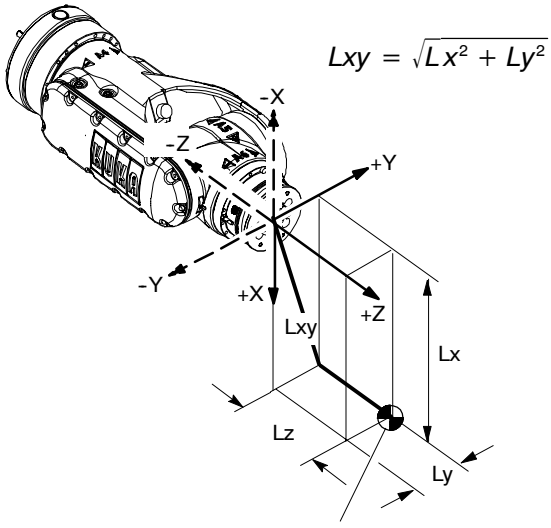


Fig. 16 Load center of gravity P and loading curves for KR 30-3; KR 60 L30-3

Information!

The values determined here are necessary for planning the application.
For commissioning the robot, additional input data are required in accordance with the KUKA software documentation.

Robot flange coordinate system



Load center of gravity P

Permissible mass inertia at the design point
(Lxy = 180 mm,
Lz = 150 mm)
18 kgm^2.

CAUTION: The mass inertia must be verified using KUKA Load. It is imperative for the load data to be entered in the controller!

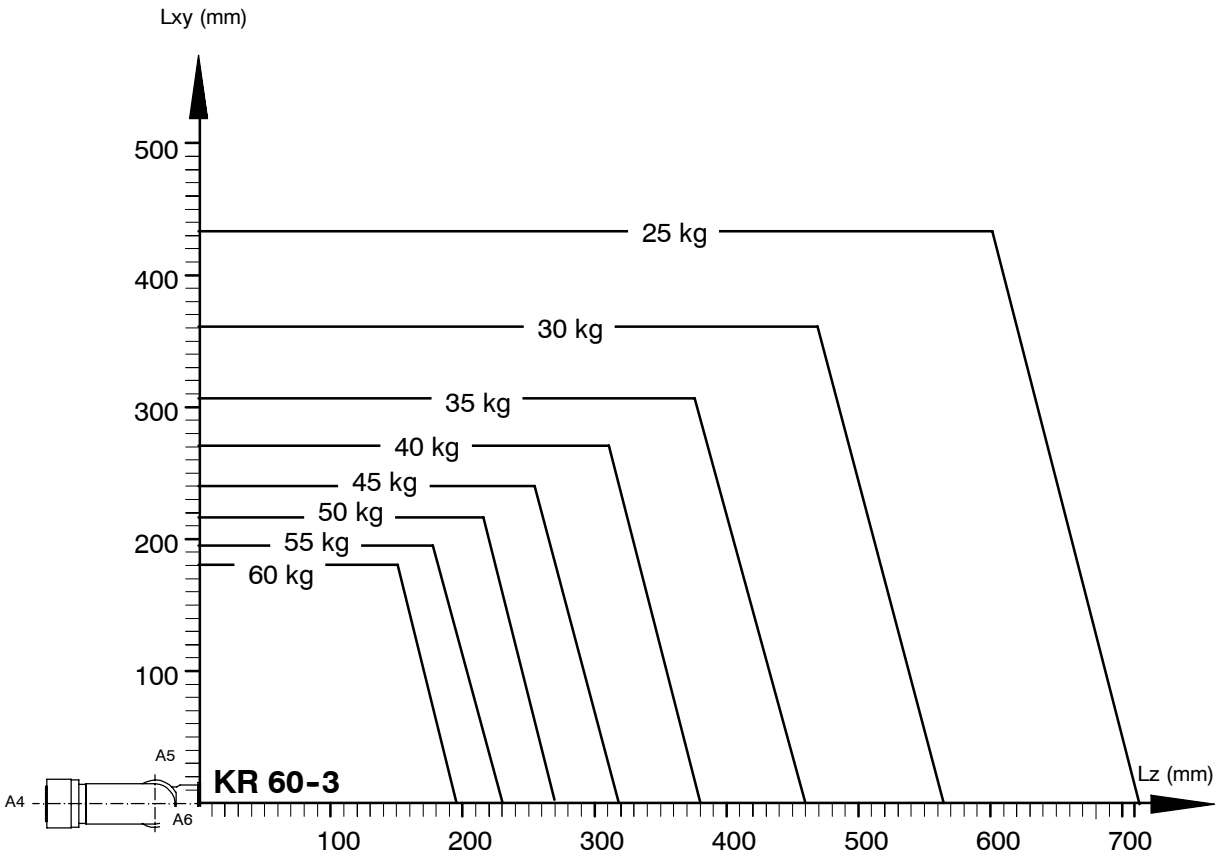
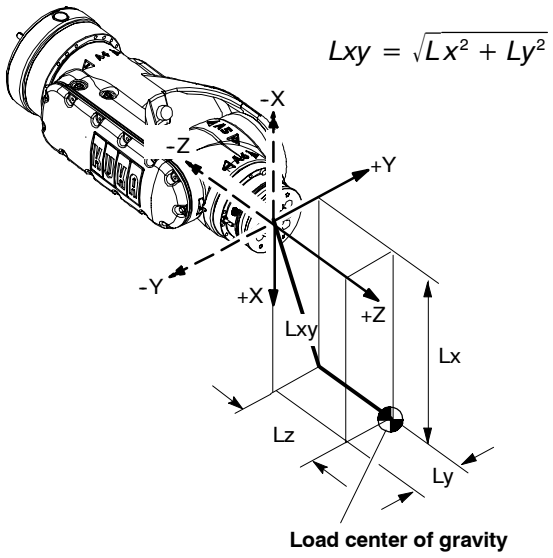


Fig. 17 Load center of gravity P and loading curves for KR 60-3

Information!

The values determined here are necessary for planning the application.
For commissioning the robot, additional input data are required in accordance with the KUKA software documentation.

Robot flange coordinate system



Permissible mass inertia at the design point
(Lxy = 180 mm,
Lz = 150 mm)
13.5 kgm^2.

CAUTION: The mass inertia must be verified using KUKA Load. It is imperative for the load data to be entered in the controller!

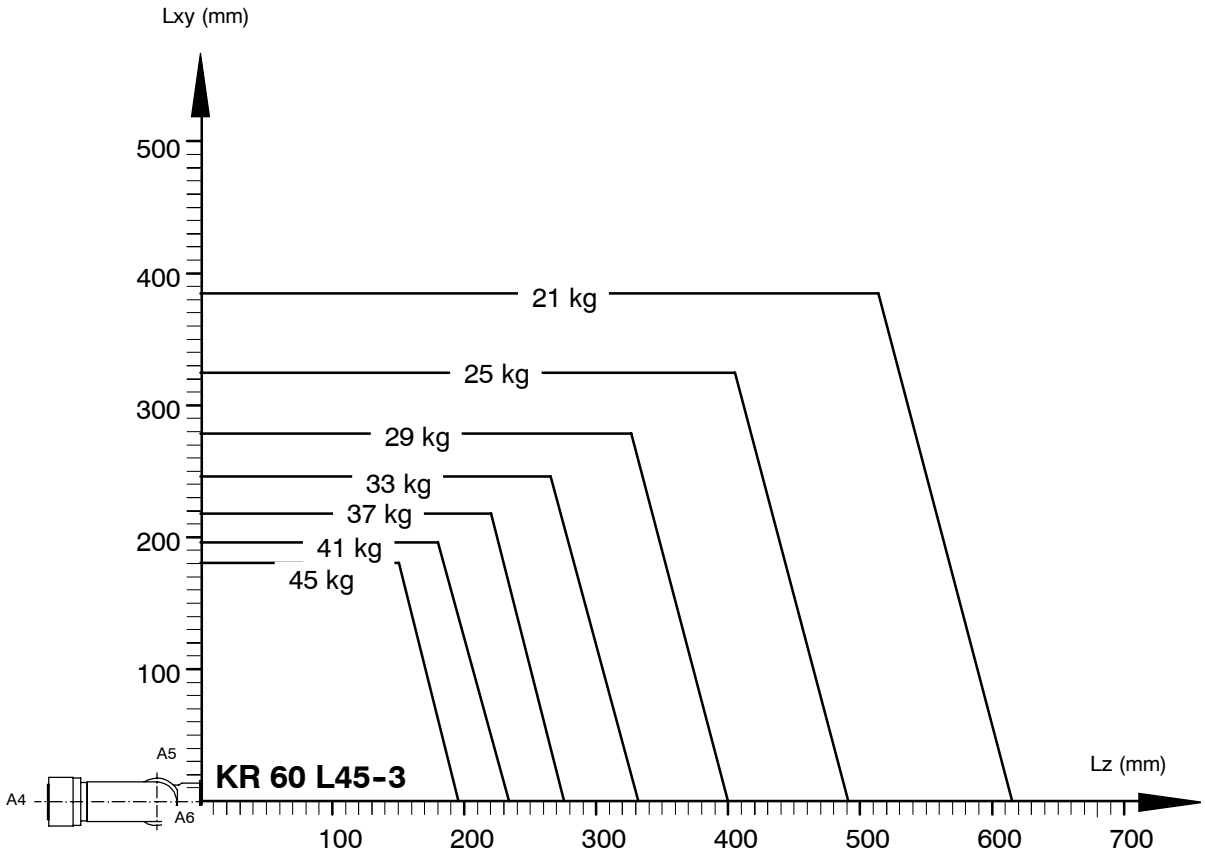


Fig. 18 Load center of gravity P and loading curves for KR 60 L45-3

Mounting flange

DIN/ISO[1)] mounting flange (Fig. 20). The mounting flange is depicted with axes 4 and 6 in the zero position. The symbol ⧫ indicates the position of the locating element (bushing). Screws of grade 10.9 are to be used for attaching payloads. The grip length of the screws in the flange must be at least 1.5 x nominal diameter.

Depth of engagement:	IW 16	min. 6 mm max. 9 mm
Depth of engagement:	IW 30/45/60	min. 12 mm max. 14 mm

1) DIN/ISO 9409-1-A50 for IW 16
DIN/ISO 9409-1-A100 for IW 30/45/60

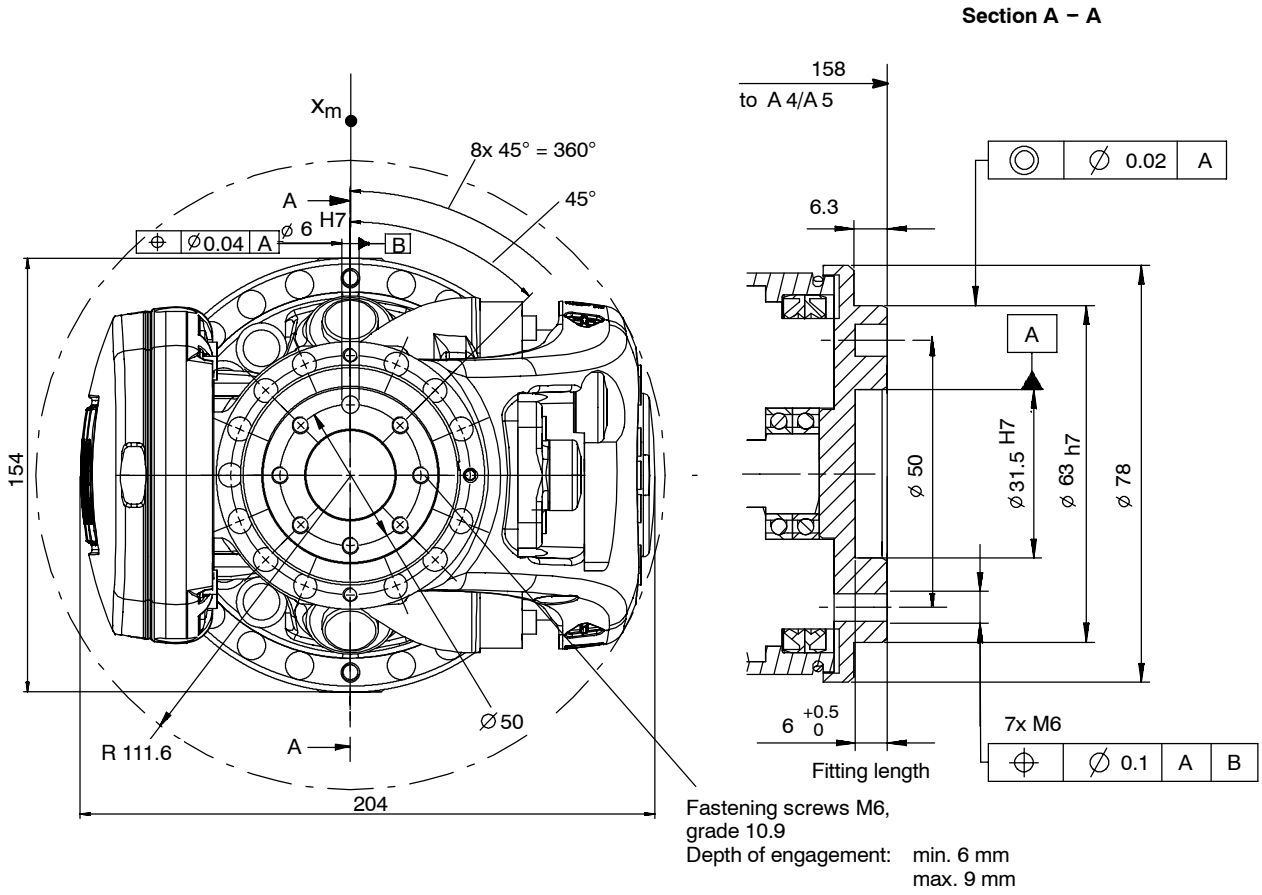


Fig. 19 DIN/ISO mounting flange for in-line wrist 16 kg

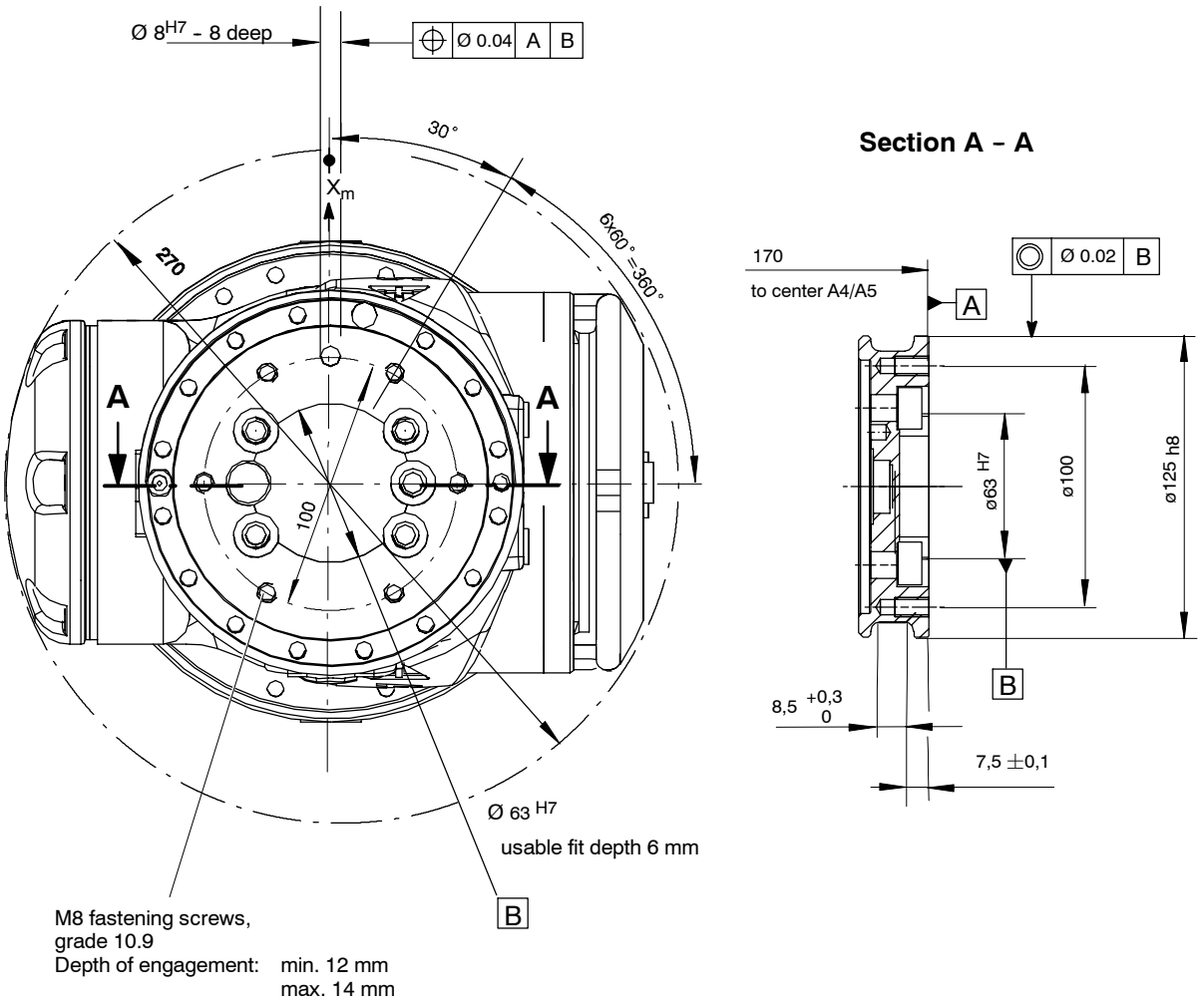
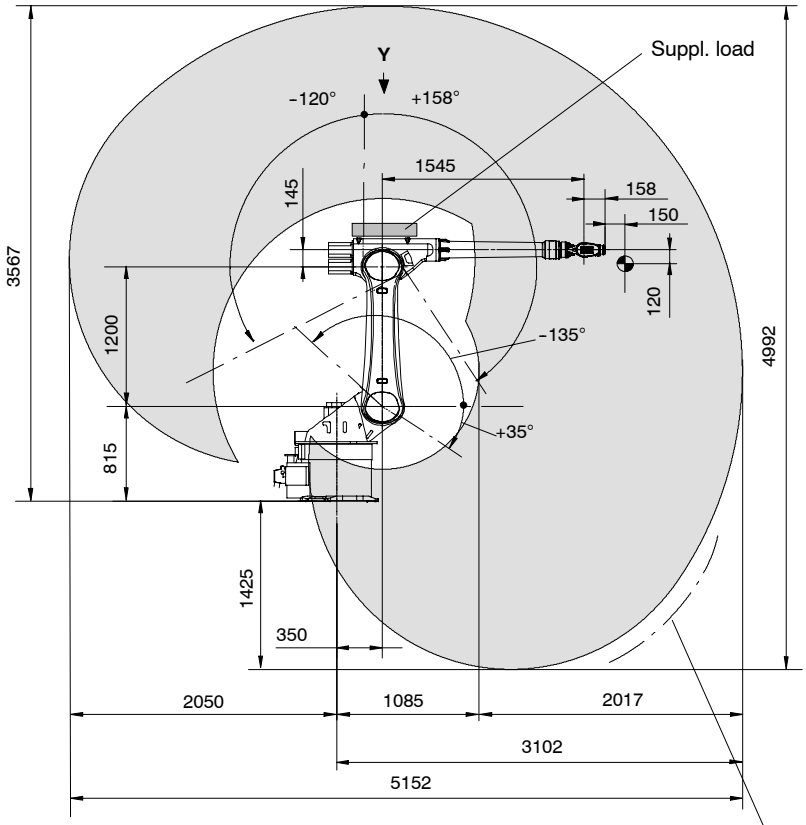
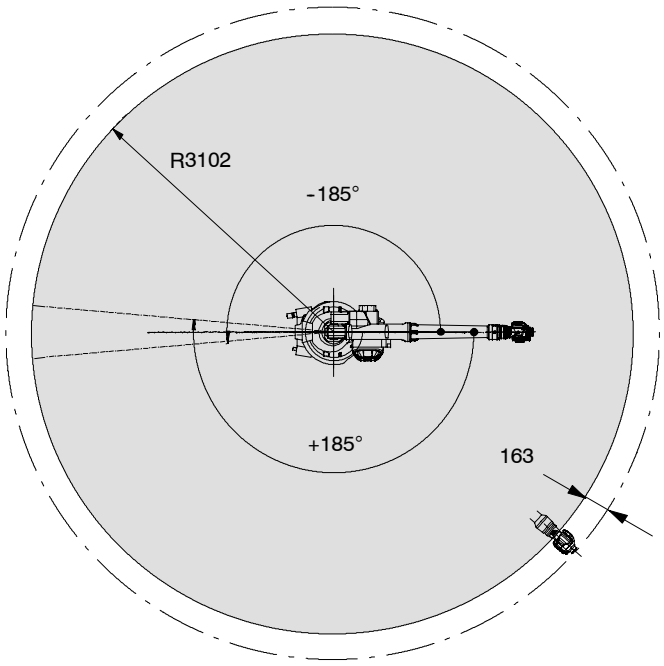


Fig. 20 DIN/ISO mounting flange for in-line wrist 30/45/60 kg



Dimensions: mm



CAUTION: The interference radius (safe area) lies approx. 163 mm beyond the reference point for the working envelope.

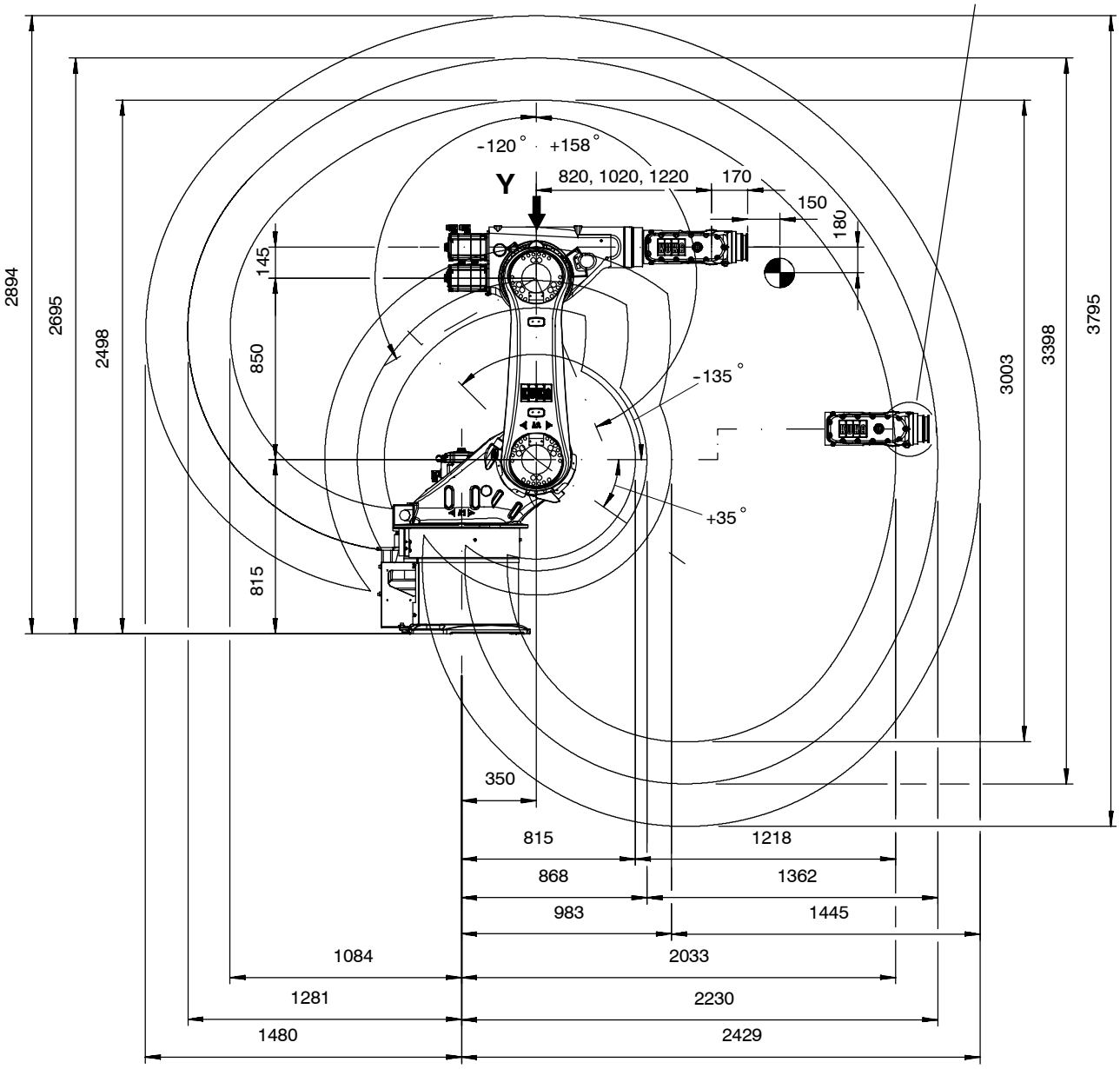
NOTE: The supplementary load center of gravity must be located as close as possible to rotational axis 3 and to line a in Fig. 24.

The reference point for the working envelope is the intersection of axes 4 and 5.

View Y, see Fig. 24.

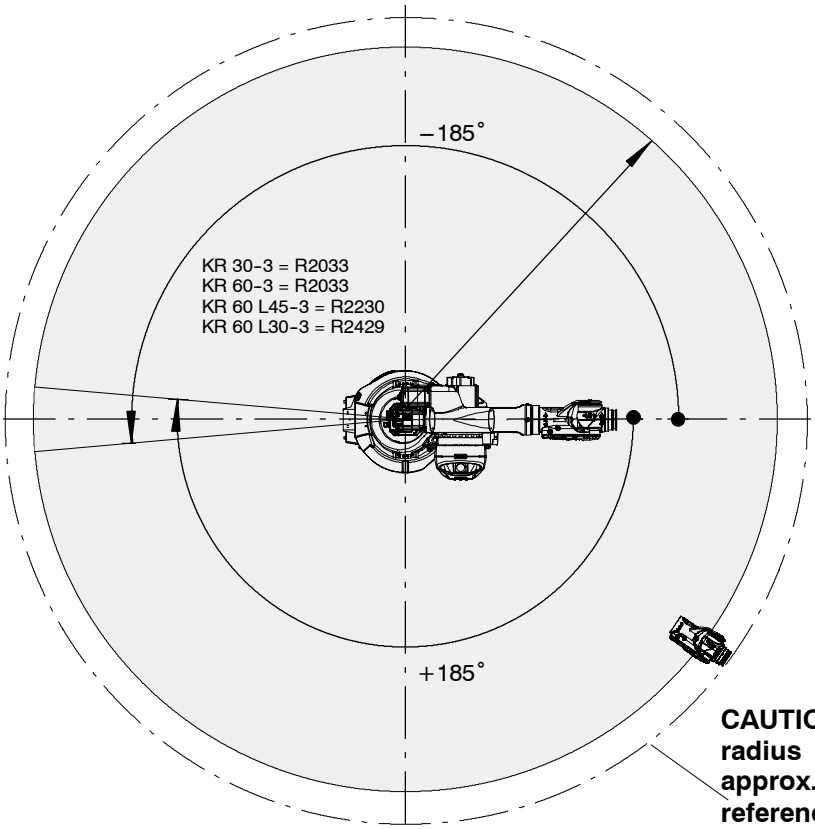
Fig. 21 Principal dimensions and working envelope for KR 30 L16-2 (software values)

CAUTION: The interference radius (safe area) lies approx. 181 mm beyond the reference point for the working envelope.



NOTE: The supplementary load center of gravity must be located as close as possible to rotational axis 3 and to line a in Fig. 24.
The reference point for the working envelope is the intersection of axes 4 and 5.
View Y, see Fig. 24.

Fig. 22 Principal dimensions and working envelope (software values)



CAUTION: The interference radius (safe area) lies approx. 181 mm beyond the reference point for the working envelope.

Fig. 23 Turning range A1, KR 30-3, KR 60-3

View Y **from Fig. 21 and Fig. 22**

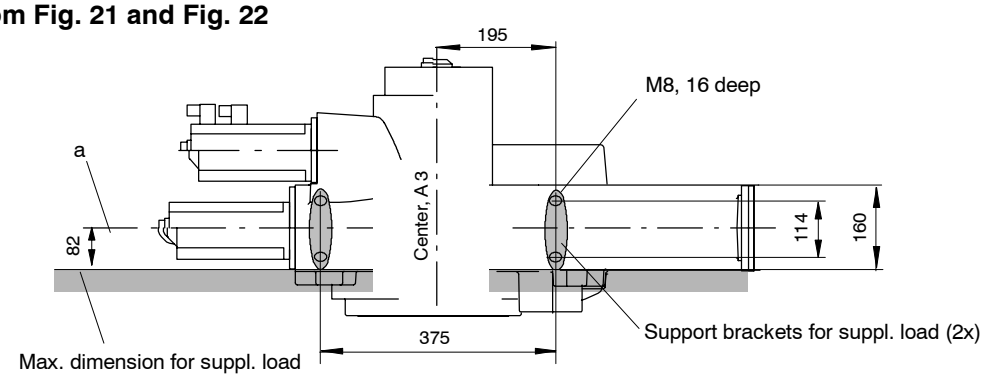
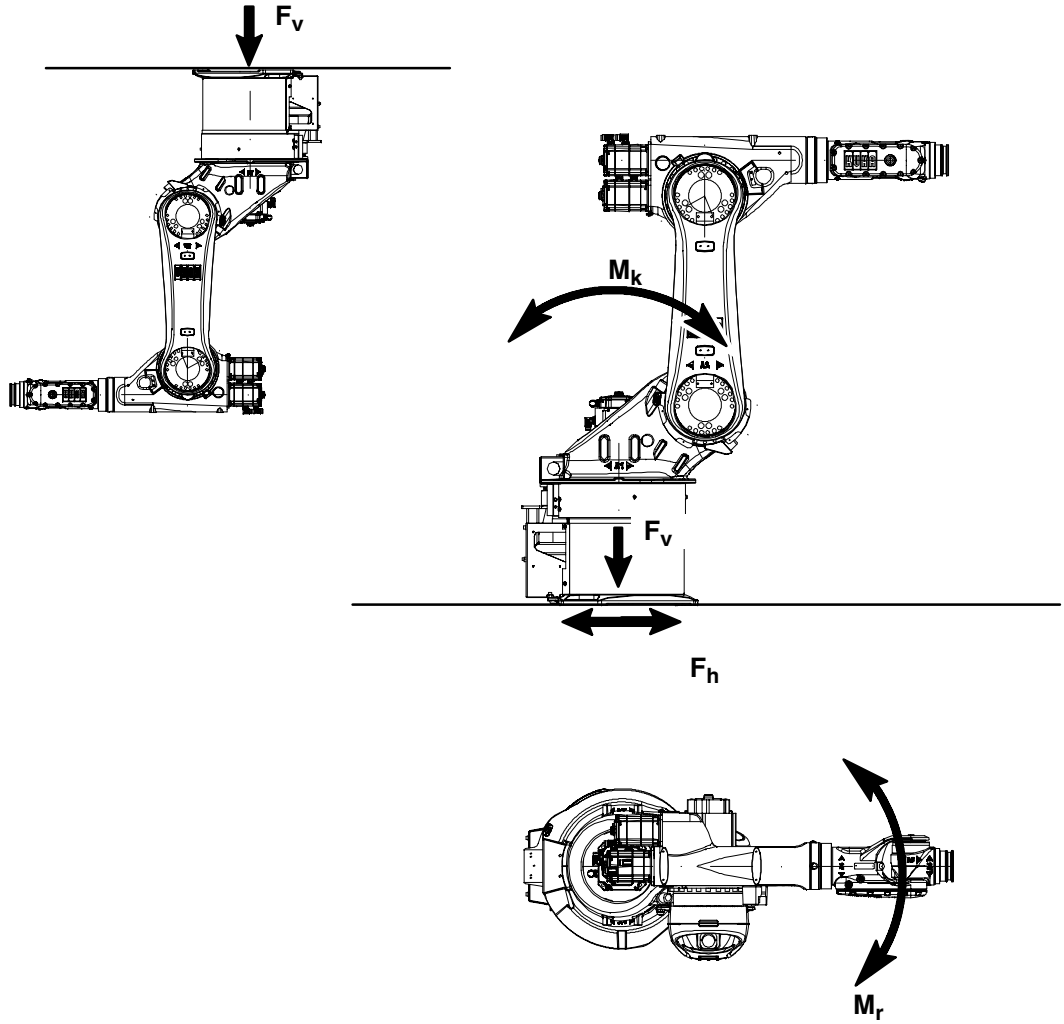


Fig. 24 Attachment holes for supplementary load

The specified forces and moments already include the payload and the inertia force (weight) of the manipulator.



			Maximum load			Normal load		
F_v	=	Vertical force	F_{vmax}	=	13 600 N	$F_{v\ normal}$	=	9 000 N
F_h	=	Horizont force	F_{hmax}	=	12 300 N	$F_{h\ normal}$	=	6 950 N
M_k	=	Tilting moment	M_{kmax}	=	21 600 Nm	$M_{k\ normal}$	=	11 900 Nm
M_r	=	Turning moment about axis 1	M_{rmax}	=	18 400 Nm	$M_{r\ normal}$	=	6 850 Nm

Total mass =

manipulator	+	total load	for type
665 kg	+	65 kg	KR 30-3
700 kg		51 kg	KR 30 L16-2
665 kg	+	95 kg	KR 60-3
671 kg	+	80 kg	KR 60 L45-3
679 kg	+	65 kg	KR 60 L30-3

Fig. 25 Principal loads acting on floor (or ceiling) due to manipulator and total load

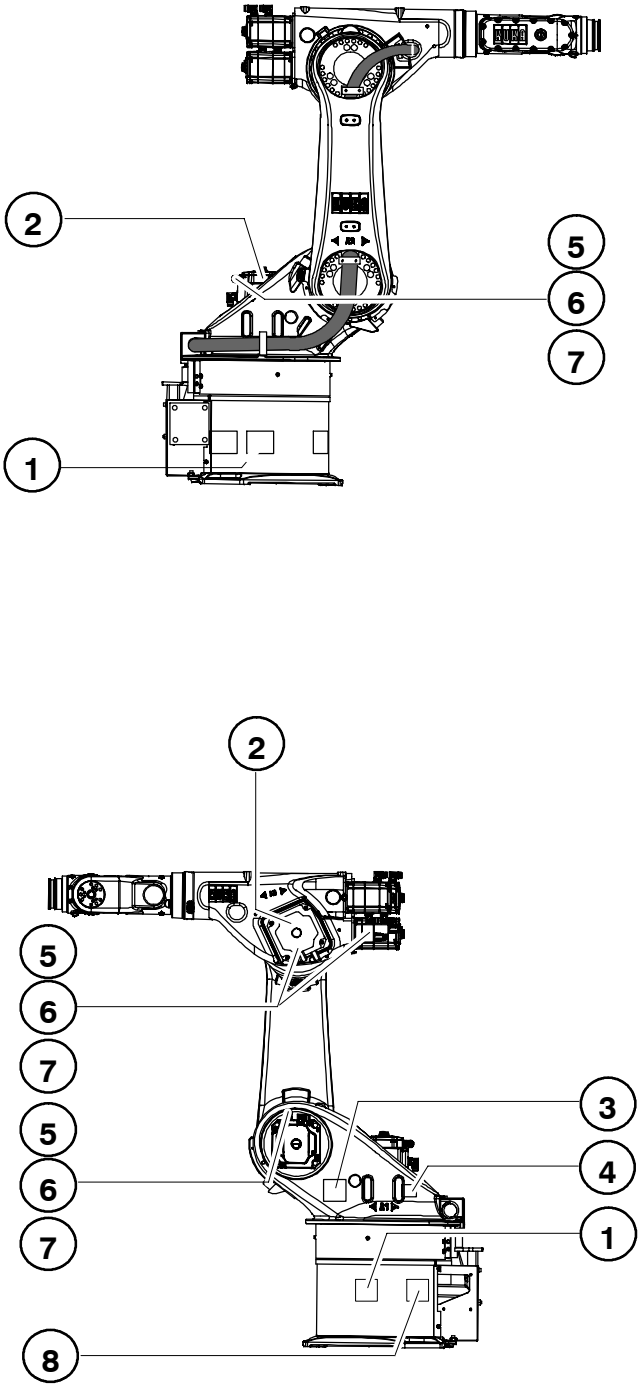
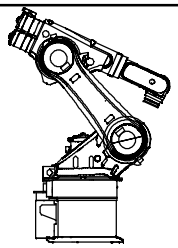


Fig. 26 Plates on manipulator (see also Fig. 27 to Fig. 34)

Transportstellung:
Transport position:
Position de transport:

A1	A2	A3	A4	A5	A6
0°	–135°	+155°	0°	+90°	



ACHTUNG!
Vor dem Lösen der Fundamentbefestigungsschrauben muss der Roboter in Transportstellung gebracht werden!

WARNING!
The robot must be in the transport position before the holding-down bolts are slackened!

ATTENTION!
Le robot doit être amené en position de transport avant de desserrer les boulons de fixation des fondations!

Artikel-Nr. 00-000-000 D/GB/F

① 2x

Fig. 27 Instructions regarding transport position KR 30, 60-3, KR 30 L16

ACHTUNG! WARNING! ATTENTION!

Vor dem Entfernen des Motors Roboterachse gegen Kippen sichern!

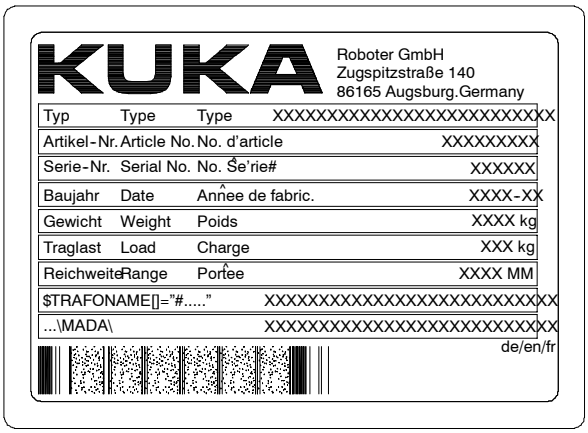
Only remove motor when robot axis is secured!

Avant démontage du moteur bloquer l'axe concerné!

D/GB/F

② 2x

Fig. 28 Instructions for safeguarding against toppling of A2 and A3

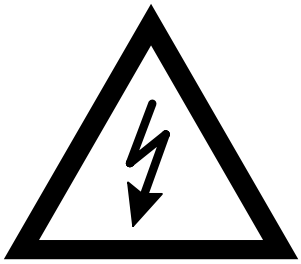


⑦

Fig. 29 Robot identification plate (example)

④

Fig. 30 Reference to operating instructions



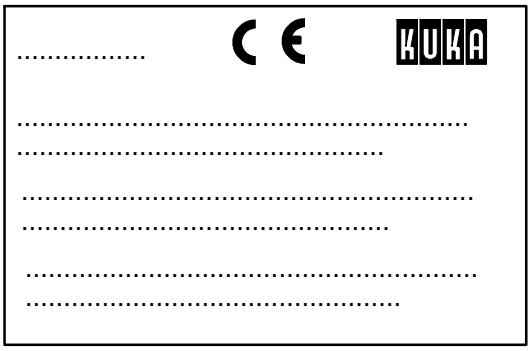
⑤

Fig. 31 High voltage warning sign

4x on each motor

⑥

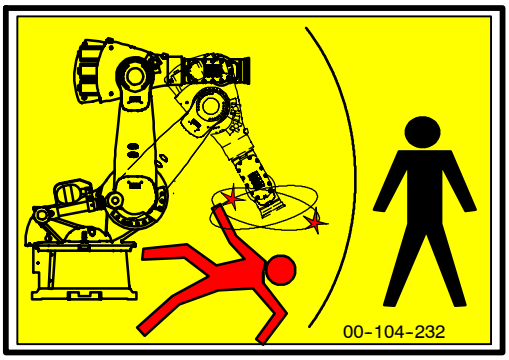
Fig. 32 Hot surface warning sign



On all motors.

⑦

Fig. 33 Drive motor rating plate



3x on base frame

⑧

Fig. 34 Danger zone

5 Safety

5.1 Representation of warnings and notes

Safety

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

Danger!

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

Warning!

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

Caution!

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

Notice!

These warnings mean that damage to property may occur, if no precautions are taken. They contain references to safety-relevant information or general safety measures. These warnings do not refer to individual hazards or individual precautionary measures.

Information!

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

5.2 General

Notice!

This “Safety” chapter refers to a mechanical component of an industrial robot.

If the mechanical component is used together with a KUKA robot controller, the “Safety” chapter of the operating instructions or assembly instructions of the robot controller must be used!
This contains all the information provided in this “Safety” chapter. It also contains additional safety information relating to the robot controller which must be observed.

Where this “Safety” chapter uses the term “industrial robot”, this also refers to the individual mechanical component if applicable.

5.2.1 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 robot system 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.

5.2.2 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.

Information!
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
- Underground operation

5.2.3 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.

5.2.4 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	KUKA Control Panel Teach pendant for the KR C2/KR C2 edition 2005 The KCP has all the operator control and display functions required for operating and programming the industrial robot.
KCP smartPAD	see “smartPAD”
Manipulator	The robot arm and the associated electrical installations.
Protected space	The safety zone is situated outside the danger zone.
smartPAD	Teach pendant for the KR C4 The smartPAD has all the operator control and display functions required for operating and programming the industrial robot.
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.

5.3 Personnel

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

- User
- Personnel

Notice!

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

Notice!

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	Operating personnel	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
Commissioning			x
Maintenance			x
Repair			x
Decommissioning			x
Transportation			x

Notice!

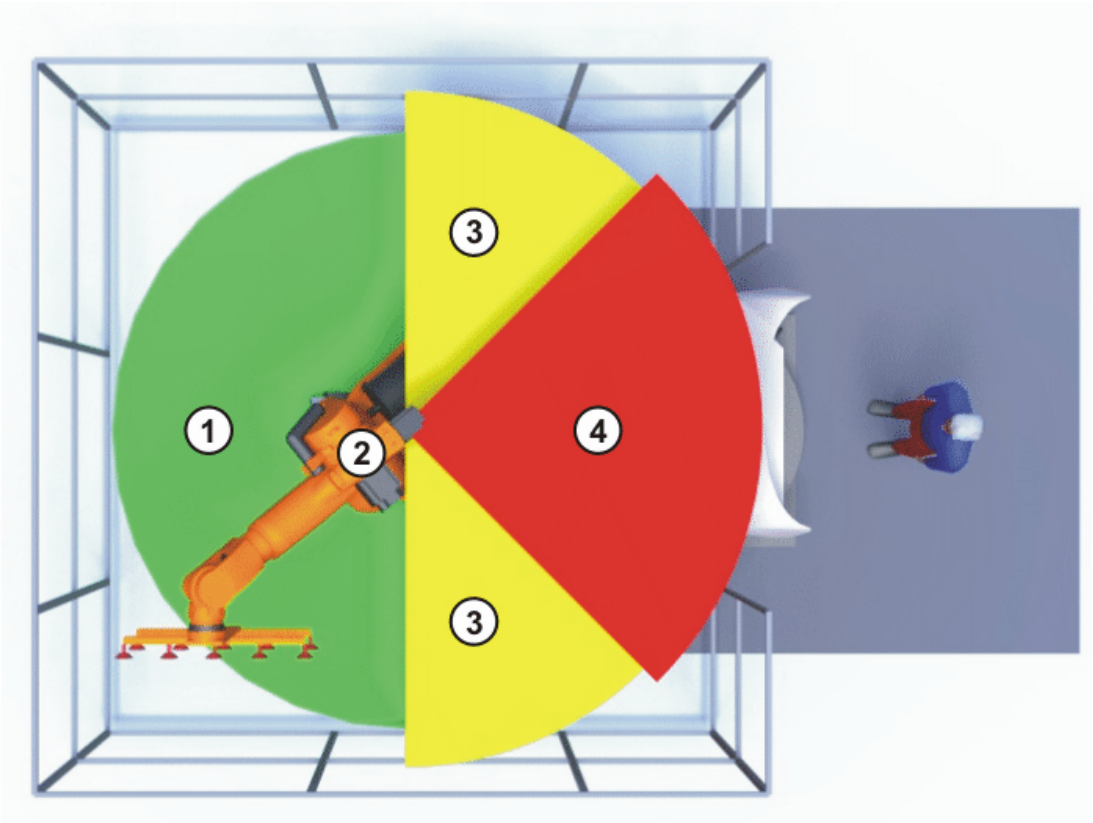
Work on the electrical and mechanical equipment of the industrial robot may only be carried out by specially trained personnel.

5.4 Workspace, safety zone and danger zone

Working zones 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.



(1) Workspace
(2) Manipulator
(3) Stopping distance
(4) Safety zone

Fig. 35 Example: axis range A1

5.5 Overview of protective equipment

The protective equipment of the mechanical component may include:

- Mechanical end stops
- Mechanical axis range limitation (optional)
- Axis range monitoring (optional)
- Release device (optional)
- Labeling of danger areas

Not all equipment is relevant for every mechanical component.

5.5.1 Mechanical end stops

Depending on the robot variant, the axis ranges of the main and wrist axes of the manipulator are partially limited by mechanical end stops.

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

Notice!

If the manipulator or an external axis hits an obstruction or a mechanical end stop or axis range limitation, this can result in material damage to the industrial robot. The manipulator must be taken out of operation and KUKA Roboter GmbH must be consulted before it is put back into operation.

5.5.2 Mechanical axis range limitation (optional)

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

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

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

Information!

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

5.5.3 Axis range monitoring (optional)

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

Information!

This option is not available for all robot models and not for the KR C4. Information on specific robot models can be obtained from KUKA Roboter GmbH.

5.5.4 Options for moving the manipulator without drive energy

Caution!

The system user is responsible for ensuring that the training of personnel with regard to the response to emergencies or exceptional situations also includes how the manipulator can be moved without drive energy.

Description

The following devices are available for moving the manipulator after an accident or malfunction:

- Release device (optional)
  The release device can be used for the main axis drive motors and, depending on the robot variant, also for the wrist axis drive motors.
- Brake release device (optional)
  The brake release device is designed for robot variants whose motors are not freely accessible.
- Moving the wrist axes directly by hand
  There is no release device available for the wrist axes of variants in the low payload category. This is not necessary because the wrist axes can be moved directly by hand.

Information!

Information about the options available for the various robot models and about how to use them can be found in the assembly and operating instructions for the robot or requested from KUKA Roboter GmbH.

Notice!

Moving the manipulator without drive energy can damage the motor brakes of the axes concerned. The motor must be replaced if the brake has been damaged. The manipulator may therefore be moved without drive energy only in emergencies or exceptional situations, e.g. for rescuing persons.

5.5.5 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

Information!

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

5.6 Safety measures

5.6.1 General safety regulations

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.

Danger!

Standing underneath the robot arm can cause death or serious 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/smartPAD

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

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

Warning!

The operator must ensure that decoupled KCPs/smartPADs 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 devices from becoming interchanged. Failure to observe this precaution may result in death, severe 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/smartPAD must not be used as long as an external keyboard and/or external mouse are connected to the control cabinet.

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

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.

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

5.6.2 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 robot.

Robot controller

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

Avoid vibrations and impacts during transportation in order to prevent damage to 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.

5.6.3 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.

Notice!

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.

Notice!

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.

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.

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 injuries or considerable damage to property may otherwise result. The correct machine data must be loaded.

5.6.4 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
- Teach
- 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.

5.6.5 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.

5.6.6 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.

Warning!

Before work is commenced on live parts of the robot system, the main switch must be turned off and secured against being switched on again by unauthorized personnel. The incoming power cable must be deenergized. The robot controller and mains supply lead must then be checked to ensure that it is deenergized.
If the KR C4 or VKR C4 robot controller is used:
It is not sufficient, before commencing work on live parts, to execute an EMERGENCY STOP or a safety stop, or to switch off the drives, as this does not disconnect the robot system from the mains power supply in the case of the drives of the new generation. Parts remain energized. Death or severe injuries may result.

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

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

Robot controller

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

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

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

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

Counterbalancing system

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

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

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

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

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

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

Hazardous substances

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

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

Notice!

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.

5.6.7 Decommissioning, storage and disposal

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

5.7 Applied norms and regulations

Name	Definition	Edition
2006/42/EC	Machinery Directive: Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)	2006
2004/108/EC	EMC Directive: Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC	2004
97/23/EC	Pressure Equipment Directive: Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment (Only applicable for robots with hydropneumatic counterbalancing system.)	1997
EN ISO 13850	Safety of machinery: Emergency stop – Principles for design	2008
EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems; Part 1: General principles of design	2008
EN ISO 13849-2	Safety of machinery: Safety-related parts of control systems; Part 2: Validation	2008
EN ISO 12100	Safety of machinery: General principles of design, risk assessment and risk reduction	2010
EN ISO 10218-1	Industrial robots: Safety	2011
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 Transportation

Information!

This description applies analogously to all of the industrial robots listed in Chapter 1, regardless of the variant or model shown in the illustrations.

Caution!

If the manipulator is transported by fork lift truck, the forks must be placed in the fork slots. It is forbidden to pick up the manipulator in any other way using a fork lift truck!

The fork lift truck, lifting tackle and crane must be suitable for handling the manipulator. For weight, see Chapter 4, "Technical data".
The manipulator must be moved into its transport position each time it is transported. It must be ensured that the manipulator is stable while it is being transported.

The manipulator must remain in its transport position until it is – depending on the type – fastened to the floor, the ceiling or to a hinged steel base.

Before the manipulator is lifted, it must be ensured that it is free from obstructions. Transport safeguards, such as nails and screws, are all to be removed in advance, as is any rust or glue on contact surfaces.

The most important factor in deciding on the method of transportation is the installation position of the manipulator.

The manipulator can be transported as follows:

- With lifting tackle and crane (Fig. 38, left-hand side)

The manipulator can be suspended from the hook of a crane by means of lifting tackle attached to three M16 DIN 580 eyebolts on the rotating column.

Caution!

The ropes or belts of the lifting tackle must be positioned so that there is no possibility of the manipulator tilting to the side and of cabling or connectors being damaged.

Caution!

Only approved handling equipment and lifting tackle with an adequate carrying capacity may be used for transporting the manipulator.
For the weight of the manipulator, see Chapter 4, "Technical data".
All three M16 DIN 580 eyebolts on the rotating column must always be used to suspend the manipulator.

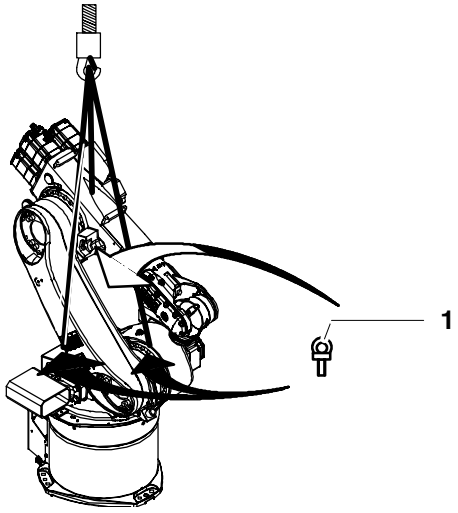


Fig. 36 Transport position

- With fork lift truck (Fig. 38, right-hand side)

Caution!

If the manipulator is transported by fork lift truck, the forks must be placed in the fork slots. It is forbidden to pick up the manipulator in any other way using a fork lift truck!

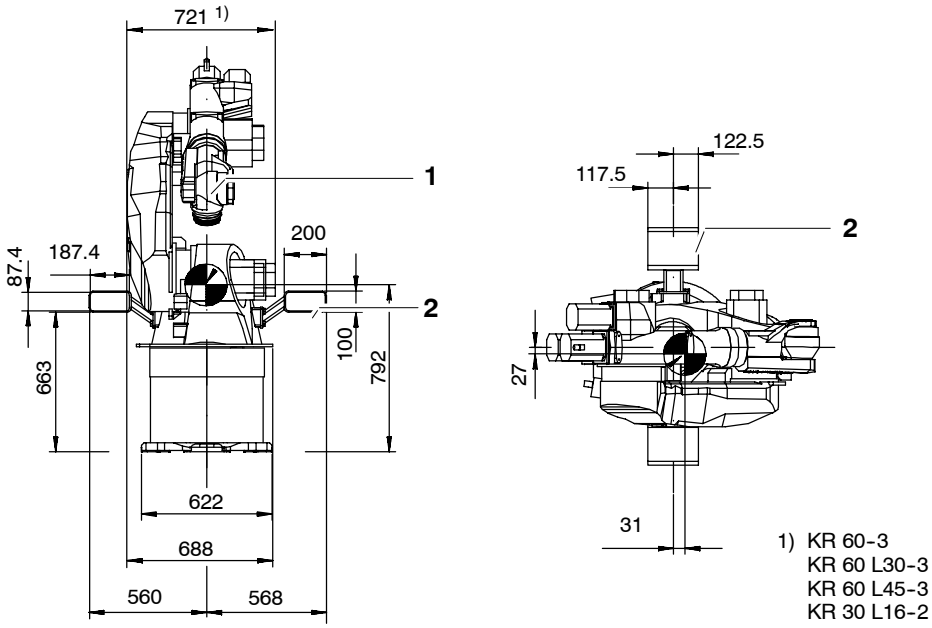


Fig. 37 Fork slots

For transport with a fork lift truck, two removable, open-ended fork slots (Fig. 37/2) are mounted on the rotating column. This allows the manipulator (1) to be picked up from two sides.

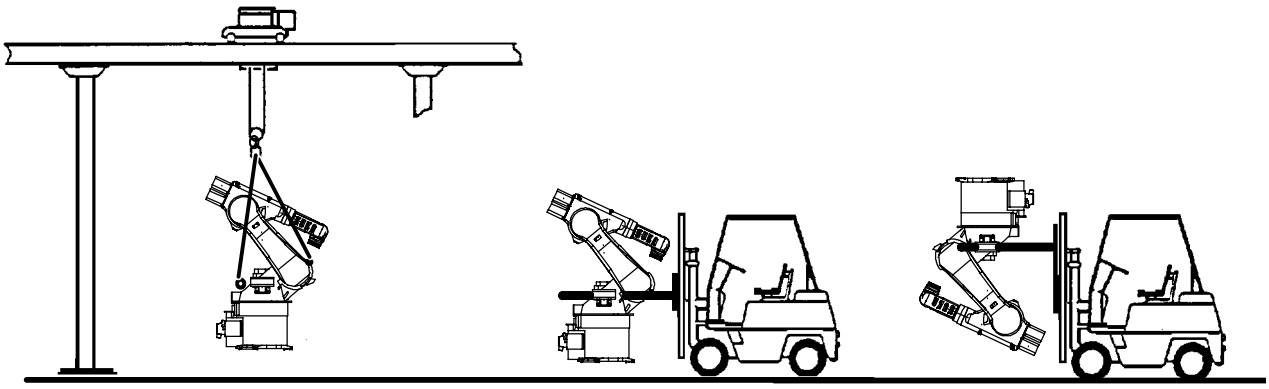


Fig. 38 Transporting floor-mounted and ceiling-mounted manipulators

If the manipulator is to be transported away from its site of operation, the following is to be observed:

Warning!

Turn main switch on the manipulator control cabinet to “OFF” and secure it with a padlock to prevent unauthorized persons from switching it on again.

(1) Remove tools and additional devices should they prevent the transport position from being reached or generally impede transportation.

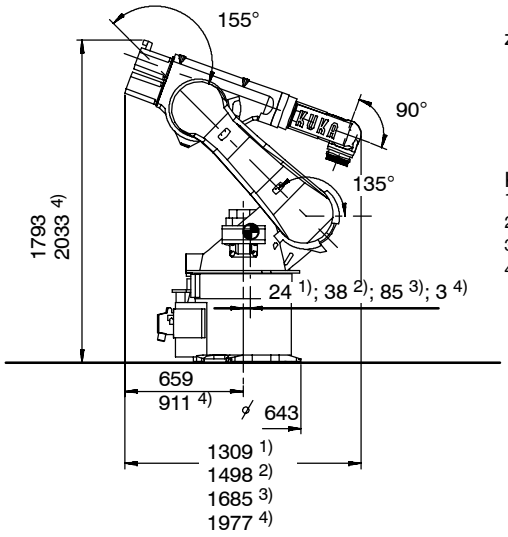
Warning!

Before performing the next step, it must be ensured that it is not possible for anyone to be injured within the range of the slowly moving manipulator.
The manipulator may only be moved at jog speed, with all applicable safety rules and regulations being observed.

(2) Put the manipulator into operation and move it into the transport position (Fig. 39, Fig. 40)*.

A1	A2	A3	A4	A5	A6
0°	−135°	+155°	0°	+90°	0°*

* All angles are specified relative to the electrical zero position or to the KCP display.



KR 30-3, 60-3
1) without arm extension
2) 200 mm arm extension
3) 400 mm arm extension
4) KR 30 L16-2

Fig. 39 Transport position for floor-mounted manipulators

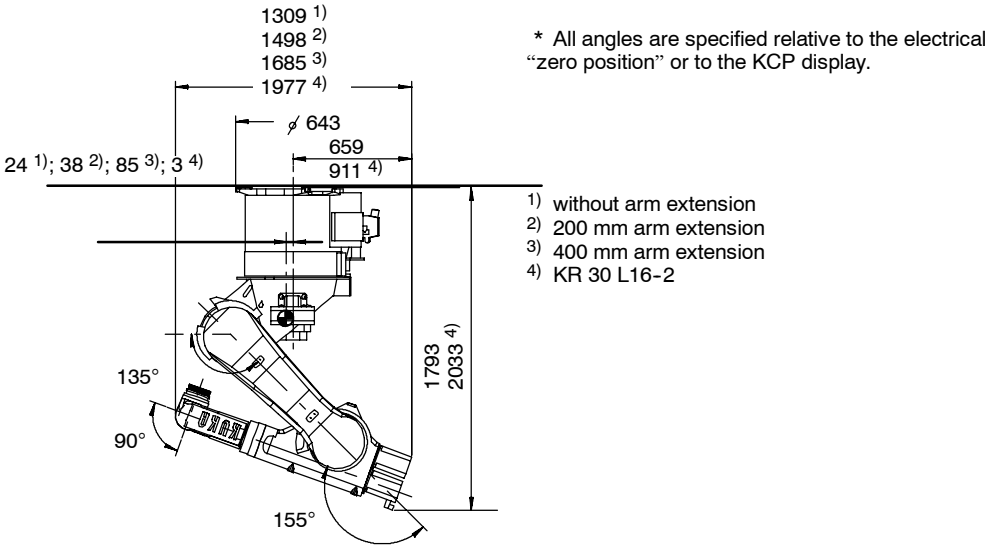


Fig. 40 Transport position for ceiling-mounted manipulators

Warning!

Turn main switch on the manipulator control cabinet to "OFF" and secure it with a padlock to prevent unauthorized persons from switching it on again.

For further work steps, see Chapter 7, "Installation, connection, exchange".

7 Installation, connection

Information!

This description applies analogously to all of the industrial robots listed in Chapter 1, regardless of the variant or model shown in the illustrations.

7.1 General

Caution!

Observe Chapter 5, “Safety”!
With all work involving the connection of the manipulator (and of the control cabinet), the control cabinet documentation “Initial Start-up” must be observed.

Notice!

When putting the manipulator into operation either for the first time or after an exchange, zero adjustment must be carried out in accordance with the Operating Handbook, Software KR C4, Chapter “Start-up”, Section “Mastering/Unmastering”.

Before any installation and exchange work is started, any attached tools or additional equipment that would hinder the installation and exchange work must be dismounted.

Caution!

If the manipulator is transported by fork lift truck, the forks must be placed in the fork slots. It is forbidden to pick up the manipulator in any other way using a fork lift truck!

The fork lift truck, lifting tackle and crane must be suitable for handling the manipulator. For weight, see Chapter 4, “Technical data”.
The manipulator must be moved into its transport position each time it is transported. It must be ensured that the manipulator is stable while it is being transported.

The manipulator must remain in its transport position until it is - depending on the type - fastened to the floor, the ceiling or to a hinged steel base.

Before the manipulator is lifted, it must be ensured that it is free from obstructions. Transport safeguards, such as nails and screws, are all to be removed in advance, as is any rust or glue on contact surfaces.

The description of the installation and exchange operations is subdivided into job steps with numbers in brackets appearing before them. The text which immediately follows these steps must also be read if it is specially marked by a **warning triangle** or either of the **hand symbols**. This is because many of these marked texts refer to the preceding job step.

Example:
(8) Lower the manipulator slowly without tilting it.

Notice!

The manipulator must be lowered vertically downwards until both locating pins are free.

Some of the specially marked texts refer exclusively to everything that follows – until the instruction is expressly revoked or the work is completed at the end of a section.

Example:

Warning!

Turn main switch on the manipulator control cabinet to “OFF” and secure it with a padlock to prevent unauthorized persons from switching it on again.

Warning!

If it is necessary to carry out work in the area beneath a manipulator, the latter must be secured to guard against the risk of unintended motion into this area. This can be done by supporting it from below or by securing it with a rope from above.

Never work or stand under suspended loads!

7.2 Information for planning

In the planning and design phase, care must be taken regarding the functions or applications to be executed by the kinematic system. The following conditions can lead to premature wear. They necessitate shorter maintenance intervals and/or earlier exchange of components. In addition, the permissible operating parameters specified in the technical data must be taken into account during planning.

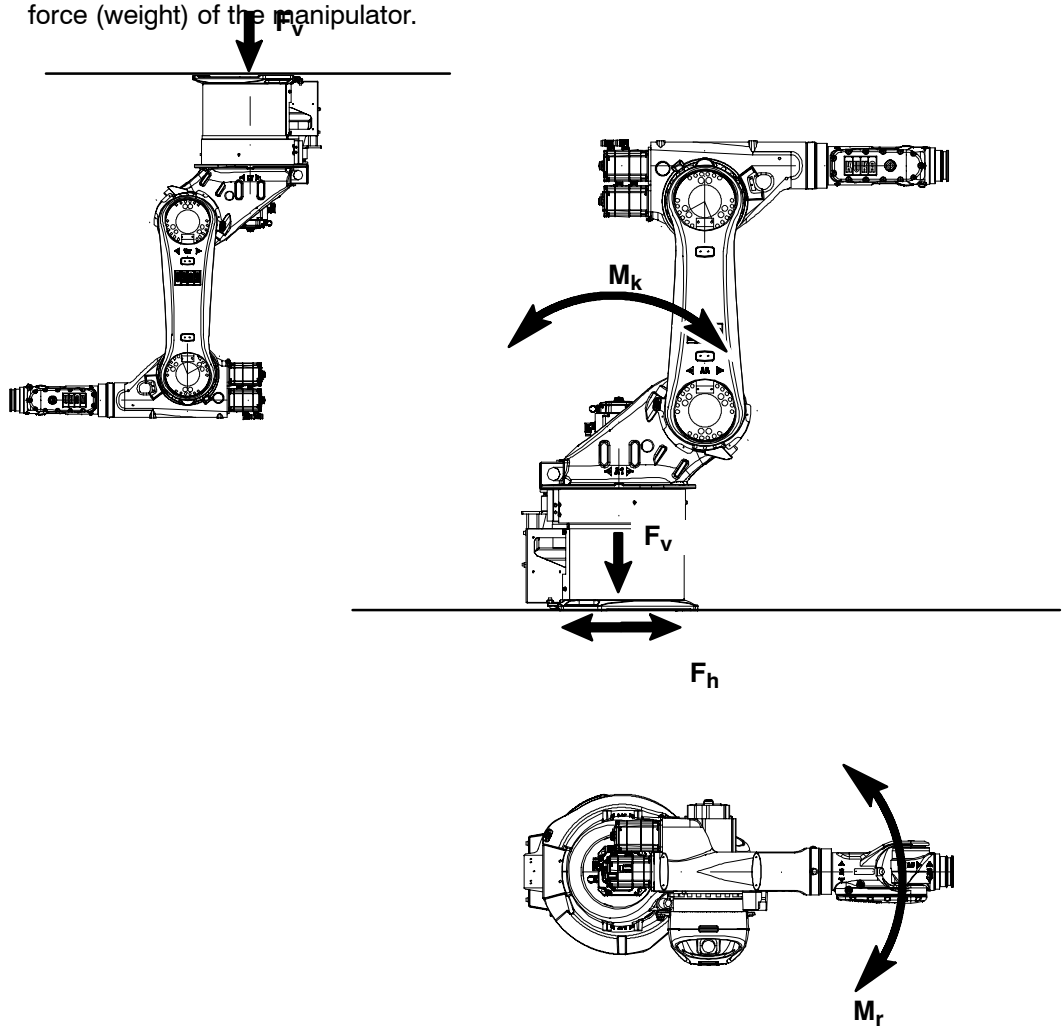
- Continuous operation near temperature limits or in abrasive environments.
- Continuous operation close to the performance limits, e.g. high rpm of an axis.
- High duty cycle of individual axes.
- Monotonous motion profiles, e.g. short, frequently recurring axis motions.
- Static axis positions, e.g. continuous vertical position of a wrist axis.

If one or more of these conditions are to apply during operation of the kinematic system, KUKA Roboter GmbH must be consulted.

7.3 Principal loads

Forces occur during operation of the manipulator which must be safely transmitted to the floor or ceiling. The forces that have to be taken into account are specified in Fig. 41. The data given in the illustration can also be used as a basis for more extensive static investigations.

The specified forces and moments already include the payload and the inertia force (weight) of the manipulator.



			Maximum load			Normal load		
F_v	=	Vertical force	F_{vmax}	=	13 600 N	$F_{v\ normal}$	=	9 000 N
F_h	=	Horizont force	F_{hmax}	=	12 300 N	$F_{h\ normal}$	=	6 950 N
M_k	=	Tilting moment	M_{kmax}	=	21 600 Nm	$M_{k\ normal}$	=	11 900 Nm
M_r	=	Turning moment about axis 1	M_{rmax}	=	18 400 Nm	$M_{r\ normal}$	=	6 850 Nm

Total mass =

manipulator	+	total load	for type
665 kg	+	65 kg	KR 30-3
700 kg		51 kg	KR 30 L16-2
665 kg	+	95 kg	KR 60-3
671 kg	+	80 kg	KR 60 L45-3
679 kg	+	65 kg	KR 60 L30-3

Fig. 41 Principal loads acting on floor (or ceiling) due to manipulator and total load

7.4 Mounting variants

The manipulator can be installed on the floor or the ceiling.

Mounting variants 1 to 3 are available for installing the manipulator on the floor; variants 2 and 3 can additionally be used for ceiling mounting:

- **Variant 1**, mounting base with centering, see Section 7.4.1.

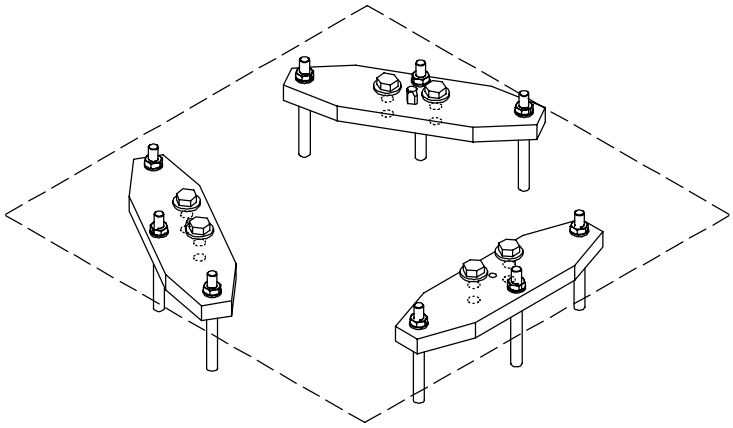


Fig. 42 Mounting base with centering

- **Variant 2**, machine frame mounting; see Section 7.4.2

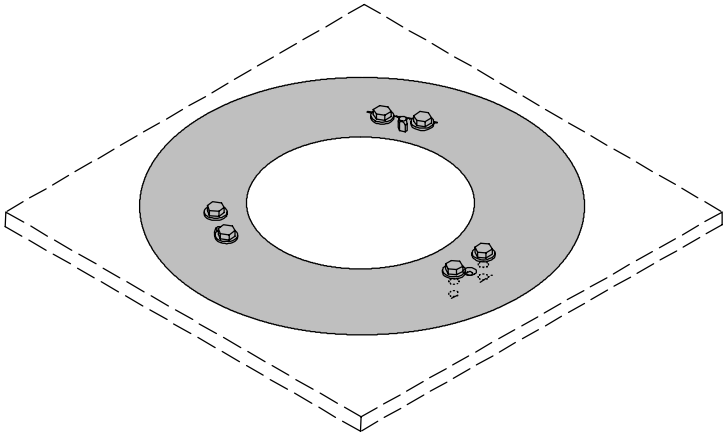


Fig. 43 Machine frame mounting

- **Variant 3**, adapter plate; see Section 3.3

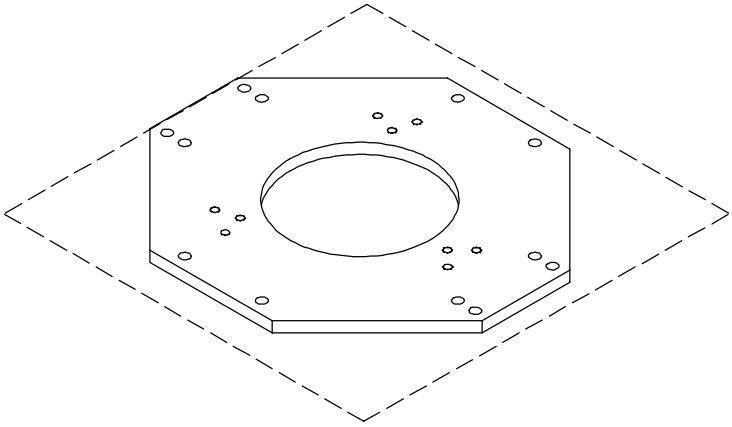


Fig. 44 Adapter base plate

If the manipulator is to be installed on the floor, being directly mounted on a concrete base, all pertinent construction specifications must be observed concerning the grade of concrete and the load-bearing capacity of the ground when preparing the concrete foundation. The concrete foundation must be able to accommodate the forces occurring during operation. There must be no layers of insulation or screed between the bedplates and the concrete foundation. When producing foundations from concrete, observe the load-bearing capacity of the ground and the country-specific construction regulations. The quality of the concrete must meet the requirements of the following standard:

- C20/25 according to DIN EN 206-1:2001/DIN 1045-2:2008

If the surface of the concrete foundation is not sufficiently smooth and even, the differences must be evened out with a suitable leveling compound.

When using resin-bonded anchors, use only resin cartridges and anchors from the same manufacturer. No diamond tools or core drills may be used for drilling the anchor holes; for preference, drilling tools supplied by the anchor manufacturer are to be used. The manufacturer s instructions for the use of resin-bonded anchors must also be observed.

To avoid distorting the base frame of the manipulator or the plate when fastening it to the concrete foundation, differences in level between the concrete foundation and the base frame must be corrected using leveling compound (filling compound).

The minimum mounting base dimensions and the orientation of the working envelope relative to the manipulator are depicted in the following diagram.

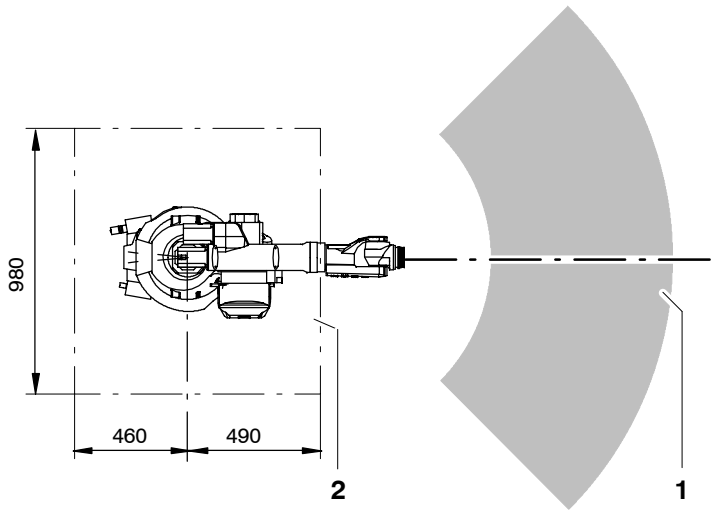


Fig. 45 Orientation of working envelope and concrete foundation

7.4.1 Variant 1, mounting base with centering

Features:

- For floor-mounted manipulators only.
- Manipulator installed on the concrete foundation.
- Manipulator fastened by means of nine chemical anchors.

Notice!

When using chemical anchors (resin-bonded anchors), only resin capsules and anchors (threaded rods) from the same manufacturer may be used.

No diamond tools or core drills may be used for drilling the anchor holes; for preference, drilling tools supplied by the anchor manufacturer are to be used.

The manufacturer's instructions for the use of resin-bonded anchors must also be observed.

Installation

(1) Lift the manipulator with fork lift truck or lifting tackle.

(2) Fasten each of the three bedplates (Fig. 46/2) to the manipulator (3) by means of two M20x70-8.8 hexagon bolts (1) and lock washers.

(3) Mark the position of the manipulator in relation to the working envelope (Fig. 45/1) on the concrete foundation (2) and bring the manipulator to the installation position.

(4) Align the manipulator horizontally.

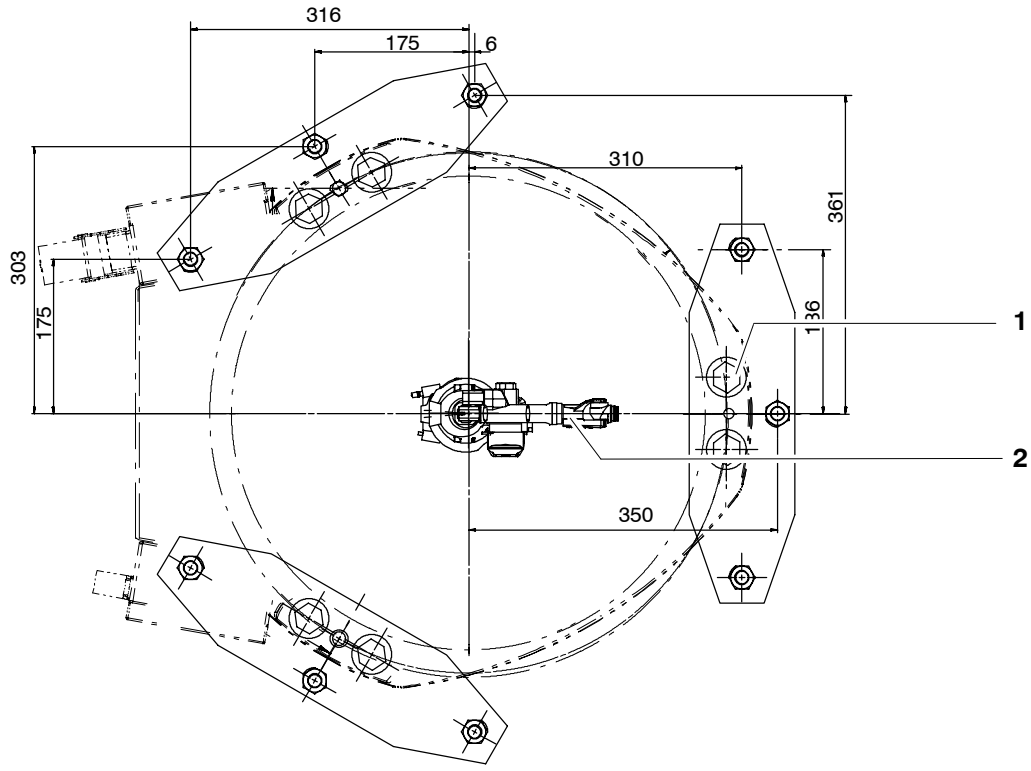


Fig. 46 Bedplates

(5) If necessary, determine the differences in level. If large differences in level are present, steps (6) to (9) must be followed.

(6) Apply leveling compound (Fig. 47/2) to the concrete foundation (4) or the underside of the bedplates.

Information!
"Knauf leveling compound", for example, is a suitable compound for this purpose. It is applied with a toothed spatula (tooth height > 2 x difference in level).

Notice!
The area (3) under each hexagon bolt (1) must be kept free from leveling compound or it must be cleared after the compound has been applied.

(7) Place the manipulator in the still plastic leveling compound and adjust its position slightly if necessary.

(8) Remove excess leveling compound.

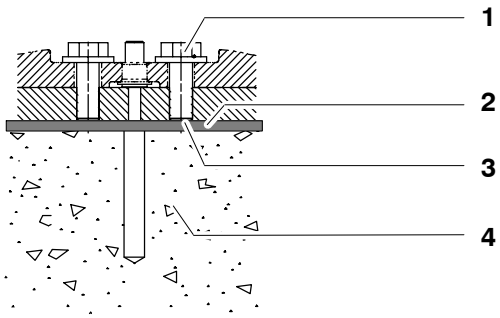


Fig. 47 Leveling compound

Notice!
If large differences in level need to be compensated for, more leveling compound must be applied. The maximum leveling compound thickness specified by the manufacturer must not be exceeded.

(9) Allow the leveling compound to cure for about three hours. The curing time is longer at temperatures below 20 °C (293 K).

Information!
At the end of the curing time, the anchor holes can be drilled.

(10) Drill nine anchor holes (Fig. 46/1) through the holes of the bedplates; depth in concrete 125 mm.

(11) Insert nine resin capsules (Fig. 48/4).

(12) Insert one threaded rod (3) into each anchor hole (5). To do this, secure the setting tool (2) in a hammer drill (1), attach the threaded rod, and insert it in the anchor hole at max. 750 r.p.m. The threaded rod is set correctly if the resin is completely mixed and the anchor hole in the concrete is completely filled to the upper edge. If the anchor hole is not completely filled, the threaded rod must be pulled out again immediately and a new resin capsule inserted.

(13) Allow the resin to cure.
The curing time is as follows:

Temperature		Time:
+20 °C	(293 K)	20 minutes
+10 °C	(283 K)	30 minutes
0 °C	(273 K)	1 hour
-5 °C	(268 K)	5 hours

(14) Mount the hexagon nuts (6) together with washers and tighten the hexagon nuts with a torque wrench in diagonally opposite sequence, increasing the tightening torque to the specified value in several stages (M_A = 80 Nm).

(15) Retighten the hexagon nuts after 100 hours of operation.

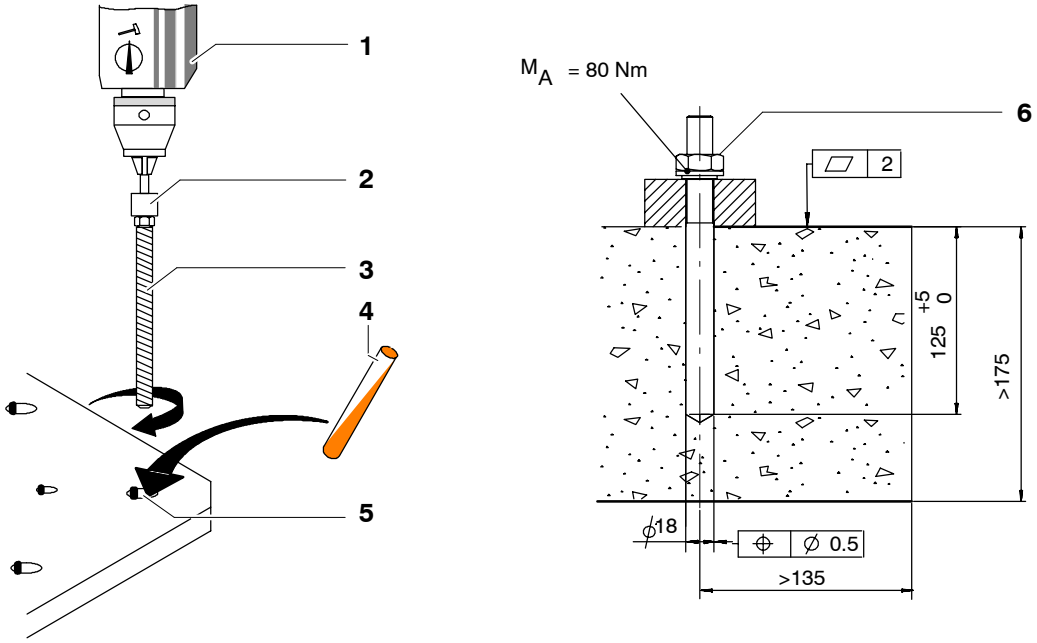


Fig. 48 Fastening the manipulator, variant 1

The manipulator is now ready for connection to the controller.

7.4.2 Variant 2, machine frame mounting

Features:

- For floor-mounted and ceiling-mounted manipulators.
- Manipulator installed on a steel structure prepared by the customer, on a steel pedestal or on a linear unit of the KL 1500 series.
- Manipulator fastened by means of six M20x55 ISO 4017 hexagon bolts.

Installation

(1) Prepare the mounting surfaces (Fig. 49/2) on the steel structure in accordance with Fig. 49.

Information!
The maximum permissible difference in level between the individual mounting surfaces (2) is 0.5 mm.

(2) Prepare six M20 tapped holes for the fastening screws (3) and two locating holes for the locating pins (1, 4).

(3) Insert the locating pins (1, 4).

Information!
The intended installation position of the manipulator, i.e. the correct orientation in relation to the working envelope (Fig. 45/1), must be taken into account when drilling the holes.

Information!
The position of the different locating pins in relation to the working envelope is important:
Looking forwards from the manipulator towards the working envelope – the arm of the manipulator points in this direction when A1 is in its zero position – the long locating pin (1) must be on the left and the short locating pin (4) must be situated on the right.

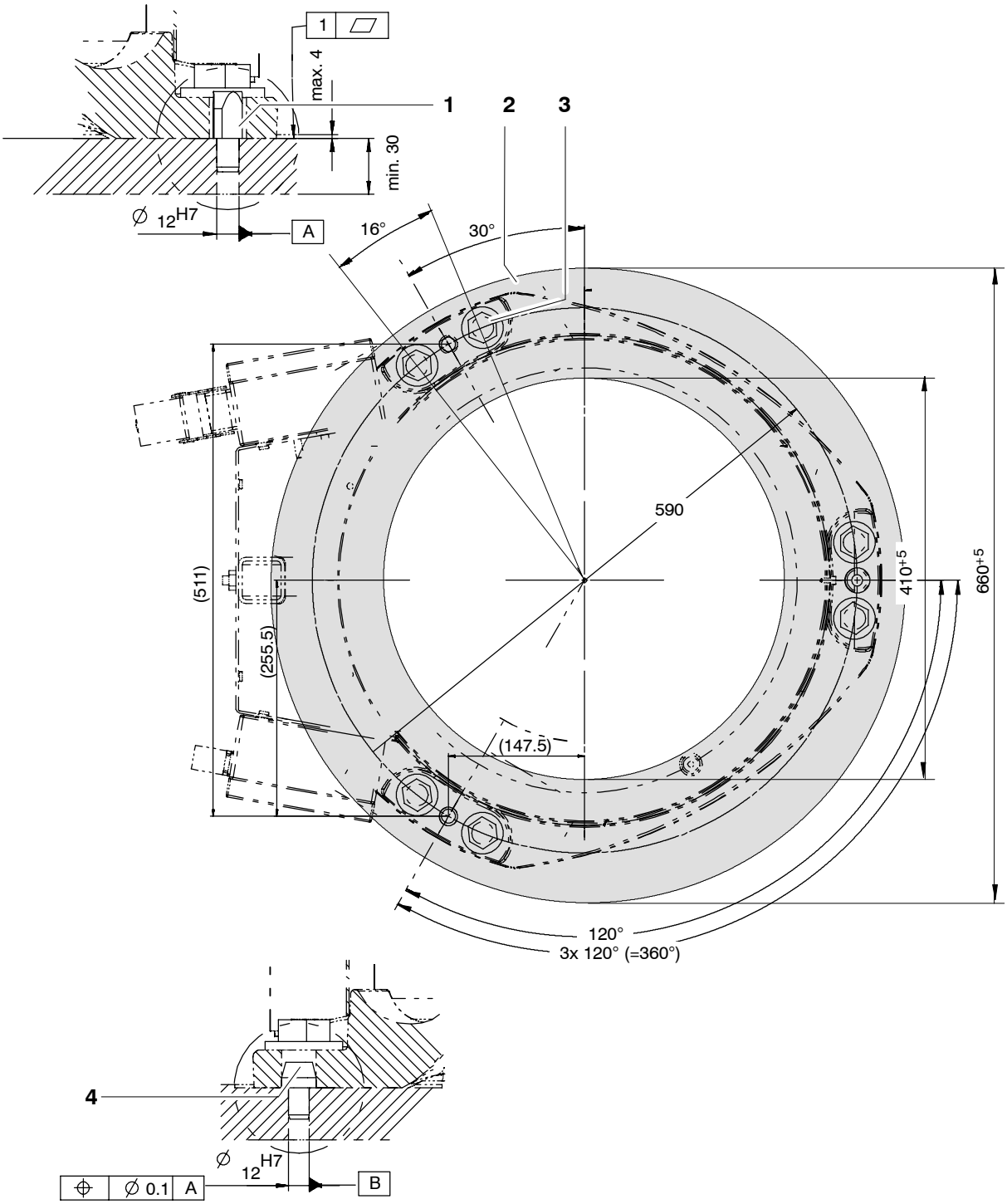


Fig. 49 Fastening the manipulator, variant 2

The steel substructure is now ready for the manipulator to be installed. Install the manipulator in accordance with the procedures given in Section 7.5.1.

7.4.3 Variant 3, adapter plate

Features:

- For floor-mounted and ceiling-mounted manipulators.
- Manipulator installed on steel structure or a KUKA linear unit.
- Easy removal and installation with optimum repeatability of the installation position.

Accessory: Machine frame mounting

Information!
The adapter plate is mounted and screwed onto a substructure that is prepared by the user. It must be ensured that the substructure is able to withstand safely the loads specified in Fig. 41.

(1) Prepare the substructure in accordance with Fig. 50.

(2) Bring the adapter plate (1) to the site of installation, set it down and align it.

(3) Insert eight M25x60 ISO 4017 Allen screws (4) and tighten them with a torque wrench.

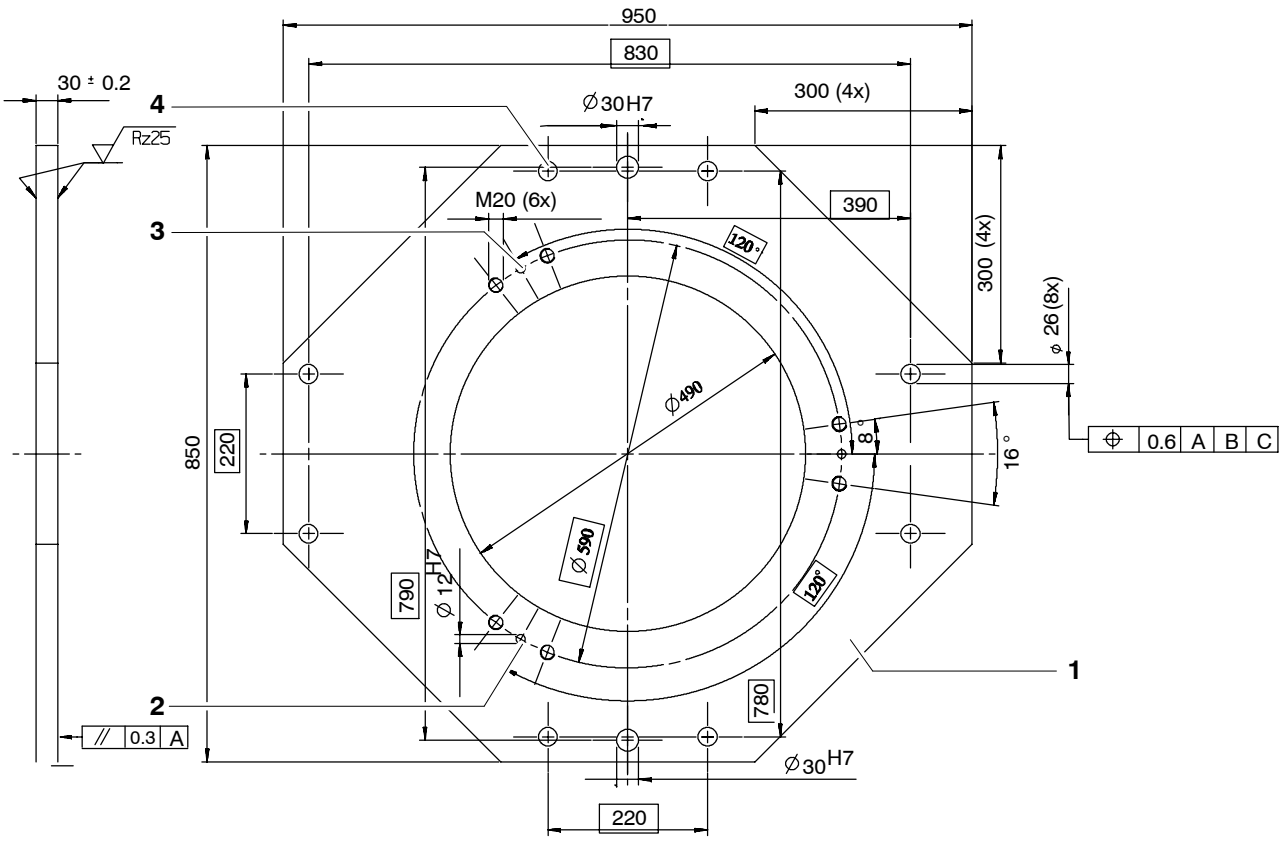


Fig. 50 Manipulator installation, variant 3

(4) Insert the locating pins (2, 3).

The steel substructure is now ready for the installation and connection of the manipulator. Install the manipulator in accordance with the procedures given in Section 7.5.1.

7.5 Connection

Information!
Observe Chapter 6, Transportation!

7.5.1 Floor-mounted manipulators

Information!
Please observe Section 7.1.

This description applies to all mounting variants for floor-mounted manipulators only. If the manipulator is to be installed on the floor in an inclined position, KUKA Roboter GmbH must be consulted beforehand.

The procedure for installing the manipulator (whether for the first time or as an exchange) is as follows:

(1) Check that the locating pins (Fig. 51/1) are undamaged and fitted securely.

Notice!
Damaged locating pins must be replaced by new ones.

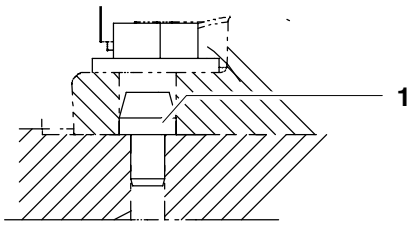
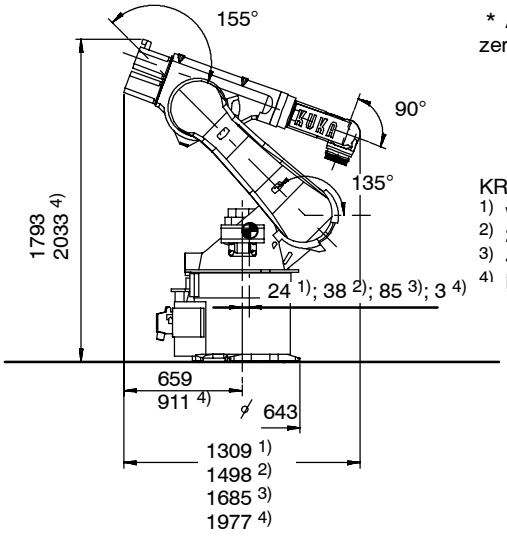


Fig. 51 Locating pins

Caution!
The manipulator must be in the transport position (Fig. 52)*.

A 1	A 2	A 3	A 4	A 5	A 6
0°	−135°	+155°	0°	+90°	0°*



* All angles are specified relative to the electrical zero position or to the KCP display.

KR 30-3, 60-3
1) without arm extension
2) 200 mm arm extension
3) 400 mm arm extension
4) KR 30 L16-2

Fig. 52 Transport position for floor-mounted manipulators

(2) Raise the manipulator with a fork lift truck or lifting tackle attached to three eyebolts on the rotating column.

Caution!

For reasons of safety, it is imperative for the lifting tackle to be attached to the manipulator at the specified points. Risk of injury!

Caution!

If the manipulator is transported by fork lift truck, the forks must be placed in the slots in the base frame. It is forbidden to pick up the manipulator in any other way using a fork lift truck!

(3) Lower the manipulator (Fig. 53/5) vertically onto bedplates (4) or steel structure. If lifting tackle is used, particular care must be taken to ensure exact vertical positioning in order to avoid damaging the pins during this operation.

Notice!

As the manipulator is lowered, the boreholes (2) must be aligned as accurately as possible with the two pins (3). If this operation is carried out inaccurately, it is more likely that parts will be damaged.

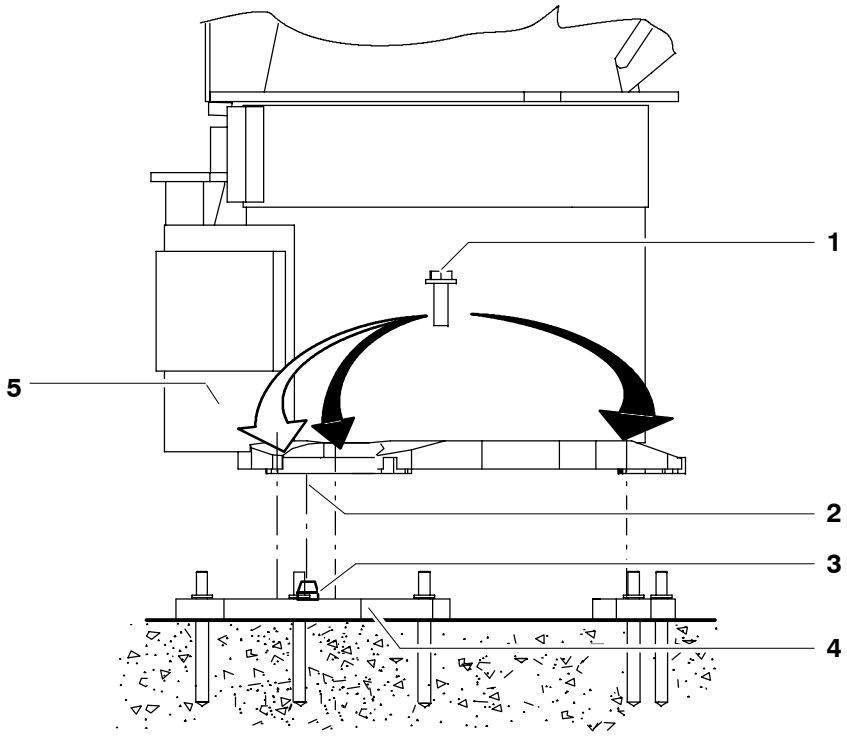


Fig. 53 Installing the manipulator on the floor

(4) Insert six M20x55 ISO 4017 hexagon bolts (1) together with washers and tighten them with a torque wrench in diagonally opposite sequence, increasing the tightening torque M_A to the specified value in several stages (M_A = 370 Nm).

(5) Remove the lifting tackle if necessary.

(6) Connect ground conductors, connecting cables and compressed air lines (if present).

(7) Retighten the hexagon bolts (1) after 100 hours of operation.

Warning!

Before performing the next step, it must be ensured that it is not possible for anyone to be injured within the range of the slowly moving manipulator.
The manipulator may only be moved at jog speed, with all applicable safety rules and regulations being observed.

(8) Put the manipulator into operation and move it into a suitable position to install the end-effector and additional equipment.

Warning!

Turn main switch on the manipulator control cabinet to “OFF” and secure it with a padlock to prevent unauthorized persons from switching it on again.

(9) Install the end-effector and additional equipment.

(10) Connect all other supply lines required.

(11) Put the manipulator into operation.

7.5.2 Ceiling-mounted manipulators

This description applies to all mounting variants for ceiling-mounted robots only, as described in Sections 7.4.2 and 7.4.3. If the robot is to be installed in an inclined position, KUKA Roboter GmbH must be consulted beforehand.

The procedure for installing the manipulator (whether for the first time or as an exchange) is as follows:

(1) Check that the locating pins (Fig. 54/1) are undamaged and fitted securely.

Notice!
Damaged locating pins must be replaced by new ones.

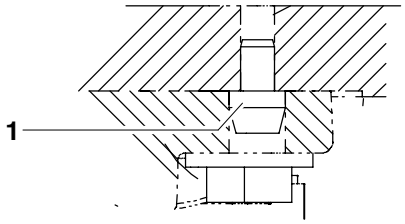
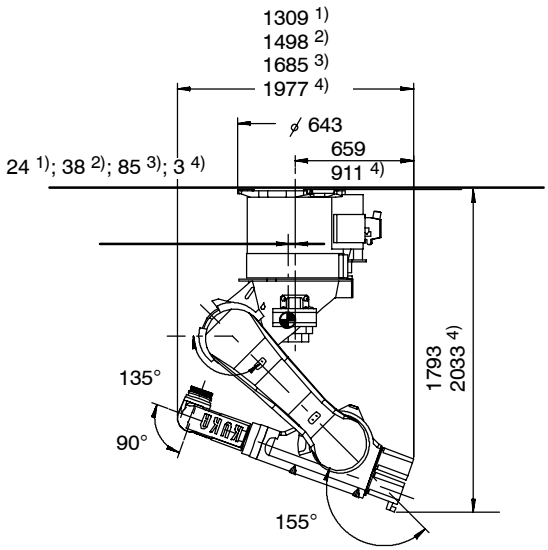


Fig. 54 Locating pins

Caution!
The manipulator must be in the transport position (Fig. 52)*.

A 1	A 2	A 3	A 4	A 5	A 6
0°	−135°	+155°	0°	+90°	0°*



* All angles are specified relative to the electrical "zero position" or to the KCP display.

1) without arm extension
2) 200 mm arm extension
3) 400 mm arm extension
4) KR 30 L16-2

Fig. 55 Transport position for ceiling-mounted manipulators

(2) Lift the manipulator with a fork lift truck.

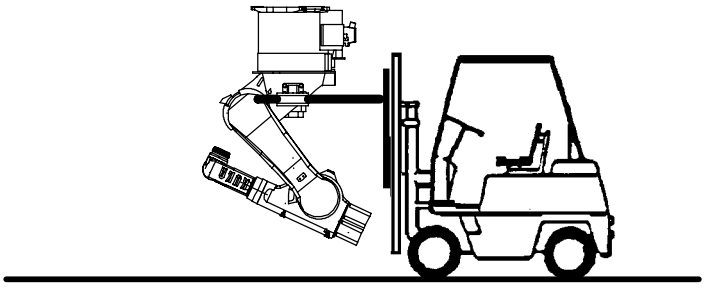


Fig. 56 Transporting the manipulator

Caution!

If the manipulator is transported by fork lift truck, the forks must be placed in the slots in the base frame. It is forbidden to pick up the manipulator in any other way using a fork lift truck!

(3) Move the manipulator (Fig. 57/5) vertically upwards onto the ceiling (4) or onto the steel structure to prevent damage to the locating pins.

Notice!

As the manipulator is raised, the boreholes (2) must be aligned as accurately as possible with the two pins (3). If this operation is carried out inaccurately, it is more likely that parts will be damaged.

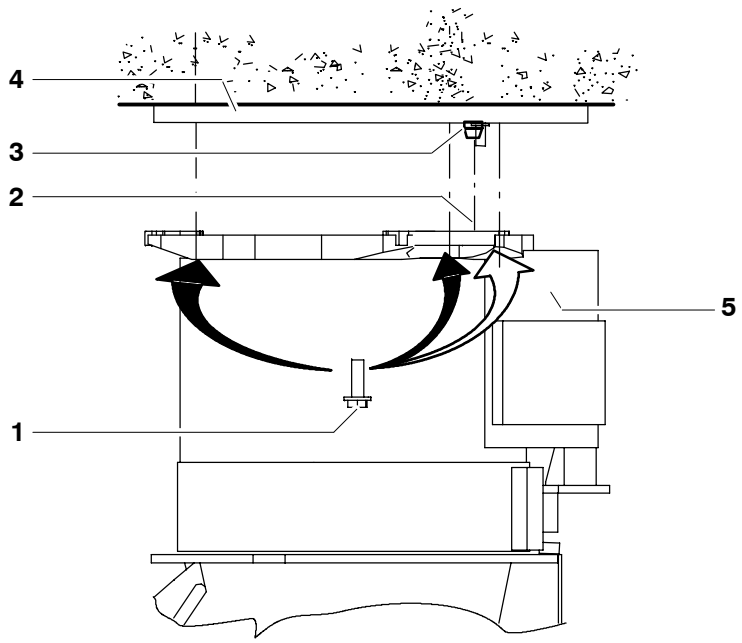


Fig. 57 Installing the manipulator on the ceiling

(4) Insert six M20x55 ISO 4017 hexagon bolts (1) together with washers and tighten them with a torque wrench in diagonally opposite sequence, increasing the tightening torque M_A to the specified value in several stages (M_A = 370 Nm).

(5) Remove the fork lift truck.

(6) Connect ground conductors, connecting cables and compressed air lines (if present).

(7) Retighten the hexagon bolts (1) after 100 hours of operation.

Warning!

Before performing the next step, it must be ensured that it is not possible for anyone to be injured within the range of the slowly moving manipulator. The manipulator may only be moved at jog speed, with all applicable safety rules and regulations being observed.

(8) Put the manipulator into operation and move it into a suitable position to install the end-effector and additional equipment.

Warning!

Turn main switch on the manipulator control cabinet to “OFF” and secure it with a padlock to prevent unauthorized persons from switching it on again.

(9) Install the end-effector and additional equipment.

(10) Connect all other supply lines required.

(11) Put the manipulator into operation.

7.6 Moving the manipulator without drive energy

The release device (optional) can be used for moving the manipulator after an accident or malfunction without drive energy. This option is only for use in exceptional circumstances and emergencies, e.g. for freeing people.

Warning!

Turn main switch on the manipulator control cabinet to “OFF” and secure it with a padlock to prevent unauthorized persons from switching it on again.

(1) Remove the protective cap (Fig. 58/1) from the motor.

(2) Push the release device (2) onto the corresponding motor and move the axis in the desired direction.

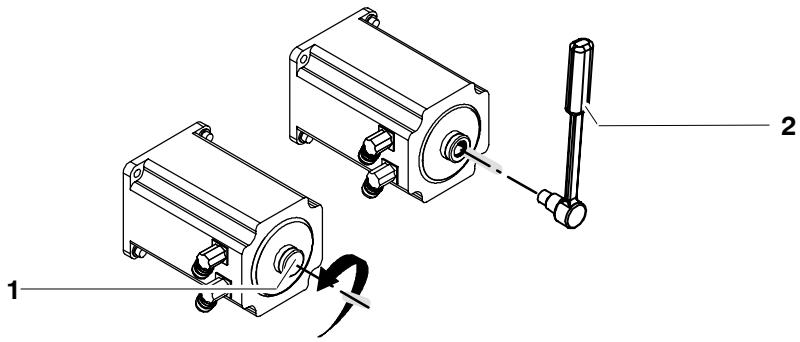


Fig. 58 Release device

Notice!

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

Caution!

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

Notice!

If a robot axis has been moved by the release device, all robot axes must be remastered.

8 Electrical installations

Information!

This description applies analogously to all of the industrial robots listed in Chapter 1, regardless of the variant or model shown in the illustrations.

The electrical installations of the robot (manipulator) form a separate assembly. It includes the “cable set” (Fig. 61), containing all the electric cables (Fig. 62 to Fig. 70). The cable set has plug-and-socket connections so that exchanges can be quickly carried out. This dispenses with the need for wiring work.

The arrangement, designation and allocation of the cables may be noted from the various diagrams. The connectors are provided with identification labels and coded. The ground conductors are fastened with cable lugs to threaded bolts.

8.1 Description

Installed on the push-in module are the RDC box (Fig. 61/7) and the MFH (multi-function housing) (3). Together with their connectors, these two housings form the interfaces with the connecting cables.

The motor cables for axes 1 to 6 are grouped together in the multi-function housing (MFH) (3) and are wired up to connector X30. This connector is at the same time the connector on the robot for the connecting cable (motor cable) between the robot and the control cabinet. The connector consists of six separate connector modules. Each connector module is assigned a particular motor connector (e.g. XM1).

The protective circuit is connected to terminals on the push-in module (2) on the base frame.

The control cables for axes 1 to 6 are grouped together in the resolver digital converter box (RDC box) (7) and are connected to an RDC board (6). Each control cable has a separate connector. The interface at the RDC box with the connecting cable (data cable) between the robot and the control cabinet is formed by connector X31. Connector X32 is used for connecting the EMD for the purpose of zero adjustment. Installed in the RDC box are the EDS (5) and the RDC (6). Both components (boards) are connected by means of the RDC cables.

A cable gland is fitted at the rear of the RDC box. From this gland, the cables are routed to the base frame and from there via the common flexible tube A1 to the rotating column. The flexible tube A1 ensures a low-stress routing of the supply lines as well as reducing the number of mechanical interface contours, without impairing the rotational motion of axis 1. The cables for the drive units of axes 1 and 2 branch off in the rotating column.

The cables for the motor units of axes 3 to 6 run from the rotating column to the arm in a flexible tube inside the hollow link arm. The flexible tubes prevent the cables from kinking.

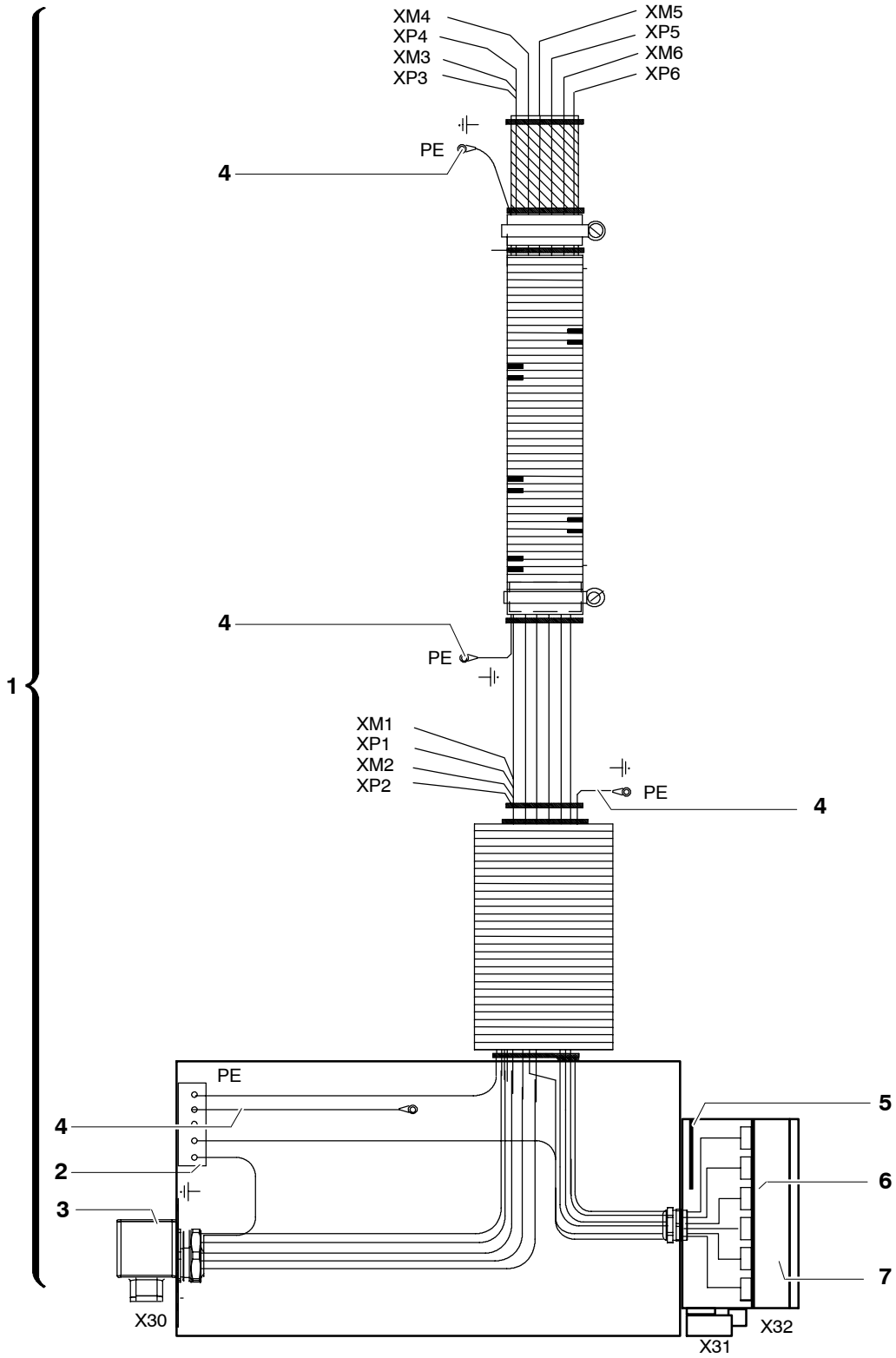
The cables installed in the manipulator are summarized in tabular form in Fig. 59 and are shown schematically in Fig. 61.

Cable	from	to	Cable	from	to
Protective circuit 00-186-281	Bolt on base frame	Bolt on rotating column			
	Bolt on rotating column	Bolt on arm			
Motor cable A1 00-181-928	Connector X30/a	XM1	Control cable A1 00-181-934	Connector X1	XP1
Motor cable A2 00-181-929	Connector X30/b	XM2	Control cable A2 00-181-935	Connector X2	XP2
Motor cable A3 00-181-930	Connector X30/c	XM3	Control cable A3 00-181-936	Connector X3	XP3
Motor cable A4 00-181-931	Connector X30/d	XM4	Control cable A4 00-181-937	Connector X4	XP4
Motor cable A5 00-181-932	Connector X30/e	XM5	Control cable A5 00-181-938	Connector X5	XP5
Motor cable A6 00-181-933	Connector X30/f	XM6	Control cable A6 00-181-939	Connector X6	XP6

Fig. 59 Table of cables installed on the robot KR 30, 60-3 with KR C4

Cable	from	to	Cable	from	to
Protective circuit 00-186-780	Bolt on base frame	Bolt on rotating column			
	Bolt on rotating column	Bolt on arm			
Motor cable A1 00-181-928	Connector X30/a	XM1	Control cable A1 00-181-934	Connector X1	XP1
Motor cable A2 00-181-929	Connector X30/b	XM2	Control cable A2 00-181-935	Connector X2	XP2
Motor cable A3 00-186-761	Connector X30/c	XM3	Control cable A3 00-186-765	Connector X3	XP3
Motor cable A4 00-186-762	Connector X30/d	XM4	Control cable A4 00-186-766	Connector X4	XP4
Motor cable A5 00-186-763	Connector X30/e	XM5	Control cable A5 00-186-767	Connector X5	XP5
Motor cable A6 00-186-764	Connector X30/f	XM6	Control cable A6 00-186-768	Connector X6	XP6

Fig. 60 Table of cables installed on the robot KR 30 L16-2 with KR C4



1 Cable set assembly
2 PE push-in module
3 Multi-function housing, MFH
4 Protective circuit
5 Electronic Data Storage EDS
6 Resolver Digital Converter RDC
7 RDC box

Fig. 61 Cable set assembly

8.2 Cabling plans and wiring diagrams

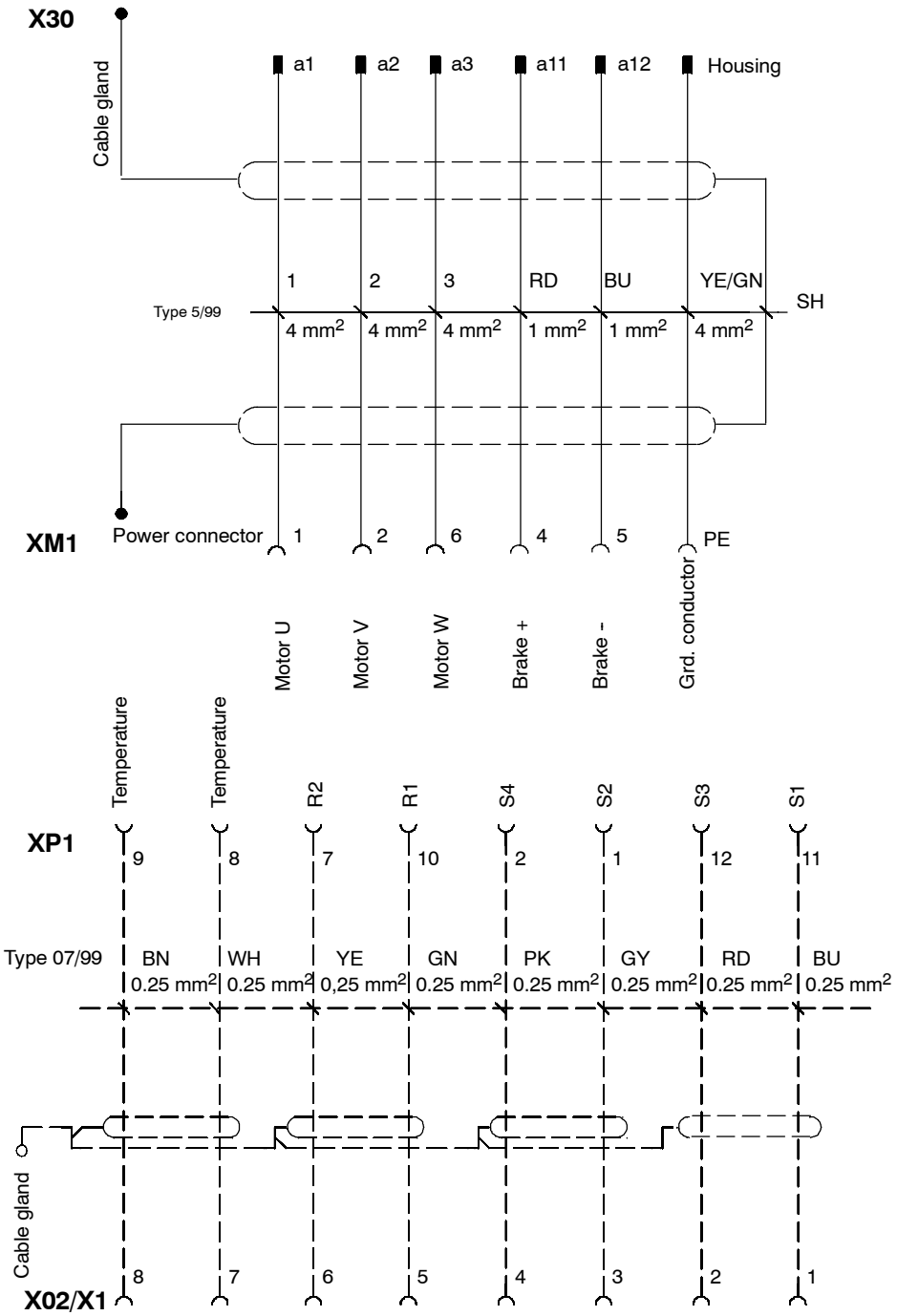


Fig. 62 Wiring diagram for drive A1

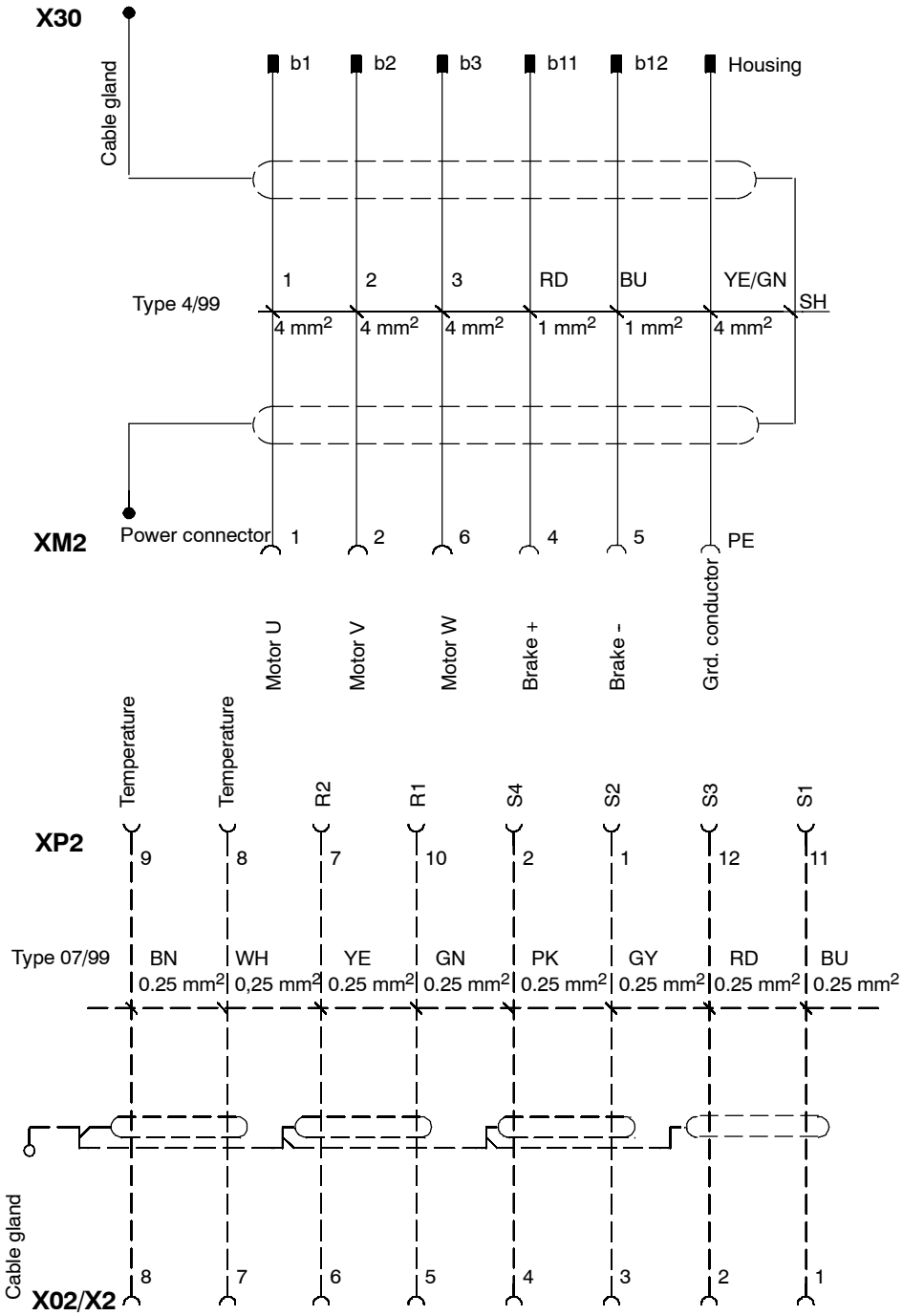


Fig. 63 Wiring diagram for drive A2

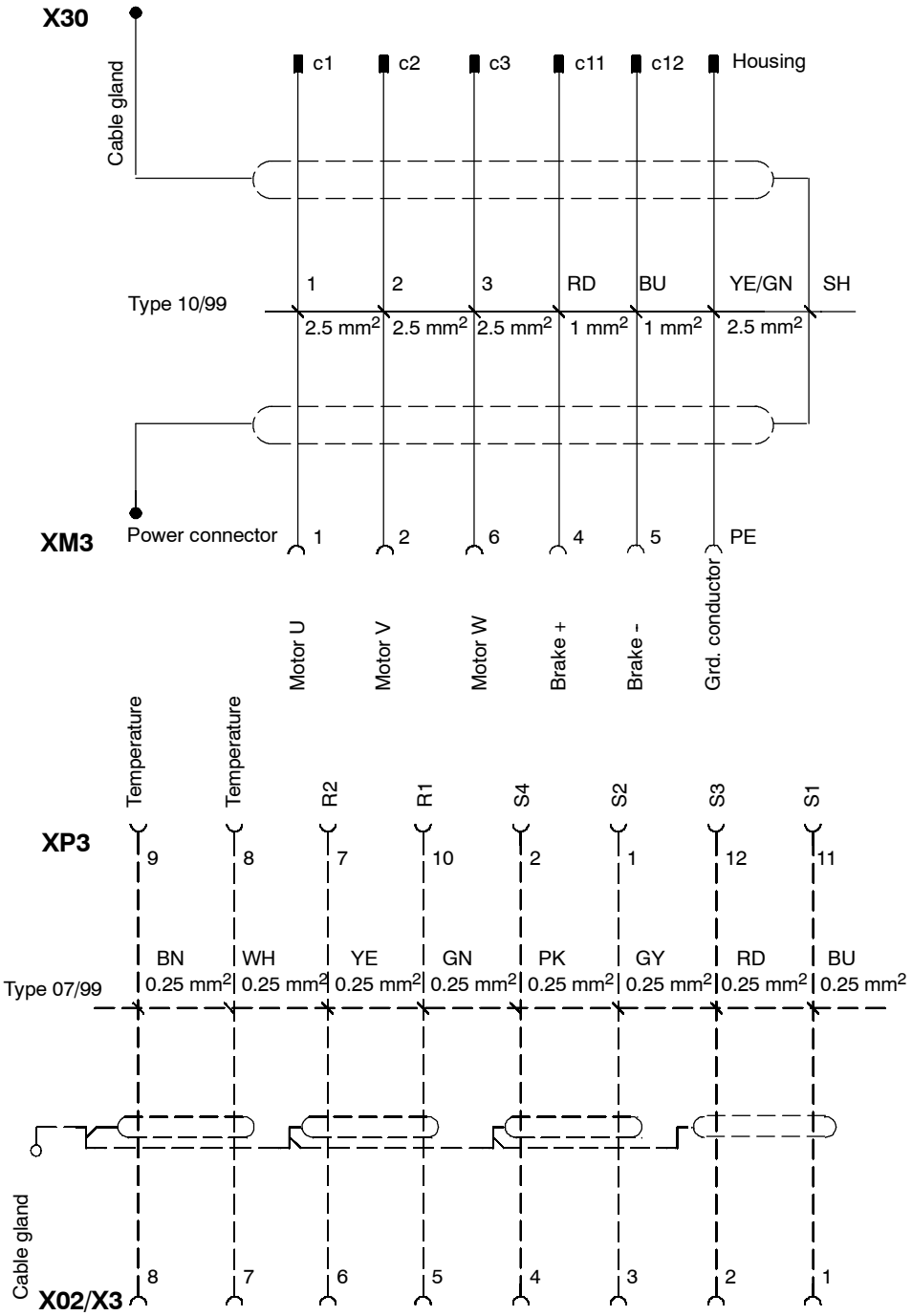


Fig. 64 Wiring diagram for drive A3

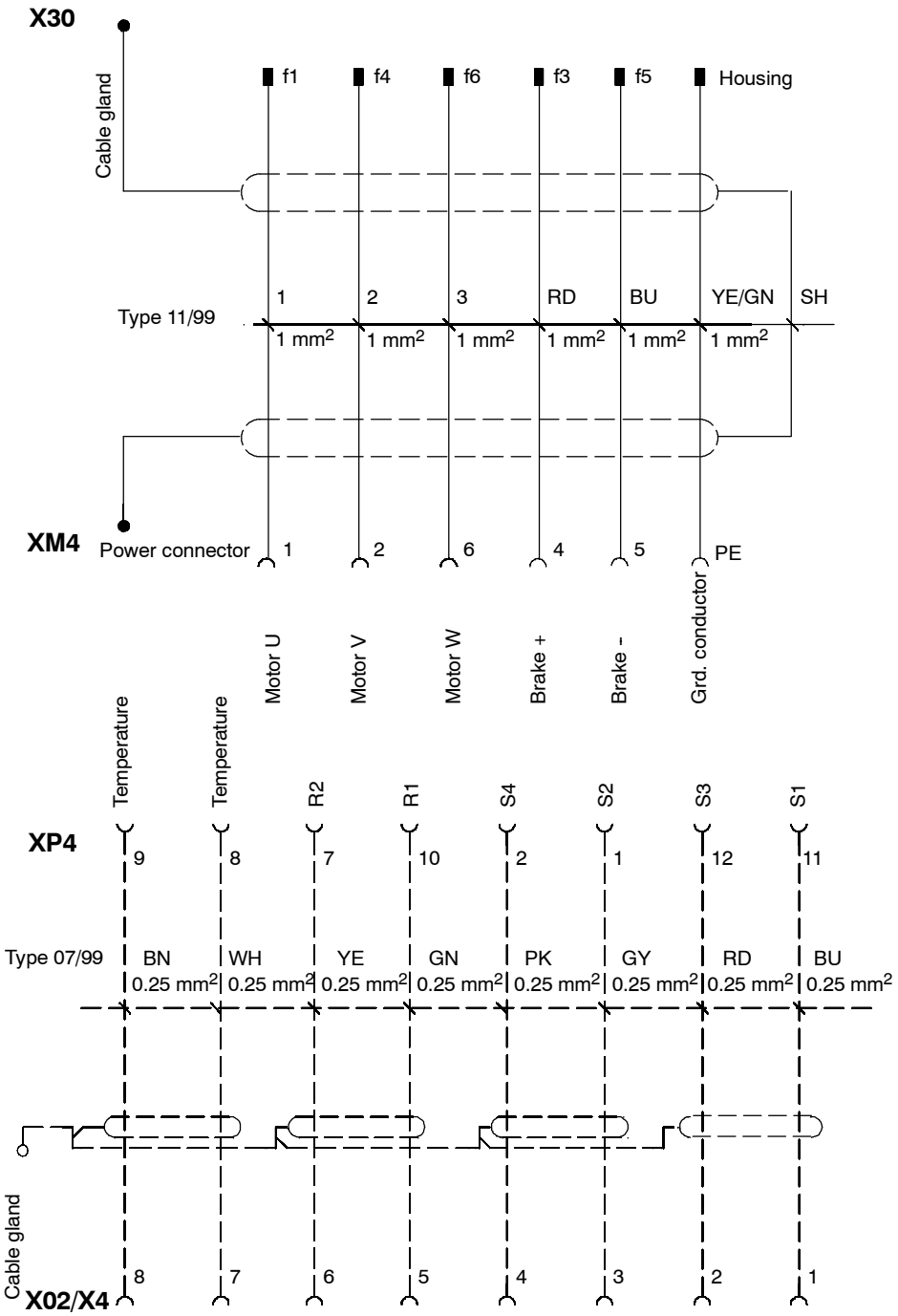


Fig. 65 Wiring diagram for drive A4

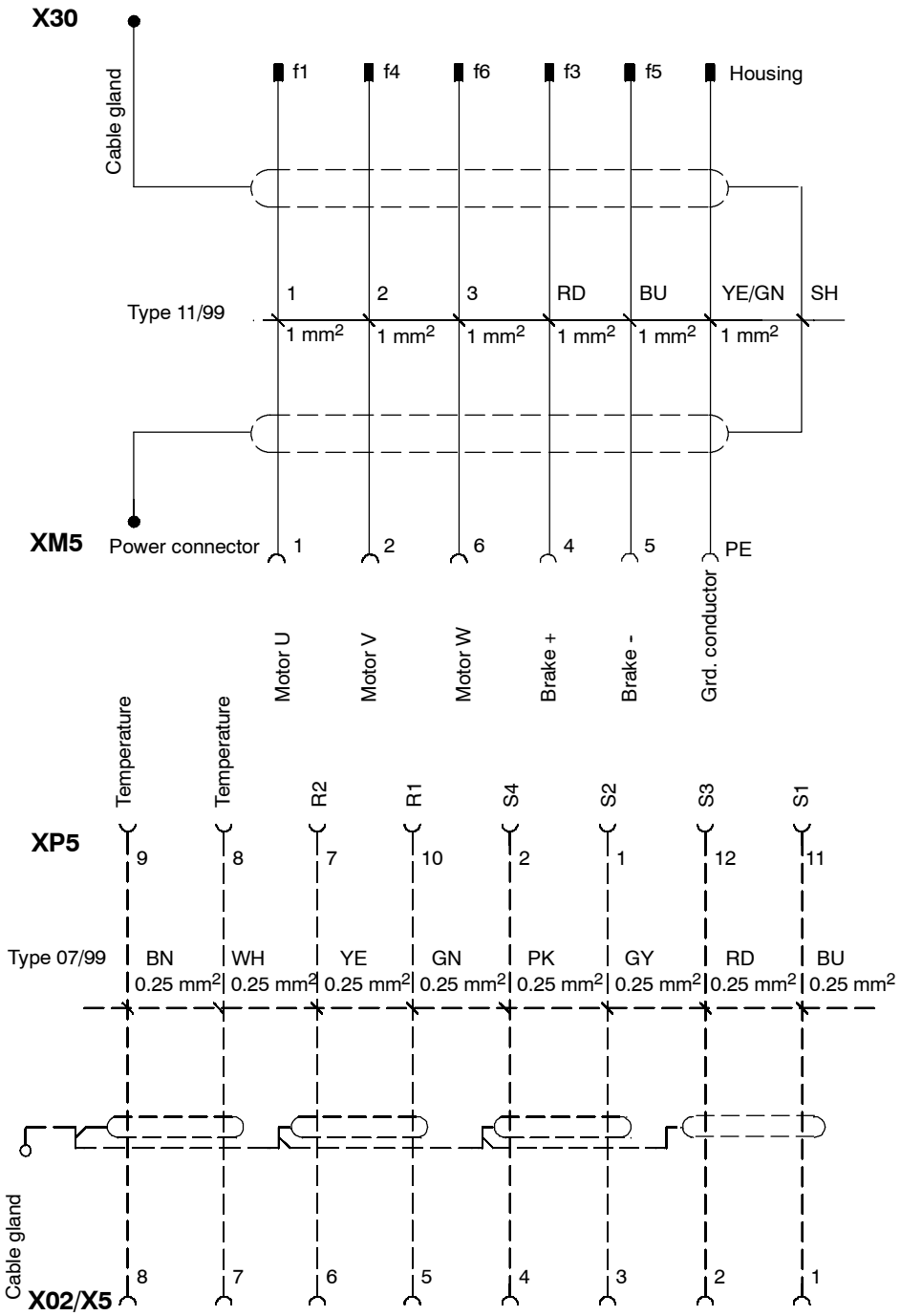


Fig. 66 Wiring diagram for drive A5

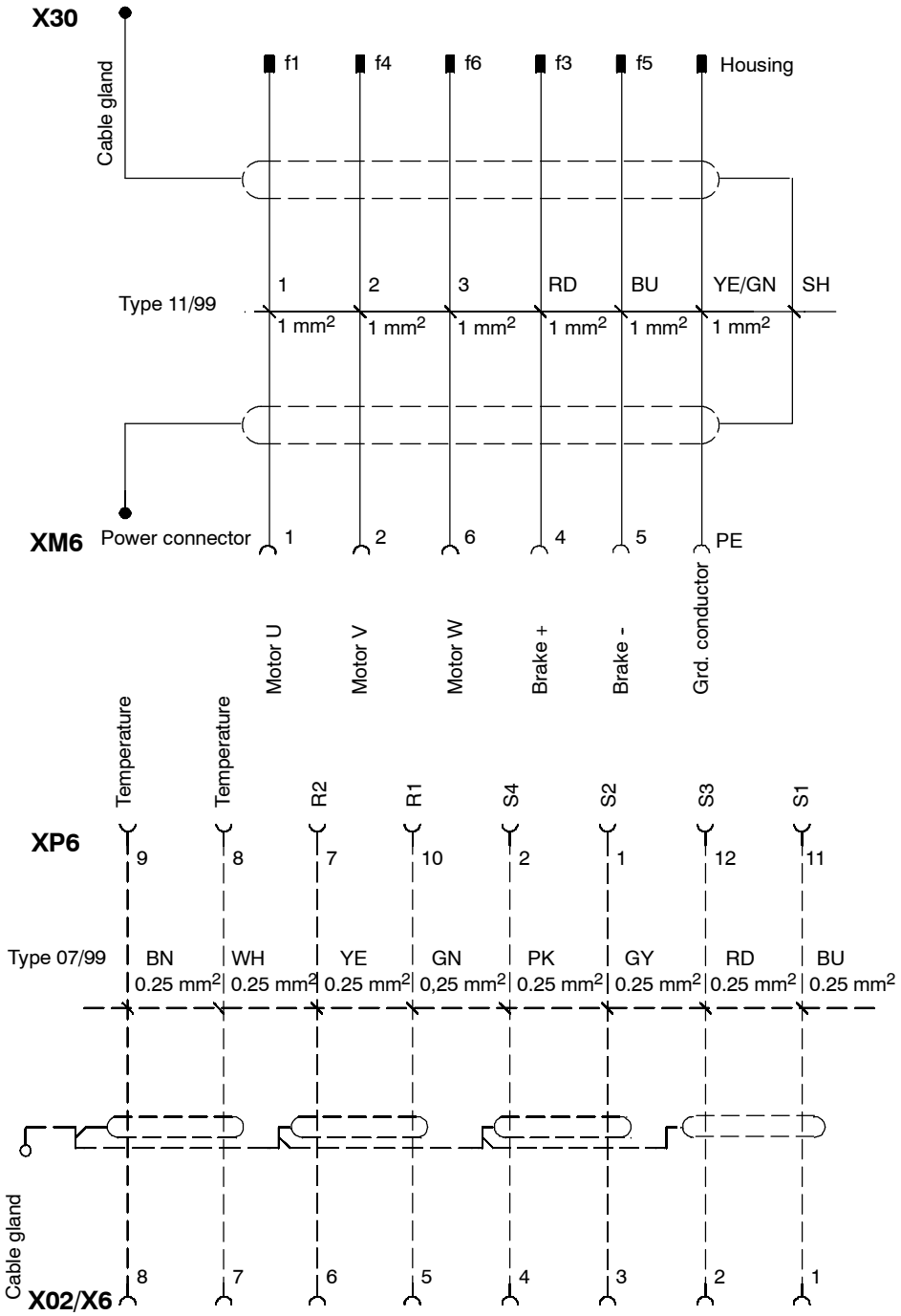


Fig. 67 Wiring diagram for drive A6

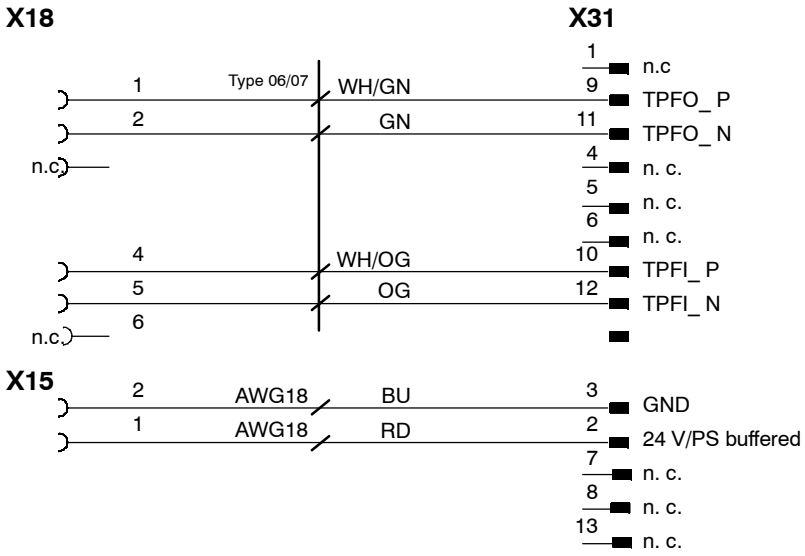


Fig. 68 Wiring diagram, RDC internal X31

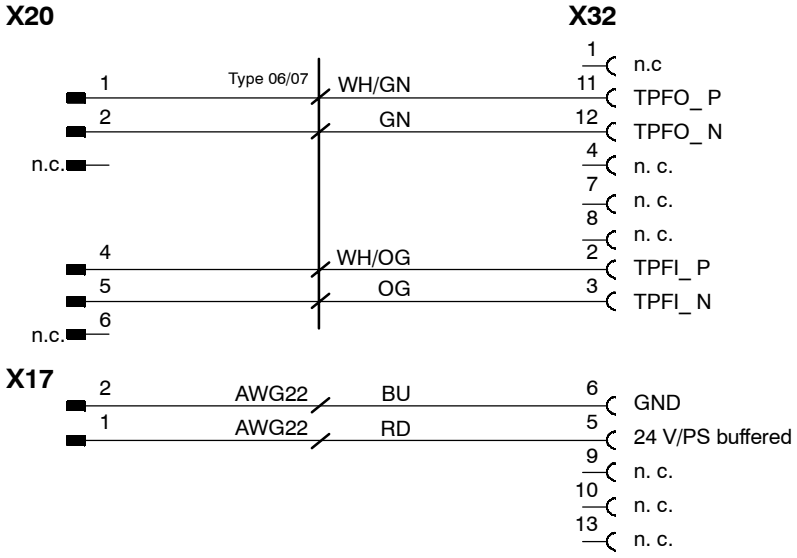


Fig. 69 Wiring diagram, RDC internal X32

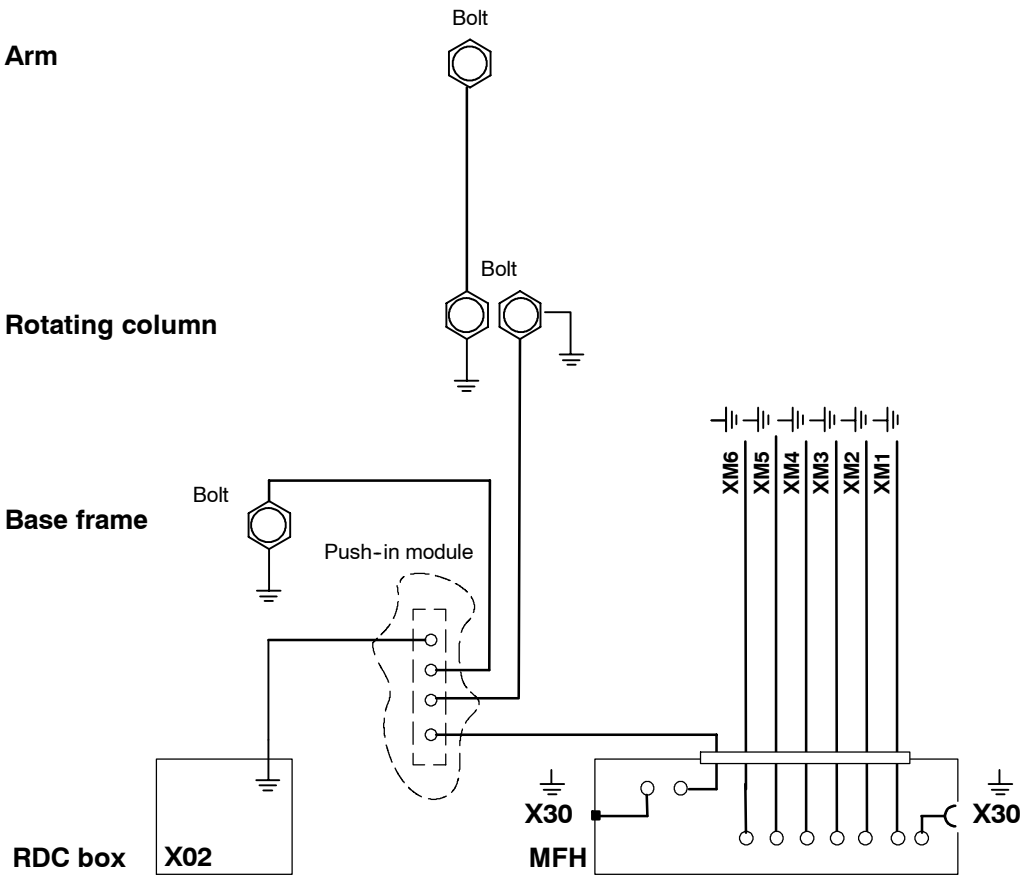


Fig. 70 Ground conductor installation, protective circuit

9 Connecting cables

Information!

This description applies analogously to all of the industrial robots listed in Chapter 1, regardless of the variant or model shown in the illustrations.

9.1 Description

Connecting cables are all the cables running between the robot (= manipulator) and the control cabinet (Fig. 71). They have plug-in connections at both ends. The terminal allocation of the connectors is given in Section 9.6. In order to avoid the connectors being mixed up, the ends of each cable are provided with a designation label, which must match the corresponding connection point on the robot or on the control cabinet. The cable connections on the manipulator and the control cabinet are shown in Fig. 71.

The interfaces of the connecting cables are the RDC box for the data cable and the MFH (multi-function housing) for the motor cable on the robot (Fig. 73) and the connector panel on the control cabinet (Fig. 74).

Notice!

The connectors must be inserted carefully to avoid damaging the contacts.

The ground conductors are fastened with cable lugs to threaded bolts. The threaded bolts are included in the scope of supply.
The ground conductors are not included in the scope of supply for the connecting cables, but can be ordered separately as an option.

Notice!

For the connecting cables, a ground conductor is always required to provide a low-resistance connection between the robot and the control cabinet in accordance with DIN EN 60204-1. The ground conductor is not part of the scope of supply and can be ordered as an option. The connection must be made by the customer. The tapped holes for connecting the ground conductor are located on the base frame of the robot.

Caution!

Before the manipulator is put into operation, the continuity of the ground conductor connection between the control cabinet and the manipulator must be tested with a ground conductor measurement in accordance with DIN EN 60204-18.2 and the relevant national regulations.

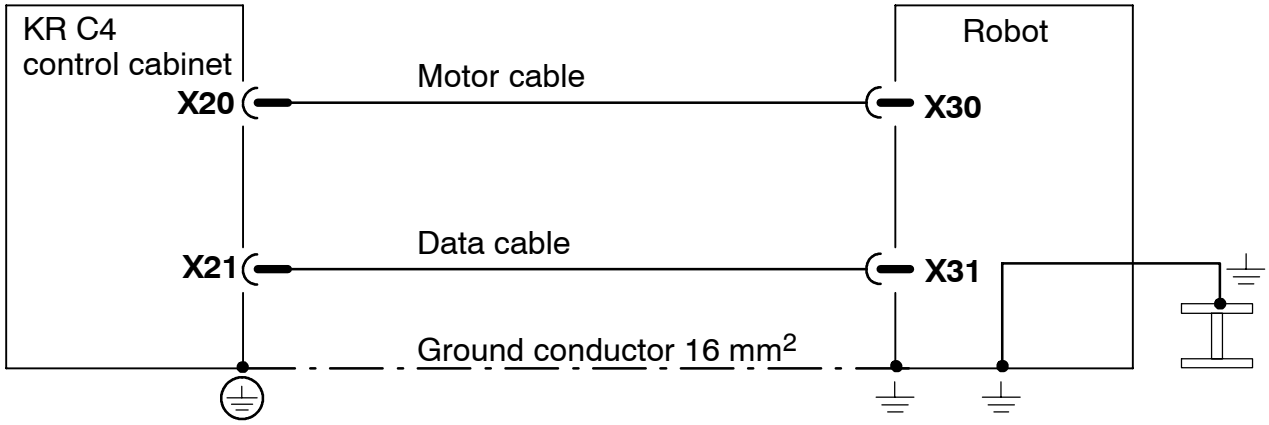


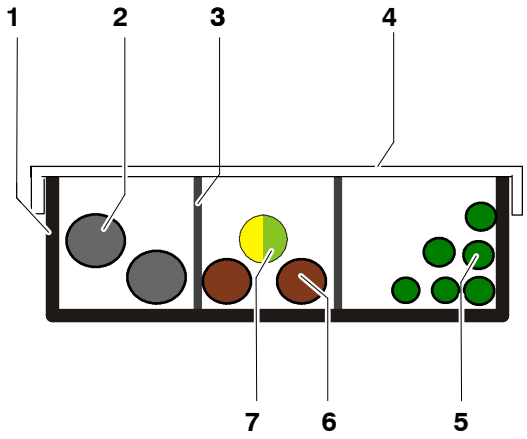
Fig. 71 Connecting cables (diagram)

9.2 Routing of cables

The following points must be observed when routing the cables:

- Bending radius of the cables for fixed installation
  - Motor cable 150 mm
  - Control cable 60 mm

  must be observed
- Protect cables against exposure to mechanical stress.
- Route the cables without tension (no tensile forces on the connectors).
- Cables are only to be installed indoors.
- Observe permissible temperature range (fixed installation) 263 K (–10 °C) to 328 K (+55 °C).
- Route the motor cables and the control cables separately in metal ducts (Fig. 72); if necessary, additional measures must be taken to ensure electromagnetic compatibility (EMC).



1	Cable duct	5	Data cables
2	Welding cables	6	Motor cables
3	Separating web	7	Equipotential bonding conductor 16 mm^2
4	Cover		

Fig. 72 Routing of cables in cable ducts

9.3 Junction boxes on the manipulator

The plug-in connections on the robot are located on the multi-function housing on the base frame for the motor cable, and on the RDC box for the data cable. The allocation of the junction boxes to the respective connectors for the robot may be noted from Fig. 73.

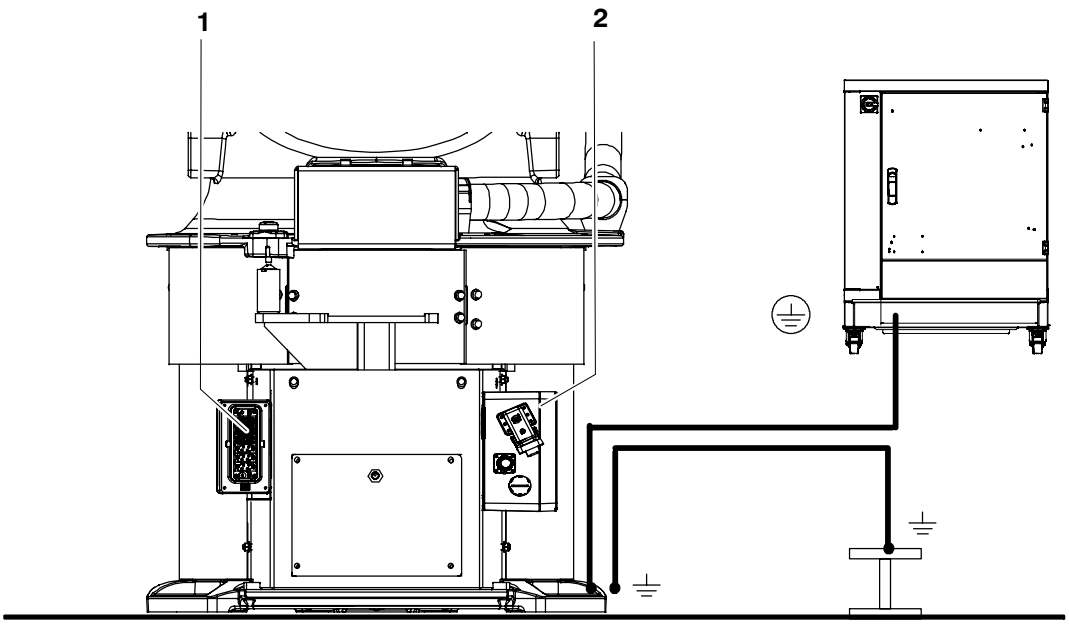
Equipotential bonding (ground conductor) between control cabinet and manipulator must be established using an M8 PE bolt at each end. The user of the robot is responsible for ensuring that this is implemented correctly.

The ground conductor is **optionally** available. It is **not** part of the connecting cable set assembly.

9.3.1 Coding

Motor cable:
Connectors X20 and X30 are each fitted with two coding pins, which prevent them from being used incorrectly.

Data cables:
In the case of the data cable, coding is achieved by the shape of the connector and the pin configuration.



1 MFH, multi-function housing 2 RDC box

Fig. 73 RDC box and MFH

9.4 Connector panel on the control cabinet

The connector panel (Fig. 74) is accessed by opening the door to the cabinet.

The connected cables are routed under the control cabinet to the rear.

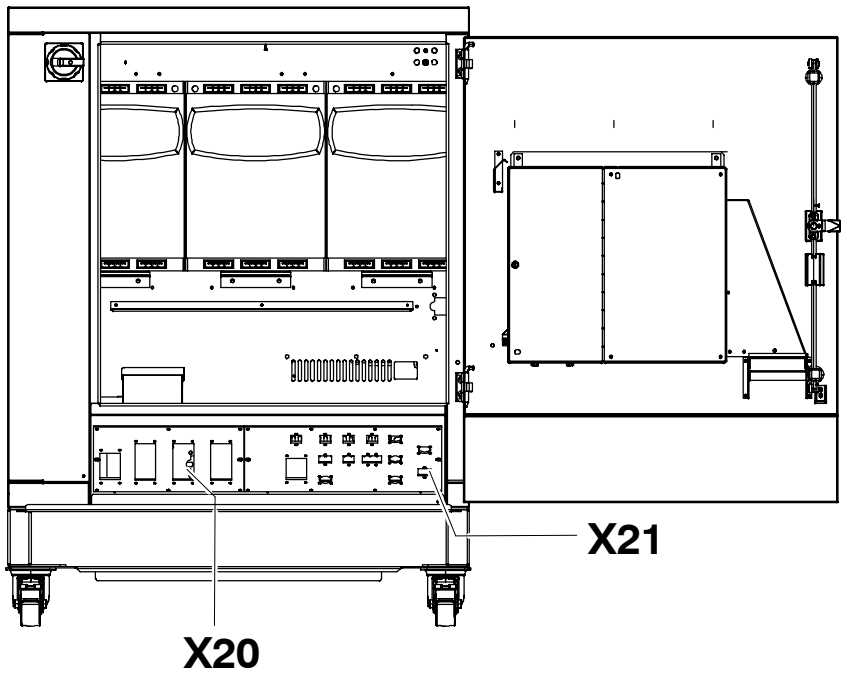


Fig. 74 Connector panel on the control cabinet

9.5 Configuration of the connecting cables

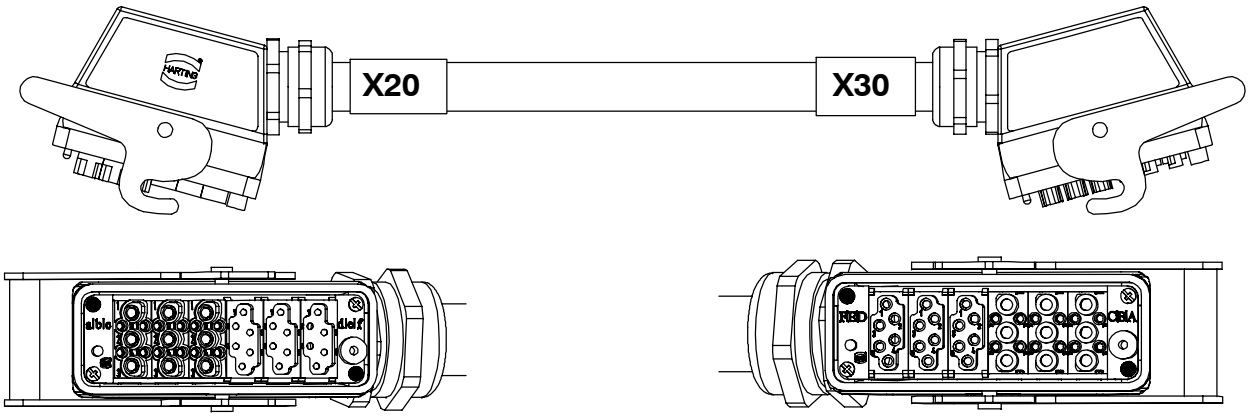


Fig. 75 Motor cable

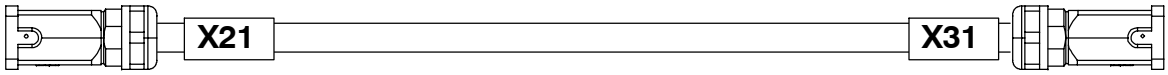
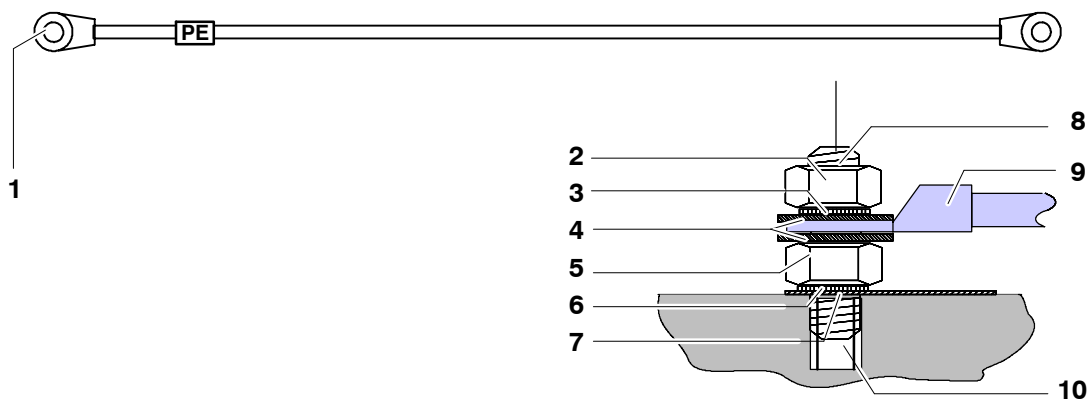


Fig. 76 Data cable



1	M8 ring cable lug	6	Conical spring washer
2	M8 nut	7	Ground plate
3	Conical spring washer	8	PE bolt
4	8.4 washer	9	Cable lug
5	M8 nut	10	M8 tapped hole

Fig. 77 Ground conductor

9.6 Wiring diagrams

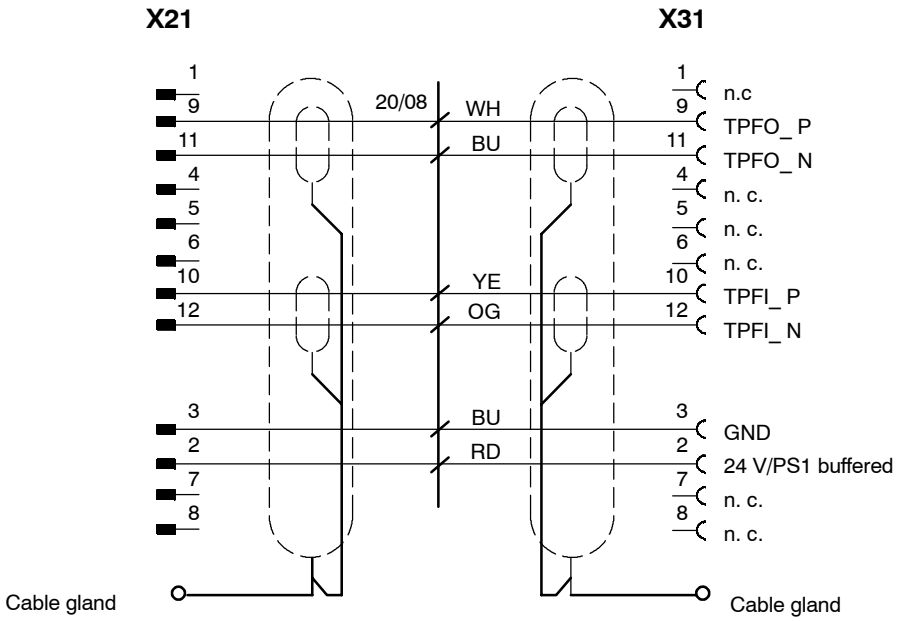


Fig. 78 Data cable X21

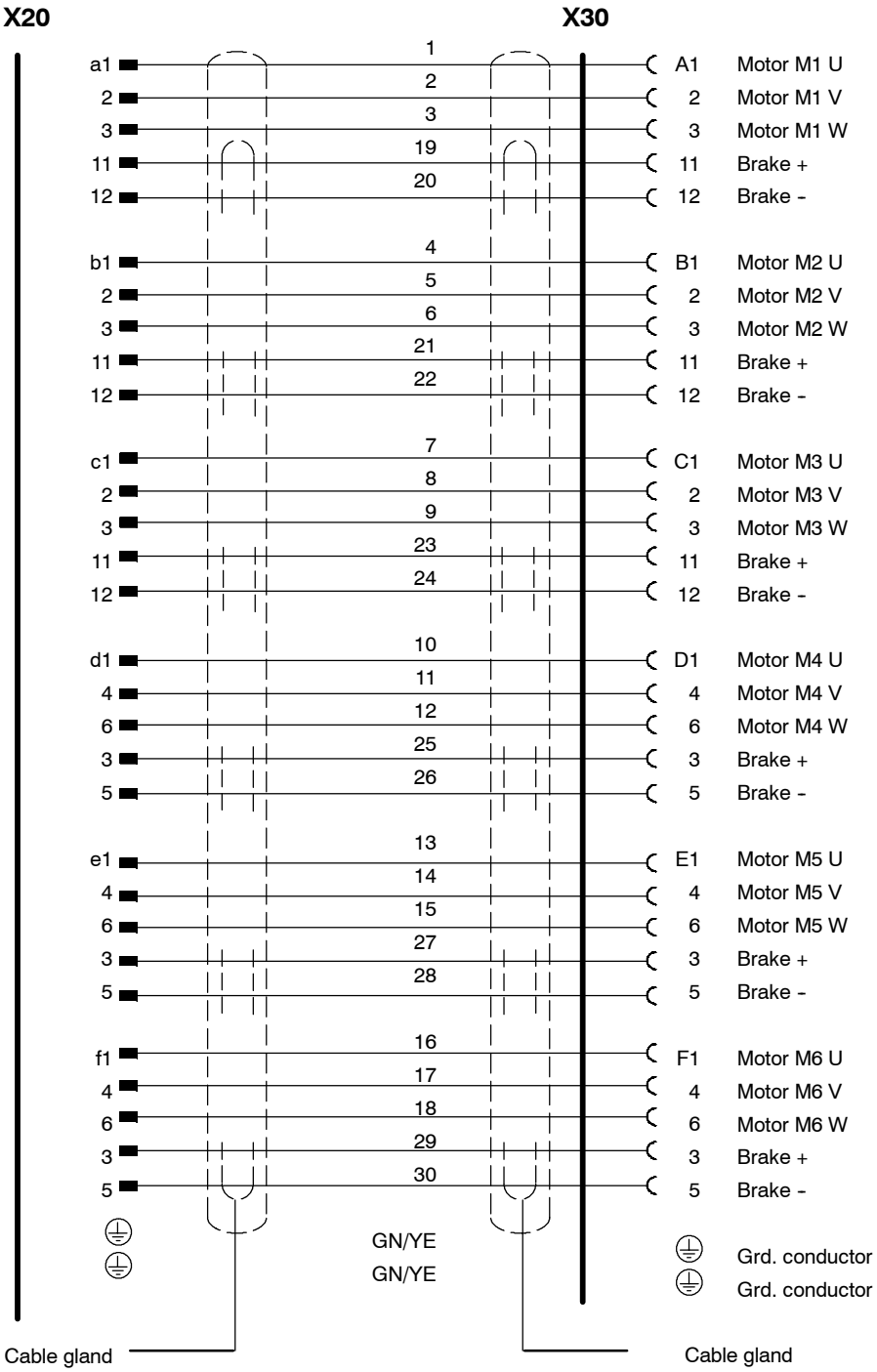


Fig. 79 Motor cable X20

10 Tightening torques

Information!

The following tightening torques are valid for screws and nuts where no other specifications are given.
The specified values apply to lightly oiled black (e.g. phosphated) and coated (e.g. mech.galv., zinc flake plating) screws and nuts.

Notice!

Too high a tightening torque can cause the screws to be overloaded and to fracture. This might result in damage to the components.

Tighten the screws with the specified torque in order to avoid damage.

	Strength classes		
Screw size	**8.8**	**10.9**	**12.9**
M1.6	0.17 Nm	0.24 Nm	0.28 Nm
M2	0.35 Nm	0.48 Nm	0.56 Nm
M2.5	0.68 Nm	0.93 Nm	1.10 Nm
M3	1.2 Nm	1.6 Nm	2.0 Nm
M4	2.8 Nm	3.8 Nm	4.4 Nm
M5	5.6 Nm	7.5 Nm	9.0 Nm
M6	9.5 Nm	12.5 Nm	15.0 Nm
M8	23.0 Nm	31.0 Nm	36.0 Nm
M10	45.0 Nm	60.0 Nm	70.0 Nm
M12	78.0 Nm	104.0 Nm	125.0 Nm
M14	125.0 Nm	165.0 Nm	195.0 Nm
M16	195.0 Nm	250.0 Nm	305.0 Nm
M20	370.0 Nm	500.0 Nm	600.0 Nm
M24	640.0 Nm	860.0 Nm	1030.0 Nm
M30	1330.0 Nm	1700.0 Nm	2000.0 Nm

11 Consumables, safety data sheets

11.1 Safety data sheet for Optitemp RB1 cable grease

The following extract from the safety data sheet according to 91/155/EEC must be observed when handling Optitemp RB1.

1 Designation of substance/formulation and manufacturer		
Trade name:	**Optitemp RB1**	Art. no. **08020**
Use:	Lubrication	
Firm:	**Optimol Ölwerke Industrie GmbH**	
Address:	Postfach 80 13 49, D-81613 Munich	
Tel.:	+49 89 4183 116	
Fax:	+49 89 4183 192	

2 Composition / Information about the components
Chemical components: Synthetic oil based lubricating grease, lithium soap and additives.
Hazardous components: This product contains no substances requiring declaration as a hazardous substance.

3 Possible hazards
This product is NOT classified as hazardous according to the German Dangerous Substances Order.

4 First aid measures	
Eyes:	Immediately rinse thoroughly with plenty of water for several minutes.
Skin:	Wash thoroughly as soon as possible with soap and water or a suitable skin cleansing agent. If the skin has a tendency to dry out, apply suitable skin cream.
Inhalation:	Remove from zone of exposure – occurrence unlikely.
Ingestion:	Consult a doctor immediately. Do NOT induce vomiting.

5 Fire-fighting measures
Extinguishing agents
Suitable extinguishing agents: Not essential. Sufficient ventilation is recommended in industry, however.
Unsuitable extinguishing agents: Water jet.

6 Measures after unintended release
Personal safety precautions: Spilled product constitutes a considerable slip hazard.
Environmental protection measures: Prevent the product from entering the drainage system or surface waters.
Disposal information: Pick up in container. Dispose of as waste.

7 Handling and storage	
Handling:	No special measures required.
Storage:	Store product in original container only. Do not store in direct sunlight. Never leave the container open.
Technical Instructions on Air Quality Control / Annex E (Class):	III
Water hazard classification:	1 (manufacturer's classification based on the law of mixtures acc. to the German Administrative Regulation on the Classification of Substances Hazardous to Waters into Water Hazard Classes (VwVwS))

8 Personal protective equipment	
Personal protective equipment:	Avoid contact with skin and eyes. Wear oil-proof gloves if handling repeatedly or for prolonged periods. A high standard of personal hygiene is necessary.

9 Physical and chemical properties

10 Reactivity	
Conditions to be avoided:	Temperatures above 180 °C
Substances to be avoided:	Strong oxidizing agents.
Hazardous decomposition products:	None if used for designated purpose.

11 Toxicological information	
The following toxicological analysis is based on the known toxicity of the individual components. Expected LD_{50} oral (rat) > 2g/kg. Expected LD_{50} dermal (rabbit) > 2g/kg.	
Effects on health	
On eyes:	Can cause temporary irritation.
On skin:	Can make the skin dry. Can cause temporary irritation. With occasional contact of short duration, irritation is unlikely.
If inhaled	The low volatility of the product makes inhalation unlikely at room temperature.
If ingested:	Can cause nausea, vomiting and diarrhea.
Chronic effects:	Repeated or prolonged skin contact can cause long-term changes in the skin.

12 Ecological information	
General assessment:	If used for the designated purpose and disposed of correctly, no adverse effects are expected on the environment.
Mobility:	Non-volatile. Paste-like. Insoluble in water.
Persistence and degradability:	Not determined.
Bioaccumulation potential:	Bioaccumulation is unlikely due to the low water-solubility.
Ecotoxicity:	Ecotoxicity for fish, daphniae and algae is not assumed. An inhibitory effect on activated sludge bacteria is not assumed.

13 Disposal information

This product must be disposed of in accordance with all pertinent regulations governing the disposal of waste and used lubricants.

	Waste code:	Recommended means of disposal:
Unused product:	54 202	SAV
Used/contaminated product:	54 202	SAV
Packaging:	54 202	SAV, SAD Container reconditioning

14 Transport regulations

This product is NOT classified as a dangerous good for the purpose of transportation according to the German Law concerning the Conveyance of Dangerous Goods.

15 Regulations

EC regulations:	EC Safety Data Sheet Directive 91/155/EEC EC Directive on Dangerous Preparations 88/379/EEC EC Framework Directive on Waste 91/156/EEC EC Directive on Hazardous Waste 91/689/EEC
National regulations (Germany):	Law concerning the Conveyance of Dangerous Goods Water Resources Law (WHG) Chemicals Law (ChemG) Dangerous Substances Order (GefStoffV) Law concerning Life-cycle Management and Waste (KrW-AbfG) Federal Immission Control Act (BImschG) Technical Guideline on Air (TA-Luft)

16 Other information

All information is based on the current state of our knowledge. It is intended only to describe our product with regard to the safety data. It is not intended to provide assurance of particular properties.

The product may only be used for the scope of work specified above; any other use requires prior consultation with KUKA. Using the product for any purpose other than for its designated use could lead to risks which are not described in this document.

Further information on the use of the product may be found in the relevant technical specifications.

11.2 Safety data sheet for Optimol Olit CLS lubricating grease

The following extract from the safety data sheet according to 91/155/EEC must be observed when handling Optimol Olit CLS.

1 Designation of substance/formulation and manufacturer		
Trade name:	**Optimol Olit CLS**	Art. no.: **08202**
Use:	Lubrication	
Firm:	**Optimol Ölwerke Industrie GmbH**	
Address:	Postfach 80 13 49, D-81613 Munich	
Tel.:	+49 89 4183 116	
Fax:	+49 89 4183 192	

2 Composition / Information about the components
Chemical components: Lubricating grease based on mineral oil and lithium-calcium soap grease as thickener.
Hazardous components: This product contains no substances requiring declaration as a hazardous substance.

3 Possible hazards
This product is NOT classified as hazardous according to the German Dangerous Substances Order.

4 First aid measures	
Eyes:	Rinse thoroughly with plenty of water for several minutes; consult a doctor if necessary.
Skin:	Wash thoroughly with soap and water; replace lost skin grease with skin cream.
Inhalation:	Not applicable.
Ingestion:	Do NOT induce vomiting; consult a doctor immediately.

5 Fire-fighting measures
Extinguishing agents
Suitable extinguishing agents: Foam, dry powder, CO_2.
Unsuitable extinguishing agents: Water.

6 Measures after unintended release
Personal safety precautions: No special safety precautions required.
Environmental protection measures: Contain polluted or extinguishing water. Prevent it from entering the drainage system or surface waters.
Disposal information: Bind lubricant with a suitable binding agent and dispose of it in accordance with regulations.

7 Handling and storage	
Handling:	No special measures required if handled in accordance with specifications.
Storage:	Store in a dry, dust-free atmosphere in closed, original containers at temperatures between 10–20 °C. Avoid large variations in temperature! Do not store together with strong oxidizing agents. Do not leave container outdoors; protect from direct sunlight.
Technical Instructions on Air Quality Control / Annex E (Class):	Not applicable.
Water hazard classification:	Not applicable.

8 Personal protective equipment	
Personal protective equipment:	The usual precautions when handling lubricants must be observed. Avoid prolonged contact with the skin. Do not eat, drink, smoke or take snuff during work. Change contaminated working clothes. Clean skin and apply skin cream after work. Wear protective neoprene gloves.

9 Physical and chemical properties

10 Reactivity	
Conditions to be avoided:	The product is stable.
Substances to be avoided:	Strong acids and oxidizing agents.
Hazardous decomposition products:	Dependent on decomposition conditions: oxides of C, S, P.

11 Toxicological information	
Effects on health	
on eyes:	Contact with eyes can cause temporary irritation of the conjunctiva.
on skin:	Avoid prolonged or repeated contact with the skin, as mild irritation may occur.

12 Ecological information	
General assessment:	Prevent the lubricant from entering soil, surface waters and drainage system.

13 Disposal information

This product must be disposed of in accordance with all pertinent regulations governing the disposal of waste and used lubricants.

	Waste code:	Recommended means of disposal:
Unused product:	54 202	
Packaging:		Contaminated packaging should be emptied optimally; it can then be recycled after appropriate cleaning.

14 Transport regulations

This product is NOT classified as a dangerous good for the purpose of transportation according to the German Law concerning the Conveyance of Dangerous Goods.

15 Regulations	
EC regulations:	EC Safety Data Sheet Directive 91/155/EEC EC Directive on Dangerous Preparations 88/379/EEC EC Framework Directive on Waste 91/156/EEC EC Directive on Hazardous Waste 91/689/EEC
National regulations (Germany):	Law concerning the Conveyance of Dangerous Goods Water Resources Law (WHG) Chemicals Law (ChemG) Dangerous Substances Order (GefStoffV) Law concerning Life-cycle Management and Waste (KrW-AbfG) Federal Immission Control Act (BImschG) Technical Guideline on Air (TA-Luft)

16 Other information
All information is based on the current state of our knowledge. It is intended only to describe our product with regard to the safety data. It is not intended to provide assurance of particular properties.
The product may only be used for the scope of work specified above; any other use requires prior consultation with KUKA. Using the product for any purpose other than for its designated use could lead to risks which are not described in this document.
Further information on the use of the product may be found in the relevant technical specifications.

11.3 Safety data sheet for Optigear Synthetic RO 150 oil

1 Designation of substance/formulation and manufacturer		
Product name:	**Optigear Synthetic RO 150**	SDS no.: **465036**
Historical SDS no.:	**DE-05254, FR-465036, SK-5254**	
Use of substance or formulation:	Lubricant For specific instructions for use, see the corresponding technical data sheet or contact a company representative.	
Supplier:	Deutsche BP Aktiengesellschaft, Industrial Lubricants & Services	
Address:	Erkelenzer Strasse 20, D-41179 Mönchengladbach	
Country:	Germany	
Tel.:	+49 (0)2161 909 319	
Fax:	+49 (0)2161 909 392	
Emergency hotline:	Carechem: +44 (0)208 762 8322	
e-mail address:	MSDSadvice@bp.com	

2 Possible hazards

The preparation is classified as hazardous in accordance with Directive 1999/45/EC in its altered and adapted version.

Environmental hazards:

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Sections 11 and 12 contain more detailed information on health hazards, symptoms and environmental risks.

3 Composition and information about the components

Chemical characterization:

Synthetic lubricant and additives.

Chemical description:

	CAS no.	%	EINECS/ELINCS.	Rating
Dithiocarbamic acid, dibutyl-, methylene ester	10254-57-6	1 - 5	233-593-1	R52/53
Tridecanamine, n-tridecyl, branched, compounds with molybdenum hydroxide oxide (1:1)	280130-32-7	0.1 - 1	442-990-0	Xi; R41, R38 N; R50/53

Refer to Section 16 for the full text of the above R-phrases.
The occupational exposure limit values, where available, are specified in Section 8.

4 First aid measures	
Eye contact:	In case of contact, rinse eyes immediately with plenty of water for at least 15 minutes. If irritation occurs, consult a doctor.
Skin contact:	Wash affected areas of skin with soap and water, or use suitable cleaning agent. Change clothing and shoes if they become contaminated with product. Wash clothing before reuse. Clean shoes thoroughly before reuse. If irritation occurs consult a doctor.
Inhalation:	Take affected person into fresh air. Consult a doctor if symptoms persist.
Ingestion:	Do NOT induce vomiting. If the person is unconscious, do not give anything by mouth. Consult a physician immediately.

5 Fire-fighting measures	
Suitable extinguishing agents	In the event of a fire: use water spray (mist), foam, dry chemicals or CO_2. This substance is harmful to aquatic organisms. Extinguishing water contaminated with this product must be contained and prevented from entering surface waters or the sewage or drainage system.
Unsuitable extinguishing agents:	Do NOT use water jets.
Hazardous decomposition products:	The decomposition products may include the following materials: Carbon oxides Nitrogen oxides Sulfur oxides
Unusual fire/explosion hazards:	This product is not inherently explosive in accordance with the applicable rules.
Special fire-fighting measures:	Not specified.
Protection of fire-fighters:	Fire-fighters must wear self-contained positive pressure breathing apparatus (SCBA) and full protective gear.

6 Measures after unintended release	
Personal safety precautions:	No measures should be taken that involve a risk to personnel or have not been adequately trained. Evacuate the environment. Refuse access to personnel who are not required or are unprotected. Do not touch or step on any spilled substance. Avoid breathing in any spray or vapors. Ensure adequate ventilation. Where there is insufficient ventilation, wear suitable respiratory equipment. Use suitable protective equipment (see Section 8).
Environmental protection measures:	Prevent released material from dispersing or flowing away and from coming into contact with soil, surface waters and drainage system. Notify the relevant authorities if the product has caused pollution (sewers, surface waters, ground or air). Substance is a water pollutant.
Large spills:	Stop the leak if you can do so without risk. Remove container from spill area. Approach the spill area only with a following wind. Prevent entry into drainage system, surface waters, basements or confined areas. Flush spilled material into a wastewater treatment plant, or proceed as follows. Contain spilled material using a non-combustible absorbent (e.g. sand, soil, vermiculite, diatomaceous earth) and collect it in the designated containers for disposal in accordance with the local regulations (see Section 13). Disposal should be entrusted to a recognized waste disposal company. Contaminated absorbents can be just as dangerous as spilled material. Note: See Section 1 for contact in emergencies and Section 13 for disposal information.
Small spills:	Stop the leak if you can do so without risk. Remove container from spill area. Absorb spill with inert material and place it in a suitable container for disposal. Disposal should be entrusted to a recognized waste disposal company.

7 Handling and storage	
Handling:	Spilled and leaked product must be prevented from coming into contact with soil and surface waters. Wash thoroughly after handling.
Storage:	Keep containers tightly sealed. Keep containers in a cool, well-ventilated area.
Germany - storage class:	10

8 Exposure limits and personal protective equipment	
Ingredient name ACGIH TLVs:	Base oil – unspecified
Limits to monitor:	**ACGIH (USA).** TWA: 5 mg/m^3 8 hour(s). Form: mineral oil mist STEL: 10 mg/m^3 15 minute(s). Form: mineral oil mist
The ACGIH values are enclosed for information and orientation purposes. Further information can be obtained from your supplier. While this section contains specific OELs for individual components, different components may be contained in any mists, vapors or dusts that are generated. The specific OELs may thus not necessarily be applicable to the product as a whole and are merely provided for general information purposes.	
Limitation and monitoring of exposure	
Limitation and monitoring of exposure in the workplace:	Provide exhaust ventilation or other engineering controls to keep the relevant airborne concentrations below their respective occupational exposure limits.
Hygiene measures:	Wash hands, forearms and face thoroughly after handling chemical products and before eating, smoking or using the toilet, as well as at the end of the working day.
Personal protective equipment	
Respiratory protection:	Not essential. Sufficient ventilation is recommended in industry, however.
Hand protection:	Wear protective gloves if prolonged or repeated contact is likely. Chemical-resistant protective gloves. Recommended: nitrile gloves The right choice of protective gloves is dependent on the chemicals to be handled, the working conditions, and the condition of the gloves themselves (even the best chemical-resistant protective gloves start to leak after repeated contact with chemicals). Most protective gloves only provide protection for a short period of time, after which they must be disposed of and replaced. As the specific working conditions and the chemicals concerned differ from case to case, appropriate safety measures must be developed for each individual application. Protective gloves should therefore be selected in consultation with the supplier/manufacturer, giving full consideration to the specific working conditions.
Eye protection:	Protective goggles with side shields to guard against splashing.
Skin and body:	Wear appropriate clothing to avoid prolonged skin contact.

9 Physical and chemical properties	
General information regarding appearance	
Physical state	Liquid.
Color:	Green.
Odor:	Slight.
Important information on health, safety and the environment	
Flash point:	Open cup: 230 °C (446 °F) [Cleveland]
Vapor pressure:	<0.01 kPa (<0.075 mm Hg) at 20°C
Viscosity:	Kinematic: 150 mm^2/s (150 cSt) at 40°C
Pour point:	-36°C
Density:	< 1000 kg/m^3 (< 1 g/cm^3) at 20 °C
Solubility:	Insoluble in water.

10 Stability and reactivity	
Stability:	The product is stable. No hazardous polymerization occurs under normal storage conditions and in normal use.
Conditions to be avoided:	No specific data.
Substances to be avoided:	Reactive or incompatible with the following substances: oxidizing materials.
Hazardous decomposition products:	The combustion products may include the following compounds: Carbon oxides Nitrogen oxides Sulfur oxides No hazardous decomposition products should be formed under normal conditions of storage and use.

11 Toxicological information

12 Ecological information	
Persistence / degradability:	Inherently biodegradable.
Mobility:	Non-volatile. Liquid. Insoluble in water.
Environmental hazards:	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

13 Disposal information
Disposal information
Disposal information / waste specifications: Generation of waste should be avoided or minimized if at all possible. Disposal of surplus material and products not suitable for recycling must be entrusted to a recognized waste disposal company. Disposal of this product and of its solutions and by-products must at all times comply with the environmental protection requirements, waste disposal legislation and the requirements of local authorities. Prevent released material from dispersing or flowing away and from coming into contact with soil, surface waters and drainage system.
Unused product
European Waste Catalog (EWC): 13 02 08* Synthetic machine oils, gear oils and lubricating oils Use of the product for purposes other than those specified and/or the presence of impurities can necessitate the use of a different waste code number by the waste producer.
Packaging
European Waste Catalog (EWC): 15 01 10* Packaging containing the residue of hazardous materials or contaminated by hazardous materials.

14 Transport information
Not hazardous as defined by the transport regulations (ADR/RID, ADNR, IMDG, ICAO/IATA).

15 Regulations
Classification and labeling have been performed according to EU directives 1999/45/EC and 67/548/EEC as amended and adapted.

Labeling requirements	
Risk (R) phrases:	R52/53 – Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Safety (S) phrases:	S61 – Avoid release to the environment. Refer to special instructions/safety data sheet.
Miscellaneous provisions	
Inventories:	**European inventory:** All components are listed or exempted. **US inventory (TSCA 8b):** All components are listed or exempted. **Australian inventory (AICS):** All components are listed or exempted. **Canadian inventory:** At least one component is not listed. **Inventory of Existing Chemical Substances in China (IECSC):** All components are listed or exempted. **Japanese inventory of Existing and New Chemical Substances (ENCS):** At least one component is not listed. **Korean Existing Chemicals Inventory (KECI):** All components are listed or exempted. **Philippine Inventory of Chemicals and Chemical Substances (PICCS):** All components are listed or exempted.
Water hazard classification (WGK), **classification acc. to the German Administrative Regulation on the Classification of Substances Hazardous to Water into Water Hazard Classes (VwVwS):**	1, Annex no. 4

16 Other information	
Full text of R-phrases referred to in Sections 2 and 3:	R41 - Risk of serious damage to eyes. R38 - Irritating to skin. R50/53 - Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. R52/53 - Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
History:	
Date of issue:	23/11/2007.
Date of previous issue:	31/08/2007.
Prepared by:	Product Stewardship Group
Notes for the reader:	

All reasonably practicable steps have been taken to ensure this data sheet and the health, safety and environmental information contained in it is accurate as at the date of issue specified below. No warranty or representation, express or implied, is made as to the accuracy or completeness of the data and information in this data sheet.
The data and advice issued are valid if the product is sold for the application(s) specified. The product should not be used for purposes other than the applications specified without prior consultation with us.
It is the responsibility of the user to check this product and to use it with care, while observing all the relevant laws and regulations in force.
The BP Group accepts no responsibility for any damage or injury resulting from uses other than the stated product use of the material, from any failure to adhere to recommendations, or from hazards inherent in the nature of the material. Those purchasing the product for supply to third parties for use at work have a duty to take all necessary steps to ensure that any person handling or using the product is provided with the information on this data sheet. Employers have a duty to tell employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken.

11.4 Safety data sheet for Microlube GL 261 lubricant

The following extract from the safety data sheet according to 91/155/EEC must be observed when handling Microlube GL 261.

1 Designation of substance/formulation and manufacturer		
Trade name:	**Microlube GL 261**	Article no.: **020195**
Use:	Lubricant	
Firm:	**KLÜBER LUBRICATION MÜNCHEN KG**	
Address:	Geisenhausenerstr. 7, D-81379 Munich	
Tel.:	+49 89 7876 0	
Fax:	+49 89 7876 333	

2 Composition / Information about the components
Chemical characterization: - Mineral oil - Lithium special soap - UV indicator
Hazardous components: This product contains no substances requiring declaration as a hazardous substance.

3 Possible hazards
This product is NOT classified as hazardous according to the German Dangerous Substances Order.

4 First aid measures	
Eyes:	Rinse thoroughly with plenty of water for several minutes; consult a doctor if necessary.
Skin:	Wash thoroughly with soap and water; replace lost skin grease with skin cream.
Inhalation:	If oil vapor has been inhaled, ensure plentiful supply of fresh air and consult a doctor if necessary.
Ingestion:	Consult a doctor if symptoms persist.

5 Fire-fighting measures
Extinguishing agents
Suitable extinguishing agents: Foam, fine water spray, dry powder, CO_2.
Unsuitable extinguishing agents: Full water jet.
Special fire-fighting measures: Cool containers at risk from fire with water spray. Residue from after a fire and contaminated fire-extinguishing water must be disposed of in accordance with the applicable regulations.
In the event of fire, the following can be released: Carbon monoxide (CO), hydrocarbons.
Special protective equipment: Do not inhale gases from explosions and combustion. Usual measures for fires involving chemicals.

6 Measures after unintended release
Personal safety precautions: No special safety precautions required.
Environmental protection measures: Contain polluted or extinguishing water. Prevent it from entering the drainage system, surface waters or other waterways.
Procedure for cleaning/removing: Bind lubricant with a suitable binding agent and dispose of it in accordance with regulations.
Additional instructions: No hazardous materials are released.

7 Handling and storage	
Handling:	No special measures required.
Storage:	Store in well sealed containers in a cool and dry place.
	Do not store together with oxidizing agents or food.
Storage class in accordance with VCI:	
	11

8 Exposure limits and personal protective equipment	
Additional information for the design of technical systems:	
	No further information.
Components with applicable occupational exposure limit values:	
	The product contains no relevant amounts of materials that are subject to monitoring of limit values in the workplace.
Additional instructions:	
	These values are based on the lists valid at the time of issue.
Personal protective equipment	
General protective and hygiene measures:	
	Immediately take off any contaminated, soaked clothing. Avoid prolonged and intensive contact with the skin. Thoroughly clean the skin after work and before taking breaks.
Respiratory protection and eye protection:	
	Not essential.
Hand protection:	Appropriate measures for precautionary skin protection are recommended.

9 Physical and chemical properties	
State:	Paste
Color:	Tawny
Odor:	Product-specific
Pour point:	>220 °C (DIN ISO 2176)
Flash point:	Not applicable.
Risk of explosion:	The product presents no danger of explosion.
Density (20 °C):	~ 0.89 g/cm^3
Solubility:	Insoluble in water.

10 Stability and reactivity
Thermal decomposition / conditions to be avoided: No decomposition if handled and stored correctly.
Substances to be avoided: Oxidizing agents.
Hazardous reactions: No hazardous reactions known.
Hazardous decomposition products: None if used for designated purpose.

11 Toxicological information
Prolonged contact with the skin can cause irritation and/or dermatitis.

12 Ecological information
Measures at wastewater treatment facilities: The product can be separated by mechanical means.
General information: Prevent from entering groundwater, surface waters or the drainage system. Water hazard classification 1 (manufacturer's classification): low hazard to waters

13 Disposal information
Waste code number: No waste code number for this product can be defined in accordance with the European Waste Catalog (EWC) until the purpose of use has been assigned by the customer. The waste code number should be determined in consultation with the regional disposal service.
Contaminated packaging:
Recommendation: Contaminated packaging should be emptied optimally; it can then be recycled after appropriate cleaning.

14 Transport regulations
This product is NOT classified as a dangerous good for the purpose of transportation according to the German Law concerning the Conveyance of Dangerous Goods.

15 Regulations
EC regulations: The product is not subject to labeling obligations due to the method of calculation in the latest version of the "EC General Classification Directive for Preparations".
Water hazard classification: WGK 1 (manufacturer's classification): low hazard to waters in accordance with the German Administrative Regulation on the Classification of Substances Hazardous to Water into Water Hazard Classes (VwVwS) 17.5.99 Annex 4

16 Other information
All information is based on the current state of our knowledge. The information does not represent any assurance of product characteristics, however, and does not establish a legally valid contractual relationship.