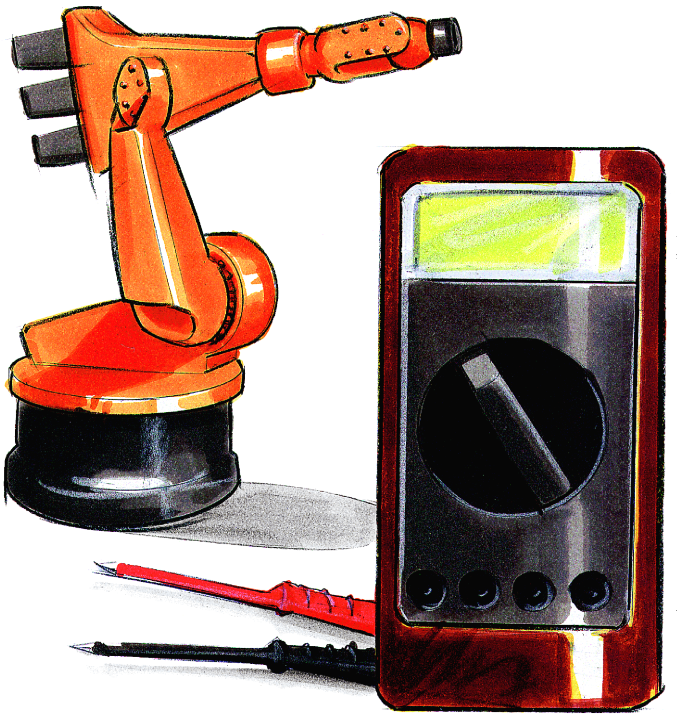
CONTROL CABINET

KR C2

Seminar workbook

of .....

Electrical Servicing



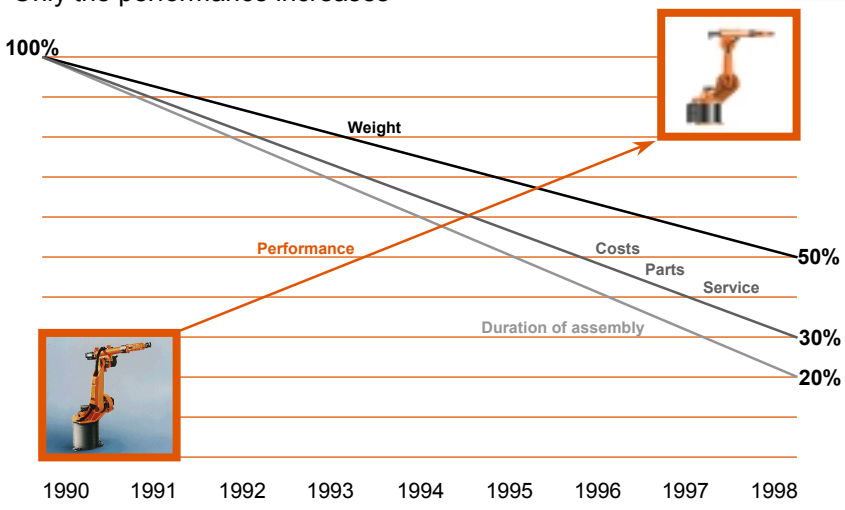
PD Interleaf

- Introduction
- Safety
- Technical Data
- Robot System
- Computer Unit
- Power Unit
- ESC Safety System
- Connecting Cables

Plant map Augsburg

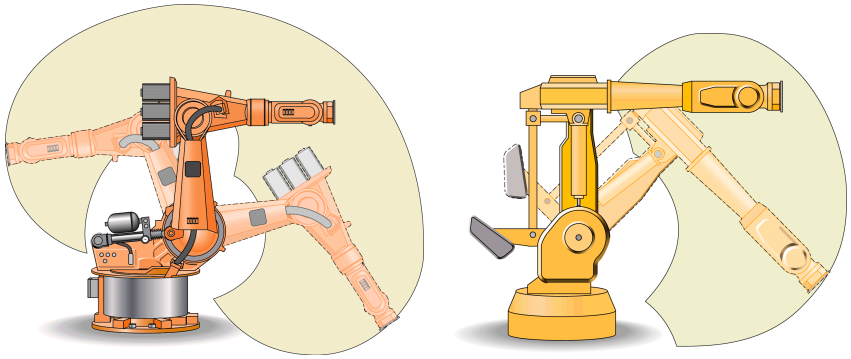
Development of KUKA robots

Only the performance increases



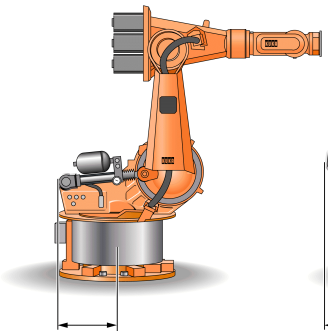
Comparison of different kinematic concepts

- Overhead motion possible
- Bigger work space

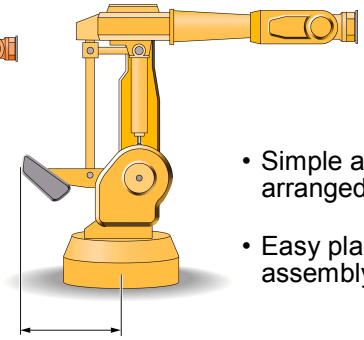


Comparison of jaming edges

KUKA Robot



Parallelogram Robot



- Simple and clearly arranged configuration
- Easy planing of robot assembly lines and cells

Modular system

No matter if KR 125, KR 150 or KR 200: the basic is always the same

- Lower planning risks
- The plant stays flexible
- Later upgrades without problems

KR 125 **KR 150** **KR 200**

KUKA robot classes

Lower Payload	Medium Payload	High Payload	Heavy Payload	Special Series
(V)KR 6/2 (V)KR 15/2	(V)KR 30/2 (V)KR 30 L15/2 (V)KR 45/2	(V)KR 125/2 (V)KR 150/2 (V)KR 200/2	(V)KR 350/2 (V)KR 350L280/2 (V)KR 350L240/2	(V)KR 60P/1 (V)KR 100P/1 (V)KR 100PA/1 (V)KR 160PA/1

Heavy duty robot (V)KR 350/2

Press to Press Link: (V)KR 60 P/2, (V)KR 100 P/2

Palettizier KR 180 PA

Console robot (V)KR 125 K/1, (V)KR 150 K/1

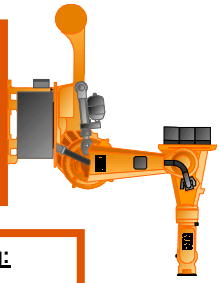
The new console robot KR 30 K

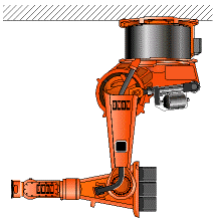
Wall mounted robot (V)KR 125 W/2

The new mini robot KR 3

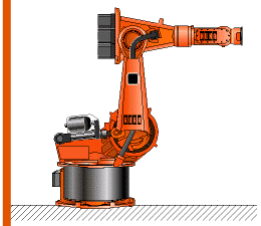
For all situations: flexible mounting positions

Wall mounting:
- ✔ (V)KR 6/2
- ✔ (V)KR 15/2
- ✔ (V)KR 30/2
- ✔ (V)KR 30L15/2
- ✔ (V)KR 125 W/2





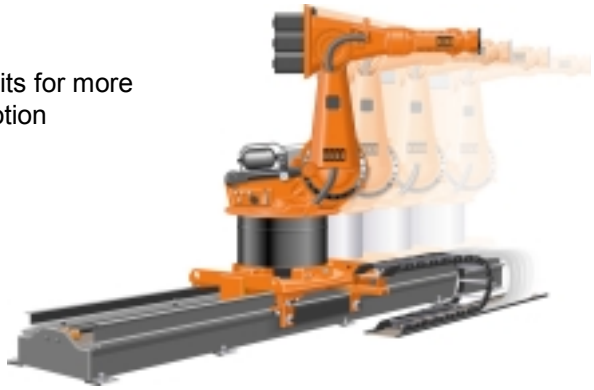
Floor mounting:
- ✔ (V)KR 6/2
- ✔ (V)KR 15/2
- ✔ (V)KR 15 L2/2
- ✔ (V)KR 30/2
- ✔ (V)KR 30 L15/2
- ✔ (V)KR 45/2
- ✔ (V)KR 125/2
- ✔ (V)KR 150/2, 200/2
- ✔ (V)KR 350/2
- ✔ KL 250, KL 1500



Ceiling mounting:
- ✔ (V)KR 6/2
- ✔ (V)KR 15/2
- ✔ (V)KR 15 L2/2
- ✔ (V)KR 30/2
- ✔ (V)KR 30 L15/2
- ✔ (V)KR 45/2
- ✔ (V)KR 125/2
- ✔ (V)KR 150/2, 200/2
- ✔ (V)KR 350/2
- ✔ KL 250, KL 1500

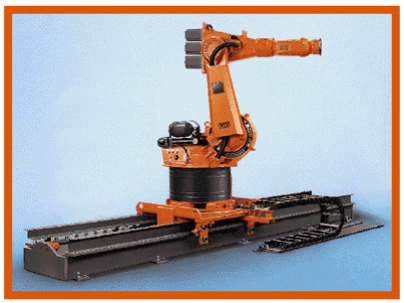
KUKA linear unit (KL)

KUKA liner units for more freedom of motion



KL 250 (max. weight 250kg) for KR 15 and smaller
KL 1500 (max. weight 1500kg) for KR 30 and higher

KL Mounting positions



Floor mounting

Ceiling mounting

- Introduction
- **Safety**
- Technical Data
- Robot System
- Computer Unit
- Power Unit
- ESC Safety System
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Safety regulations for working with industrial robots

Liability

- The robot system is built using state-of-the-art technology and in accordance with the recognized safety rules. Nevertheless, improper use of the robot system or its employment for a purpose other than the intended one may cause **danger to life and limb** or **damage to material property**.

The robot is always stronger than you!

- The robot system may only be used in **technically perfect condition** in accordance with its designated use and only by safety-conscious persons who are fully aware of the risks involved in its operation. Any functional disorders affecting the safety of the robot system must be rectified immediately.
- The robot system is designed to comply with the **EC Machinery Directive** and associated standards. These include, for example, EN 775, the European norm for the safety of industrial robots.

Designated use

- The robot system is designed exclusively for the specified **applications**.

  Applications for the KR 125/2 include:
  - Spot welding
  - Handling
  - Assembly
  - Application of adhesives, sealants and preservatives
  - Machining
  - MIG/MAG welding
  - YAG laser beam welding.

Using the robot system for any other or additional purpose is considered contrary to its designated use. The manufacturer cannot be held liable for any damage resulting therefrom. The risk of such misuse lies entirely with the user.

Safety symbols

This symbol is used where failure to fully and accurately observe operating instructions, work instructions, prescribed sequences and the like could result in **injury or a fatal accident**.

This symbol is used where failure to fully and accurately observe operating instructions, work instructions, prescribed sequences and the like could result in **damage to the robot system**.

This symbol is used to draw attention to a **particular feature**. Observance of the note will generally result in facilitation of the work concerned.

General safety regulations

- **Improper use** of the robot system or its employment for a purpose other than the intended one may cause
  - danger to life and limb
  - danger to the robot system and other assets of the user and
  - danger to the efficient working of the robot system or its operator.

General safety regulations

- Every person involved with the robot system must have read and **understood** these operating instructions, particularly the **chapter "Safety"**, paying special attention to the passages marked with this warning symbol ⚠.

- Installation, exchange, adjustment, operation, maintenance and repair must be performed only as specified in these operating instructions and only by **personnel specially trained** for this purpose.

General safety regulations

- The **responsibilities** involved in operation of the robot system and in all other work performed on the robot system or in its immediate vicinity must be clearly **defined** and **observed** by the user in order to prevent any uncertainty regarding spheres of competence in matters of safety.

- The user and operating personnel must ensure that only **authorized personnel** are permitted to work on the robot system.

- The user must clearly set out what the responsibilities of operating personnel actually entail and give them the authority to **refuse to carry out instructions** from third parties which are **contrary to safety procedures**.

General safety regulations

- The **danger zones of the robot system** must be safeguarded to prevent persons or objects from entering these zones. This safety facility is the responsibility of the user.
- The **switching times of the EMERGENCY STOP system** must be taken into account when determining the size of the danger zones.

Particular safety regulations for the user and the operating personnel

- The robot system must be switched off before **maintenance work**, i.e. the main switch on the control cabinet must be turned to "OFF".
- Secure it with a **padlock** to prevent unauthorized persons from switching it on again.
- **De-energize power supply lead** and disconnect X1.
- Before exchanging the **power unit** (power module), wait at least **5 minutes**.
- Work on the electrical equipment of the robot system may only be carried out by a **skilled electrician**.
- Skin contact with grease is to be avoided.

Particular safety regulations for the user and the operating personnel

- The operating personnel are obliged to **inform** the user **immediately** of any **changes** to the robot system **which impair its safety**.

- The user must ensure that the robot system is only ever operated in faultless condition.

- **No functional safety equipment** may be **dismantled** or taken out of operation.

Particular safety regulations for the user and the operating personnel

- When **work** is carried out **in the danger zone** of the robot, the latter may only, if absolutely essential, be operated at **manual traversing speed** at the most.

- All persons situated in the environment of the robot must be informed in good time that the robot is about to move.

- Wherever possible, **only one person** should work in the danger zone of the robot at any time.

Particular safety regulations for the user and the operating personnel

- In **sensor-assisted operation**, the robot is liable to perform **unexpected movements** and path corrections if the main switch on the control cabinet has not been turned to "OFF".

- Due regard must be paid to **hazards** posed by the **peripheral system** components of the robot such as grippers, conveyors, feed devices or other robots in a multi-robot system.

- Any unauthorized **conversion** or **modification** of the robot system is **not allowed**.

Singularities of a 6-axis robot

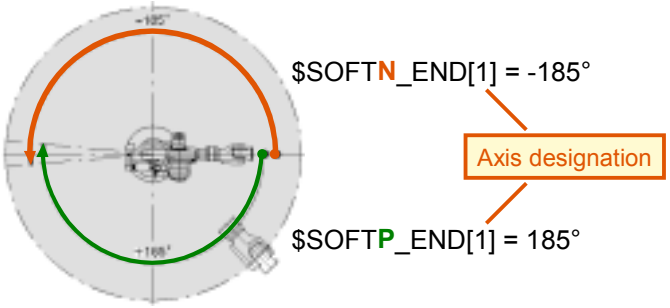
- Singularities are points through which the robot cannot be moved using **Cartesian traversing**. In the immediate vicinity of these points, the affected axes are subjected to extreme acceleration. This results in the robot motion being stopped by the controller and the generation of an error message.

Safety features of the robot system: working space limitation

- The means of limiting the working space of the robot comprise:
  - **adjustable software limit switches** for all axes and
  - for some axes **mechanical limit stops** with a buffer function,
  - which as the **working range limitation** accessory are also adjustable.

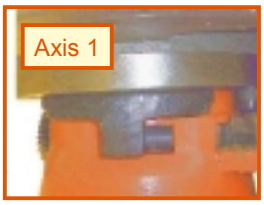
Safety features of the robot system: working space limitation

- Example: software limit switches for axis 1



Safety features of the robot system: working space limitation

- Examples: working range limitation on the KR 125



Safety features of the robot system: counterbalancing system

- Some robot types are equipped with a hydropneumatic or mechanical **counterbalancing system**.
- Work on the hydropneumatic counterbalancing system may only be carried out by persons having special knowledge and experience of hydraulic and pneumatic systems.

- If work is to be carried
  the counterbalancing sys
  the parts of the robot a
  by these systems must be
  secured so that they are
  to move.

Safety features of the robot system: temperature monitoring

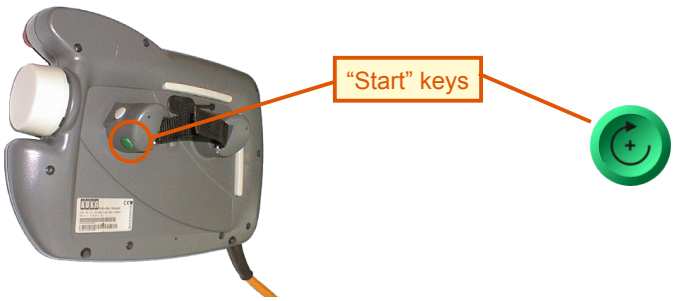
- The motors are protected against overload by means of temperature sensors in the motor windings.

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

- The temperatures inside the control cabinet (internal temperature) are monitored. The controller is switched off if defined limits are exceeded.

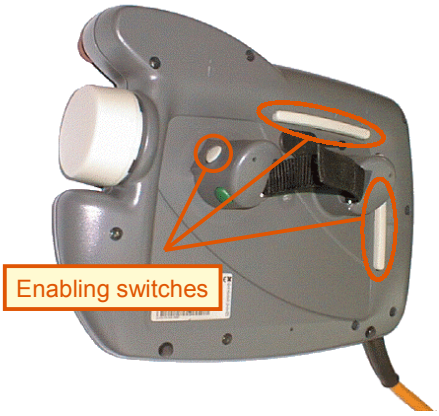
Safety features of the robot system: jog mode

- **Jog mode** (deadman function). All programs can be executed manually in the test modes at reduced velocity. However, program execution is only possible as long as the “Start” key is held down. If the “Start” key is released, the robot stops. The program can only be continued by pressing the “Start” key again.



Safety features of the robot system: enabling switches

- The **enabling switches** on the KUKA Control Panel (KCP)



Release device for robot axes

- The robot can be moved after a malfunction via the main axis drive motors and, depending on the type of robot, also via the wrist axis drive motors in some instances. It is only intended for use in **emergencies**.

- The release device may only be used if the robot **control cabinet** has been **switched off**.

- If a robot axis has been moved using the release device, **all robot axes** must be **remastered**. The motor concerned must be exchanged.

Release device for robot axes

- The release device (reversible ratchet with size 12 socket wrench insert) is pushed onto the axle of the motor (remove protective cap), which can then be turned. It is necessary to overcome the resistance of the mechanical motor brake and any other loads acting on the axis.

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

Planning and construction: safety and working zones

- Working zones are to be restricted to the necessary minimum size. **On no account may persons or equipment be exposed to any danger.**

- The danger zones must be safeguarded by means of **protective barriers** and indicated by means of **paint markings** on the floor.

- The **safety fences** must be high enough to prevent anybody from reaching over them. Design measures must be taken to prevent them from bending. The number of entrances must be kept to a minimum. All entrances must be connected to the overall EMERGENCY STOP system
  ➔ **operator safety** on the gate, Emergency Stop on the safety fencing.

- The **foundations** and **substructures** must meet the quality specifications laid down by KUKA.
- The **loads** to be expected when operating the robot system must lie within the permissible range.

- The operation of robots of normal design is not permitted in **potentially explosive areas**!

- The robot can be equipped with a **collision protection device** (additional equipment).

- Removal and installation stations must be provided to allow **tools to be changed**. These stations must be accessible to the operator outside the danger zone and the robot must be able to move to them by means of a special program step.

- If the presence of operating personnel in the work envelope of the robot is unavoidable (e.g. for loading components), the danger zone is to be isolated by means of a **safety mat** or light curtain.

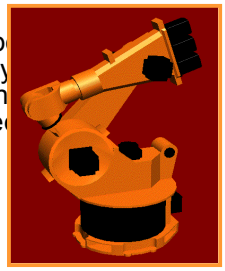
Planning and construction

- If the robot system is operated in conjunction with a **higher-level controller**, the two EMERGENCY STOP circuits must be interconnected.
- Both these circuits must be of **failsafe design** (dual EMERGENCY STOP contactors with reciprocal monitoring).
- It is particularly important that a regular check is made to ensure that that the EMERGENCY STOP devices are **functioning correctly**.
- **Outputs** are to be **preset** in accordance with the main project file, i.e. signals for hold functions must not be reset when the robot controller is switched off if personnel or equipment would be endangered as a result.

Installation and operation

- All persons working within the danger zone of the robot system must wear **protective clothing**. Of particular importance are safety helmets, safety footwear and closely fitting clothing.

- The prescribed **transport positions** for the rob must be observed. Only suitable and technically faultless lifting gear and load-bearing equipmen with an adequate carrying capacity may be use



- Never work or stand under **suspended loads**!

- No welding may be carried out in the immediate vicinity of the open control cabinet due, among other factors, to the risk of EPROMs being erased by **UV radiation**. **Foreign matter** (e.g. swarf, water, dust) must be prevented from entering the control cabinet.

- During **start-up**, check that all **protective devices** are complete and functioning correctly. No persons or objects are allowed in the danger zone during start-up. It must be ensured that the **correct machine data** have been loaded before the system is put into operation for the first time.

- All **safety regulations** must be adhered to while the robot system is in operation.

- Check the robot system at least once per working shift for **obvious damage and defects**.

- Never use the robot or the control cabinet as a **climbing aid**.

- The software must be checked for **viruses**.

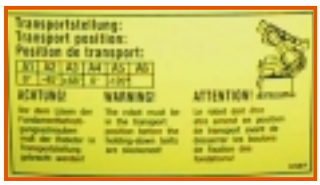
Installation and operation: safety instruction

- 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**.
- **Records** are to be kept of the content and extent of the instruction.

- Personnel must be instructed **orally every six months** and in **writing every two years** with regard to the observance of safety regulations and precautions.

Safety labeling

- All plates, labels, symbols and marks constitute safety-relevant parts of the robot system. They must remain attached to the robot or control cabinet concerned for the whole of their service lives in their specified, clearly visible positions.



- It is forbidden to remove, cover, obliterate, paint over or alter in any other way detracting from their clear visibility
  - identification plates,
  - warning labels,
  - safety symbols,
  - designation labels and
  - cable marks.

Safety instructions for KUKA training cells

- Entering the **motion range of the robot** is only permitted with the robot operated in **“T1”** mode (at reduced velocity) using a **KCP**.
- All persons situated in the environment of the robot (at its own or adjacent cells) must be **informed** in good time **that the robot is about to move**.
- On **leaving** the training cell, press the **EMERGENCY STOP button** on the KCP, set **operating mode “T1”** and secure the KCP in its holder.
- **Never lean over the safety fencing** from outside!

Safety instructions for KUKA training cells

- When **testing programs**, always execute the program in “T1” mode first and then in “T2” mode at reduced velocity.
- During program execution in **“T2” mode**, no persons are permitted in the cell and the gate to the cell must remain closed.
- The robot and its tooling must never **touch or project beyond the safety fence**.
- Warning: **memory dumps** from KUKA College must not be loaded into **manufacturing systems**.

ESD directives

ESD = **e**lectrostatic **s**ensitive **d**evices

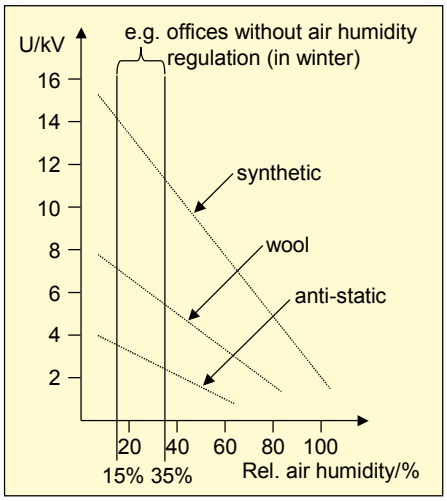
e.s.d. = **e**lectro**s**tatic **d**ischarge

ESDs can be destroyed by voltages which are imperceptible to humans.

As well as causing complete failure of components, **e.s.d.** can also be responsible for partial damage to an IC or component, which can reduce its service life or lead to sporadic faults.

For these reasons, not only new modules, but also defective modules, must be handled very carefully in a way suitable for ESDs.

ESD directives



Average values for electrical voltages to which a person can be charged

Element	Voltage (V)
MOSFET	100-200
EPROM	100
JFET	140-7000
OP amplifiers	100-2500
CMOS	250-3000
Schottky diodes	300-2500
Thick/thin-film circuits	300-3000
Bipolar transistors	300-7000
Schottky TTL	1000-2500

e.s.d. vulnerability of semiconductor elements

Handling ESD modules:

- Components should only be unpacked if
  a) you are wearing ESD shoes
  or b) you are wearing ESD shoe grounding strips
  or c) you are grounded by means of an ESD armband.
- Before touching an electronic module you should discharge the voltage from your own body.
- Do not place electronic modules near monitors.
- Only measure with grounded measuring instruments or discharge the measuring head before measuring.

- *Introduction*
- *Safety*
- *Technical Data*
- *Robot System*
- *Computer Unit*
- *Power Unit*
- *ESC Safety System*
- *Connecting Cables*

Technical data 1

- Control cabinet type: KR C2
  - Control cabinet for max. 8 axes
- Protection classification: IP54
- Permissible environmental conditions:
  - without cooling unit: max. 45 °C
  - with cooling unit: max. 55 °C
- Weight: approx. 185 kg
- Power supply connection:
  - Supply voltage: 3x400 V to 3x415 V clockwise rotating field
  - Permissible tolerance: 400 V -10% to 415 V +10%
  - Power frequency: 49-61 Hz
  - Connected load: 6 kVA
  - Fusing: min. 3x25 A slow-blowing
  - Mains filter leakage current: approx. 300 mA

Technical data 2

- Brake control
  - Brake voltage: 24 V
  - Brake current: max. 10A
  - Monitoring: open circuit, short-circuit
- PC supply voltage: 27 V
- Microprocessor: Celeron 400 MHz
- Main memory 64 MB

- KPS 600:
  - Intermediate circuit voltage: 600 V
  - Voltage distribution 27 V
  - Ballast resistor: 22 Ω / 800 W

- *Introduction*
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KR C2 - Important differences from KR C1

- New cabinet dimensions 800x1250x540
- In the cabinet
  - 2 external axes possible
  - space for integration of customer options
- More flexible options
- Drive module variants
- Non-interchangeable connections, e.g. motor cables
- Extended safety interface
- Not all spare parts compatible: MFC II, KCP II, DSE, drive modules
- Software versions V2.5 and V 4.0

Concept comparison KR C1 - KR C2

Integrated 6-axis solution for robot only

W 650 mm
H 940 mm
D 540 mm

Integrated 8-axis solution for robot (6 axes and 2 external axes)

W 800 mm
H 1250 mm
D 540 mm

External axis solution (8 axes)

W 650 mm
H 1795 mm
D 540 mm

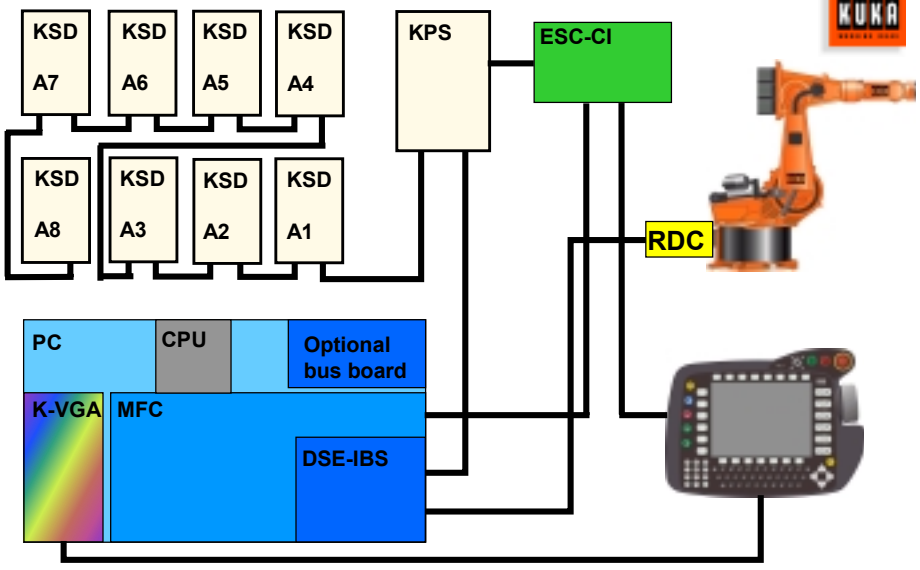
Standard solution (8 axes)

W 800 mm
H 1250 mm
D 540 mm

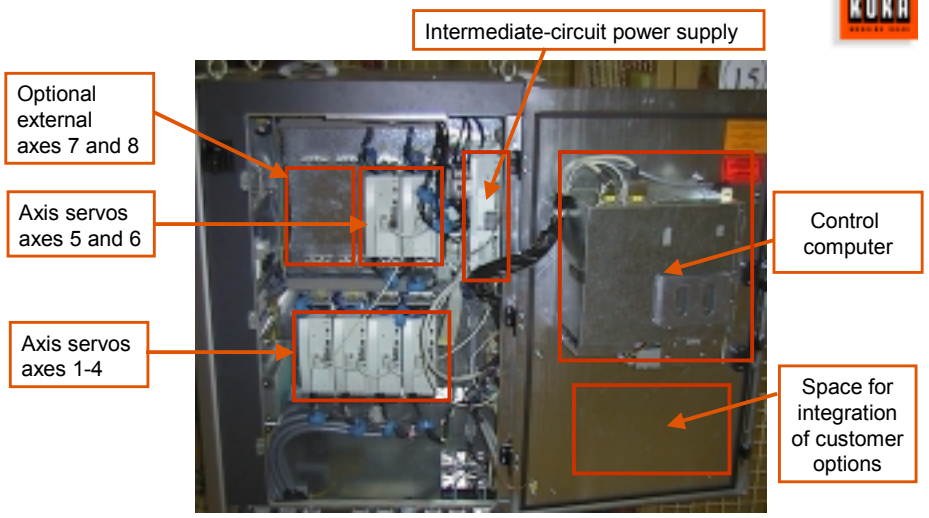
Centralized drive technology
Analog control
Limited expandability
Cramped

Decentralized drive technology
Digital control
Versatile expandability
Maintenance-friendly

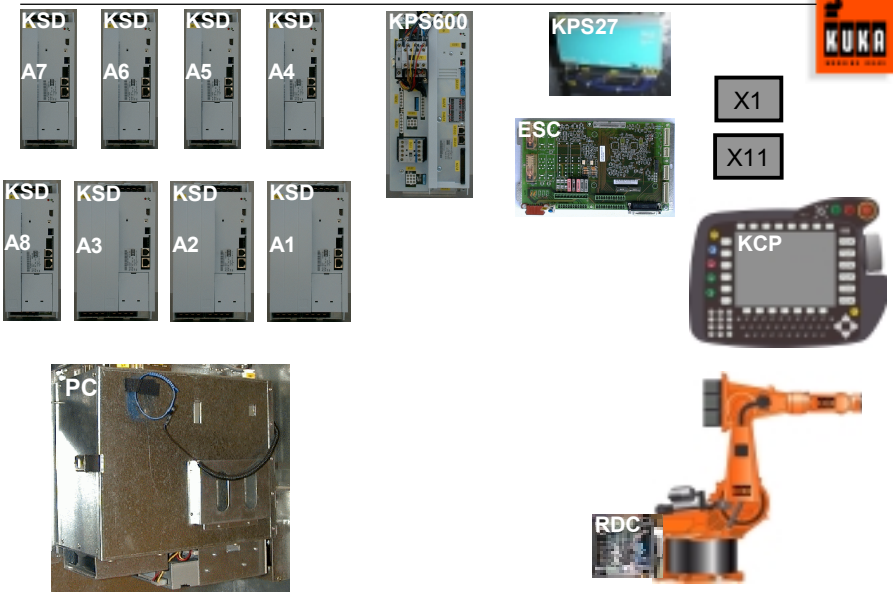
KR C2 drive technology system concept

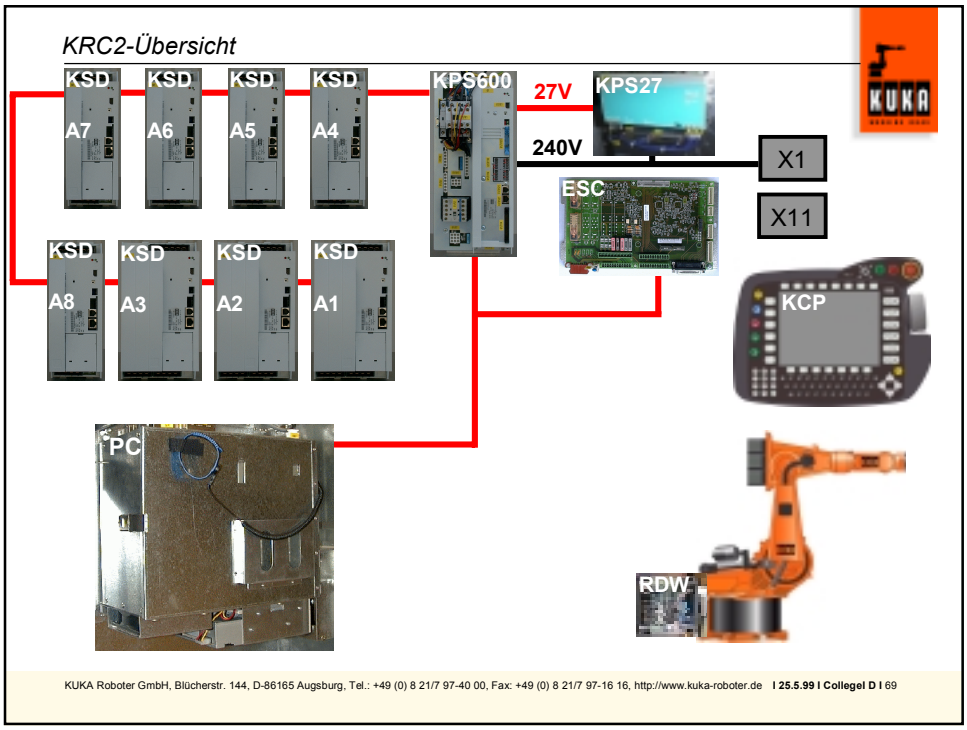


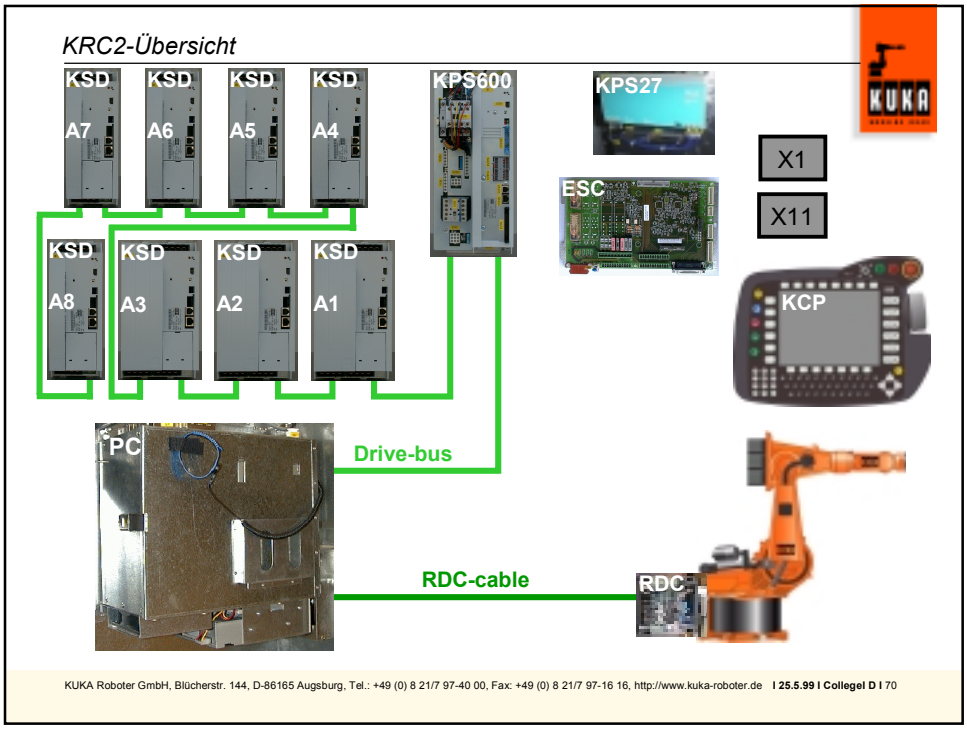
Layout of the control cabinet

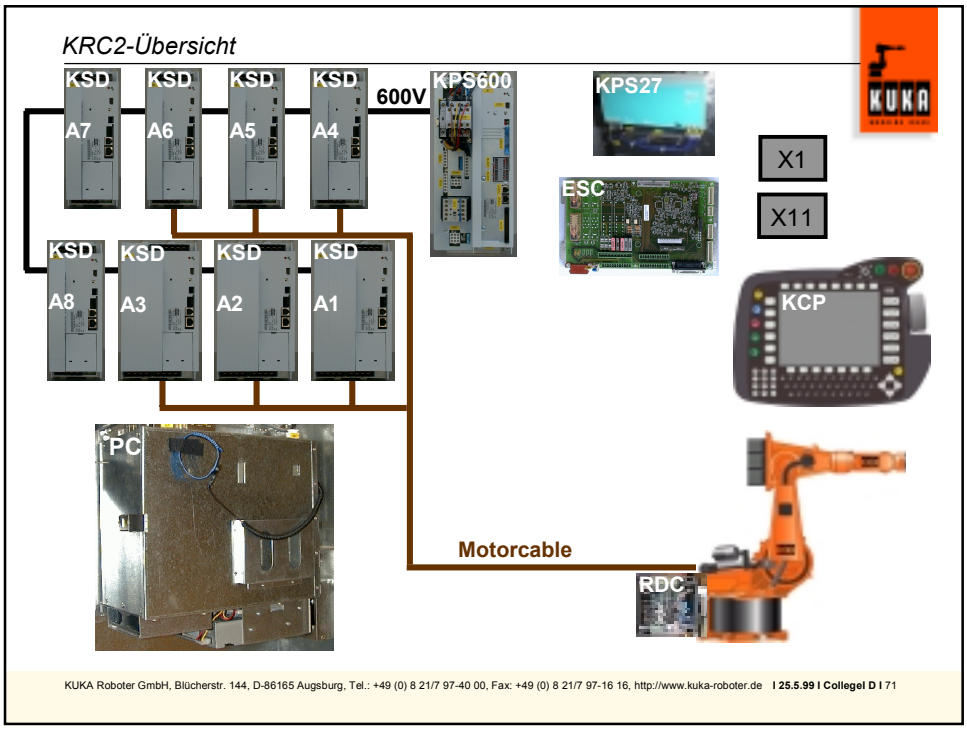


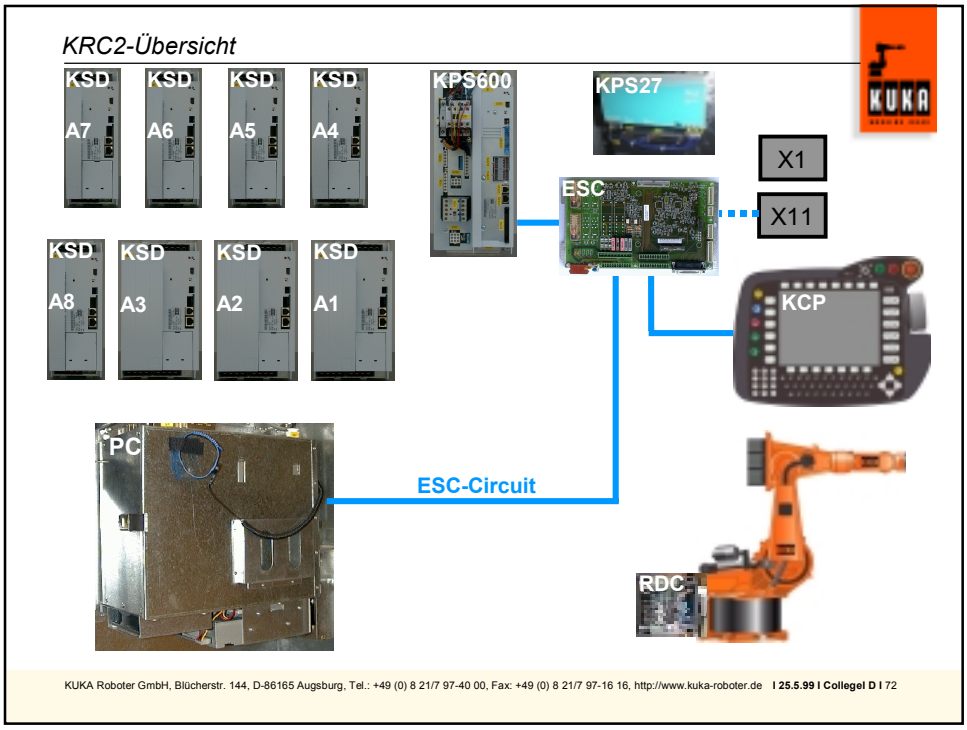
KRC2-Übersicht




KRC2-Übersicht
KSD A7
KSD A6
KSD A5
KSD A4
KPS600
27V
KPS27
240V
X1
X11
ESC
KSD A8
KSD A3
KSD A2
KSD A1
KCP
PC
RDW
KUKA Roboter GmbH, Blücherstr. 144, D-86165 Augsburg, Tel.: +49 (0) 8 21/7 97-40 00, Fax: +49 (0) 8 21/7 97-16 16, http://www.kuka-roboter.de I 25.5.99 I Collegel D I 69


KRC2-Übersicht
KSD A7
KSD A6
KSD A5
KSD A4
KPS600
KPS27
X1
X11
ESC
KSD A8
KSD A3
KSD A2
KSD A1
KCP
PC
Drive-bus
RDC-cable
RDC
KUKA Roboter GmbH, Blücherstr. 144, D-86165 Augsburg, Tel.: +49 (0) 8 21/7 97-40 00, Fax: +49 (0) 8 21/7 97-16 16, http://www.kuka-roboter.de I 25.5.99 I Collegel D I 70


KRC2-Übersicht
KSD A7
KSD A6
KSD A5
KSD A4
600V
KPS600
KPS27
X1
ESC
X11
KSD A8
KSD A3
KSD A2
KSD A1
KCP
PC
Motorcable
RDC
KUKA Roboter GmbH, Blücherstr. 144, D-86165 Augsburg, Tel.: +49 (0) 8 21/7 97-40 00, Fax: +49 (0) 8 21/7 97-16 16, http://www.kuka-roboter.de I 25.5.99 I Collegel D I 71


KRC2-Übersicht
KSD A7
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KSD A5
KSD A4
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X1
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X11
KSD A8
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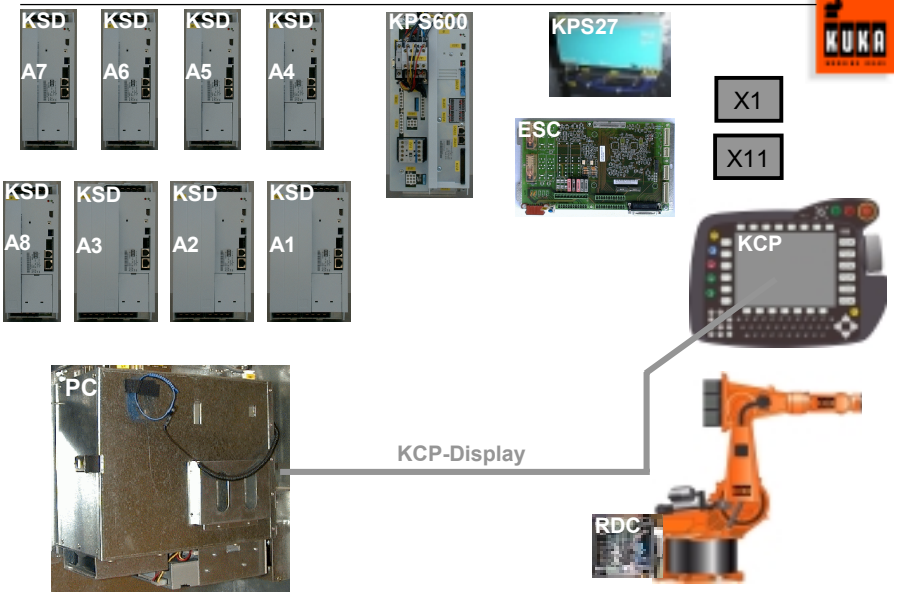
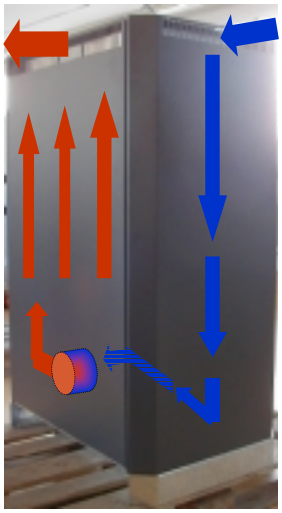
KSD A2
KSD A1
KCP
PC
ESC-Circuit
RDC
KUKA Roboter GmbH, Blücherstr. 144, D-86165 Augsburg, Tel.: +49 (0) 8 21/7 97-40 00, Fax: +49 (0) 8 21/7 97-16 16, http://www.kuka-roboter.de I 25.5.99 I Collegel D I 72

KRC2-Übersicht



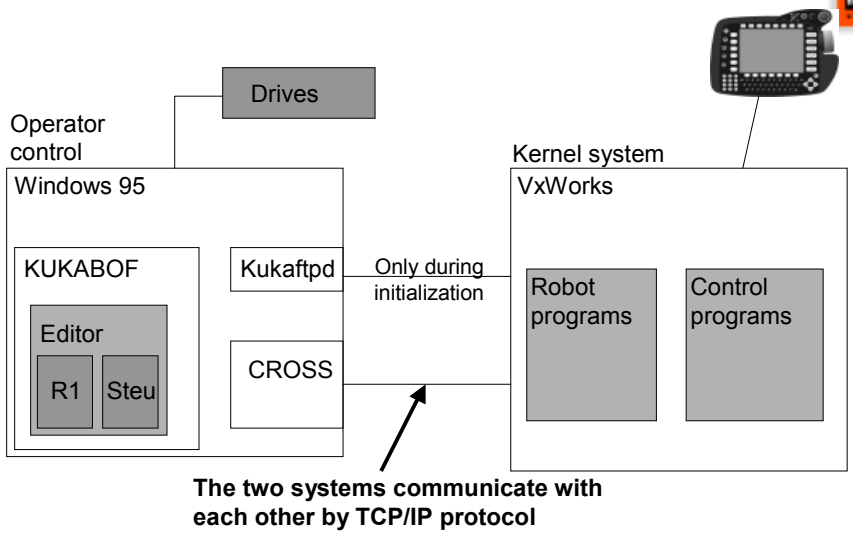
Control cabinet cooling

Make sure that the fan motors turn the right way



- Outer cooling:
  - New fan
  - New air inlet
  - Optional filter
- Dirt prevention:
  - Overpressure in the cabinet interior

Software concept

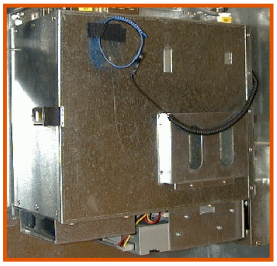


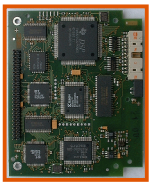
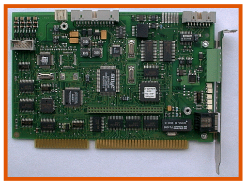
- Introduction
- Safety
- Technical Data
- Robot System
- **Computer Unit**
- Power Unit
- ESC Safety System
- Connecting Cables

Overview PC

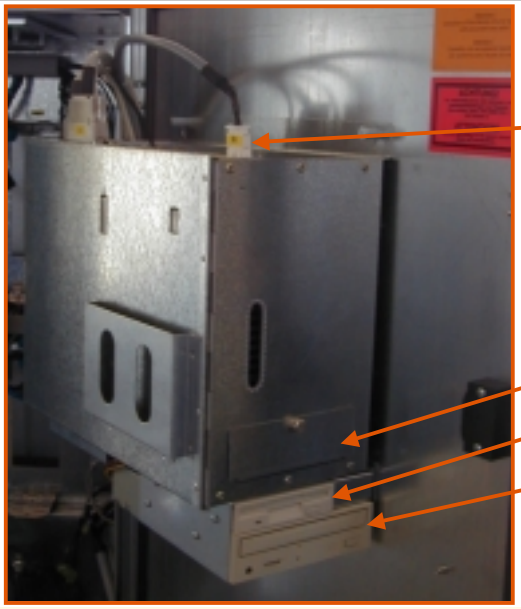




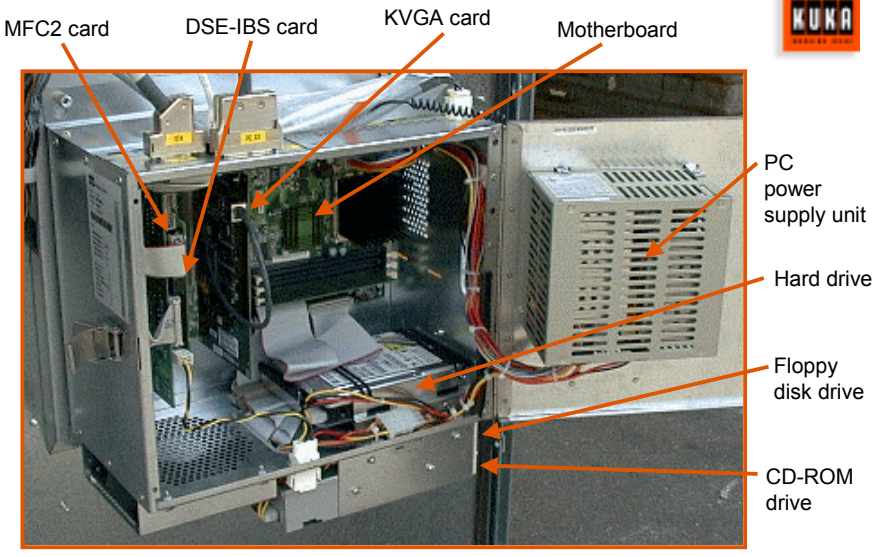


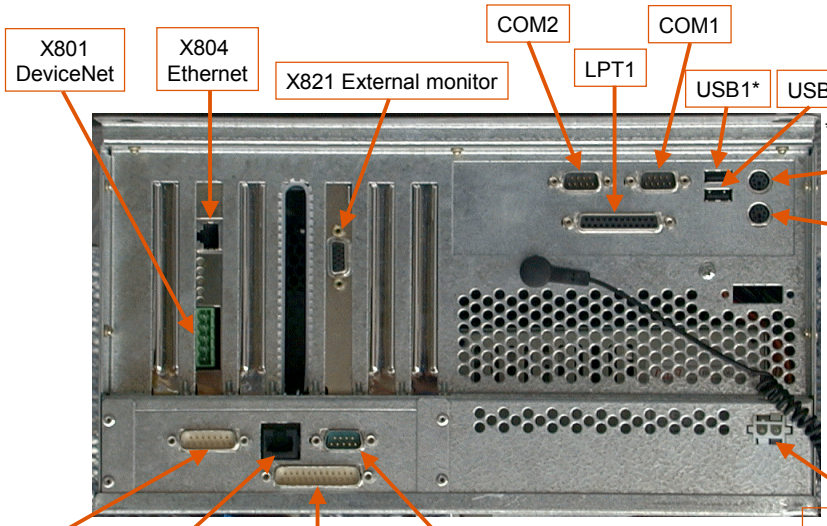

PC housing



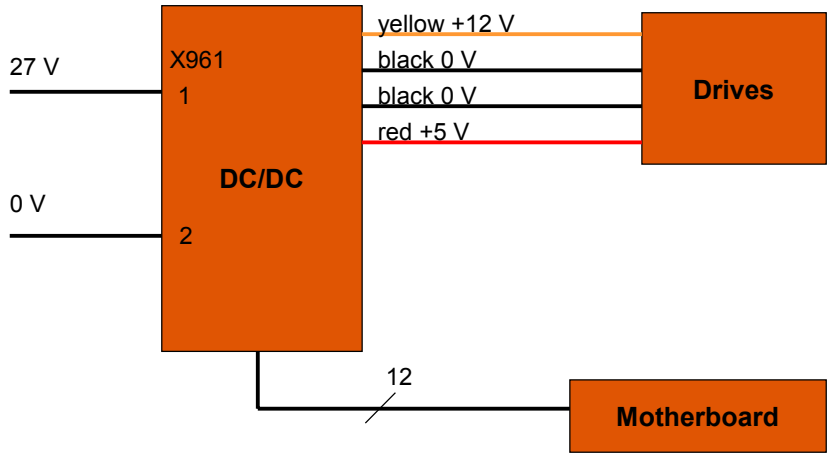
Rear view of the PC



Plan view of the PC

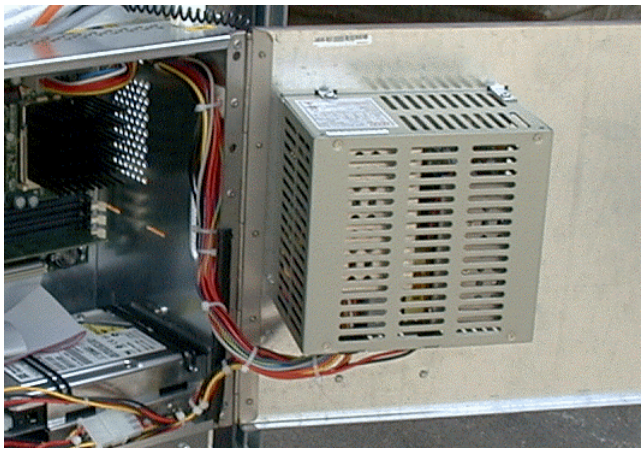


PC power supply unit

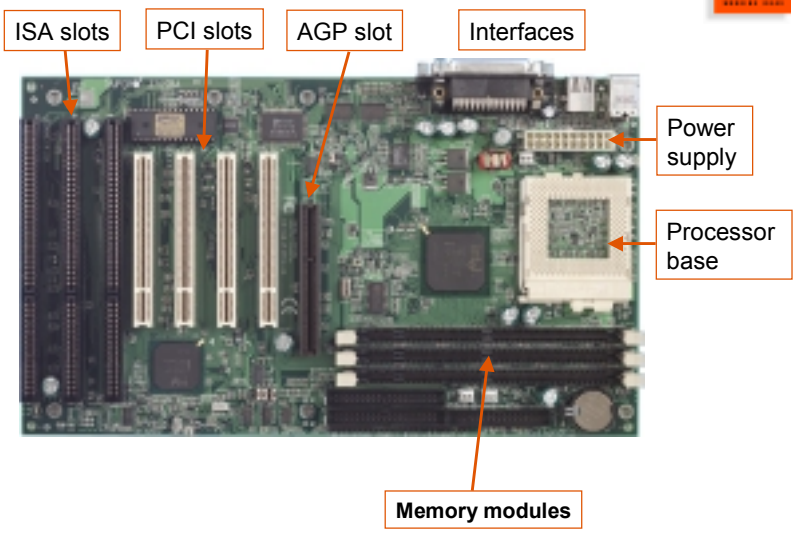


(red = +5 V, blue = -5 V, yellow = +12 V, brown = -12 V)

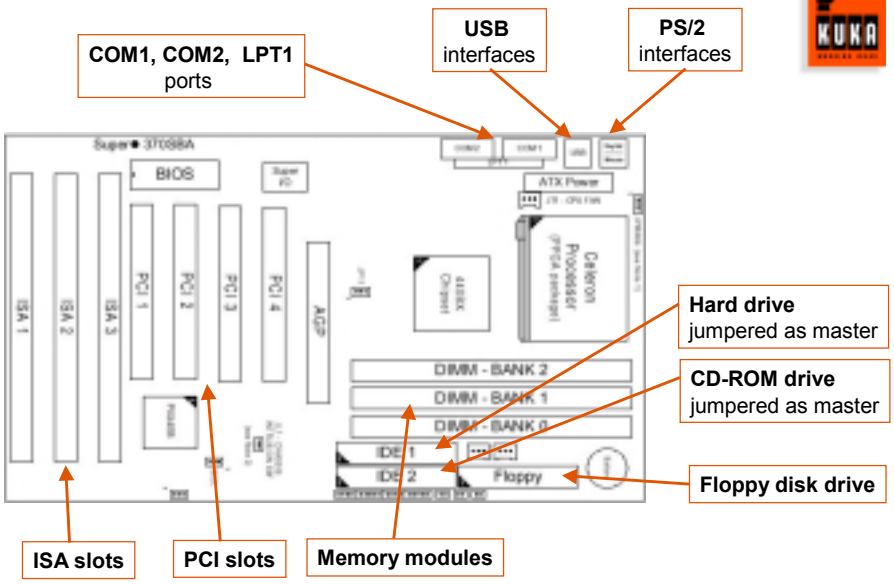
PC power supply unit



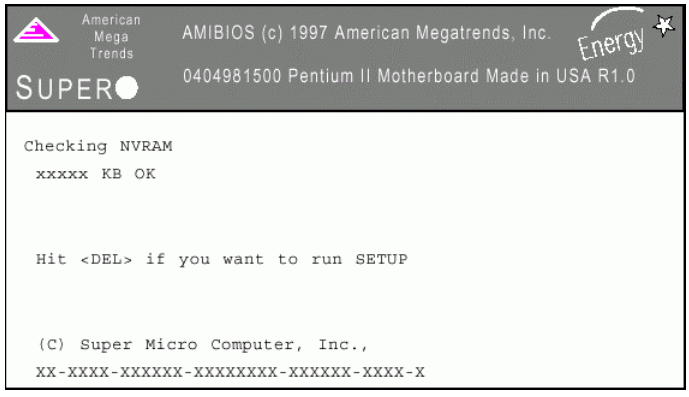
Motherboard SUPER 370SBA (SUPERMICRO)



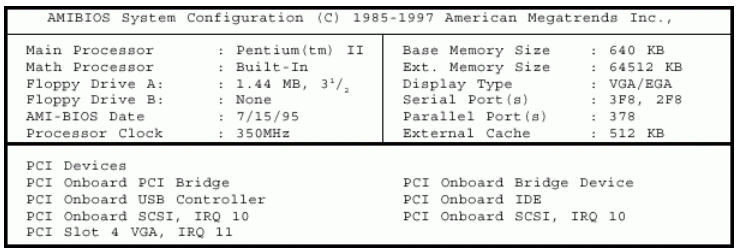
Motherboard interfaces



AMI BIOS



AMI BIOS



```
AMIBIOS System Configuration (C) 1985-1997 American Megatrends Inc.,

Main Processor       : Pentium(tm) II      Base Memory Size     : 640 KB
Math Processor       : Built-In            Ext. Memory Size     : 64512 KB
Floppy Drive A:      : 1.44 MB, 3 1/2      Display Type         : VGA/EGA
Floppy Drive B:      : None                Serial Port(s)       : 3F8, 2F8
AMI-BIOS Date        : 7/15/95             Parallel Port(s)     : 378
Processor Clock      : 350MHz              External Cache       : 512 KB

PCI Devices
PCI Onboard PCI Bridge                     PCI Onboard Bridge Device
PCI Onboard USB Controller                 PCI Onboard IDE
PCI Onboard SCSI, IRQ 10                   PCI Onboard SCSI, IRQ 10
PCI Slot 4 VGA, IRQ 11
```


BIOS structure

Menu structure in BIOS:

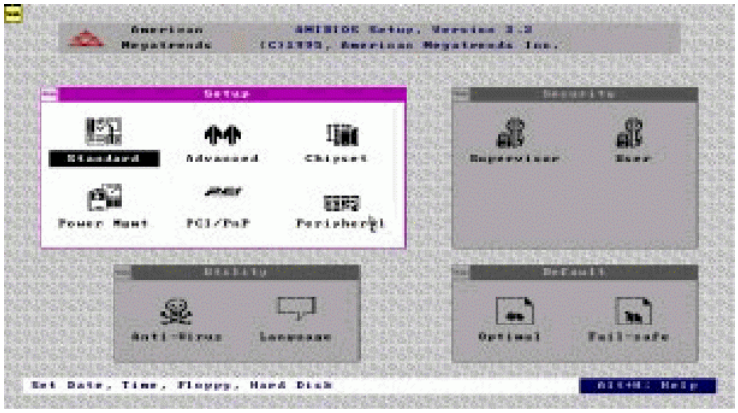
- -Setup
  - -Standard
  - -Advanced Setup
  - -Chipset
  - -Power Management
  - -PCI/PnP
  - -Peripheral
- -Security
  - -Supervisor
  - -User
- -Utility
  - -Anti-Virus
  - -Language
- - Default
  - -Optimal
  - -Fail-Safe

BIOS settings

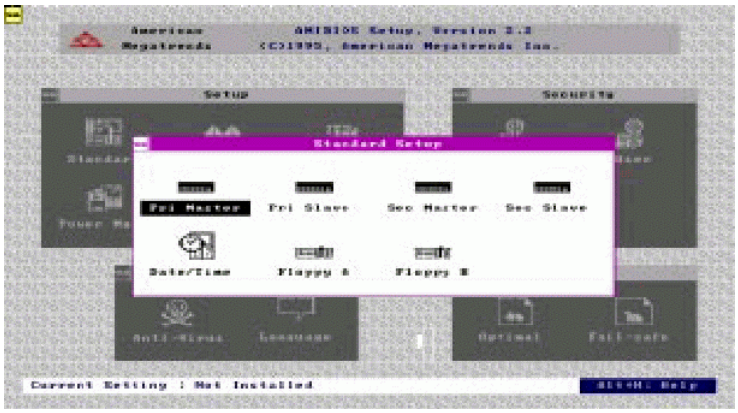
KUKA BIOS settings

-Standard
  -Date/Time
-Advanced Setup
  -Quick Boot: Enabled
  -1st Boot Device: 1st IDE-HDD
  -2nd Boot Device: Floppy
  -Initial Display Mode: Silent
-Chipset
  -USB Function: Disabled
  -Power Management
  -Power Management Mode: Disabled
-PCI/PnP
  -IRQ3: ISA/EISA
  -IRQ4: ISA/EISA
  -IRQ5: ISA/EISA
  -IRQ11: ISA/EISA
  -IRQ15 ISA/EISA
  -Default Primary Video: PCI
-Peripheral
  -Power loss control: Always ON
  -Power loss control: Always ON

AMI BIOS



AMI BIOS



Hard drive

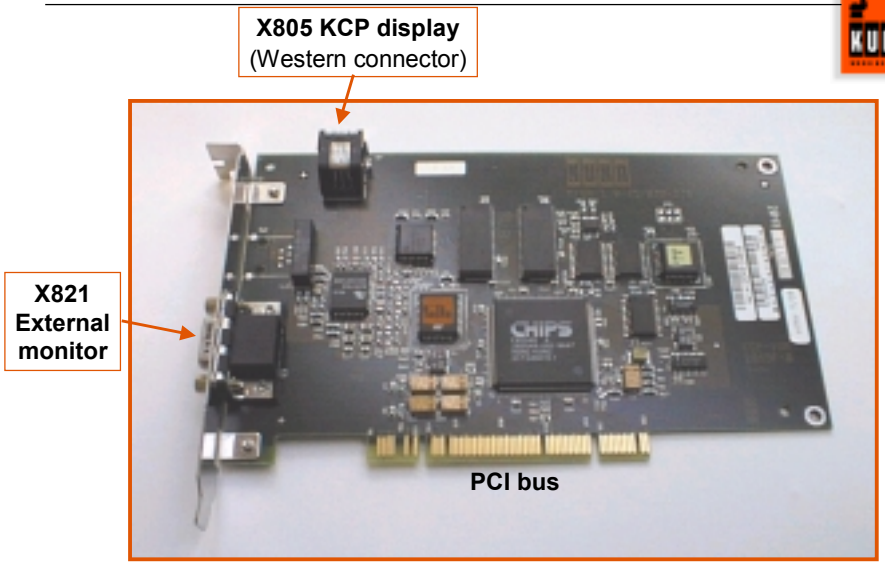
Hard drive types in the KR C2

- Western Digital, Caviar 64AA (6.4 GB)
- Western Digital, Caviar (10 GB)

Floppy disk drive

CD-ROM drive

KUKA VGA card



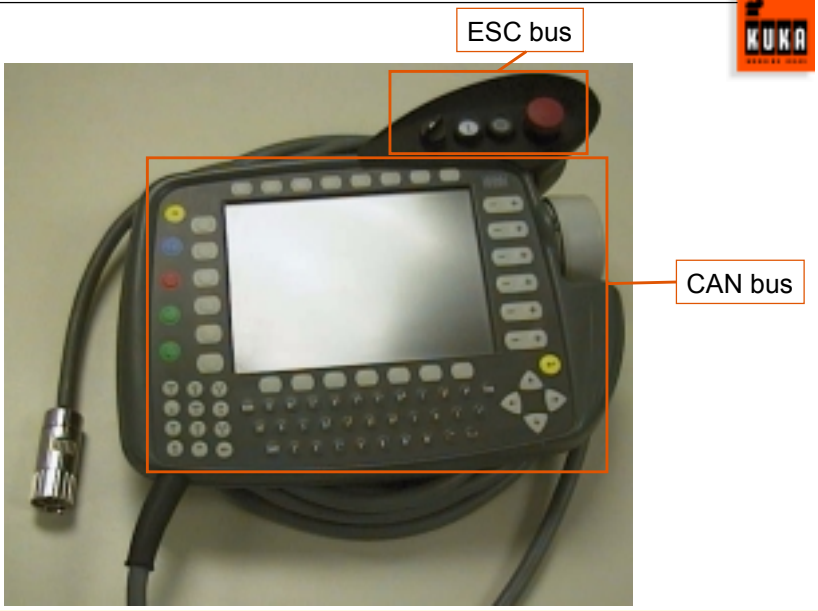
KUKA VGA card

KVGA card ratings

- Standard VGA card
- Connection for an LCD display
- Connection for an external VGA monitor
- Resolution: 640 x 480
- Maximum number of colors: 16 (old card) or 256 (new card)
- 1 MB graphics memory
- Screen output settings made via the Windows Control Panel (new card) or by activation of a *.COM file

There are 3 different screen output options:
- External monitor only (CT.COM)
- KCP mode only / default setting (FP.COM)
- KCP and external monitor (SM.COM)

Front view of the KUKA Control Panel (KCP2)

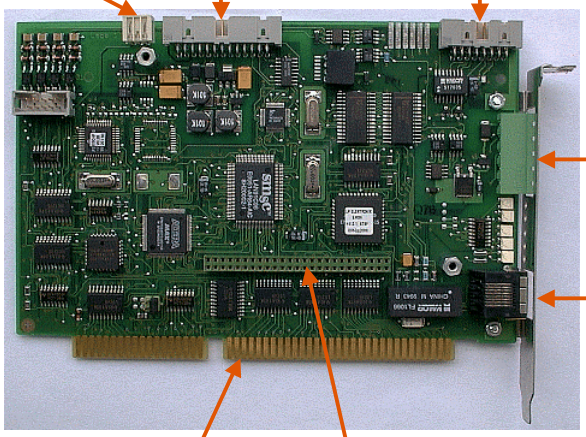


KUKA Control Panel

Components of the KCP

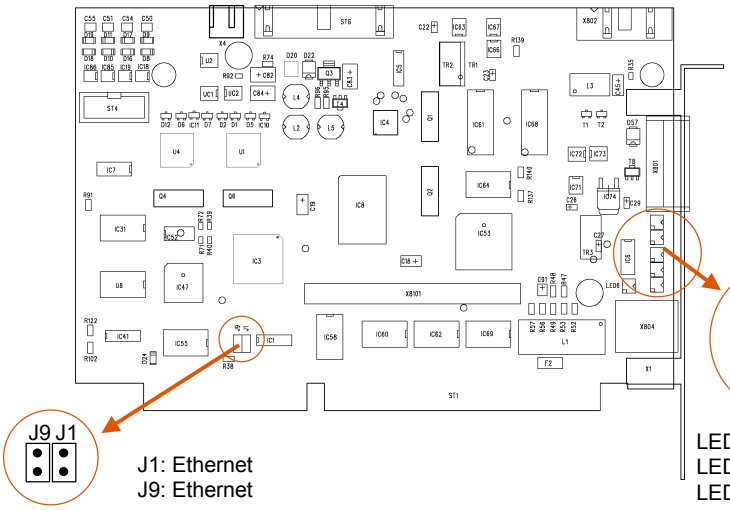
- Operator control elements via ESC safety bus (operating mode switch, EMERGENCY STOP, Drives ON/OFF, dual-channel, 3-step enabling switch)
- LCD color display in VGA mode (640 x 480, 256 colors)
- Keyboard as input unit (CAN bus)
- Function keys (CAN bus)
- Space Mouse for moving the robot as alternative to the traversing keys (CAN bus)

Multi-function card (MFC)



* Attachment Unit Interface (external network adapter)

Configuration of the MFC

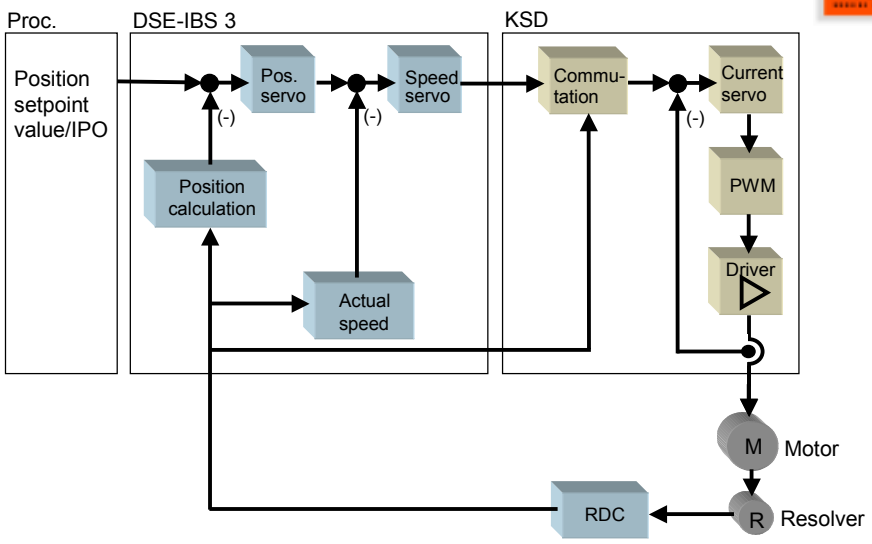


J1: Ethernet
J9: Ethernet

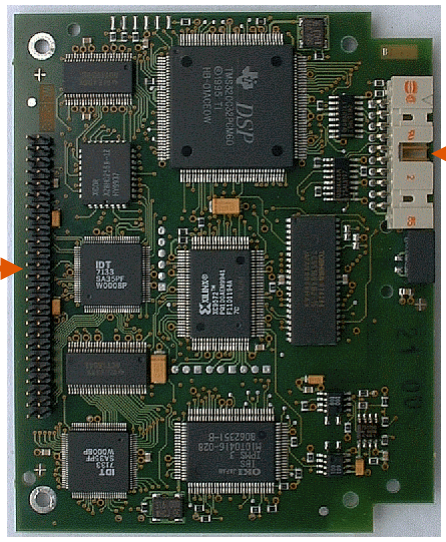
LED2: CAN bus
LED1: CAN bus
LED5: Ethernet
LED7: Ethernet
LED8: Ethernet

Performance features of the MFC

- Designed as ISA card
- System and user I/Os via CAN bus interface
- Ethernet connection for networking robot controllers
- DeviceNet/CAN bus connection
- Interface between the KCP and the PC
- Interface between the ESC and the PC
- Accommodation of max. two DSE-IBS cards (for max.12 robot axes)
- Generation of an NMI (non-maskable interrupt) for switching between Windows95 and VxWorks



Digital servo-electronics (DSE-IBS 3)



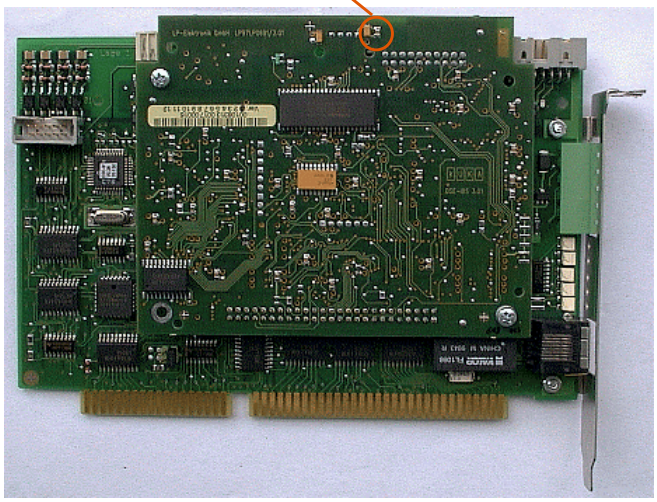
Description of the DSE-IBS 3

- A DSE-IBS 3 card takes over the drive control of up to 8 axes, thus reducing the workload of the main processor.

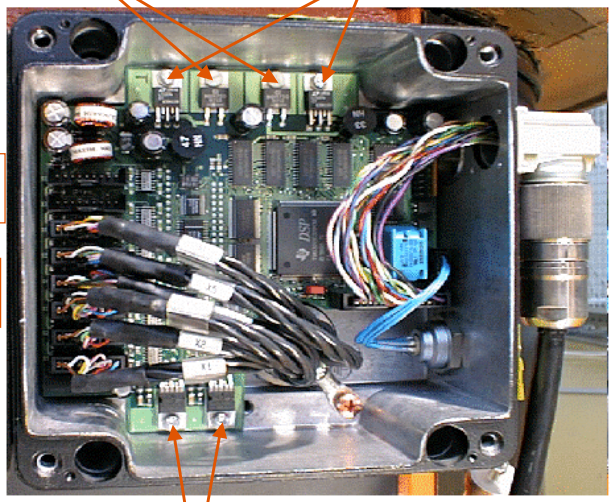
DSE-IBS 3 tasks

- Actual position sensing
- Position control
- Speed control
- Supplies current setpoints to the KSD

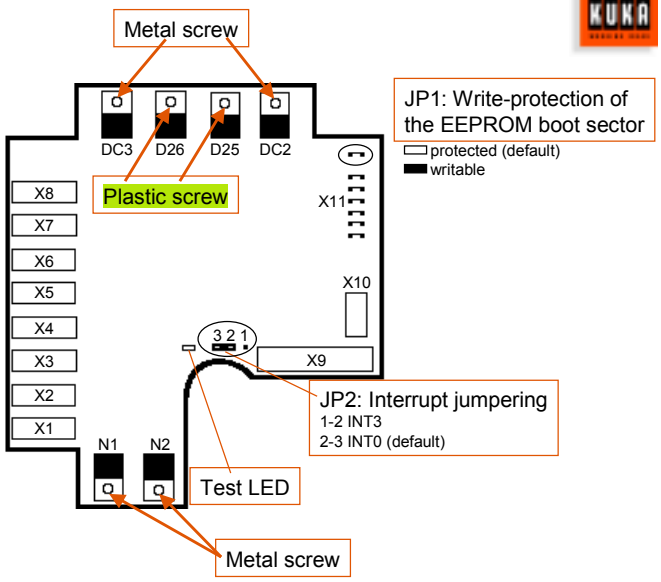
MFC with DSE



Resolver/digital converter (RDC)



Jumper settings on the RDC

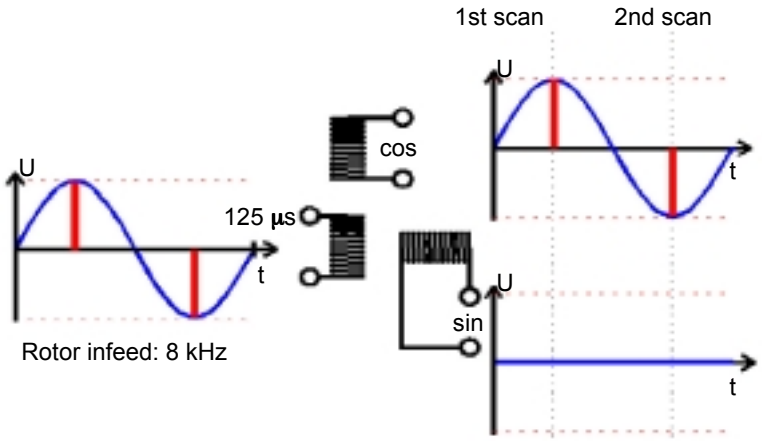


Resolver/digital converter (RDC)

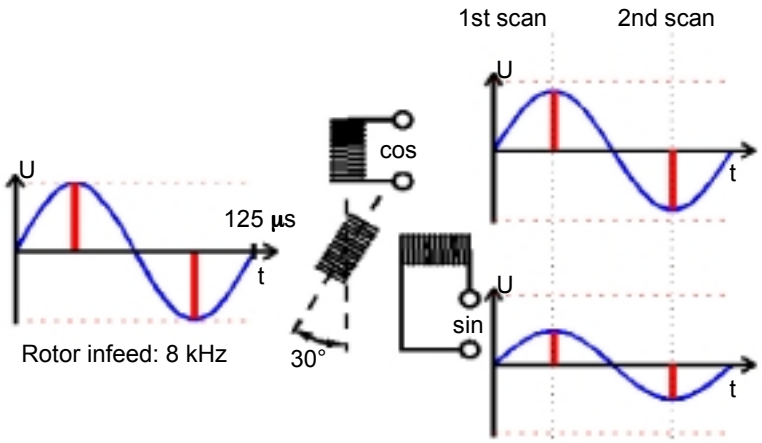
Description of the RDC

- Generation of all necessary operating voltages from the 27 V supply
- Resolver power infeed for 8 axes
- Isolated supply to 8 temperature sensors (KYT 84) in the motor windings
- R/D conversion of up to 8 axes (12-bit resolution)
- A/D conversion of 8 temperature sensors (12-bit resolution)
- Evaluation of 2 EMT channels (1 EMT)
- Open-circuit monitoring of the resolvers
- Motor temperature monitoring
- Communication with the DSEAT via an RS422 serial interface
- Backup of the following data on an EEPROM on deactivating the controller:
  - Operating hours meter ($ROBRUNTIME)
  - Absolute position in increments
  - Resolver position in increments
  - Adjustment data (offset, symmetry)

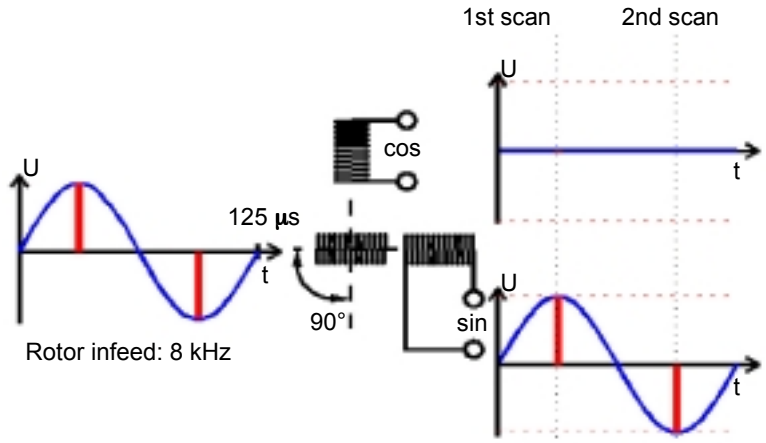
Functional principle – Resolver (1)



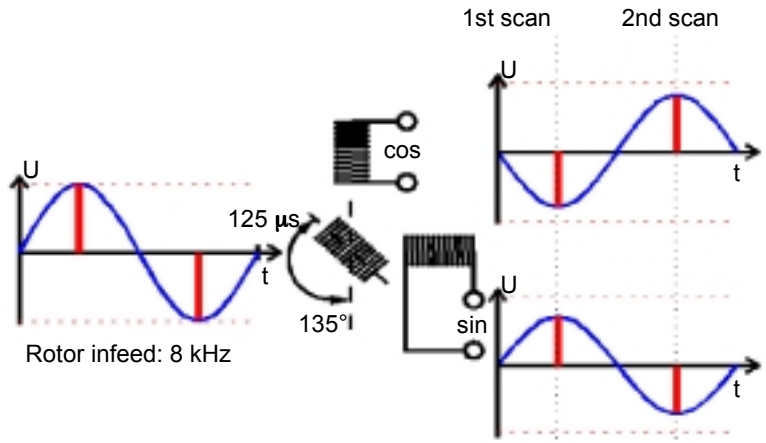
Functional principle – Resolver (2)



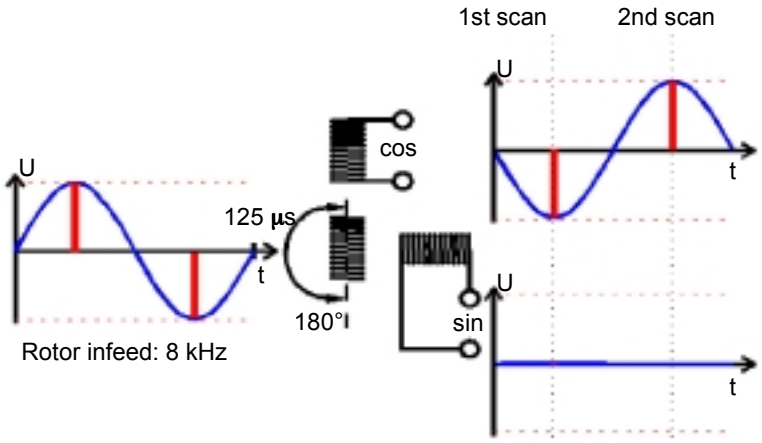
Functional principle – Resolver (3)



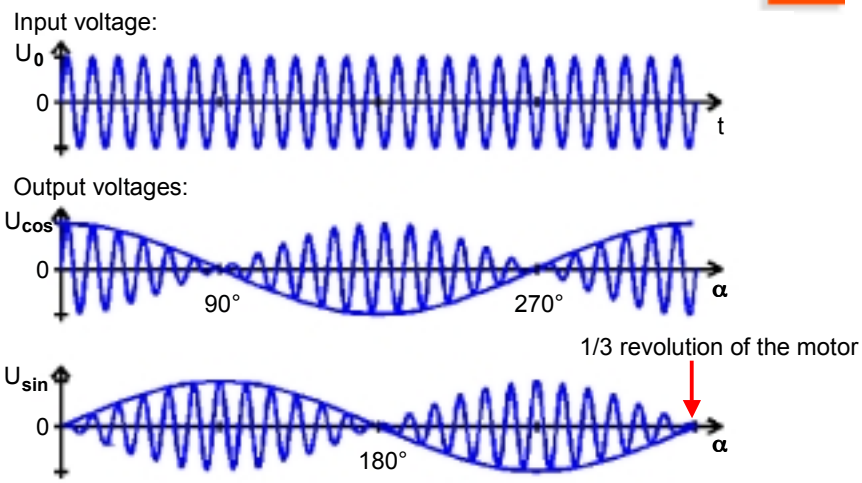
Functional principle – Resolver (4)



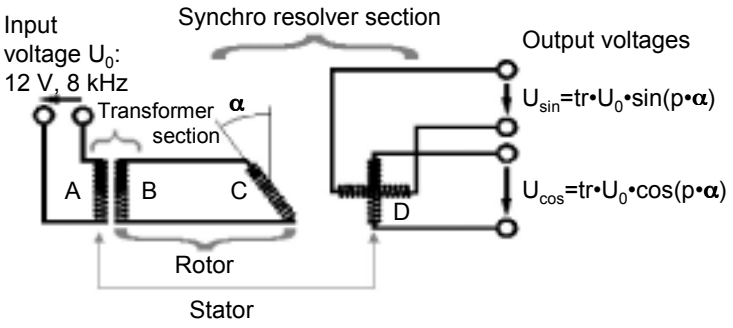
Functional principle – Resolver (5)



Functional principle – Resolver (6)



Functional principle – Resolver (7)

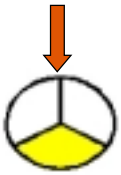


tr: transformation ratio
p: number of pairs of poles

The real resolver

3 pairs of poles → Absolutely accurate position control within a third of a revolution of the motor

(Exception:
motor type B,
4 pairs of poles)



Resolution with 12 bits
(4096 increments)

Power infeed
approx. 16 V_{pp} 8 kHz

incr./rev.= 3 • 4096 = 12288 incr.

electrostatic sensitive devices

- The module may only be exchanged with the control cabinet switched off and the intermediate circuit discharged. The connectors must also be unplugged.
- The module contains electrostatic sensitive devices (ESD). In order to protect the electronic components from being destroyed by electrostatic discharge, do not touch them with bare hands.

- Introduction
- Safety
- Technical Data
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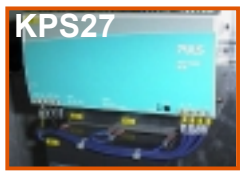
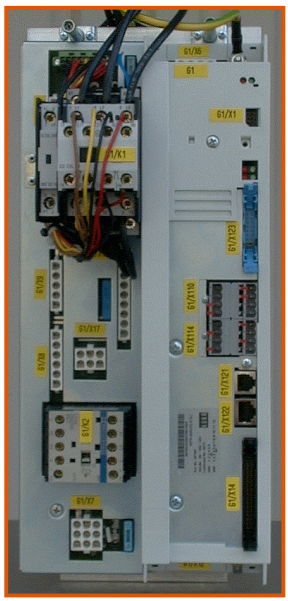
- Computer Unit
- **Power Unit**
- ESC Safety System
- Connecting Cables

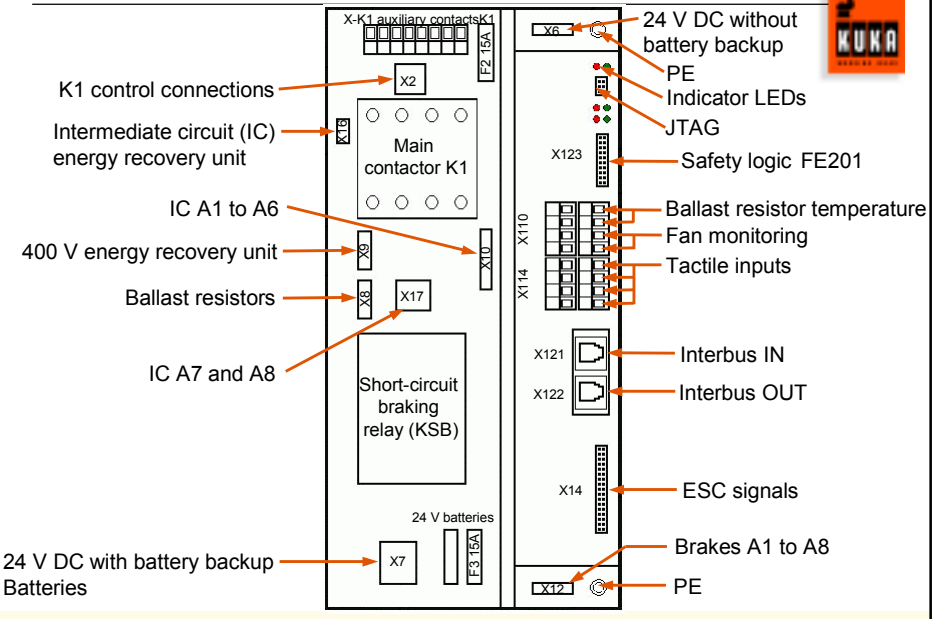
Overview Power unit



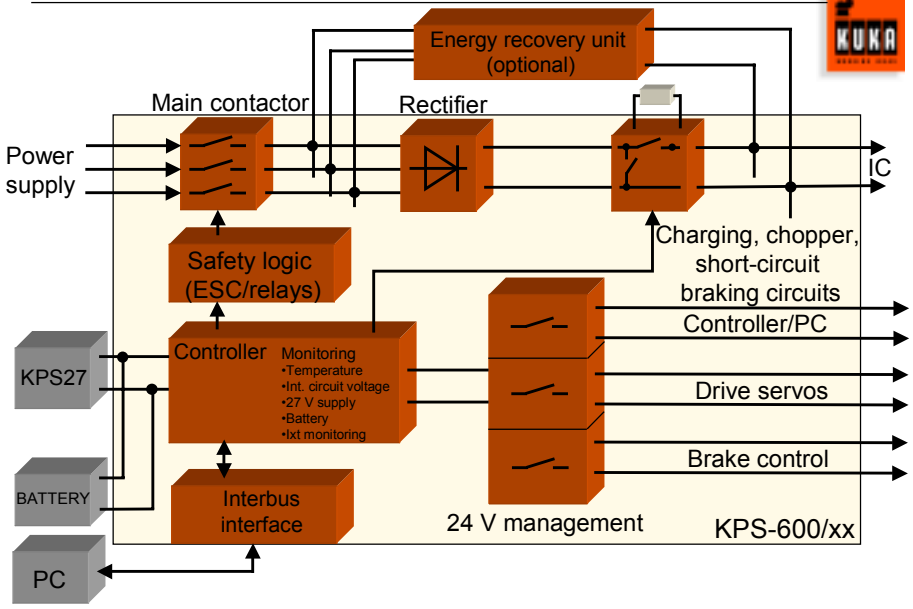
KUKA Power Supply KPS-600



Supply unit KPS-600



Block diagram of the KPS-600



Description of the KPS-600

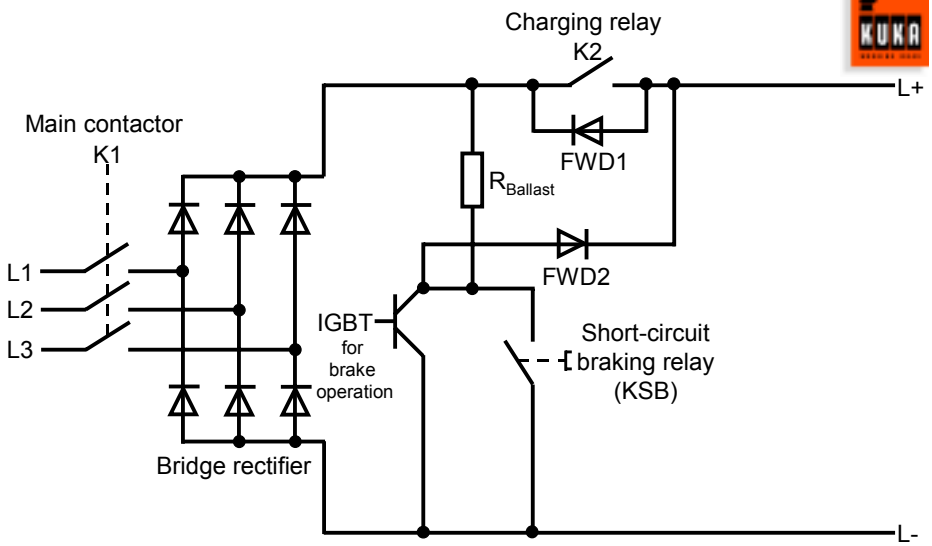
The KPS-600 incorporates:

- Mains contactor
- Power supply with starting circuit
- Ballast circuit
- Brake control (in common for all 6 robot axes and separate for 2 external axes)
- Interface to DSE-IBS and servo drive IBS
- Voltage distribution 24 V
- Battery circuit

The following signals are acquired:

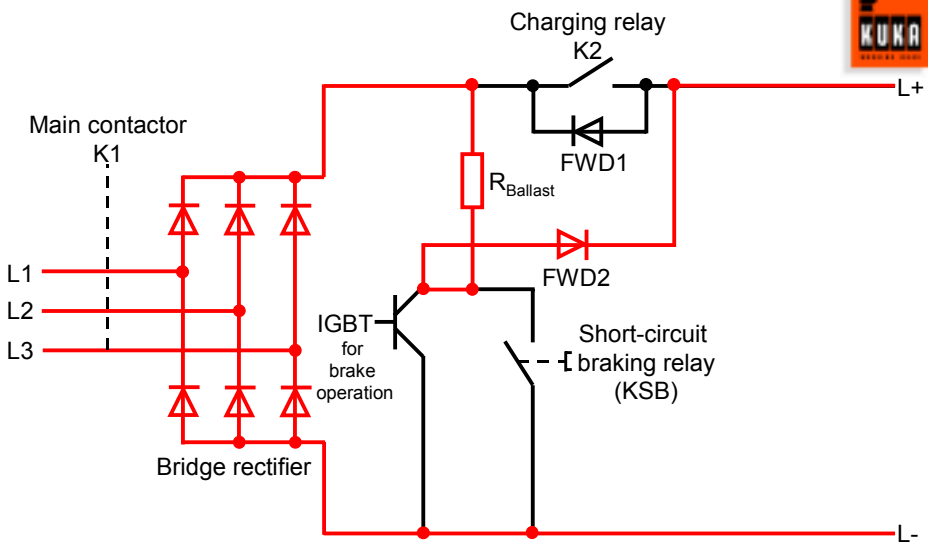
- Analog measured variables:
  - Heat sink temperature
  - Interior temperature
  - Ballast temperature
  - Intermediate circuit voltage
- Binary signals:
  - Robot periphery
  - Bimetal contacts
  - Control cabinet fans

Circuit schematic, intermediate circuit



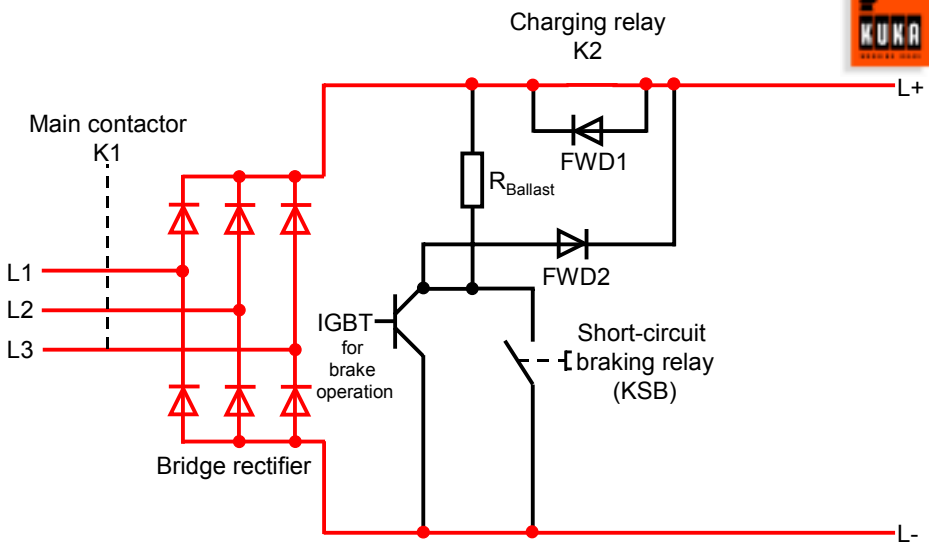
FWD: free-wheeling diode, L+/L-: intermediate circuit voltage

Charging the intermediate circuit capacitors via the ballast resistor



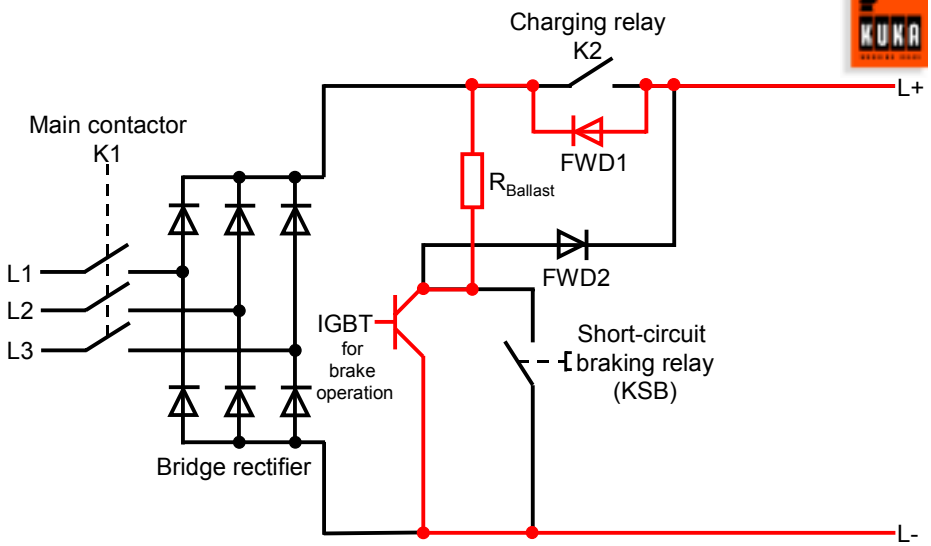
FWD: free-wheeling diode, L+/L-: intermediate circuit voltage

Operating state with intermediate circuit charged



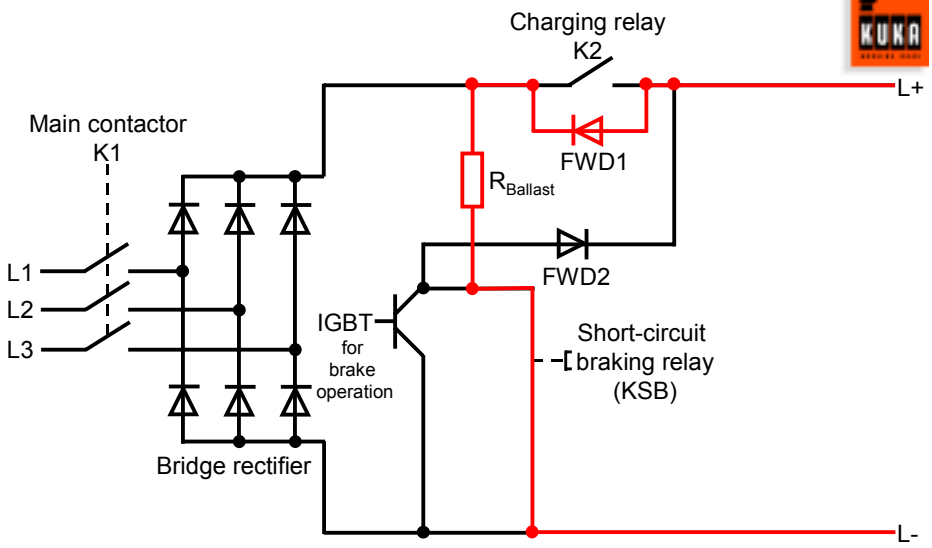
FWD: free-wheeling diode, L+/L-: intermediate circuit voltage

High-speed dischage



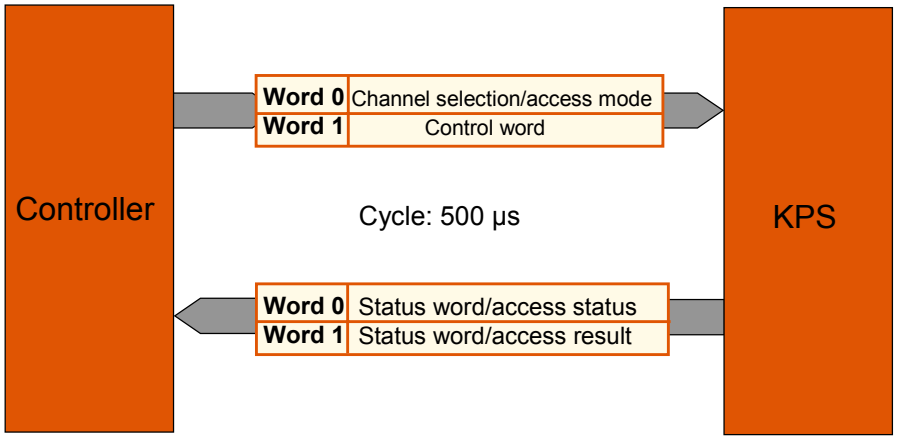
FWD: free-wheeling diode, L+/L-: intermediate circuit voltage

Short-circuit braking



FWD: free-wheeling diode, L+/L-: intermediate circuit voltage

Communication via Interbus



KPS-27 low-voltage power supply

KPS-27 low-voltage power supply

The KPS-27 is responsible for the 27 V power supply to the:

- Motor brakes
- Periphery
- Robot controller
- Servo controllers
- Batterys

Fuses

Motor protection F1:	KPS600/20
Motor protection F2:	KPS27
Motor protection F3:	Fans
Fuse F4:	Service socket / cabinet lighting 240 V (optional)
Motor protection F5:	External cooling unit (optional)

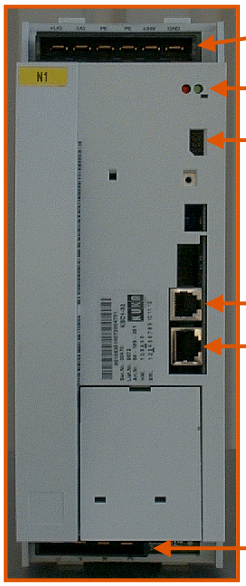
F11:	24 V supply KPS600 with battery backup (X7)
F12:	24 V supply KPS600 without battery backup (X6)
F13:	Cabinet lighting 24 V Fan monitoring K100
F14:	ESC power supply without battery backup
F15:	PC supply with battery backup
F16:	RDC supply with battery backup
F17:	ESC-CI board supply with battery backup
F18:	KSD supply with battery backup
F19:	Brake supply KPS600 (X12)
FG3:	Battery fuses

KUKA Servo Drive KSD

KSD1-08
KSD1-16
KSD1-32

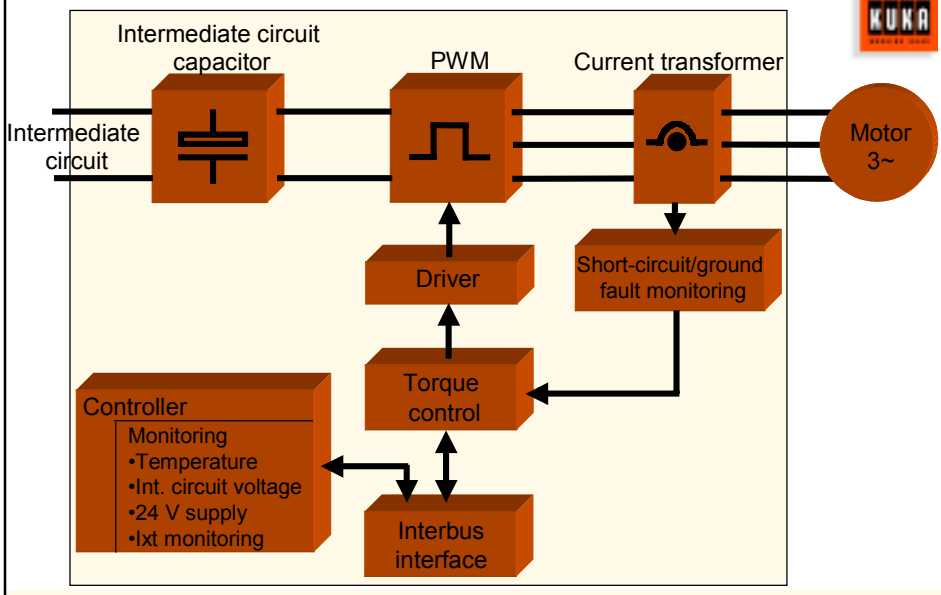
KSD1-48
KSD1-64

Connector allocation KSD1-08/16/32

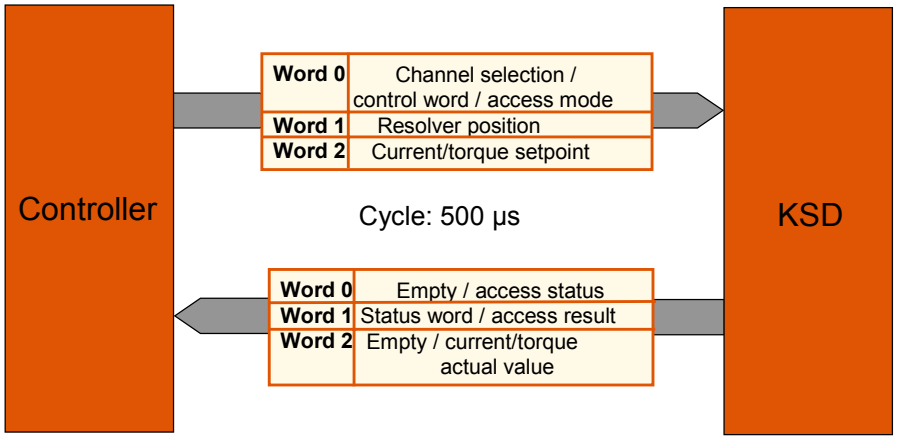


Connector allocation KSD1-48/64

Block diagram KSD1-xx

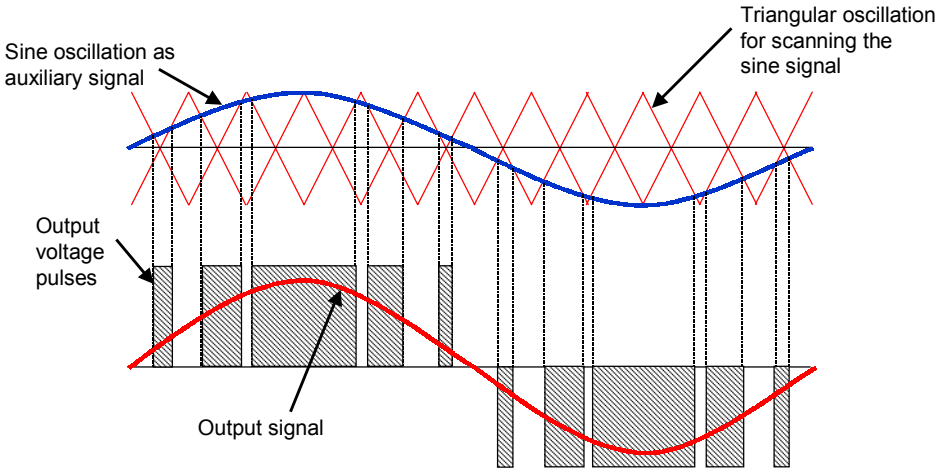


Communication via Interbus



Principle of pulse width modulation

Pulse width modulation makes low-loss power control possible. The power is controlled by means of the pulse width and not by the amplitude.



Description of the KUKA Servo Drive

Function of the servo drive modules

- Field-oriented current or torque control
- Monitoring of all drive functions and drive hardware
- 4 kHz / 8 kHz PWM frequency

Power classes

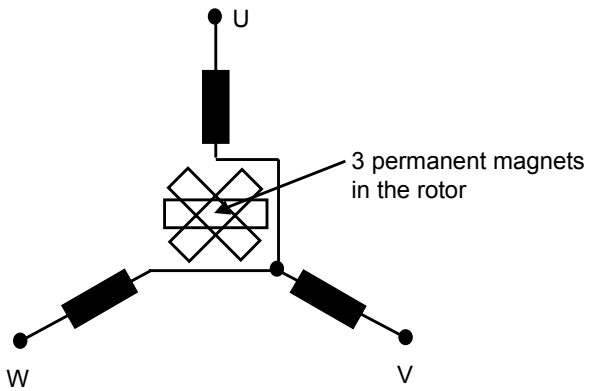
Drive servo	KSD1-08	KSD1-16	KSD1-32	KSD1-48	KSD1-64
Int. circuit voltage	0 - 770 V				
Rated current	4 A	8 A	16 A	17 A	20 A
Max. output current	8 A	16 A	32 A	48 A	64 A
Dimensions WxHxD	88 x 240 x 180 mm			132 x 240 x 180 mm	

Assignment of KSD types to robot models

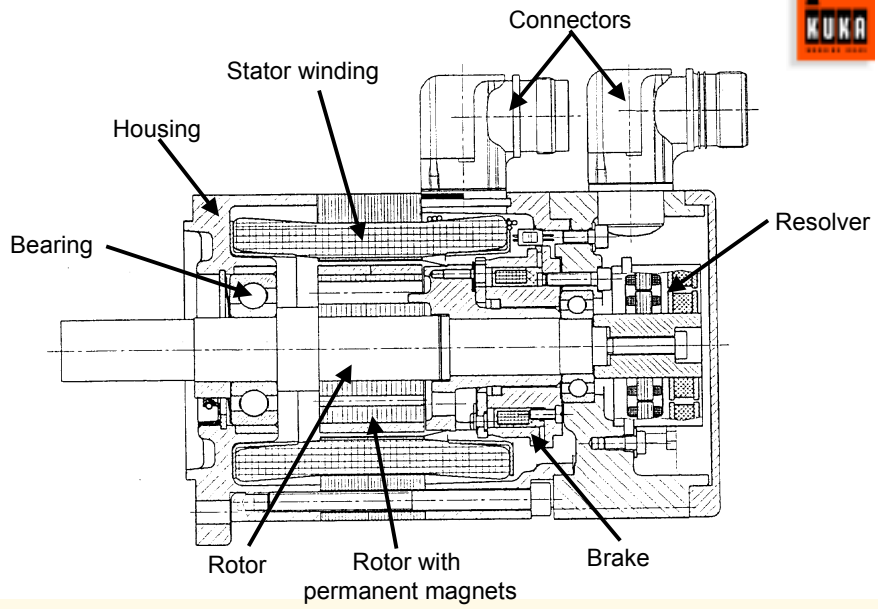
Robot model	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
KR6/2 / KR15/2	KSD1-16	KSD1-16	KSD1-8	KSD1-8	KSD1-8	KSD1-8
KR30/2	KSD1-32	KSD1-32	KSD1-16	KSD1-8	KSD1-8	KSD1-8
KR30 L15/2	KSD1-48	KSD1-48	KSD1-32	KSD1-8	KSD1-8	KSD1-8
KR45/2	KSD1-32	KSD1-48	KSD1-16	KSD1-8	KSD1-8	KSD1-8
KR125/2	KSD1-32	KSD1-32	KSD1-32	KSD1-16	KSD1-16	KSD1-16
KR125/2 w	KSD1-64	KSD1-64	KSD1-32	KSD1-16	KSD1-16	KSD1-16
KR150/2	KSD1-32	KSD1-32	KSD1-32	KSD1-16	KSD1-16	KSD1-16
KR200	KSD1-32	KSD1-32	KSD1-32	KSD1-16	KSD1-16	KSD1-16
KR350	KSD1-64	KSD1-64	KSD1-64	KSD1-32	KSD1-32	KSD1-32
KR60 P/2 KR100 P/2	KSD1-64	KSD1-64	KSD1-64	---	KSD1-32	KSD1-32
KR100 PA/2 KR160 PA/2	KSD1-64	KSD1-64	KSD1-48	KSD1-32	KSD1-32	KSD1-32

Servomotor

Principle: three-phase synchronous motor

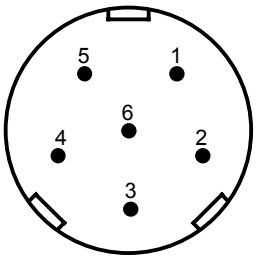


Structure of a servomotor

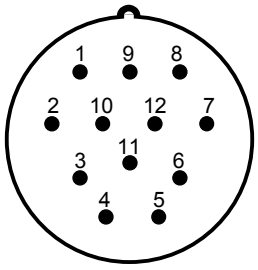


Pin assignment on motor

Power connector on motor



Resolver connector on motor



Assignment of motor types to KR models (600 V technology)

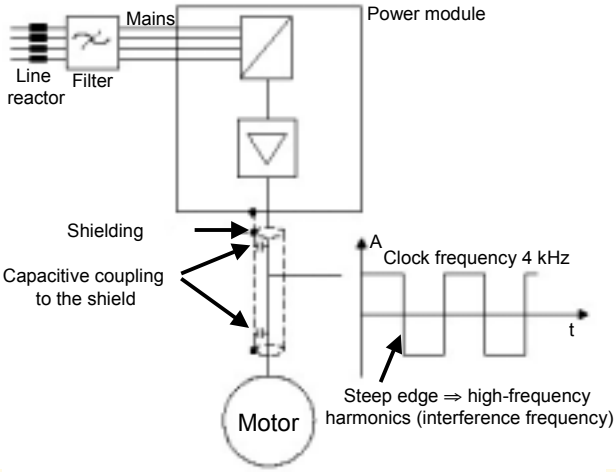
Robot model	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6
KR 6/1, KR15/1	KK53Y	KK53Y	KK4EY	1FK6032	1FK6032	1FK6032
KR 6/2, KR15/2	1FK6081	1FK6081	KK4EY	1FK6032	1FK6032	1FK6032
KR30	1FK6100	1FK6100	1FK6081	KK4EY	KK4EY	KK4EY
KR45	1FK6100	KK65Y	1FK6081	KK4EY	KK4EY	KK4EY
KR30 L15	KK65Y	KK65Y	KK55Y	KK4EY	KK4EY	KK4EY
KR60 P, KR100 P	KK67Y	KK67Y	KK65Y	KK55Y	KK55Y	KK55Y
KR100 PA	KK67Y	KK67Y	KK65Y	-	KK55Y	KK55Y
KR125 S	1FK6100	1FK6100	1FK6100	KK53Y	KK53Y	KK53Y
KR125 K	KK65Y	KK65Y	KK65Y	KK53Y	KK53Y	KK53Y
KR125 W	KK67Y	KK67Y	1FK6100	KK53Y	KK53Y	KK53Y
KR125, KR150, KR200	1FK6100	1FK6100	1FK6100	KK53Y	KK53Y	KK53Y
KR350	KK67Y	KK67Y	KK65Y	KK55Y	KK55Y	KK55Y
KL250	KK53Y					
KL1500	1FK6100					

Motors of the KUKA robots

Type	Rated power in kW	Rated torque in Nm	Rated speed in min^{-1}	Resolver poles
KK67Y	8.2	26.0	3000	6
KK65Y	6.6	21.0	3000	6
1FK6100	3.8	12.0	3000	8
1FK6081	3.5	11.0	3000	6
KK53Y	2.8	9.0	3000	6
KK55Y	3.8	12.0	3000	6
KK4EY	0.78	2.5	3000	6
1FK6032	0.5	0.8	6000	6

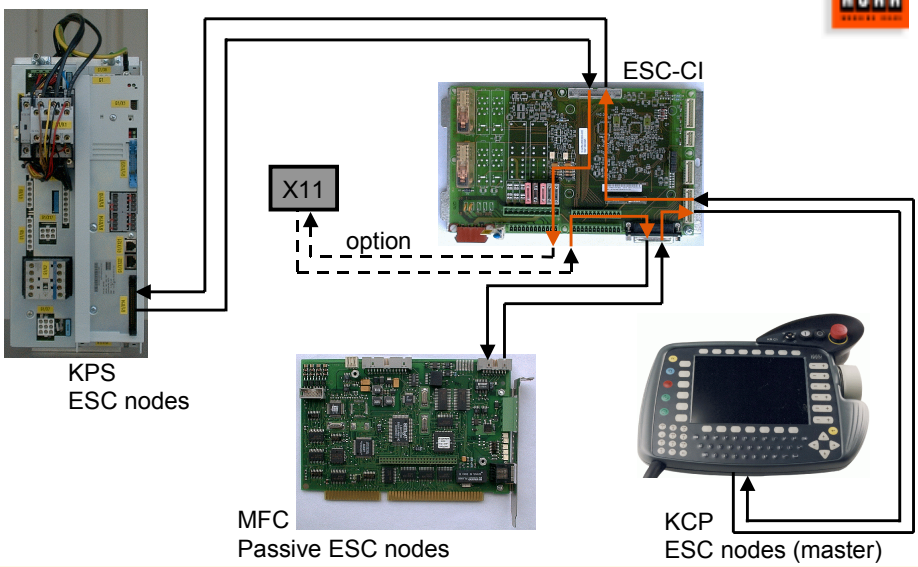
Mains filter

The principal function of mains filters (interference suppressor filters) is to allow the useful signal (in this case the 50 Hz supply voltage) to pass through as cleanly as possible and to effectively suppress noise signals (higher-frequency, conducted interference) primarily from the power module (low-pass character).



- Introduction
- Safety
- Technical Data
- Robot System
- Computer Unit
- Power Unit
- **ESC Safety System**
- Connecting Cables

ESC nodes



Failsafe inputs

NA - Local Emergency Stop
ENA - System Emergency Stop
ZS1 - Enabling input
ZS2 - Enabling, panic position
BA - Operating mode (Test/Auto)
QE - Qualifying input (loading stations, range limitation)
BS - Operator safety input (safety gate)

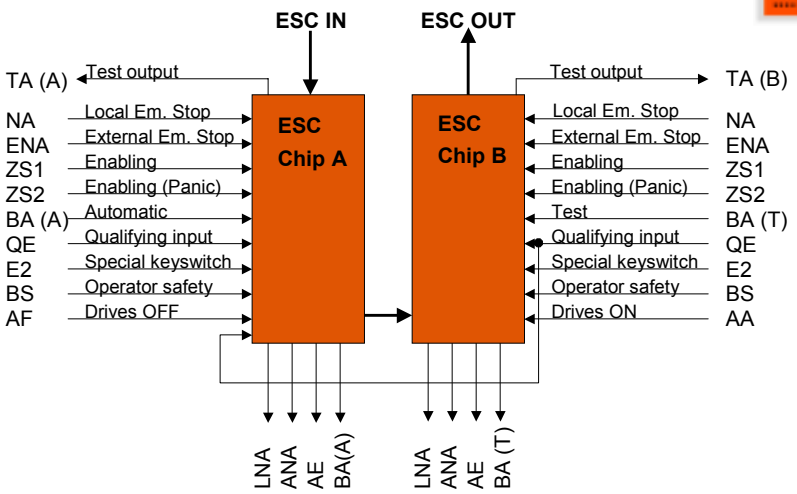
Controller inputs

AA - Drives ON
AF - Drives OFF

Failsafe outputs

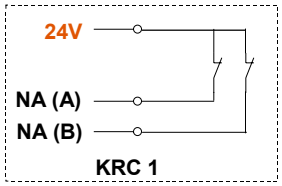
AE - Drives ON (drive contactor)
LNA - Local Emergency Stop
ANA - System Emergency Stop
BA - Operating mode (Test/Auto)

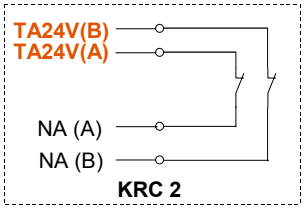
ESC node structure



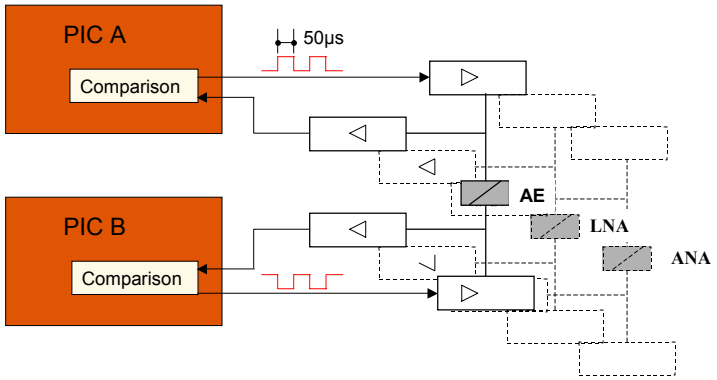
Comparison of KR C1 with KR C2

Wiring of dual-channel inputs as exemplified by Emergency Stop



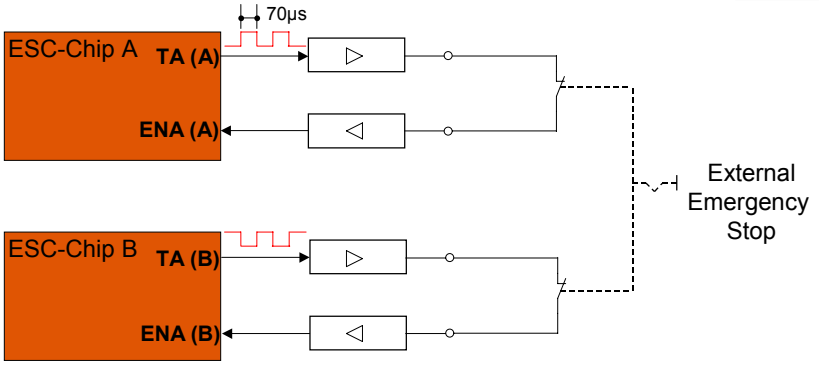


Software & hardware safety functions



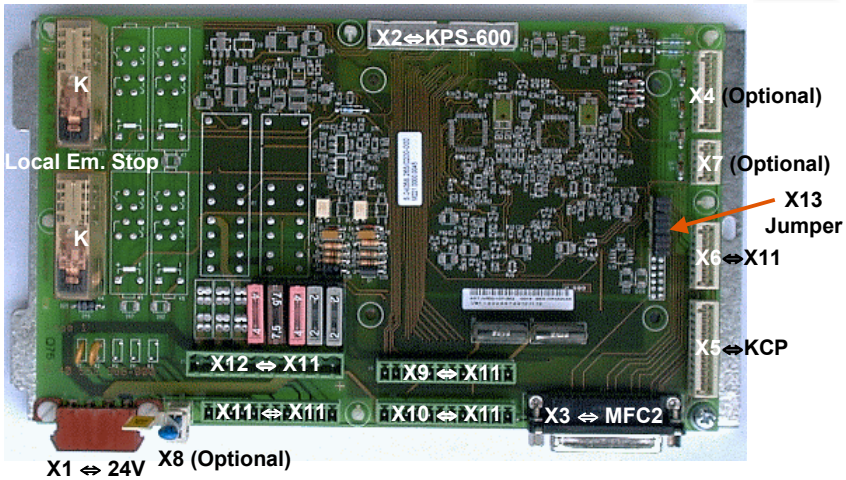
Each PIC sends a bit pattern to its outputs and compares the return signals with this pattern

Eelctronic Safety Circuit



ENA=Anlagen Not-Aus

ESC board



ESC board interface assignments

X1:	⇔ Power supply with/without battery backup
X2:	⇔ KPS
X3:	⇔ MFC
X4:	⇔ Stationary operating mode switch (optional)
X5:	⇔ KCP
X6:	⇔ X11 (ESC safety circuit)
X7:	⇔ CAN user I/O to peripheral interface (optional)
X8:	⇔ X11 (external drives OFF)
X9:	⇔ X11 (test outputs A/B, external Emergency Stop)
X10:	⇔ X11 (inputs: drives ON, enabling, safeguard, test outputs)
X11:	⇔ X11 (outputs: operating modes, external Emergency Stop, internal Emergency Stop)
X12:	⇔ X11 (outputs: drives ON, 24V control voltage)
X13:	⇔ Jumper/interface to other safety bus systems

Fuses G30	
F1-A:	2A ESC
F1-B:	2A ESC
F1-C:	7.5A Drives ON
F1-D:	4A Drives ON
F1-E:	2A Drives ON
F1-F:	7.5A Periphery
F1-G:	4A Periphery
F1-H:	4A Periphery

Dropout delay

KUKA standard:	Dropout delay 1 s for Emergency Stop in Automatic mode for operator safety violation in Automatic mode
GM:	Dropout delay 1 s for Emergency Stop in Automatic and Test modes for operator safety violation in Automatic mode
VW:	Dropout delay 1 s for Emergency Stop in Automatic mode for operator safety violation in Automatic mode E2 keyswitch activated

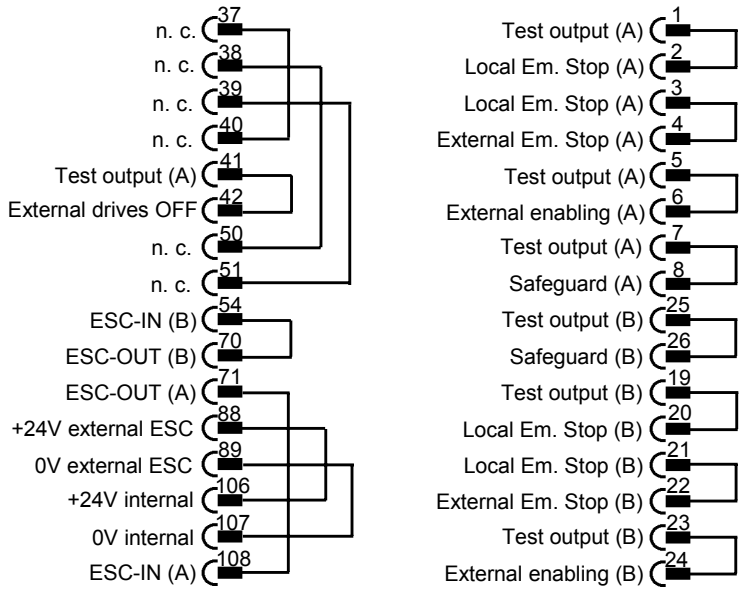
Braking reactions of the KR C2

	TEST (T1 or T2)	AUTO or AUTOEXT
Emergency Stop	Path-oriented braking	Path-maintaining braking
Enabling sw. released	Path-oriented braking	---
Safety gate opened	---	Path-maintaining braking
Drives OFF	Path-oriented braking	
Mode change	Path-oriented braking	
Encoder error (DSE-RDC connection broken)	Short-circuit braking	
Move enable	Ramp-down braking	
Stop key	Ramp-down braking	

Braking reactions of the KR C2

Technical term	Reaction of drives	Intermediate circuit	Short-circuit braking relays	Brakes	Software
Short-circuit braking	Switched off immediately	High-speed discharge	Applied immediately	Applied immediately	---
Path-maintaining braking	Only switched off after 1 s hardware delay	Remains charged for 1 s, then high-speed discharge	Remain open for 1 s, then applied	Applied after 1 s	In this time the controller brakes the robot on the path using a steeper stop ramp.
Path-oriented braking	Switched off immediately	Discharged; high-speed discharge if U_{IC} < 50 V	Applied if U_{IC} < 50 V	Applied immediately	The controller attempts to brake the robot on the path with the remaining inter-mediate circuit voltage. When the intermediate circuit voltage is no longer sufficient, short-circuit braking is activated.
Ramp-down braking	Remain ON	Remains charged	Remain open	Remain open	Normal ramp which is also used for normal acceleration and deceleration at a point

Jumper plug X11



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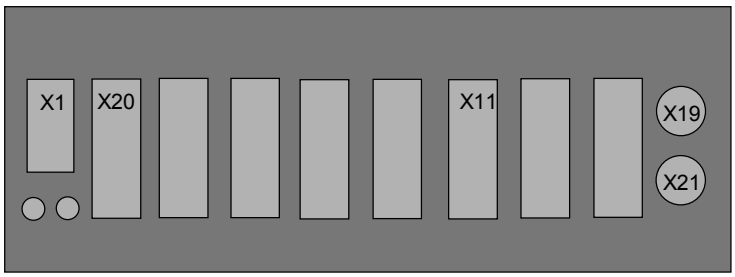
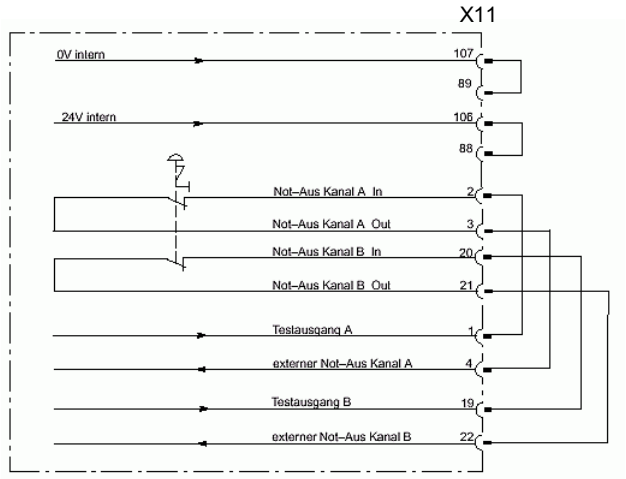
- *Software Installation*
- *Maintenance / Repair*
- *Diagnostic Software*
- *Fault Analysis*

Connector panel

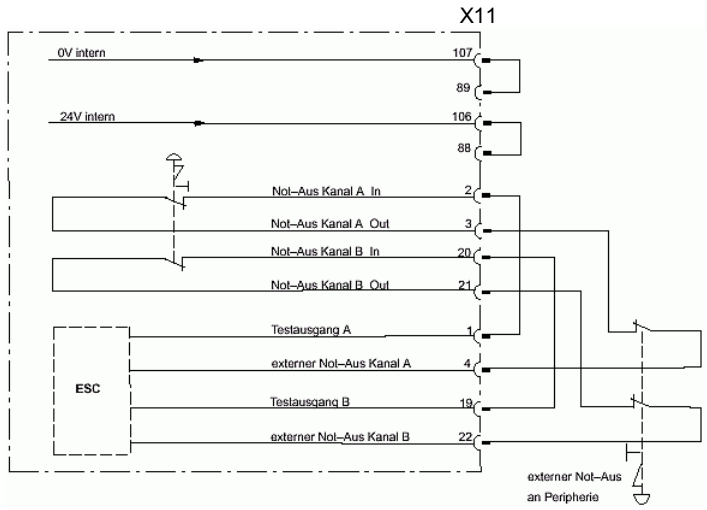


X1: Mains connection
X19: KCP connector
X20: Motor connectors A1 to A6
X21: Data cable connectors A1 to A8

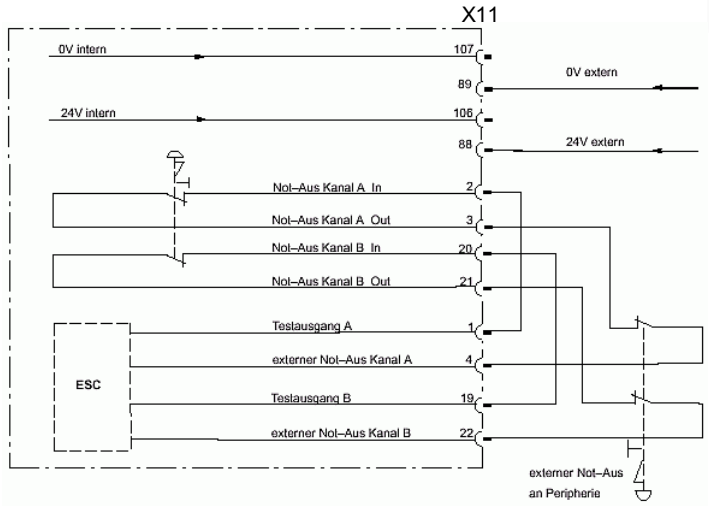
Emergency Stop circuit for one robot without periphery



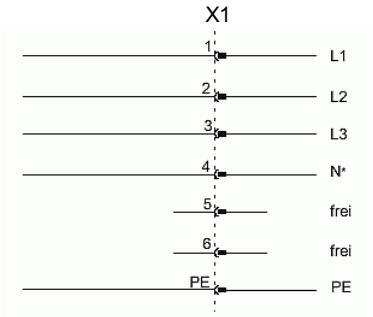
Emergency Stop circuit for one robot with periphery

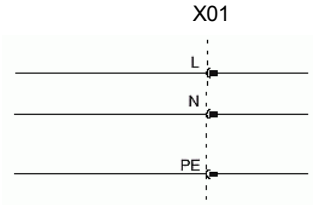


Emergency Stop circuit for one robot with external power supply and periphery

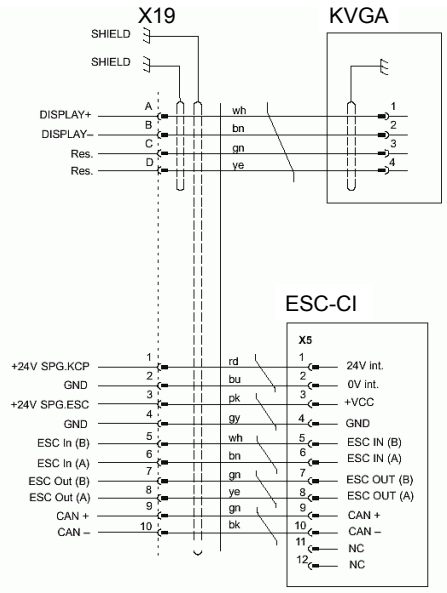


Power supply connection X1, service socket X01

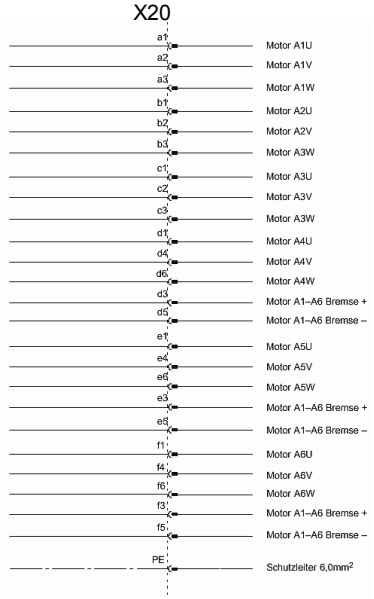




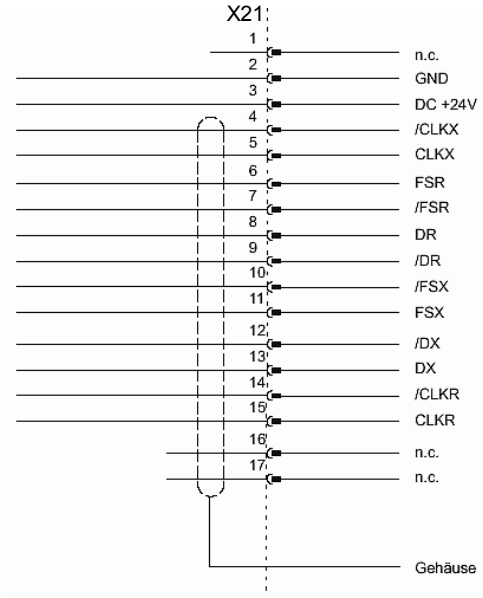
KCP connector X19



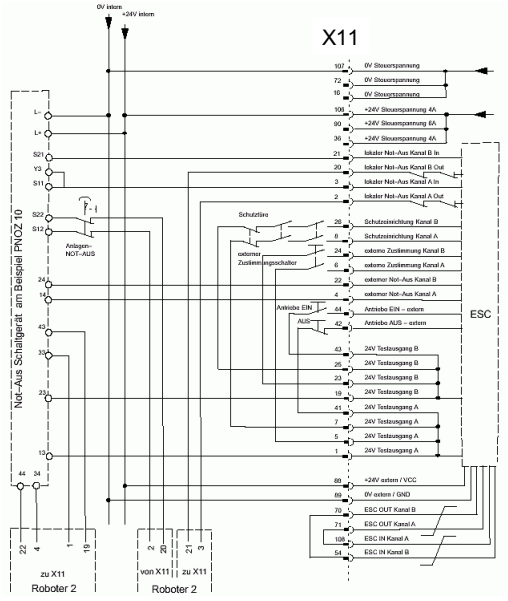
Motor connectors X20, axes 1 to 6



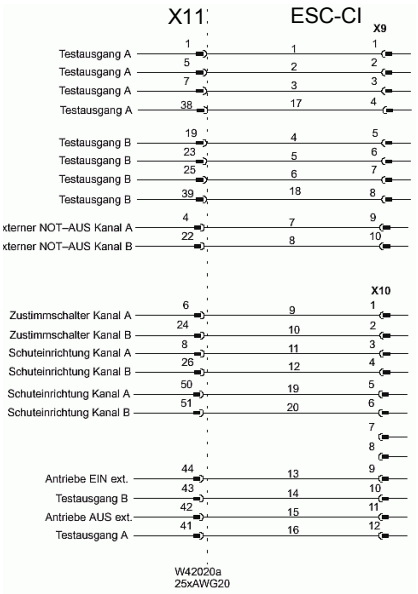
Data cable X21, axes 1 to 8



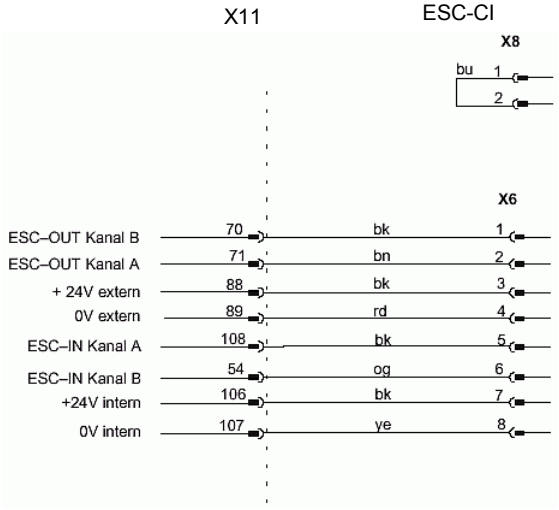
Peripheral connector X11 (optional)



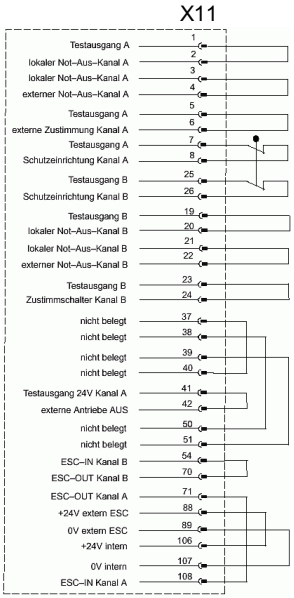
Connection between connector X11 and ESC-CI (part 1)



Connection between connector X11 and ESC-CI (part 2)



Jumper plugs for stand-alone operation X11



- *Periphery*
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- *Software Installation*
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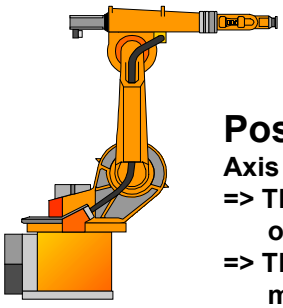
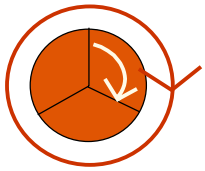
- *Diagnostic Software*
- *Fault Analysis*

Why mastering is carried out ?





Position recording via resolver:

Axis positions are saved on a cyclically absolute basis.
=> The resolver position is absoulte within one third of a revolution of the motor.
=> The number of one third revolutions of the motor must be counted.
This yields a position value in increments.

At the mastering procedure the positing system will be calibrated:

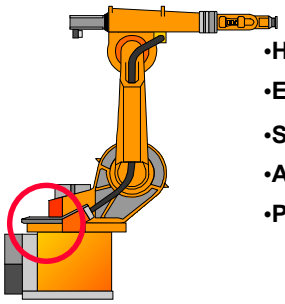
A1 = 0°, A2 = - 90°, A3 = 90°
A4 = 0°, A5 = 0°, A6 = 0°

Resons making a mastering necessary

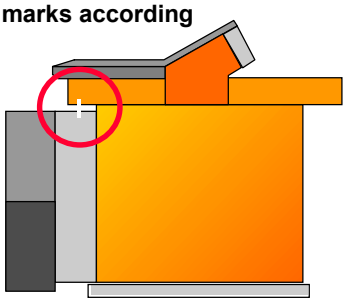
A new mastering has to be done	The mastering will be erased
after repair	automatically while booting
if the robot has been moved without controller	automatically while booting
after hitting a hard stop with a Velocity higher than jogging velocity	manual by the operator
after a collision between robot and work piece	manual by the operater

A demastering may be done..	The mastering will be erased
if the saved mastering data of specific Axis should be erased	manual by the operater

Mastering procedure

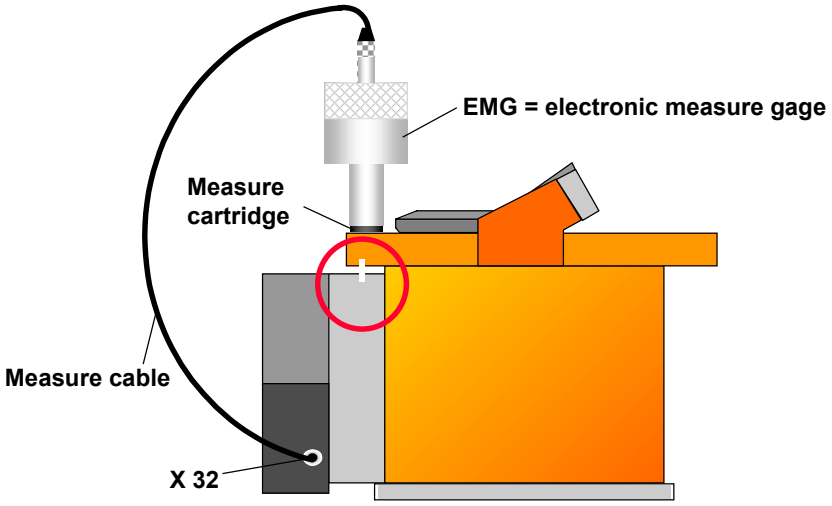


- Has to be done in joint jogging
- Each axis separately
- Start with axis 1 upwards
- Always form + to - jogging
- Premastering position = marks according

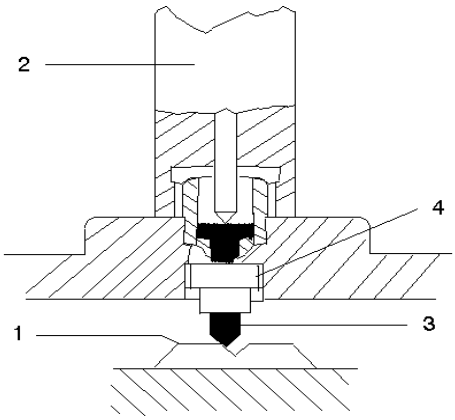


Dial gage

EMG

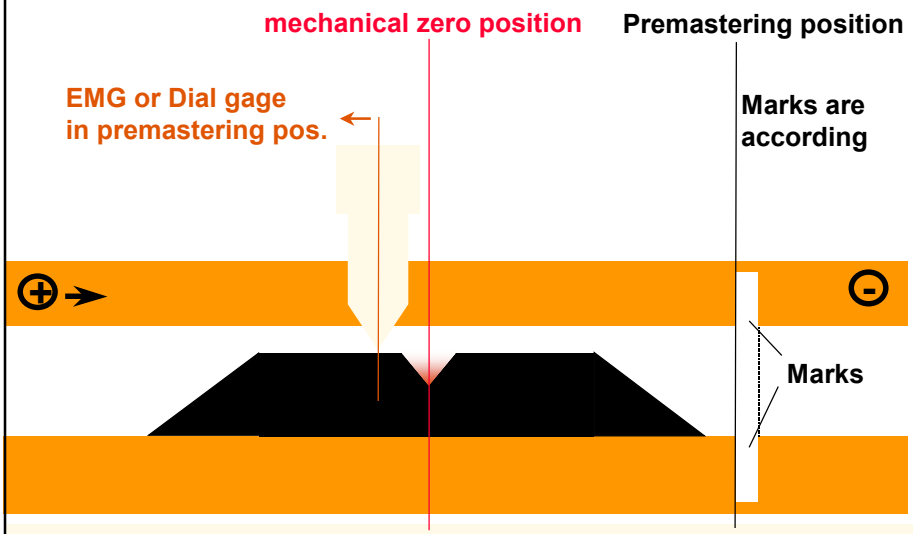


Construction of the mastering system



1 Notch
2 Gage
3 Pin
4 Measure cartridge

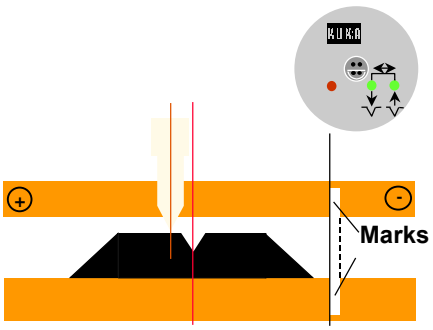
Measure pin with notch



Mastering drive with EMG 1/2

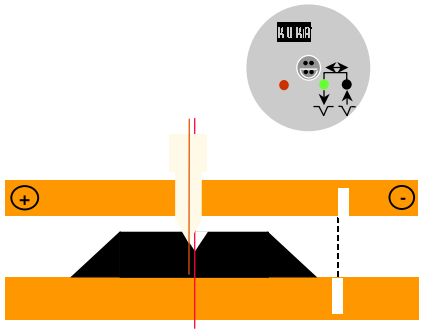
1

- Premastering postion
- red LED get off
- both green LEDs goes on
- Marks are according



2

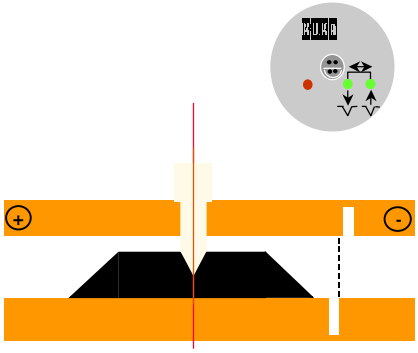
- EMG slides in the notch
- links green LED goes on



Mastering drive with EMT 3/4

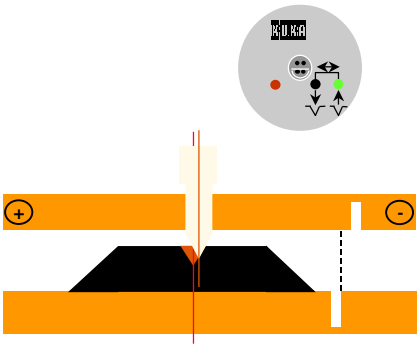
3

- Mastering position
- positioning system calibration
- green LEDs switches

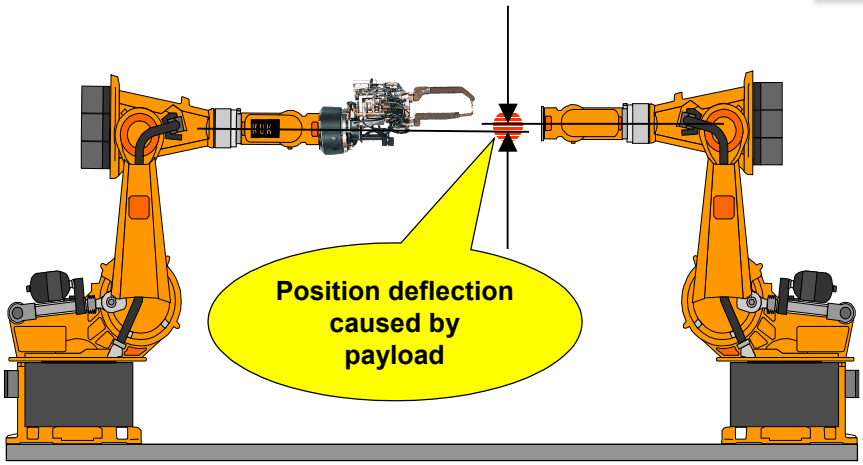


4

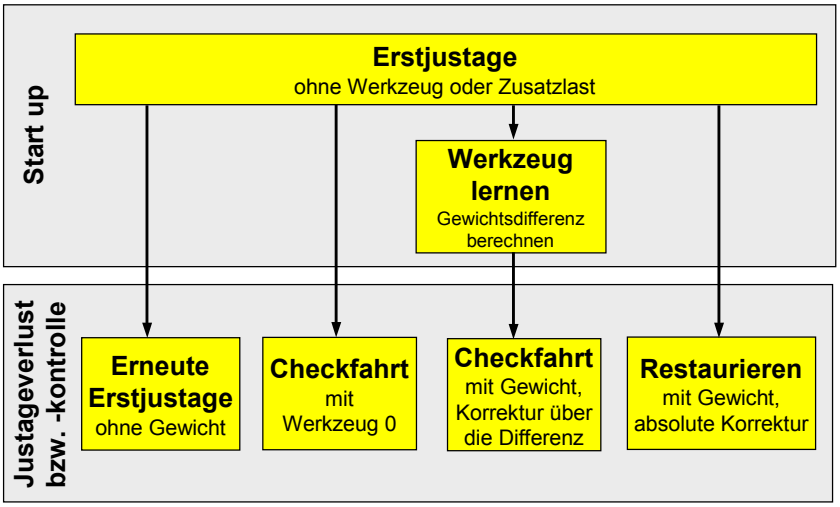
- Position of EMG – cause braking delay
- no effect of mastering
- right green LED off



Robot with and without tool



Functions of the EMG mastering



- *Periphery*
- *Start-up*
- *Electrical Installation*
- *Software Installation*
- *Maintenance / Repair*
- *Diagnostic Software*
- *Fault Analysis*

- *Periphery*
- *Start-up*
- *Electrical Installation*
- *Software Installation*
- *Maintenance / Repair*
- *Diagnostic Software*
- *Fault Analysis*

Completely deleting the hard disk

Preparation:

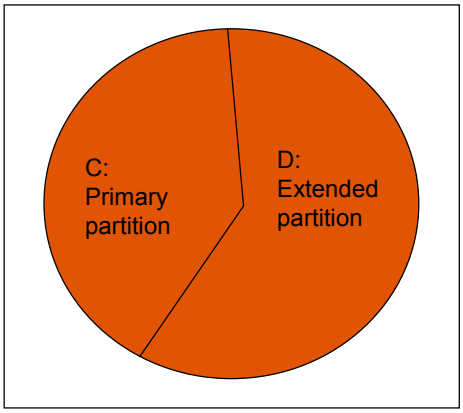
- **Save data:**
  - Save all data to floppy disk, scan drive A: for viruses
- **Create boot disk if none is present**
  - Select the menu item “Format” in Win95 Explorer
  - Copy “BOOTDISK” onto the boot disk (CD driver)
  - If required, copy SM.COM for an external monitor and insert call in the AUTOEXEC.BAT file

Execution:

- **Change boot sequence in BIOS from C,A to A,C**
- **Using FDISK, delete the partitioning**

Partitioning of the hard disk

Logical DOS drive



Total	C: KUKADISK	D: KUKADATA
4.3 GB	2.1 GB	2.1 GB
10 GB	2.1 GB	2.1 GB

Reinstallation of the hard drive

- **Automatic hard drive detection with IDE HDD AUTO DETECTION**
- **Using FDISK, recreate the partitioning**
- **FORMAT C: and D:**
- **Copy Win95 to D:**
- **Install Win95 from D:**
- **If required, activate external monitor**
- **Install Win95 Year 2000 Update**
- **Install the “Shared Memory” driver**
- **Install the KRC software**

- *Periphery*
- *Start-up*
- *Electrical Installation*
- *Software Installation*
- *Maintenance / Repair*
- *Diagnostic Software*
- *Fault Analysis*

"Recommended operating times" table

Article	**Rec. operating time / MTBF acc. to manuf.**	**Recommended exchange interval**	**Comments**
Lead battery	3 years	2 years	Incl. allowance for capacity loss
PC fan	60 hours	5 years [1)]	
Cabinet fan	46000 hours	5 years [1)]	
Motherboard battery	10 years	5 years	
Filter insert, pressure compensating valve	---	Depends on installation conditions and degree of clogging	

[1)] with 3-shift operation

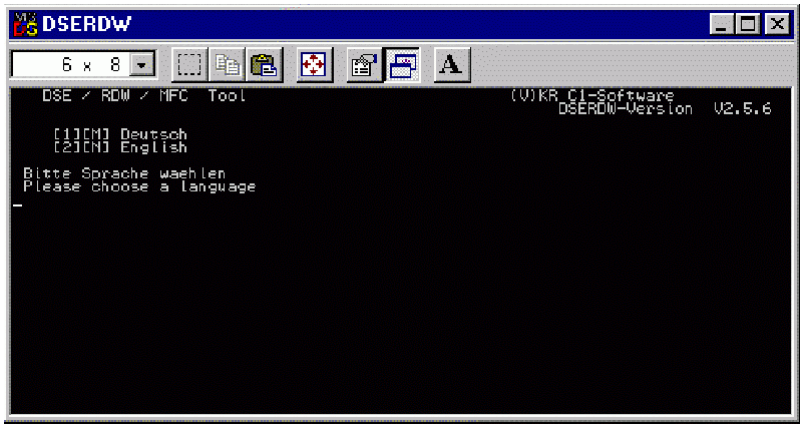
Maintenance / Repair

Maintenance point	Maintenance interval			Activity, specification
	6 months	1 year	Recommended exchange interval	
Side of control cabinet, air conditioner	●	○		Clean heat exchanger with brush
Side and rear of control cabinet, heat sink	●	○		Clean heat sink with brush and check that it is securely fastened
Control cabinet, internal and external fans	●	○		Clean fans with brush
			X	Exchange fans
Control cabinet, PC fan			X	Exchange PC fan
Control cabinet, computer unit motherboard battery			X	Exchange motherboard battery, (only after consultation with KUKA Service)
Control cabinet, interior			X	Exchange batteries
Filter insert, pressure compensating valve			X	Exchange filter insert

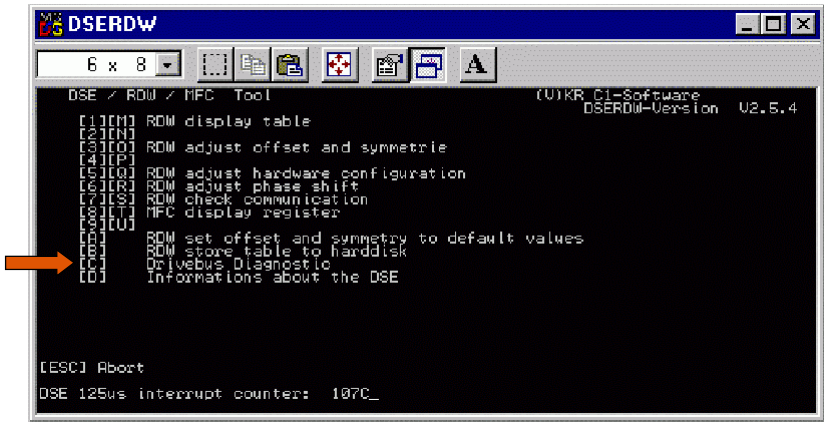
● = recommended maintenance interval ○ = maximum maintenance interval

- Periphery
- Start-up
- Electrical Installation
- Software Installation
- Maintenance / Repair
- **Diagnostic Software**
- Fault Analysis

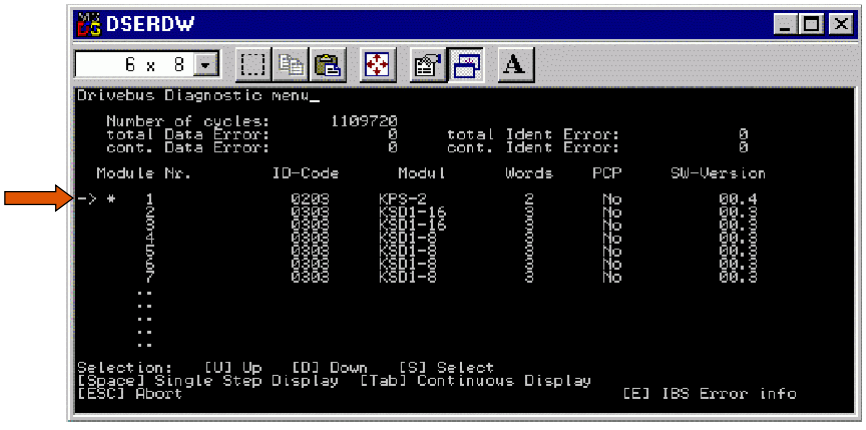
DSERDW-Tool



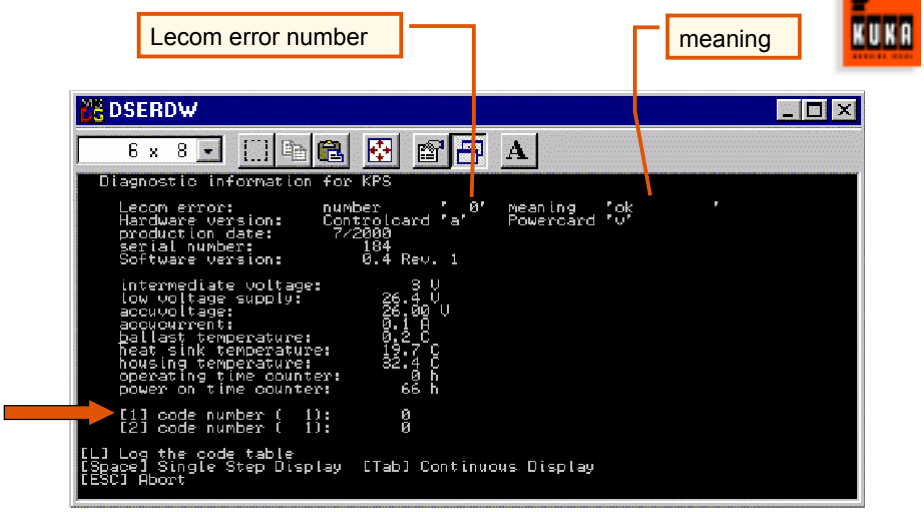
DSERDW-Tool Main menu



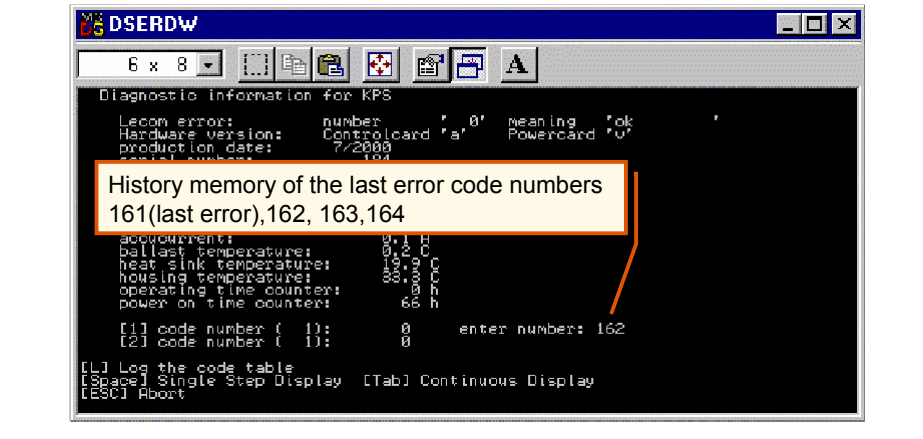
[C] Drivebus Diagnostic menu



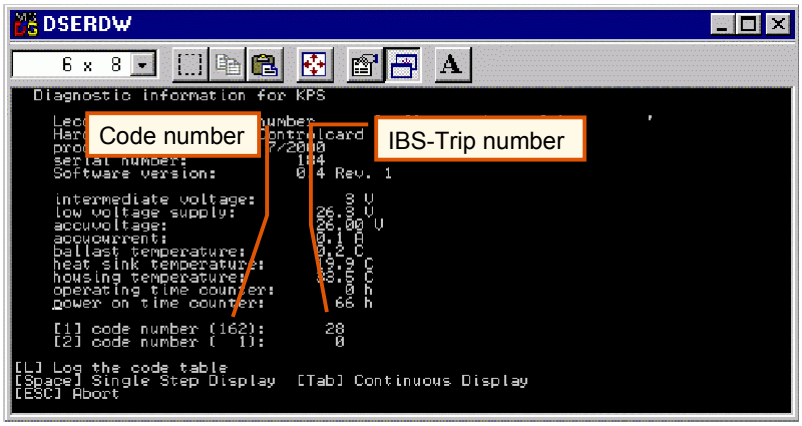
Diagnostic information for KPS



Diagnostic information for KPS



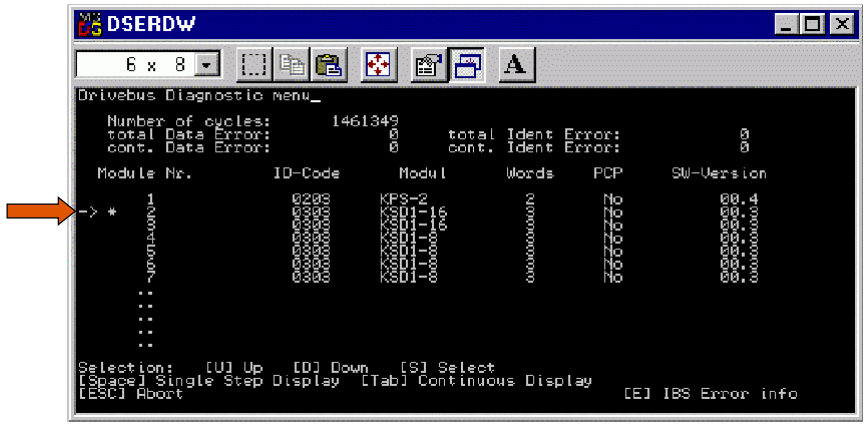
Diagnostic information for KPS



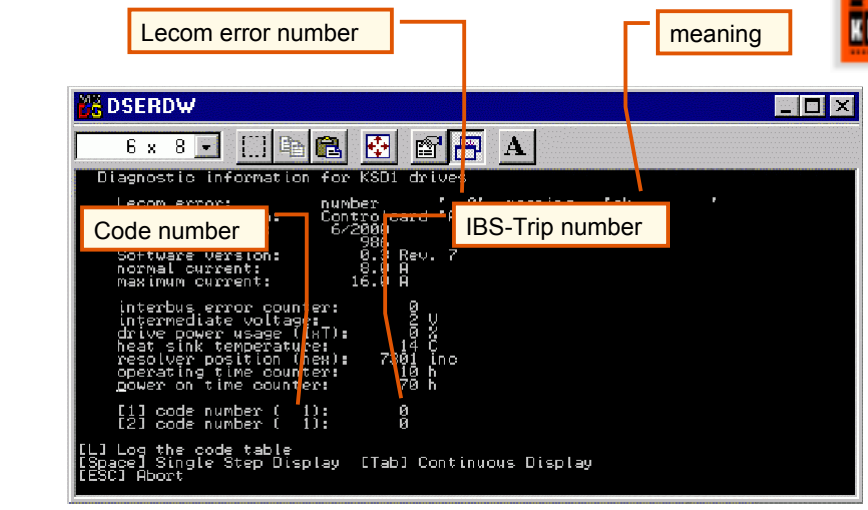
Error massages of the KPS

IBS-Trip number	Lecom error number	error massage	meaning
0	0	“ok “	Device status o.k.
1	72	“Pr1 - Trip“	Checksum Error Parameterdata1
3	105	“HO5 - Trip“	Checksum Error controller
5	71	“CCr - Trip“	Crash of the micro controller
6	11	“OC1 - Trip“	Ixt-overload ballastresistor while charging
8	15	“OC5 - Trip“	Ixt-overload ballastresistor while operation
10	50	“OH - Trip“	Overtemperature heatsink
39	52	“OH2 - Trip“	Overtemperature cabinet
24	79	“Pr5 - Trip“	Kommunikationerror controller EEPROM
28	65	“CE4 - Trip“	Too much transmission error on the Drive bus
35	131	“OV1 - Trip“	Overvoltage of the intermediate circuit while charging
36	132	“OV2 - Trip“	Overvoltage of the intermediate circuit while operation
31	121	“LV1 - Trip“	Undervoltage 27V supply
32	122	“LV2 - Trip“	Accumulator voltage too low , U<22V
33	123	“LV3 - Trip“	Accumulator voltage too low, U<19V
34	124	“LV4 - Trip“	Undervoltage intermediat circuit while charging, U<500V
41	141	“BR1 - Trip“	Brake error robot axis
30	142	“BR2 - Trip“	Brake error external axis
37	112	“BEA - Trip“	error while charging the intermediate circuit. Ballast Opto no current
40	111	“K1 - Tripp“	Mains contactor welded on the KPS

[C] Drivebus Diagnostic menu



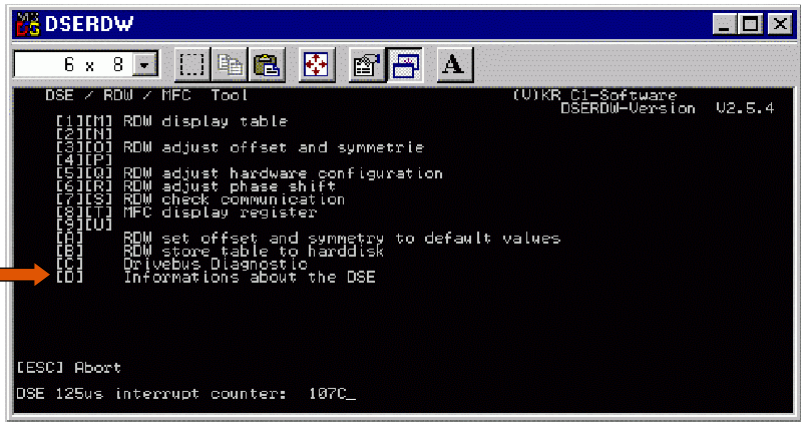
Diagnostic information for KSD1 drives



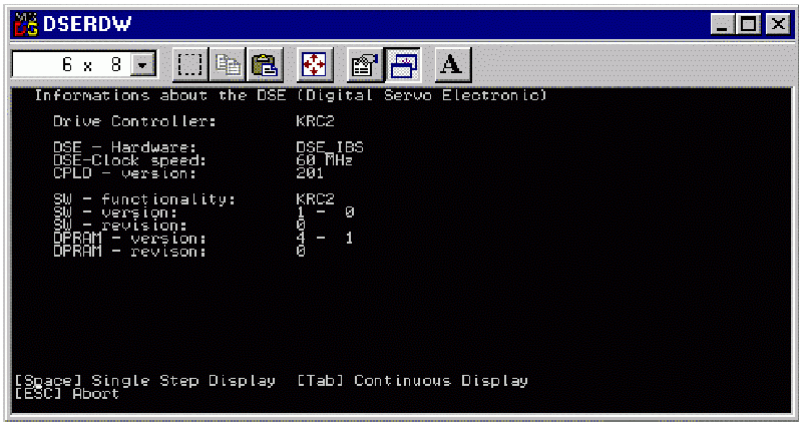
Error massages of the KSD

IBS-Trip number	Lecom error number	Error massage	meaning
0	0	“ok “	Device status o.k.
1	72	“Pr1 - Trip“	Checksum Error Parameterdata1
3	105	“HO5 - Trip“	Checksum Error controller
5	71	“CCr - Trip“	Crash of the Micro controller
6	11	“OC1 - Trip“	Overcurrent power unit (Short-circuit, Ground fault) HW-monitoring
7	12	“OC2 - Trip“	Ground fault SW-monitoring
8	15	“OC5 - Trip“	Ixt-overload
10	50	“OH - Trip“	Overtemperature heatsink
11	91	“EEr - Trip“	External Error, Short-circuit braking from the DSE
19	32	“LP1 - Trip“	Failure motorphase
24	79	“Pr5 - Trip“	Communikation error controller EEPROM
28	65	“CE4 - Trip“	Too much communikation errors on the drive-bus (SCB)
43	80	“PR6 - Trip“	Communikation error Power unit EEPROM
44	106	“HO6 - Trip“	Checksum error Power unit

DSERDW-Tool main menu



[D] Informations about the DSE



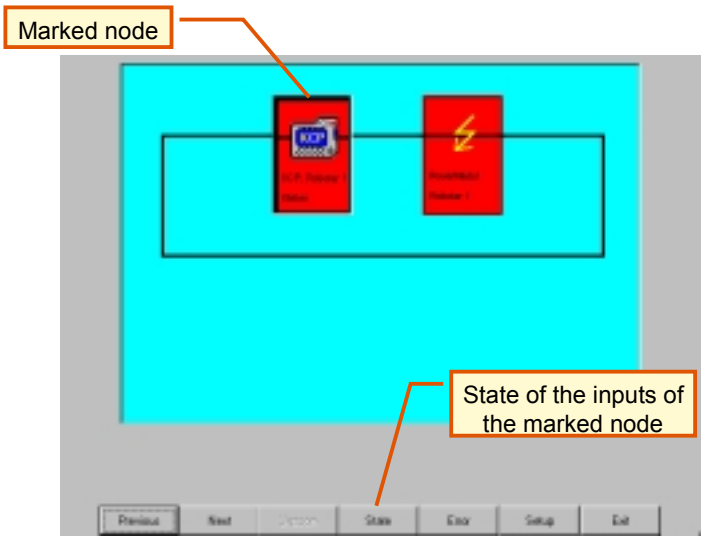
ESC-Diagnostic

ESC-note numbers

The node number results from the order of the bus wiring.
The Master receives the number 0.
ESC-note 0 = KCP
ESC-note 1 = KPS

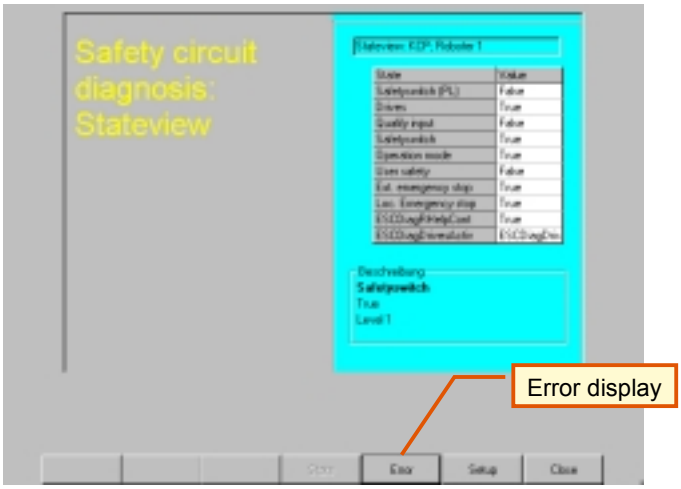
The MFC does not have a noten number (passive note).

ESC-Overview

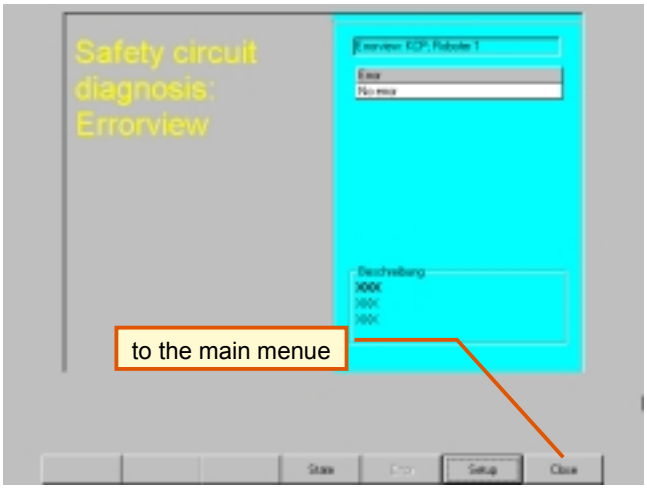


ESC-Stateview

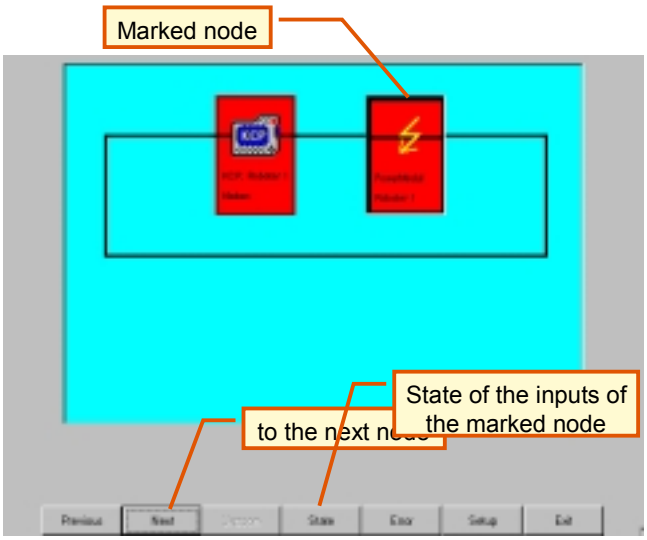
ESC-Stateview



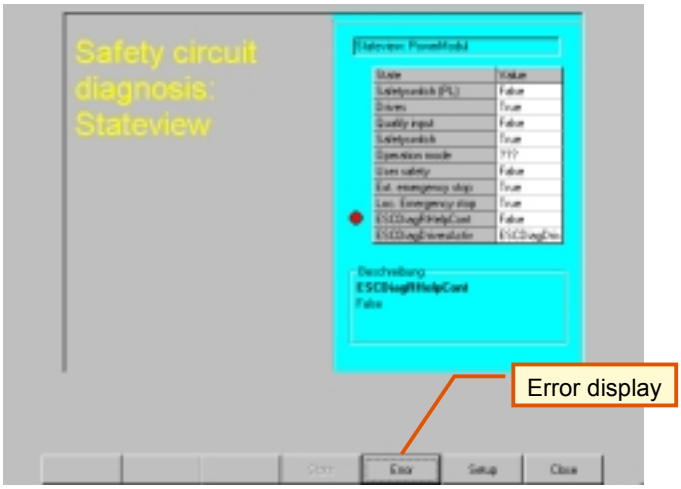
ESC-Errorview



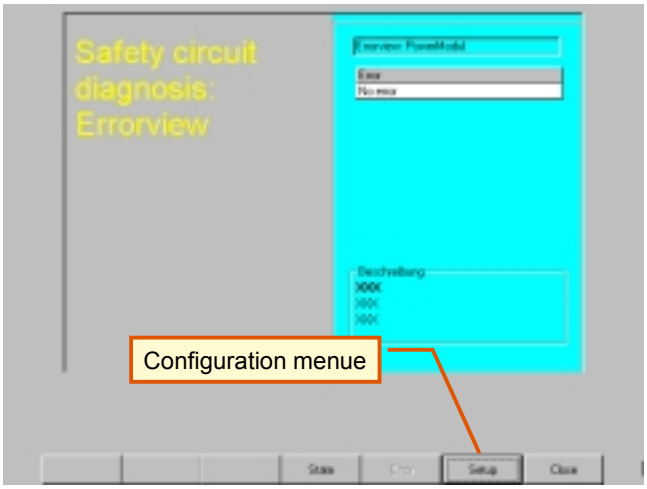
ESC-Overview



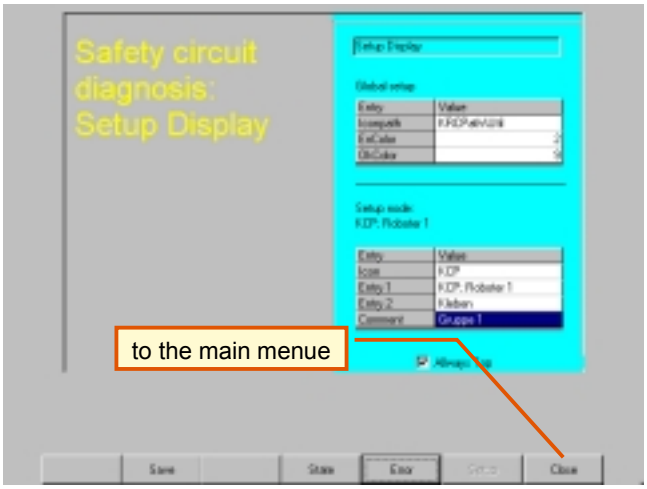
ESC-Stateview



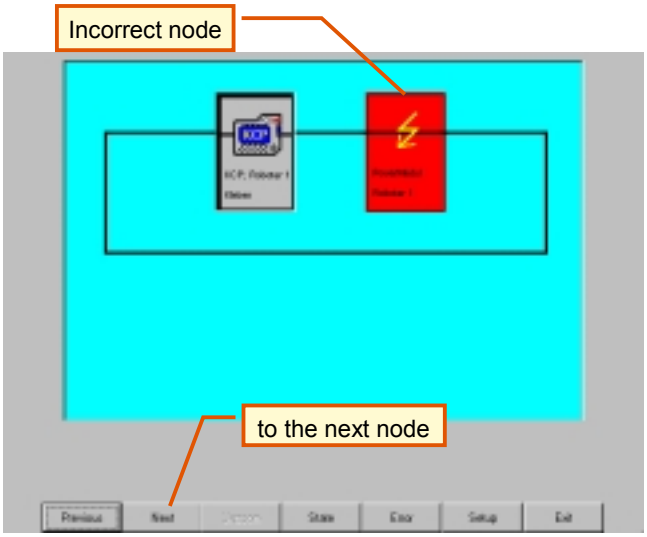
ESC-Errorview



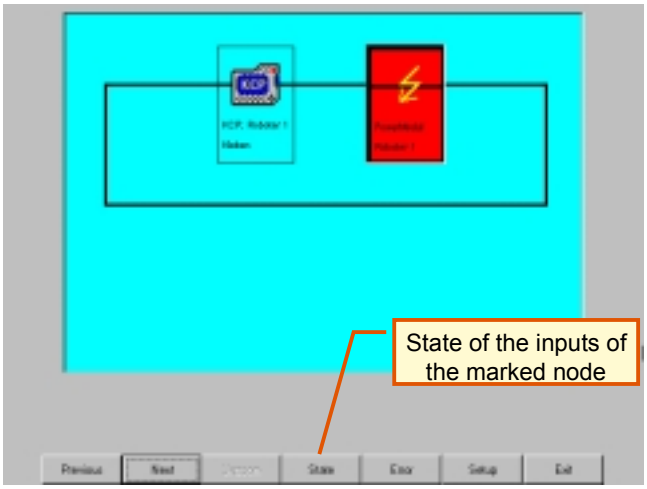
ESC-Configuration menue



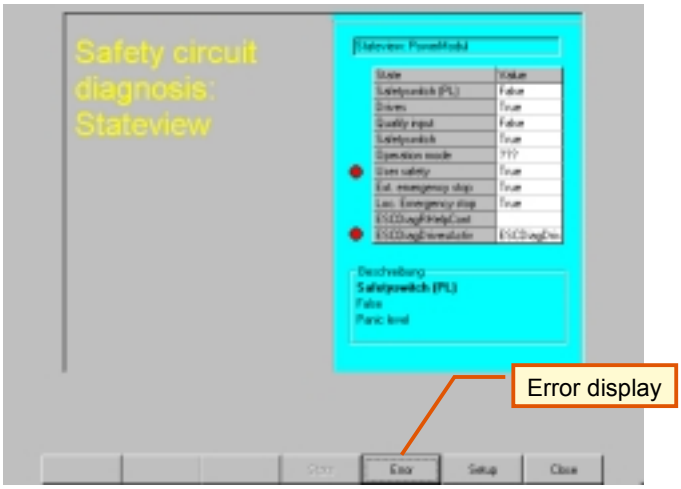
ESC- Error (Dual channel protection fault)



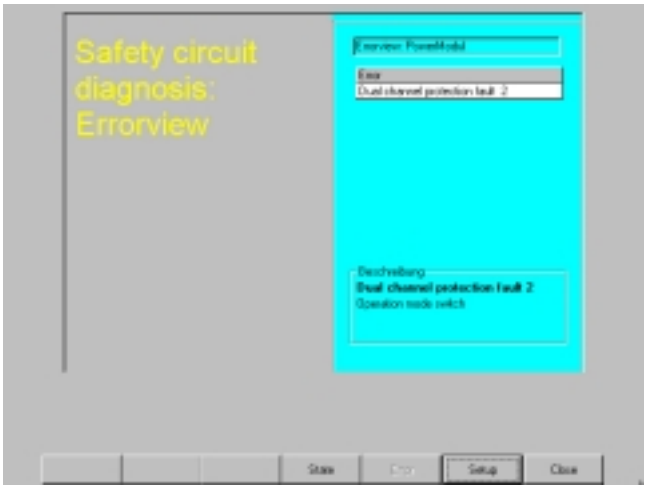
ESC- Error (Dual channel protection fault)



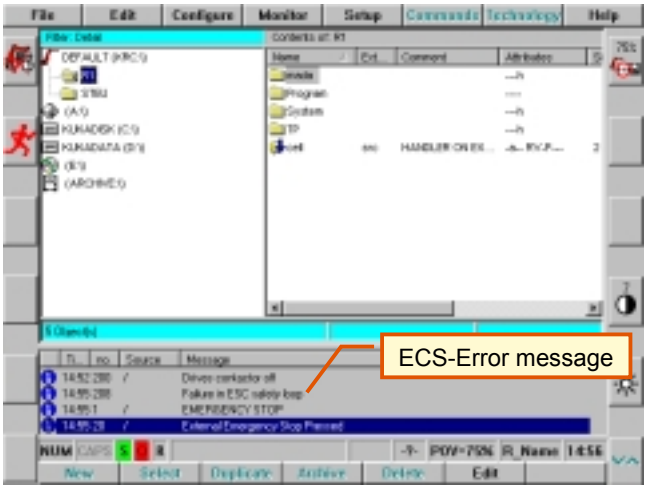
ESC-Error (Dual channel protection fault)



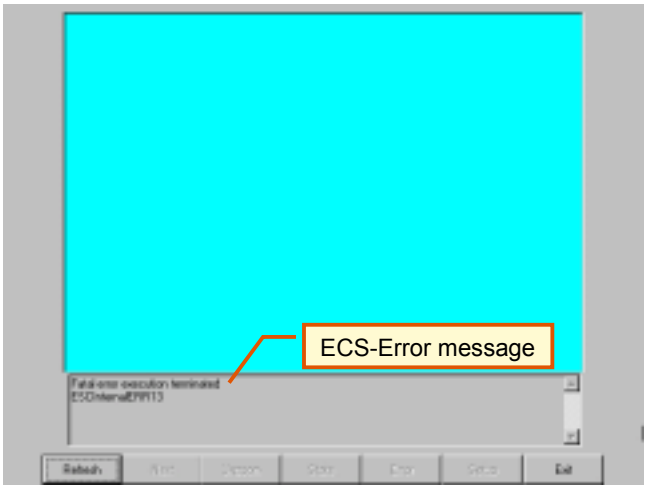
ESC-Error (Dual channel protection fault)



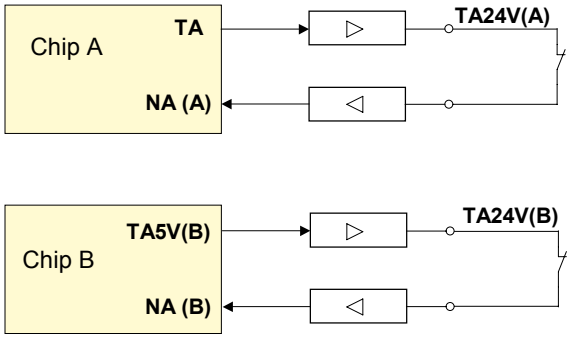
ESC-Error



ESC-Circuit fault

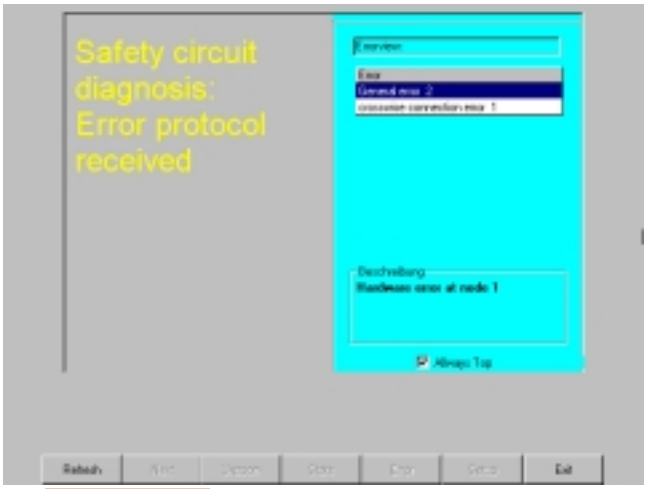


Short-circuit



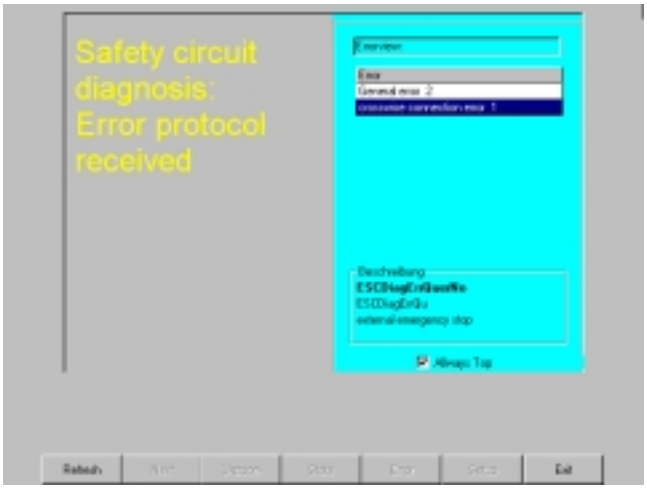
Check wiring

Short-circuit between Chanel A and B



Check wiring

Short-circuit between Chanel A and B

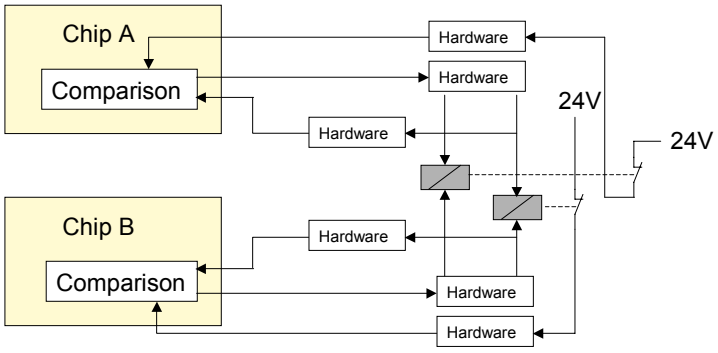


Check wiring

Short-circuit between Chanel A and B

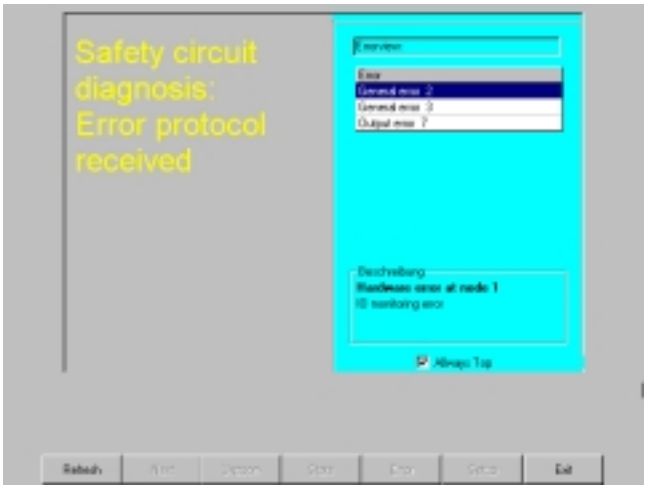
- crosswise connection error lokal emergency stop
- crosswise connection error external emergency stop
- crosswise connection error Operation mode switch
- crosswise connection error qualify input
- crosswise connection error Safety switch 1
- crosswise connection error User safety
- crosswise connection error E2-locking
- crosswise connection error Panic level
- crosswise connection error AF or AA

Return signals

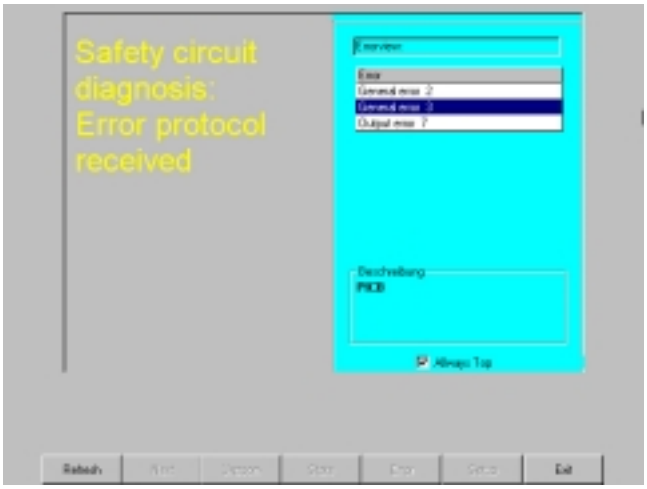


Each chip compares the status of the outputs with the status of the return signals. With inequality the outputs are set in safe status.

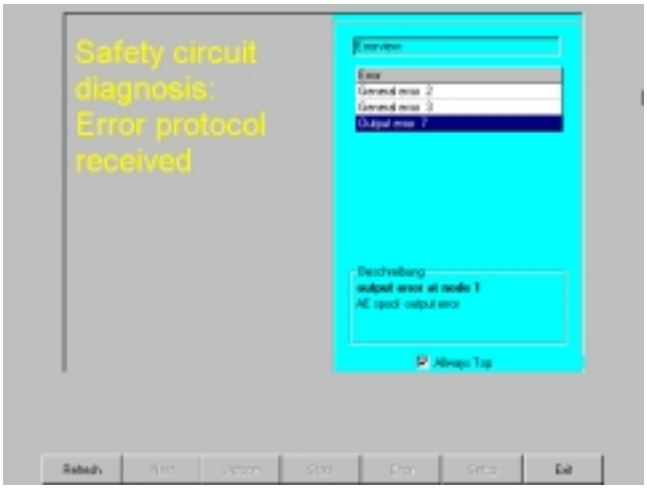
Return signals spool output error K1 A2



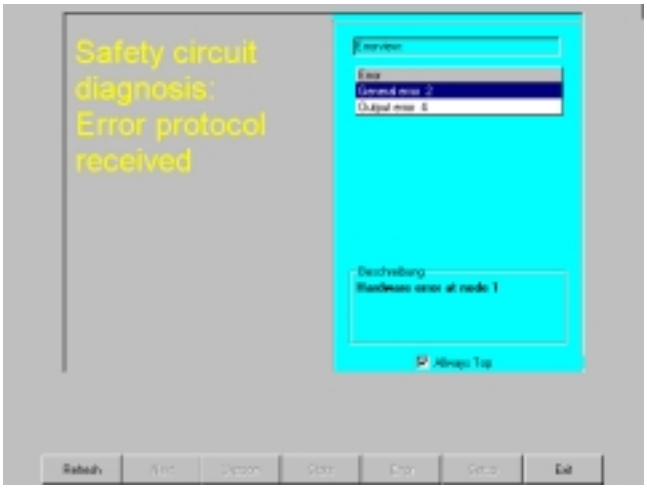
Return signals spool output error K1 A2



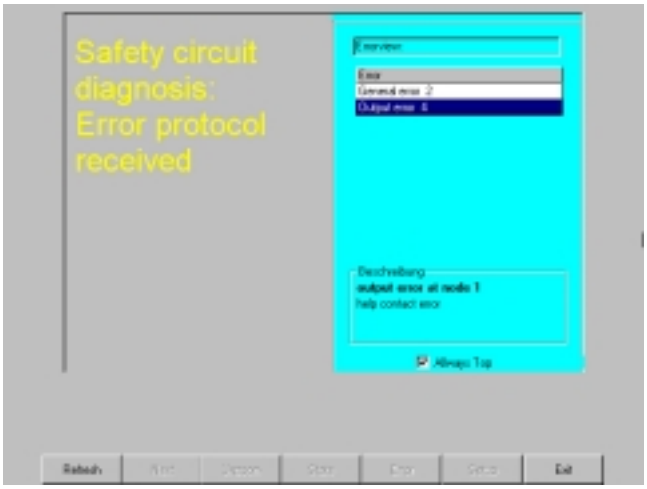
Return signals spool output error K1 A2



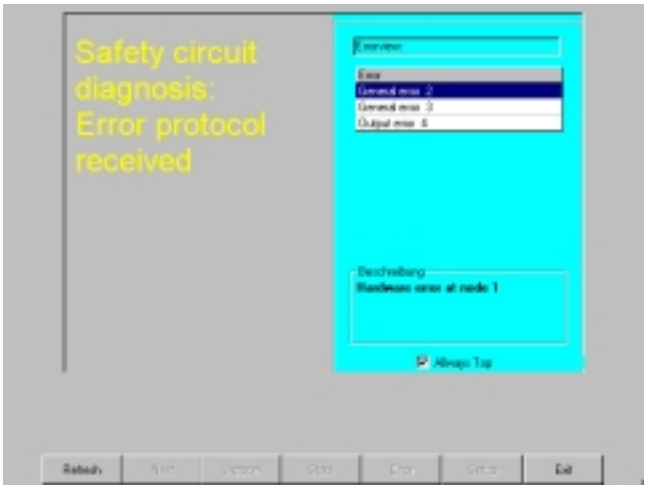
Return signals help contact error K1



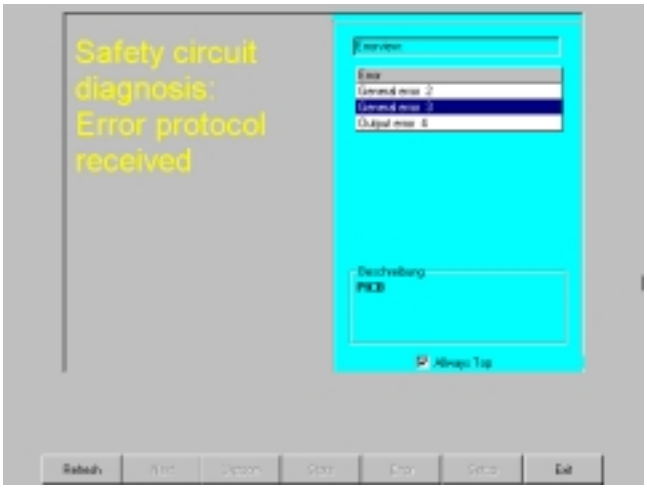
Return signals help contact error K1



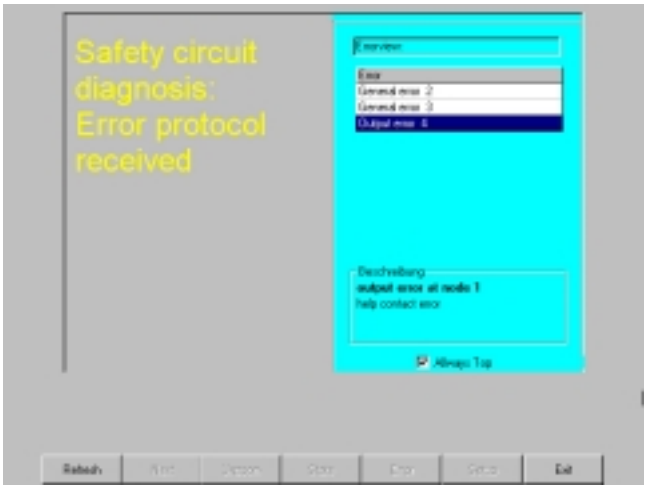
Return signals help contact error K2 (option)



Return signals help contact error K2 (option)



Return signals help contact error K2 (option)

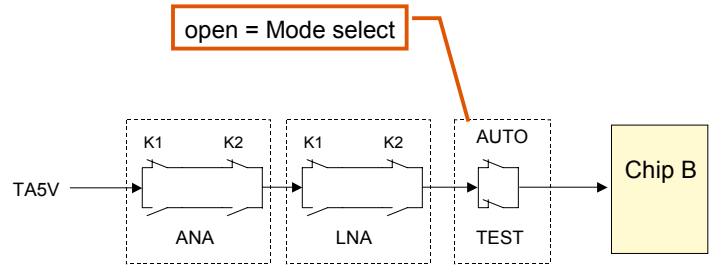


Return signals

- local emergency output error
- Output error AA or AF (Drives On) *)
- Output error operation mode *)
- external emergency output error *)
- AE spool output error
- Output error help contact error

*) Only with ESC-CI-board with ESC nodes

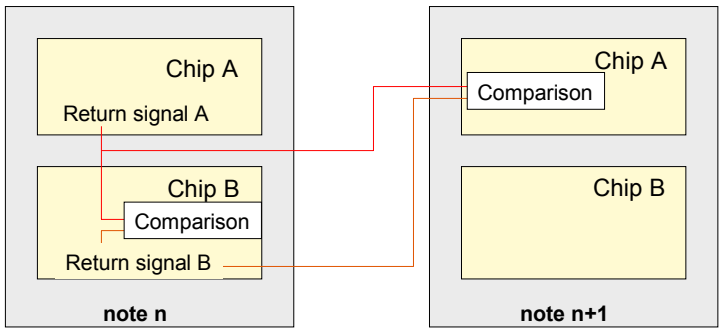
Relay-Test



IO monitoring error

(change module, change CI-Board, check wiring to the KPS)

Supervisor



? Hardware error ?

Chip B compares the log files of A and B of the own node.

Chip A compares the log files of A and B of the previous node

PIC=0 (Chip A) change Modul n-1
PIC=1 (Chip B) change Modul n

Initialization error

Initialization error

Softwareerror Initialization error
⇔ change one part after the other

Configuration error

Configuration error

Unequal configuration Chip A, Chip B
⇔ change KCP (initialize the modules)

Communication error

Communication error

invalid headerbyte

Interface error

CRC error in protocol

Bytetimeout at protocol reception

Operation mode error

No protocol received

Communication Error ⇔ conside Byte 0 and Status line
(further bits are coincidental and not meaningful)

Software error

Software error

Software Error ⇔ change Nodenumber modul

Error protocol

Error protocol received

The node received an error log and transmitted its own.
⇔ a further error is on.

RAM error

RAM error

RAM-Error ⇔ Change modul.

MFC-error

No MFC found

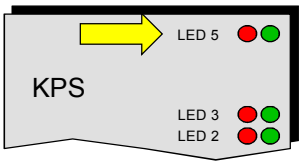
Change MFC

- *Periphery*
- *Start-up*
- *Electrical Installation*
- *Software Installation*
- *Maintenance / Repair*
- *Diagnostic Software*
- *Fault Analysis*

General procedure for fault analysis and elimination

- Exact analysis of the fault profile
  - –When did the fault first arise?
  - –What error messages are displayed in the message window?
  - –Does the fault profile suggest a hardware problem?
    - ⇒Check all LEDs on the DSE, RDC, power module and FE201
    - ⇒Check connecting cables
  - –Is a peripheral interface signal missing?
    - ⇒Test with jumper plug X11
  - –Is it a sporadic fault?
- Comparison with typical fault profiles
- Isolation of faults by exchanging components
- Set analysis settings to output state
- Final function tests

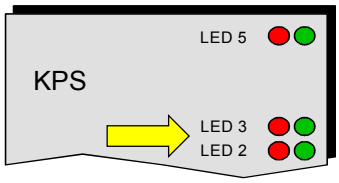
Status and fault indication, LED5



Green LED 5	Red LED 5	Device state
OFF	OFF	Processor without power supply
Flashes, 1.5 Hz	X	Intermediate circuit voltage < 60 V
ON	X	Intermediate circuit voltage > 60 V
X	Flashes, 6.1 Hz	Communication error
X	Flashes, 3.1 Hz	Brake error
OFF	ON	K1 stuck
X	Flashes 5 times, 1.5 Hz	Ballast monitoring fault
X	Flashes 4 times, 1.5 Hz	Ballast fault
X	Flashes 3 times, 1.5 Hz	Overvoltage in intermediate circuit
X	Flashes twice, 1.5 Hz	Overtemperature in interior / heat sink
X	Flashes once, 1.5 Hz	Low voltage supply fault

The red LED blinks n times; this is followed by a 4-second pause, in which the LED is extinguished, and then repeated.

Meaning of the LED2 and LED3



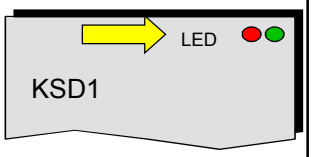
red LED 2	red LED 3	meaning
ON	OFF	external Emergency stop
ON	ON	local Emergency stop
OFF	ON	Internal ESC fault

green LED 2	External brakes
green LED 3	Robot brakes

Lit means activated

Meaning of the LED´s

Red LED	Green LED	meaning:
OFF	Flashes slowly	Uic < 250V
OFF	Flashes quickly	Uic > 250V
OFF	ON	Servo enable, Uic>60V



Red LED	Green LED	meaning:
OFF	OFF	No supply voltage
ON	OFF	Undefined drive controller state
Flashes quickly	Flashes quickly (Uic > 250V)	Fault present
	Flashes slowly (Uic < 250V)	
Flashes slowly	Flashes slowly (Uic < 250V)	Alarm present
	Flashes quickly (Uic > 250V)	