CONTROL CABINET

KR C2 edition2005

User Manual

Fault Analysis / Diagnosis

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KUKA

Contents

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1 Repair and procurement of spare parts

Repairs to the KR C may only be carried out by KUKA customer support personnel or by customers authorized to do so after participation in a relevant KUKA Robot Group service seminar.

1.1 Customer repair

As far as customer repairs to the KR C are concerned, only the exchange of modules is envisaged. A defective motherboard is exchanged together with the PC rack.

1.2 Repair by KUKA service personnel

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

A repair by KUKA Robot Group service personnel carries the following guarantees:

- carried out by specially trained, experienced personnel
- compliance with the ESD directives
- use of the required special tools
- optimal conditions for locating faults and searching for the exact causes
- technical revisions carried out
- overall test of the PC on completion of repair.

1.3 Procurement of spare parts

The article numbers for spare parts are listed in the electronic spare parts catalog (KUKA Parts) on a CD-ROM that accompanies every control cabinet.

The KUKA Robot Group supplies the following types of spare parts for KR C repairs:

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

- **Exchange parts**
  Once the exchange part has been installed, the part that has been removed is returned to the KUKA Robot Group.

A "Robot Repair Card" is supplied with the exchange parts.
The Repair Card must be completed (see Chapter 12) and returned to the KUKA Robot Group.

2 Fault analysis and elimination

The following procedure is recommended for isolating the cause of the fault and enabling effective repair of the KRC:

2.1 Fault analysis

Is the fault reproducible?

- Permanent fault
- Sporadic fault

Did the fault occur after installation or conversion?

- Transportation damage
- Commissioning faults

Did the fault occur during operation?

- Operator influence, incorrect operation
- Program modifications
- Software configuration modifications

Was the fault caused by external factors?

- Electrical factors such as undervoltage/overvoltage, static electricity, interference fields
- Mechanical factors such as impact, vibration
- Environmental factors such as heat, cold, humidity

What is the fault profile?

- Observe the status of operator control and display elements on the KR C (switch positions, lamps, LEDs)
- Interpret error messages in the message window of the KCP (for more detailed information see Section 3.2 and the following sections)
- Collate the statuses and error messages of higher-level controllers (process control systems, automation components)
- Read logbook entries

2.2 Isolation of faults using checklists

The cause of the fault can be isolated by comparing the fault profile with a list of typical fault profiles (see Section 3.1.5).

2.3 Isolation of faults by exchanging components

In the case of a **potentially defective overall system**, functioning modules are introduced into the system one after the other and changes in the behavior of the system are observed.

In the case of a **potentially defective component**, this is introduced into a functioning system and changes in the behavior of the system are observed.

3 Typical fault profiles

3.1 Fault profiles related to the PC

3.1.1 Power supply

The motherboard and drives are supplied with power by an integrated switched-mode power supply.

Typical power supply fault profiles are:

- Supply voltage that is characterized by dropouts or spikes
- Output voltage overload
- Output voltage failure
- Internal overheating due to fan failure
- Defects in power switch and ATX power-on logic

3.1.2 Basic configuration

The processor, main memory, CMOS memory and other hardware are integrated onto the motherboard.

Typical faults in the motherboard basic configuration are:

- Memory faults in the CMOS-RAM due to undervoltage in the lithium battery
- Incorrect BIOS entries
- Memory faults in the main memory (RAM modules)
- Overheating due to failure of CPU fan

3.1.3 Drives

The hard drive, floppy disk drive and CD-ROM drive are integrated into the PC chassis.

Typical faults in the drives are:

- Hard drive defect caused by impact or vibration
- Data error caused by dust in the floppy disk drive and CD-ROM drive
- Cabling fault in the IDE bus and floppy disk bus

3.1.4 PC-related peripherals

PC-related peripherals include input and output devices and additional plug-in cards.

Typical faults in the PC-related peripherals are:

- Keyboard does not respond
- Monitor display faults
- Fault in the interplay between the VGA chip and the KVGA card
- Bus errors and communication errors due to incorrectly configured plug-in cards (MFC, Ethernet, field bus cards)

3.1.5 Fault profile checklist

Main switch on PC to "ON", system fails to boot, display stays dark, power supply fan and CPU fan do not work

Possible causes:

- Power supply defective
- Short circuit on the motherboard
- Short circuit on a connected device

Elimination of fault:

- Disconnect all devices from the power supply unit. Switch on PC and measure output voltages at the power supply unit. If an output voltage is too low, exchange the power supply unit.
- Connect the power supply to the motherboard with the power supply unit switched off. Switch on PC and measure supply voltages at the power supply unit. If an output voltage is too low, exchange the PC rack (motherboard fault).
- Reconnect each device in turn to the power supply unit (drives, plug-in cards) with the power unit switched off. Switch on PC and measure output voltages at the power supply unit. If an output voltage is too low, exchange the device in question.

System does not boot, display stays dark

Possible causes:

- Ribbon cable not correctly connected (male connector without coding)
- Defective expansion card (Interbus, MFC, KVGA)
- Memory modules (RAM modules) not correctly snapped into place (contact fault)
- Memory modules defective
- Defective motherboard

Elimination of fault:

- Connect ribbon cable correctly (red marking on the ribbon cable corresponds to pin 1)
- Disconnect expansion cards (Interbus, Ethernet card) and test system again; replace expansion cards if necessary
- Snap memory modules correctly into place
- Exchange memory modules
- Exchange PC rack

System boots sporadically, display stays dark

Possible causes:

- Incorrect BIOS version

Elimination of fault:

- Carry out BIOS update

System boots normally, display stays dark

Possible causes:

- KVGA defective

- KCP2 connecting cable snapped

- 24 V supply voltage for KCP2 not present in MFC3

Elimination of fault:

- Exchange KVGA

- Exchange KCP2 connecting cable (KVGA to X19)

- Exchange connecting cable (X3) from the ESC–CI board to the MFC (X807)

- Exchange safety logic

System crash when booting, no keyboard entries possible

Possible causes:

- Defective motherboard

Elimination of fault:

- Exchange PC rack

The system repeatedly resets itself

Possible causes:

- Memory modules defective

- Memory modules of different types installed

- Defective or incorrectly installed graphics card (KVGA)

Elimination of fault:

- Exchange defective memory modules

- Install memory modules that are all of the same type

- Check KVGA card for correct fit in PCI slot, exchange if necessary

BIOS error message "CMOS Checksum Error"

Possible causes:

- Undervoltage in lithium battery on the motherboard
- Incorrect or missing entries in CMOS setup
- CMOS memory on motherboard defective

Elimination of fault:

- Replace lithium battery
- Check entries in CMOS setup and correct if necessary
- Exchange PC rack

BIOS error message "MEMORY TEST FAILED"

Possible causes:

- Defective memory module(s)

Elimination of fault:

- Exchange memory module(s)

Cannot boot from hard disk

Possible causes:

- BIOS fails to detect hard drive
- IDE cable incorrectly connected
- IDE drives incorrectly configured
- Power supply connector incorrectly connected
- Hard drive defective
- IDE interface on motherboard defective

Elimination of fault:

- Activate "Autodetect" in CMOS SETUP. Set boot sequence.
- Compare hard drive parameters in CMOS setup with specifications on label of hard drive.
- Check IDE cable (lateral offset, PIN1 marking)
- Check drive configuration (master/slave, slave present, CHS/LBA)
- Ensure that power supply connector is correctly connected
- Exchange hard drive
- Exchange PC rack (motherboard fault)

Cannot access floppy disk drive (FDD)

Possible causes:

- CMOS setup: FDD type not correctly entered or FDD controller deactivated
- FDD data cable and power supply not connected correctly
- FDD defective
- FDD interface on motherboard defective

Elimination of fault:

- Check CMOS settings and correct if necessary
- Connect data cable and power supply correctly
- Exchange FDD
- Exchange PC rack

CD-ROM drawer does not open

Possible causes:

- Power supply not correctly connected
- CD-ROM drive defective

Elimination of fault:

- Connect power supply correctly
- Exchange CD-ROM drive

CD-ROM drawer opens, CD-ROM cannot be read

Possible causes:

- BIOS fails to detect CD-ROM drive
- IDE cable incorrectly connected
- IDE drives incorrectly configured
- Power supply connector incorrectly connected
- CD-ROM drive faulty
- CD-ROM defective or inserted incorrectly

Elimination of fault:

- Check CMOS entry for CD-ROM drive
- Connect IDE cable correctly
- Configure IDE drives (master/slave, slave present, CHS/LBA)
- Exchange CD-ROM drive
- Exchange CD-ROM or insert it correctly (label upwards!)

Operating system crashes with exceptional error (blue screen)

Possible causes:

- Defective memory module(s)

Elimination of fault:

- Exchange memory module(s)

Controller hangs when loading software components

Possible causes:

- MFC not correctly connected
- MFC defective
- Additional expansion card (e.g. Interbus) interfering with functioning of MFC
- PCI bus on motherboard faulty

Elimination of fault:

- Connect MFC correctly
- Exchange MFC
- Remove expansion card and run controller up again
- Exchange PC rack

KUKA HMI does not boot and is aborted with a General Protection fault

Possible causes:

- Defective files in the software installation
- Settings in CMOS setup incorrect
- Defective memory module(s)

Elimination of fault:

- Reinstall control software
- Check settings in CMOS setup
- Exchange memory module(s)

3.2 Fault profiles related to DSE and machine data

3.2.1 Program crashes (with possible loss of mastering)

Faulty cable shields can seriously reduce the controller's immunity against interference. In the event of error messages affecting DSE–IBS, yet for which no other cause is apparent, the connecting cable between the resolver interface and the control cabinet should be checked.

3.2.2 The robot does not move in jog mode

The robot does not move in jog mode; the brakes and servo enable remain closed. The axis-specific actual values do change, however.

The following points must be checked:

- Is the variable value Office=FALSE entered in the file hw_inf.ini?
  (Path: C:\KRC\Roboter\init\hw_inf.ini)
- Are the correct servo files loaded?
- Are the correct machine data configured?

If no machine data have been copied into the directory, the standard machine data in the system for the Office version are used, i.e. the axes are all in axis simulation mode.

To check the machine data, carry out the following steps:

- By pressing the menu key "Configure" and selecting the menu item "Settings" → "Robot name", you can see which machine data are present and whether or not they are valid.
- By pressing the menu key "Monitor" and selecting the menu item "Modify variable", you can check whether or not the correct machine data have been loaded into the system. $TRAFONAME[ ] (transformation name) must contain the name of the robot and $AX_SIM_ON (axis simulation) must be zero. If $TRAFONAME[ ] is "OFFICE ROBOT KR125", then the machine data are completely missing in the Mada directory.
- If the machine data are incorrect, copy the correct machine data from the CD into the directory C:\KRC\Roboter\KRC\mada.

With KUKA HMI active, the machine data are overwritten again during the Power Off backup.
- Exit the HMI beforehand, by means of EXIT, or
- Carry out a controlled exit from the boot sequence and change the machine data

3.2.3 The drives cannot be switched on

- Is the peripheral connector X11 plugged in?
  If the connector is not connected or is incorrectly wired, the message "EMERGENCY STOP" or "Motion enable" or "Operator safety" is displayed.

- Has the DSE booted?
  If the DSE has booted, the LED on the DSE flashes.

- Check the E-Stop circuits using the ESC diagnostic tool.

- Is the VxWorks real-time operating system still running?

- Is there an encoder error present at any axis?
  If there is an encoder error, the controller cancels the RC Ready signal on the MFC and the brakes are applied.

- Is there a KSD (KUKA Servo Drive) error message present? Certain errors (e.g. overcurrent, overvoltage) cause the servo drive module to deactivate the drives automatically.

3.3 DSE error messages when booting the system

3.3.1 DSE x not found

The MFC checks whether a DSE is connected. If no connected DSE is detected, the error message "DSE x not found" is generated. The loading of the machine data is canceled.

The following follow-up message is generated: "DSE axis assignment Ax, machine data loader canceled, erroneous %1 machine data".

Possible causes:

- DSE not connected

- DSE incorrectly configured

- DSE defective

- MFC defective

3.3.2 Memory test error DSE x

If a connected DSE is detected, a memory test of the dual-port RAM is initiated. If this memory is faulty, the error message "Memory test error DSE x" is generated. The loading of the machine data is canceled.

The following follow-up message is generated: "DSE axis assignment Ax, machine data loader canceled, erroneous %1 machine data".

Possible causes:

- DSE dual-port RAM defective

- Access via the PCI bus to the DSE memory disrupted by another plug-in card.

3.3.3 DSE x does not run up

The servo-control program for the DSE is loaded from the hard drive into the DSE memory and started when the PC is booted.

If the DSE does not boot when the program is loaded, the error message "DSE x does not run up" is generated. The loading of the machine data is canceled.

The following follow-up message is generated: "DSE axis assignment Ax, machine data loader canceled, erroneous %1 machine data".

Possible causes:

- DSE incorrectly configured (jumper)

- DSE defective

3.3.4 DSE axis assignment Ax

Either the error is merely a follow-up message or the axis assignment with $DSECHANNEL is incorrect.

Possible causes:

- DSE, MFC defective (follow-up message)
- $DSECHANNEL incorrect axis assignment

3.3.5 Power module axis Ax not / incorrectly connected

The current calibration of the axes is compared with the value $CURR_CAL in the machine data list. The message is generated if the axis connector to the power module is incorrectly connected.

Further possible causes:

- MFC/DSE, KPS or KSD function faulty
- Ribbon cable between DSE and power module incorrectly connected or defective
- PCI bus on motherboard faulty

3.3.6 Machine data loader canceled

Possible causes:

- The error is a follow-up message relating to a previous error
- Other machine data in the machine data list are incorrect

3.3.7 Incorrect machine data

Possible causes:

- The error is a follow-up message relating to a previous error
- Other machine data in the machine data list are incorrect

3.4 DSE error messages during operation

3.4.1 Watchdog interpolation cycle Ax

The interpolator sends one feed value per interpolation cycle to the DSE. If this transmission is interrupted for one or more cycles, the watchdog is triggered and this error message is generated.

3.4.2 Synchronization error with DSE Ax

The interpolator sends one feed value per interpolation cycle to the DSE. If the DSE does not read this feed value from the interface, the synchronization monitoring is triggered and this error message is generated.

3.4.3 Regulator limit exceeded Ax

The position controller output has gone into limitation, i.e. the axis does not follow the command value. Possible causes:

- The motor is blocked because
    - the brake does not release
    - the robot has caused a collision during a motion
    - the axis has hit an end stop

- The acceleration is too high because
    - incorrect machine data have been loaded
    - an incorrect weight is entered in the variable $LOAD
    - the weight on the tool is too high

- There is no servo-control of the motor because
    - the enable signal is missing (KSD defective)
    - the motor cables have been interchanged or are defective
    - the motor is not connected

- The controller amplification is incorrect

3.4.4 Stopped Ax

The axis has moved outside the standstill window, although the interpolator had not specified a movement. Possible causes:

- The brake is defective and the axis sags.

- The weight on the tool is greater than the holding torque of the axis.

- There is no servo-control of the motor because
    - the enable signal is missing (KSD defective)
    - the motor cables have been interchanged or are defective
    - the motor is not connected

3.4.5 Motor temperature Ax

The permissible motor temperature has been exceeded. Possible causes:
    - External temperature is too high
    - Encoder cable is interrupted
    - The motion pauses in the motion program are too short
    - The axis is sluggish
    - The weight on the flange is too high

3.5 Fault profiles related to the MFC

3.5.1 Controller hangs when loading software components

Possible causes:

- MFC cannot be initialized
- MFC incorrectly connected
- Additional expansion card (e.g. Interbus) interfering with functioning of MFC
- PCI bus on motherboard faulty

Elimination of fault:

- Remove expansion card and run controller up again
- Check for correct fit of MFC
- Exchange MFC
- Exchange motherboard

3.5.2 KCP control panel does not work

Possible causes:

- CAN controller on the MFC faulty, connecting cable defective
- KCP, cable or connector faulty

Elimination of fault:

- Exchange MFC
- Exchange KCP

3.5.3 No image on KCP

Possible causes:

- Power supply to connector X5 for KCP missing
- KCP, cable or connector faulty
- KVGA card defective
- Defective motherboard

Elimination of fault:

- Restore power supply
- Exchange KCP
- Exchange KVGA card
- Exchange MFC

3.5.4 Operating mode switchover on KCP does not react

Possible causes:

- Mode detection on MFC defective
- Mode selector switch on KCP, cable or connector faulty

Elimination of fault:

- Exchange MFC
- Exchange KCP
- Exchange ESC board

3.5.5 When PC is booted, the operating system VxWorks does not run up

Possible causes:

- MFC defective

Elimination of fault:

- Exchange MFC

3.6 Fault profiles related to the KCP

3.6.1 No display on the LCD

Possible causes:

- Connecting cable defective
- KVGA defective
- KCP defective

Elimination of fault:

- Exchange connecting cable
- Exchange KVGA
- Exchange KCP

3.6.2 Drives cannot be switched on

Possible causes:

- Connecting cable defective
- Enabling switch jammed
- KCP defective
- ESC board defective

Elimination of fault:

- Exchange connecting cable
- Exchange KCP
- Exchange MFC
- Exchange ESC board

3.6.3 No entries can be made via KCP

Possible causes:

- Connecting cable defective
- MFC defective (CAN bus)
- KCP defective

Elimination of fault:

- Exchange connecting cable
- Exchange MFC
- Exchange KCP

3.6.4　EMERGENCY STOP cannot be acknowledged

Possible causes:

- EMERGENCY STOP button defective
- Connecting cable defective

Elimination of fault:

- Exchange KCP
- Exchange connecting cable

3.6.5　Space Mouse does not work

Possible causes:

- Connecting cable defective
- Space Mouse defective
- MFC defective (CAN bus)

Elimination of fault:

- Exchange connecting cable
- Exchange KCP
- Exchange MFC

3.7 Fault profiles related to a field bus card

3.7.1 Communication via diagnostic interface not possible

Possible causes:

- Data cable, periphery faulty
- Diagnostic interface on field bus card defective

Elimination of fault:

- Take appropriate measures on data cable, periphery
- Exchange field bus card

3.7.2 Error message "xxxxx I/O driver configuration error"

Possible causes:

- Field bus card incorrectly configured
- Field bus card cannot be initialized
- Incorrect configuration of the file IOSYS.INI

Elimination of fault:

- Check configuration
- Exchange field bus card
- Check entries in IOSYS.INI

3.7.3 After inserting the field bus card: no display, controller does not boot (Stop 0)

Possible causes:

- Field bus card defective
- Field bus card interferes with MFC function

Elimination of fault:

- Exchange field bus card

3.7.4 The controller "hangs" after initialization of the field bus card

Possible causes:

- Field bus card defective

Elimination of fault:

- Exchange field bus card

3.7.5 No external power supply for slave when controller switched off

Possible causes:

- Interbus filter defective or not correctly connected
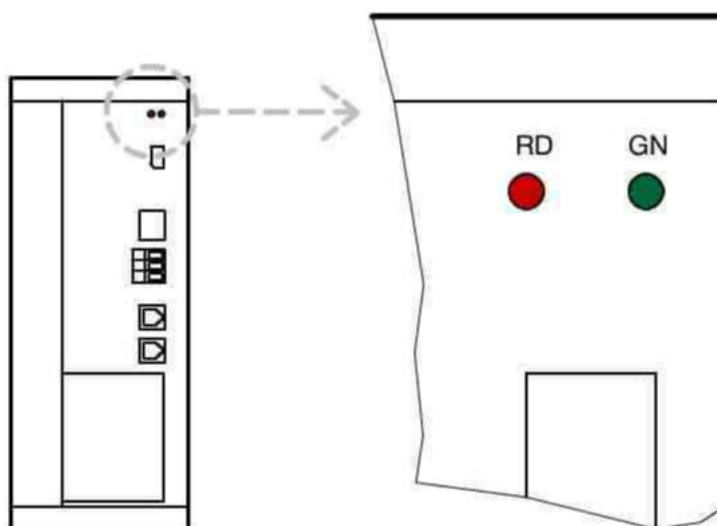- External power supply input on IBS card defective

Elimination of fault:

- Exchange Interbus filter (if fiber-optic cable)
- Exchange Interbus card

4 Servo drive module messages and error displays

In the event of a drives error, messages are displayed in several ways.

4.1 Servo drive module LEDs (KSD1)

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

Fig. 1 Servo drive module LED indicators

Red LED	Green LED	Meaning (message/fault)
Off	Off	No 24 V voltage
On	Off	Undefined drive servo state
Flashes quickly	Flashing quickly (UIC > Ulimit)	Fault present
Flashes slowly	Flashing slowly (UIC < Ulimit) Flashing quickly (UIC > Ulimit)	Message is present (except in case of undervoltage UIC) [default value is 250 V]

Red LED	Green LED	Meaning (no message/fault)
Off	Flashes slowly	UIC < Ulimit
Off	Flashes quickly	UIC > Ulimit
Off	On	Servo enable, UIC > Ulimit

UIC: intermediate circuit voltage
Ulimit: intermediate circuit voltage = 250 V

4.2 KCP messages for drives diagnosis

The following KSD error messages are displayed in the message window of the KCP.

Display in message window	Meaning/ cause of error	Troubleshooting/ possible fault elimination
DRIVES ERROR Ax No.: TRIP	KSD is in a fault state; robot carries out Emergency Stop.	See detailed error message which is also displayed.
OVERCURRENT Ax	1. Overloading of the axis 2. I^2t overload 3. KSD defective	Reduce load on axis (reduce OVR, $ACC_AXIS), exchange KSD.
SYNCHRONISA- TION ERROR DRIVE MODULE Ax	Max. permissible number of commu- nication errors with the servo bus exceeded. Too many consecutive toggle bit er- rors; cause short–circuit braking.	Check Interbus cable between DSE, KPS and KSDs.
HEAT SINK TEMPERATURE Ax	Overtemperature, heat sink	Check cabinet cooling circuit/fans; reduce load on axis (reduce OVR, $VEL_AXIS or $ACC_AXIS).
Parameter error Ax PR1	Checksum error in parameter set 1	Check KSD/restart/exchange
MOTOR CABLE Ax	Power unit overcurrent (short–circuit or ground fault), hardware monitoring Ground fault, software monitoring	Check motor cable/motor
FAILURE OF MOTOR PHASE Ax	Motor phase failure	Check motor cable/motor
Drives error Ax no.: 105	Checksum error in the control unit device set	Check KSD/restart/exchange
Drives error Ax no.: 71	Microcontroller crash	Check KSD/restart/exchange
Drives error Ax no.: 79	Communication error with the EEPROM in the control unit	Check KSD/restart/exchange
Drives error Ax no.: 80	Communication error with the EEPROM in the power unit	Check KSD/restart/exchange
Drives error Ax no.: 106	Checksum error in the power unit device set	Check KSD/restart/exchange

5 KPS-600 messages and error displays

5.1 KPS-600/10 and /20 LED indicators

There are six LEDs on the front of the KPS-600.

LED 1 (red) and LED 2 (green) indicate internal states of the KPS.

LED 3 (green) and LED 4 (green) are reserved for the safety logic and are not yet assigned.

LED 5 (red) and LED 6 (red) indicate the state of the brake control.
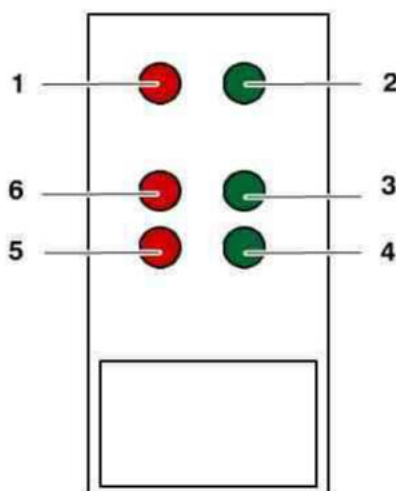

Fig. 2 KPS-600 LED indicator

5.1.1 Meaning of LEDs 1 and 2

LED 1 (red)	LED 2 (green)	Priority*	Meaning
OFF	OFF		Processor without power supply
OFF	Flashes at 1.5 Hz		Intermediate circuit voltage < 60 V
OFF	ON		Intermediate circuit voltage > 60 V
Flashes at 6 Hz	OFF	1	Communication error
Flashes at 3 Hz	OFF	2	Brake error
ON	OFF	3	Main contactor K1 stuck
Flashes 5 times at 1.5 Hz	any	4	Error in BEA signal (signal for flow of current through the ballast resistor)
Flashes 4 times at 1.5 Hz	any	5	Ballast error
Flashes 3 times at 1.5 Hz	any	6	Overvoltage in intermediate circuit
Flashes twice at 1.5 Hz	any	7	Overtemperature in interior / heat sink
Flashes once at 1.5 Hz	any	8	Fault in the low voltage supply (27 V not present)

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

5.1.2 Meaning of LEDs 3 and 4

LED 3	Meaning
Off	Robot brakes not activated
On	Robot brakes activated

LED 4	Meaning
Off	External axis brakes not activated
On	External axis brakes activated

5.1.3 Meaning of LEDs 5 and 6

Designation	State of the red LED	Meaning
V1	LED on	General EMERGENCY STOP activated
V2	LED on	Local EMERGENCY STOP activated

5.1.4 KPS-600 error messages on the KCP

Display in message window	Meaning/cause of error	Troubleshooting/ possible remedy
Parameter error PMx checksum	Checksum error in parameter set 1	Restart/exchange KPS
Parameter error PMx Control	Checksum error in the control unit device set	Restart/exchange KPS
Drives error PMx no.: 71	Microcontroller crash	Restart/exchange KPS
Ballast switch energized for too long PMx during charging	Ixt overload of the brake resistor during charging	Ballast resistor defective or not correctly connected
Ballast switch energized for too long PMx	Ixt overload of the brake resistor during operation	Ballast resistor defective or not correctly connected; deceleration phases in robot program too long; use energy recovery unit
Heat sink temperature PMx	Overtemperature, heat sink	Cabinet ventilation is not working
Cabinet temperature too high PMx	Overtemperature, interior	Cabinet ventilation is not working
Drives error PMx no.: 79	Communication error with the EEPROM in the control unit	Restart/exchange KPS
Watchdog power module PMx	Max. permissible number of communication errors with the servo bus exceeded, causes short-circuit braking	Check field bus – drives cable
Overvoltage PMx during charging	Overvoltage in intermediate circuit while charging	Mains voltage too high (transformer may be necessary)
Overvoltage PMx	Overvoltage in intermediate circuit during operation	Mains voltage too high; ballast switch defective >> exchange KPS
Undervoltage PMx	Low-voltage supply undervoltage	Check low-voltage supply (rated voltage 27.1 V)

Display in message window	Meaning/cause of error	Troubleshooting/ possible remedy
Buffer battery voltage low	Battery undervoltage, $U<22$ V	Charge battery
Check battery PMx	Battery undervoltage, $U<19$ V	Charge battery Exchange battery
Undervoltage PMx during charging	Undervoltage in intermediate circuit while charging, 500 V threshold not reached	Mains voltage too low
Brake error Ax/PMx channel x	Brake error, main axes	Brakes not connected or short–circuit on the brake cable
Brake error Ax/PMx channel x	Brake error, external axes	Brakes not connected or short–circuit on the brake cable
Intermediate circuit charging circuit defective PMx	Optocoupler for ballast resistor current detection signals that no current is flowing	Restart/exchange KPS
K1 contactor welded PMx	Main contactor K1 stuck	Exchange KPS

The mastering can be saved manually via the KUKA HMI.

Before changing the battery: Setup > Master > Save current data

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6 KPS-27 operating state indicators

On the front of the KPS-27 are two LEDs which indicate the operating states of the low-voltage power supply unit:

LED indicator	State	Meaning
Green LED (OK)	Lit	Normal operation
Red LED (overload)	Lit	Overload operation
Red LED (overload)	Flashes slowly	Short-circuit operation

7 DSE-IBS operating state indicators

When the DSE-IBS is plugged in, the green diagnostic LED is on the upper side. The meaning of the LEDs is explained in the following table:

Green LED	Meaning
Off	Servo program not active
Lit	Error
Flashing	Servo program active – operating state OK *

* The LED display is only meaningful once the controller has booted.

8 RDC2 operating state indicators

There are two diagnostic LEDs on the RDC2.
The meaning of the LEDs is explained in the following table:

LED indicator	State	Meaning
Green LED	Off	No power supply
	On	3.3 V power supply OK
Red LED	Flashing	RDC not yet ready (boot procedure)
	On	RDC ready for operation
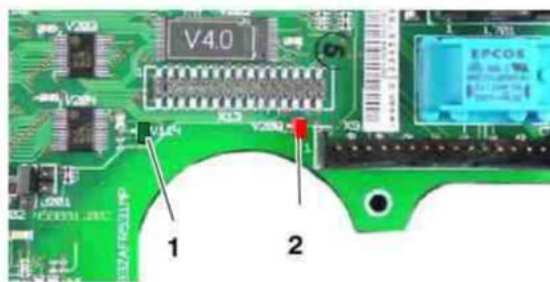
1	Green diagnostic LED	2	Red diagnostic LED

Fig. 3 LED indicators on the RDC2

9 ESC diagnostic tool

The computer–aided safety system "ESC" (Electronic Safety Circuit) allows the permanent monitoring of all connected ESC circuit nodes. These include safety–related elements, such as Emergency Stop buttons or operator safety.

> ESC diagnosis is supported from controller version "KR C2" onwards.

> Only the safety circuit of the controller itself can be monitored.

Monitor

Open the "Monitor" menu and select the command "Diagnosis" –> "Securitycircuit".

```
0 I/O                    ►
1 Rob. Position          ►
2 Cyclic Flags (Notice)
3 Flags
4 Counter
5 Timer
6 Variable               ►
7 Diagnosis              ►    0 Oscilloscope      ►
8 Refresh display             1 Log book          ►
9 Windows                ►    2 CROSS Log book
10 Icon Edit                  3 Caller Stack
                              4 Interrupts
                              5 Securitycircuit
```
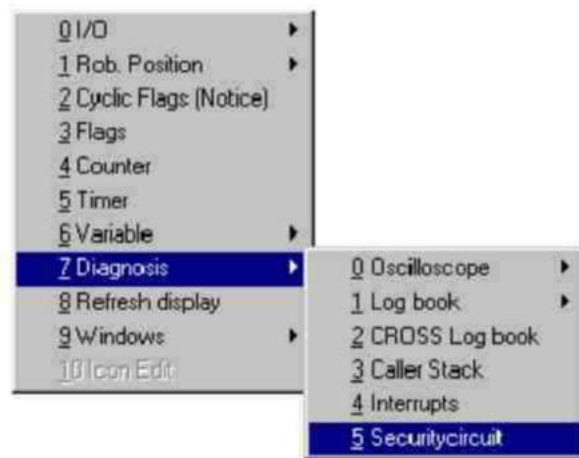
The ESC diagnosis window is then displayed. The type and number of nodes available depend on the periphery used.
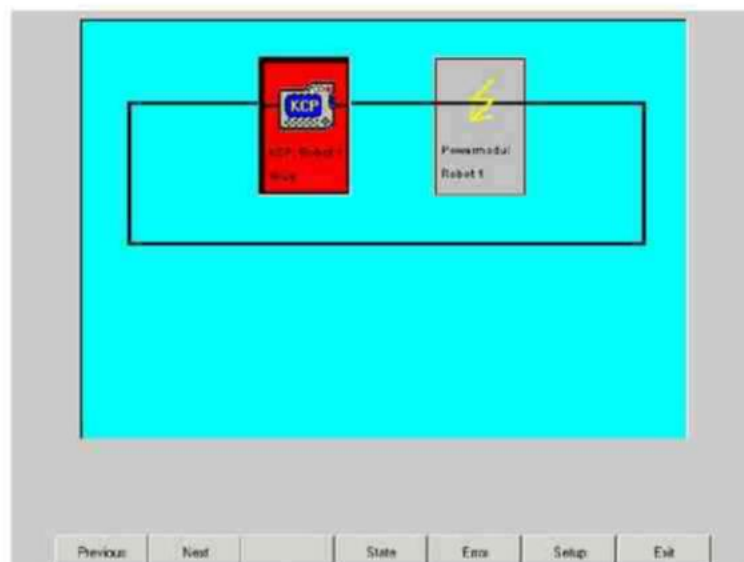
Fig. 4 Example: KR C2 standard configuration with KCP, KPS–600, MFC and CI board

The safety circuit units present are shown in the display. The passive MFC node is not displayed. The CI board does not have a node.

The current node is highlighted by means of a selection frame (focus). Special node states are indicated in color.

> **i** ESC diagnosis can also be started without the robot controller running. To do so, open the Windows Start menu and select the option "Run". Enter the following command in the input line in the Run window:
>
> "C:\KRC\Util\ESCView.exe"

9.1 Softkey bar

Previous

Pressing the softkey "Previous" places the "focus" on the next node down, thus selecting it as the current element.
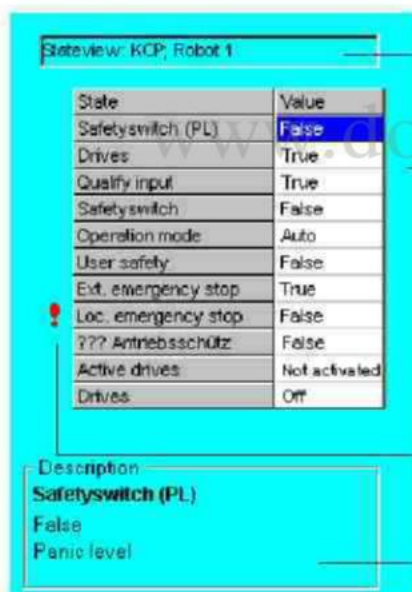
If the current node has the number "1", the node with the highest number is selected.

Next

Pressing the softkey "Next" causes the next node up to be selected, thus making it the current element. If the current node has the highest possible number, the node with the number "1" is selected.

State

The softkey "State" is used to open the status indicator of the safety circuit. Data relevant to the selected node are listed here.

Information about the selected node. Settings can be made using the softkey "Configure" or in the file "ESCDiag.ini".

The states of an individual node and its values can be viewed here.
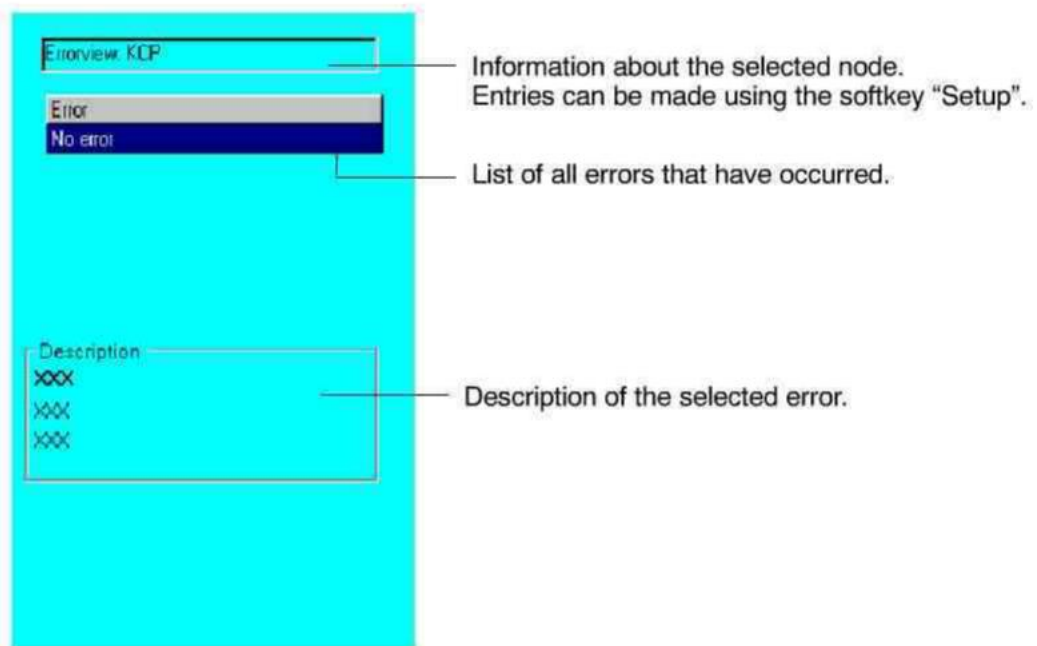The values are updated cyclically.

If the node has a special state, i.e. it is highlighted in color, the reason can be viewed here (in this example, the drives must be activated and the enabling switch pressed).

Descriptions of the last state changed (in this example, the panic position has been pressed and released again).
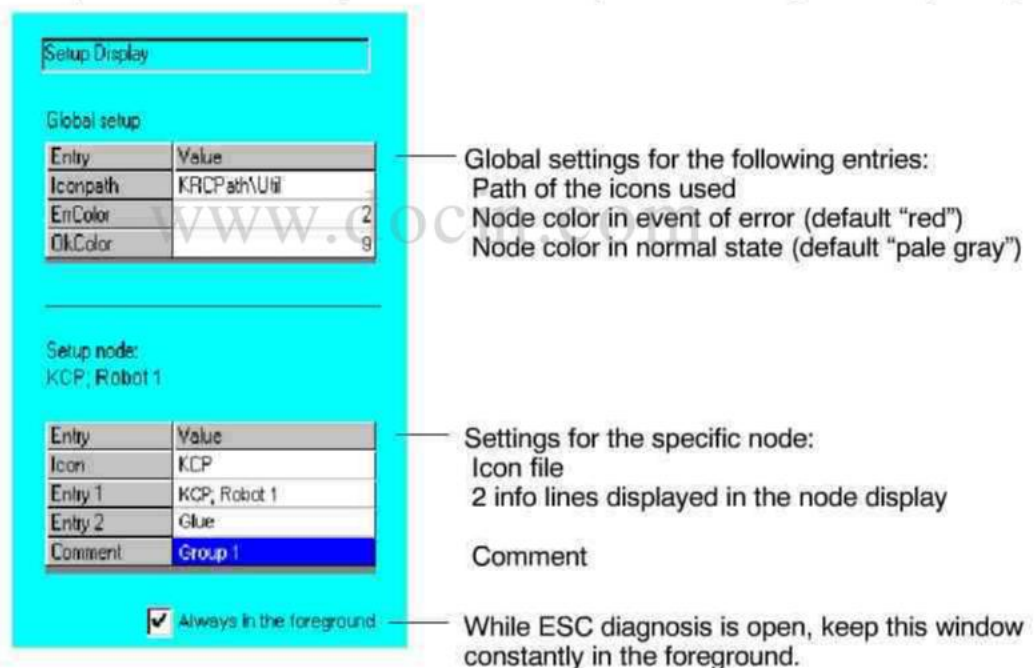
Error

This softkey opens the error display. Errors that are not assigned to any particular node are displayed here. These include communication errors in the safety circuit as well as hardware and software errors.

Errorview: KCP

Error
No error

Description
XXX
XXX
XXX

Information about the selected node.
Entries can be made using the softkey "Setup".

List of all errors that have occurred.

Description of the selected error.

Setup

At Expert level, certain settings can be made for a specific node using the softkey "Setup".

Setup Display

Global setup

Entry	Value
Iconpath	KRCPath\Util
ErrColor	2
OkColor	9

Global settings for the following entries:
Path of the icons used
Node color in event of error (default "red")
Node color in normal state (default "pale gray")

Setup node:
KCP; Robot 1

Entry	Value
Icon	KCP
Entry 1	KCP; Robot 1
Entry 2	Glue
Comment	Group 1

Settings for the specific node:
Icon file
2 info lines displayed in the node display

Comment

☑ Always in the foreground

While ESC diagnosis is open, keep this window constantly in the foreground.

ℹ The settings of the "Setup" window are stored in the file "C:\KRC\Roboter\Init\ESC-Diag.ini".

☞ If errors occur while loading the .ini file, an error message is generated.
For entries that cannot be evaluated, the default values are used.

Exit

This softkey is used to close the "State", "Error" and "Setup" windows or terminate ESC diagnosis.

9.2 ESC diagnosis error messages

Safety circuit diagnosis display	Corrective measure
Byte timeout during receipt of log	Check bus wiring
Checksum error in log	Check bus wiring
Invalid header byte	Check bus wiring
Interface error	Check bus wiring
Mode error	Both operating modes active Only one operating mode may be selected.
No log received	Check bus wiring
Initialization error	Two KCPs in the ESC circuit! Only one KCP (master) may be present in the circuit.
Configuration error	Wrong configuration on ESC master (KCP). Exchange KCP.
Hardware fault	General message
PICA/PICB	ESC chip from which the message comes
Communication error	Check bus wiring
Software error	Exchange module with software error
I/O monitoring error	Check wiring to external contactor
RAM error	Exchange module
Relay error	Two modules are active or relays on the module are stuck
Output error	General message
Output error, operating mode	Relay error (operating mode)
Output error, drives contactor (auxiliary contact)	Check wiring to external contactor (auxiliary contact)
Output error, local E-Stop	Relay error (EMERGENCY STOP)
Output error, AE coil	Check wiring to external contactor
Cross-connection error at: Local E-Stop	Short-circuit TA24(A) / TA24(B). Check wiring of the input for local E-Stop (NA)
Cross-connection error at: External E-Stop	Short-circuit TA24(A) / TA24(B). Check wiring of the input for external E-Stop (ENA)
Cross-connection error at: Operator safety	Short-circuit TA24(A) / TA24(B). Check wiring of the input for operator safety (BS)
Cross-connection error at: Qualifying input	Short-circuit TA24(A) / TA24(B). Check wiring of the input for qualifying input (QE)
Cross-connection error at: Enabling switch 1	Short-circuit TA24(A) / TA24(B). Check wiring of the input for enabling switch 1 (ZS1)
Cross-connection error at: Mode selector switch	Short-circuit TA24(A) / TA24(B). Check wiring of the input for operating mode (Auto/Test)
Cross-connection error at: E2 keyswitch	Short-circuit TA24(A) / TA24(B). Check wiring of the input for keyswitch E2

Safety circuit diagnosis display	Corrective measure
Cross-connection error at: Enabling switch 2	Short-circuit TA24(A) / TA24(B). Check wiring of the input for enabling switch 2 panic position (ZS2).
Cross-connection error at: Activate drives or Drives enable	Short-circuit TA24(A) / TA24(B). Check wiring of the input for Activate drives (AA) and Drives enable (AF).

10   DSE-RDW diagnostic tool

This service option offers you a range of options for displaying states and fault diagnosis as well as for configuring the DSE–RDW part of the robot system.

10.1   Main menu of the DSE–RDW diagnostic tool

Navigate within the menus using the mouse, or use the keypad to enter the number preceding the menu text. The "ESC" key takes you up a level in the menu structure. Pressing the "ESC" key at the top menu level exits the diagnostic tool.

> **Only alter the configuration settings if you have adequate knowledge of its function, and of the consequences of the alteration!**
>
> **The contents of the EEPROM in the RDC unit can be overwritten.**
>
> **These data cannot be restored simply by booting the system.**

Setup > Service > DSE–RDW
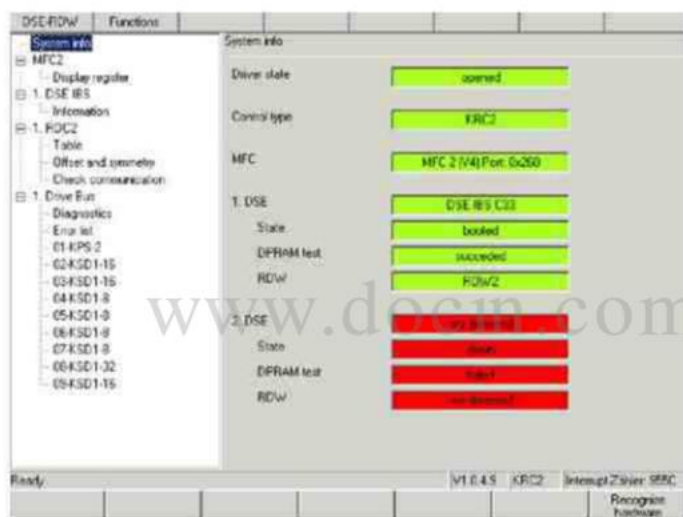
Softkey assignment:

- Recognize hardware
  Initiates the update of the data in the display boxes.

10.1.1 Language selection

The language for the menus is selected via:

DSE–RDW > Language > [desired language]:

Display in the status line:

- – Version number of the DSE–RDW diagnostic tool

- – Type of control cabinet

- – Current value of the DSE interrupt counter: incrementation of the counter indicates that the DSE control program is running correctly.

10.1.2 System info

Displays the operating state of the DSE.
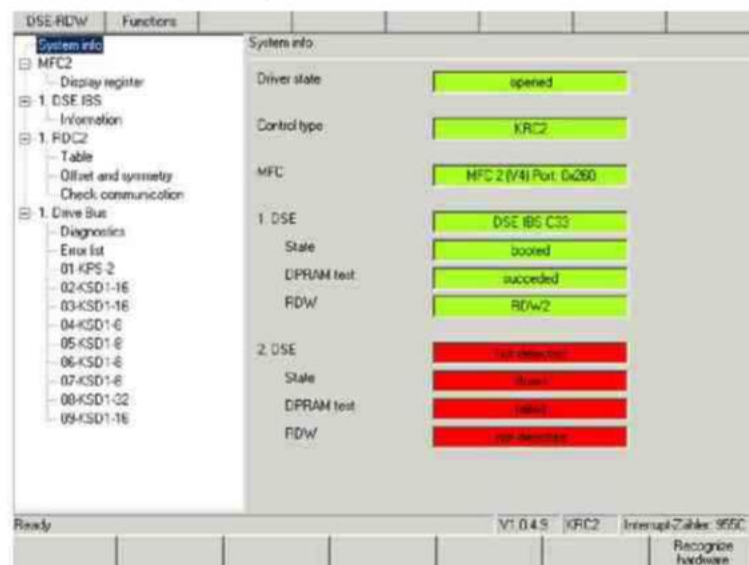
Display box assignment:

- Driver state: program is being executed

- Control type: type of controller (KR C1, KR C2, KR C3)

- MFC: version of the MFC module used

- 1. DSE: type of the first DSE module

  - State: operating state of the DSE module

  - DPRAM test: result of the dual–port RAM test

  - RDW: type of RDC module used

There is no second DSE present in this case; the four display boxes are identical to those for the first DSE.

Softkey assignment:

- Recognize hardware
  Initiates the update of the data in the display boxes.

10.1.3 MFC2 register display

Displays the contents of the MFC register.
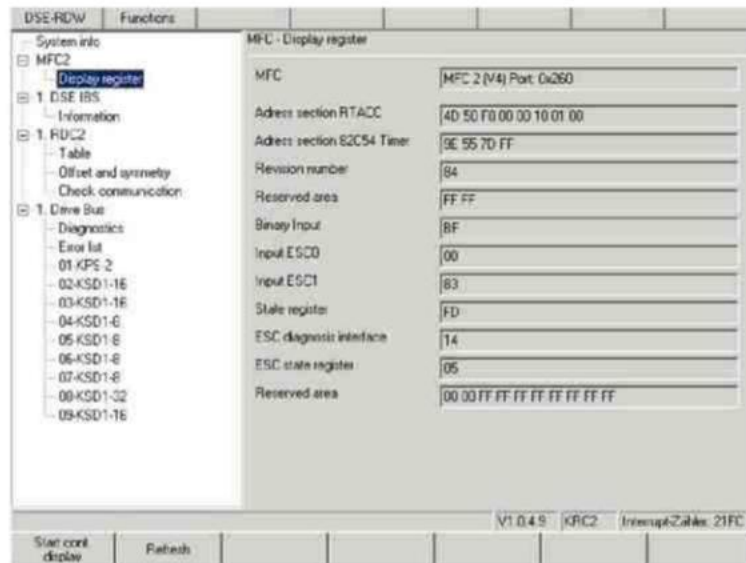
Display box assignment:

- MFC: version of the MFC module used

- Remaining display boxes: development data

Softkey assignment:

- Start continuous display
  Start / stop the continuous updating of the display

- Refresh
  Triggers a one-off update of the display

10.1.4 DSE IBS information

Displays DSE hardware and software versions.
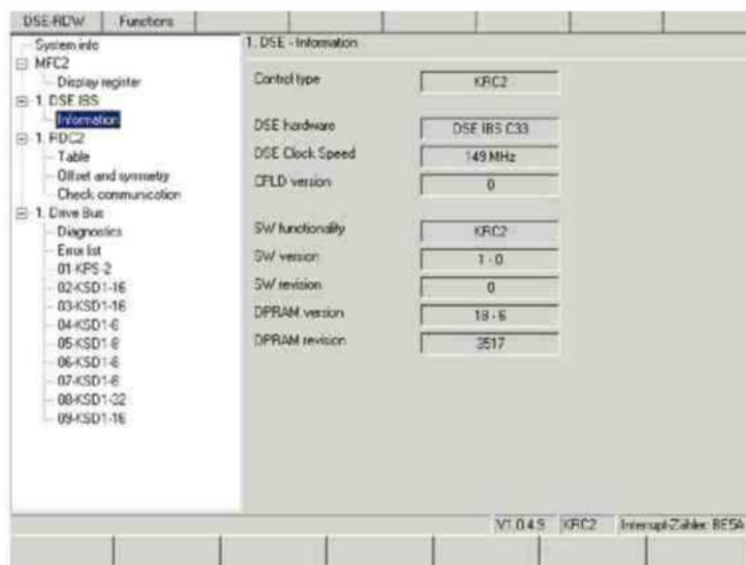
Display box assignment:

- Control type: type of controller (KR C1, KR C2, KR C3)

- DSE hardware: hardware version of the DSE

- DSE Clock Speed: clock frequency of the DSE used

- Remaining display boxes: internal version numbers

10.1.5 Display RDC table

Displays RDC measurement and configuration data.

Softkey assignment:

- Start continuous display
  Start / stop the continuous updating of the display

- Refresh
  Triggers a one–off update of the display

- Export
  Saves the current RDC table to the hard drive

- Page up / Page down
  Navigation within the table

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

10.1.6 RDC offset and symmetry adjustment

Displays the adjustment data for all axes.

Adjustment of the following values is carried out automatically.

- Sine offset
- Cosine offset
- Sine calibration
- Cosine calibration

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

Softkey assignment:

- Set default values
  The default values should be set if motors or the RDC module have been exchanged, or if sporadic encoder errors have occurred.

10.1.7 Check RDC–DSE communication

The RDC sends data words to the DSE in a 125 μs cycle. This function can be used to check the communication between the DSE and the RDC.
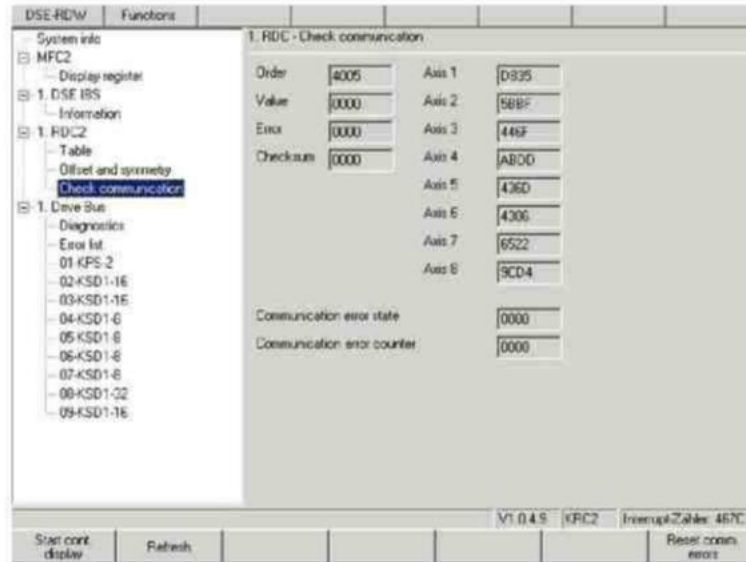
Meaning of the values displayed in the message window:

- **Order:** The last command the DSE has sent to the RDC.

- **Value:** Motor temperatures of axes 1 to 8.

- **Error:** Encoded display of the encoder error bits and EMT signals

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

- **Checksum:** Checksum for all transferred data.

- **Communication error state:**
  If more than three transmissions have failed, the value 0001 is displayed.

- **Communication error counter:**
  Sum of all incorrect transmissions since the last "Reset comm. errors".

- **Axis nn:** Displays the resolver positions of axis nn. The values vary during operation. If a resolver position has the value zero, there is an encoder error.

Softkey assignment:

- Start continuous display
  Start / stop the continuous updating of the display

- Refresh
  Triggers a one-off update of the display

10.1.8 Drive bus diagnostics

The values displayed in the message window have the following meaning:

- Number of cycles: number of data transmissions between DSE and RDC since system switched on / reset

- Data errors: number of data errors in the data transmissions between DSE and RDC (sporadic errors)

- Data errors in series: number of consecutive data errors following the first three

- Ident errors: number of errors during transmission

Softkey assignment:

- Start continuous display
  Start / stop the continuous updating of the display

- Refresh
  Triggers a one-off update of the display

10.1.9 Drive bus error list

Displays the error statistics with the drive bus running.

Softkey assignment:

- Start continuous display
  Start / stop the continuous updating of the display

- Refresh
  Triggers a one-off update of the display

- Reset cycle counter

- Reset errors

- Reset error list

10.1.10 Drive bus diagnostics - KPS-2

Softkey assignment:

-   Start continuous display
    Start / stop the continuous updating of the display

-   Refresh
    Triggers a one-off update of the display

-   Export code table
    Saves the current code table to the hard drive
    (example: C:\KRC\Roboter\Log\Drivebus1-4_KSD1-8.log)

Meaning of the values displayed in the message window:

-   Lecom error
    Lenze communication error number

-   Hardware version of control and power unit

-   Various voltages, currents and temperatures of the KPS

-   Operating time counter: intermediate circuit has been active for xx hours

-   Power-on time counter: KPS-2 has been active for xx hours

-   1st and 2nd code position:
    Polling of the current error memory and the last three history entries:
    Code position   161:   current error
                       162:    current error -1
                       163:    current error -2
                       164:    current error -3

10.1.11 Drive bus KSD 1-16

Softkey assignment:

- Start continuous display
  Start / stop the continuous updating of the display
- Refresh
  Triggers a one-off update of the display
- Export code table
  Saves the current code table to the hard drive
  (example: C:\KRC\Roboter\Log\Drivebus1-4_KSD1-8.log)

Meaning of the values displayed in the message window:

- Lecom error
  Lenze communication error number

- Hardware version of control and power unit

- Various voltages, currents and temperatures of the KSD

- Operating time counter: intermediate circuit has been active for xx hours

- Power-on time counter: KSD 1-16 has been active for xx hours

- 1st and 2nd code position:
  Polling of the current error memory and the last three history entries:
  Code position   161:   current error
                  162:   current error -1
                  163:   current error -2
                  164:   current error -3

10.1.12 Error messages valid for the KPS-600

IBS trip number	Lecom error number	Message text	Meaning
0	0	"ok"	Device state OK
1	72	"Pr1–Trip"	Checksum error in parameter set 1
3	105	"HO5–Trip"	Checksum error in the control unit device set
5	71	"CCr–Trip"	Microcontroller crash
6	11	"OC1–Trip"	Ixt overload of the brake resistor while charging
8	15	"OC5–Trip"	Ixt overload of the brake resistor during operation
10	50	"OH–Trip"	Overtemperature, heat sink
39	52	"OH2–Trip"	Overtemperature, interior
24	79	"Pr5–Trip"	Communication error with the EEPROM in the control unit
28	65	"CE4–Trip"	Max. permissible number of communication errors with the drive bus exceeded, causes short–circuit braking
35	131	"OV1–Trip"	Overvoltage in intermediate circuit while charging
36	132	"OV2–Trip"	Overvoltage in intermediate circuit during operation
19	32	"LP1–Trip"	Mains phase failure
31	121	"LV1–Trip"	Low voltage supply undervoltage
32	122	"LV2–Trip"	Battery undervoltage, U<22 V
33	123	"LV3–Trip"	Battery undervoltage, U<19 V
34	124	"LV4–Trip"	Undervoltage in intermediate circuit while charging, 500 V threshold not reached
41	141	"BR1–Trip"	Brake error, main axes
30	142	"BR2–Trip"	Brake error, external axes
37	112	"BEA–Trip"	Optocoupler for ballast resistor current detection signals that no current is flowing
40	111	"K1–Trip"	Main contactor K1 stuck

10.1.13 Error messages valid for the KSDs

(valid from Firmware V0.3 onwards)

IBS trip number	Lecom error number	Message text	Meaning
0	0	"ok"	Device state OK
1	72	"Pr1-Trip"	Checksum error in parameter set 1
3	105	"HO5-Trip"	Checksum error in the control unit device set
5	71	"CCr-Trip"	Microcontroller crash
6	11	"OC1-Trip"	Power unit overcurrent (short-circuit or ground fault), hardware monitoring
7	12	"OC2-Trip"	Short-circuit, software monitoring
8	15	"OC5-Trip"	I*t overload
10	50	"OH-Trip"	Overtemperature, heat sink
11	91	"EEr-Trip"	External error, short-circuit braking requested by the controller
19	32	"LP1-Trip"	Motor phase failure
24	79	"Pr5-Trip"	Communication error with the EEPROM in the control unit
28	65	"CE4-Trip"	Max. permissible number of communication errors with the drive bus exceeded, or too many toggle bit errors in succession, causes short-circuit braking.
43	80	"PR6-Trip"	Communication error with the EEPROM in the power unit
44	106	HO6 trip	Checksum error in the power unit device set

11 Oscilloscope

The submenu "Oscilloscope" contains the two additional menu items "Display" and "Configure".

Monitor   Using the menu key "Monitor", open first the submenu "Diagnosis" and then the menu "Oscilloscope". The following submenu is displayed:

```
0 I/O                    ▶
1 Rob. Position          ▶
2 Cyclic Flags (Notice)
3 Flags
4 Counter
5 Timer
6 Variable               ▶
7 Diagnosis              ▶    0 Oscilloscope    ▶    0 Display
8 Refresh display             1 Log book        ▶    1 Configure
9 Windows                ▶    2 CROSS Log book
10 Icon Edit                  3 Caller Stack
                              4 Interrupts
                              5 Securitycircuit
```
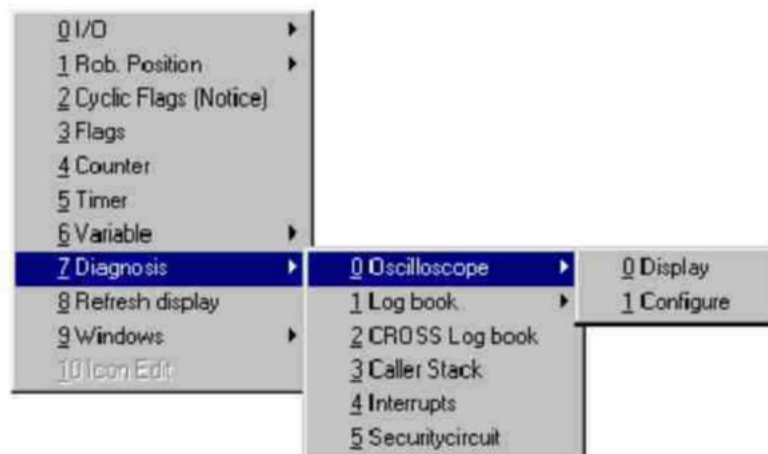
> ℹ️ The commands in the menu bar are deactivated and cannot be selected while the oscilloscope is being displayed or configured.

11.1 Display

This function allows you to display and analyze saved traces.
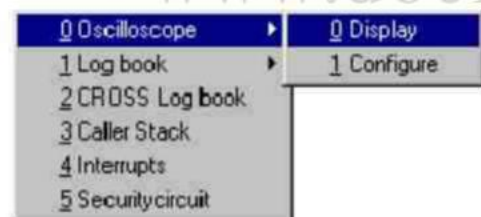
```
0 Oscilloscope      ▶    0 Display
1 Log book          ▶    1 Configure
2 CROSS Log book
3 Caller Stack
4 Interrupts
5 Securitycircuit
```

A window is opened on the display. All files which are archived in the directory `C:\KRC\Roboter\TRACE` and have the extension TRC are displayed here.

```
BEW11.TRC
BEW21.TRC
BEW31.TRC
BEW33.TRC
BEW41.TRC
ERRTRIG1.TRC
STATRIG1.TRC
```

11.1.1 File selection

The desired file can be selected using the arrow keys. The name of the selected file is indicated by a color highlight. Move the cursor to a file having the end digit "1". It contains data from the digital servoelectronics DSE ("3" = I/O data, "4" = interpolator data, "%" = test data).

| Ok |

After selecting this file, please press the softkey "Ok".

The oscilloscope display is opened.

| 2nd file |

The softkey "2nd file" is described in more detail in the section **[Superposing traces]**.

11.1.2 Oscilloscope screen

The contents of your screen should now look similar to those below. However, you have probably recorded other data with a different configuration. For this reason, the individual curves also have different forms and different colors on your screen.
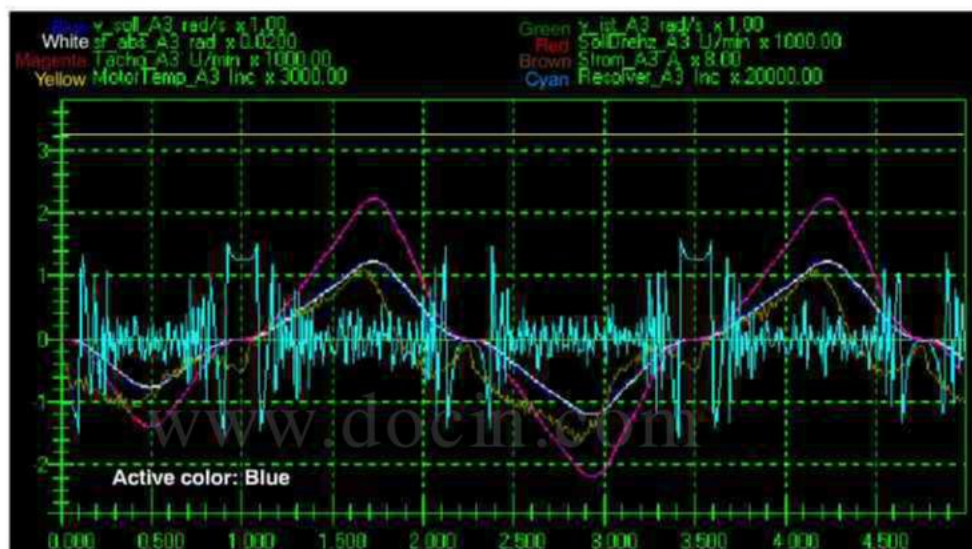
More detailed information about the curves can be found in the upper part of the display. The color, the name, the unit of measurement and the scale of the display are listed in sequence for each curve.

The left bar (vertical) shows values which, when multiplied by the scale of the display, represent the value of a curve at a point in time that is shown below on the time axis (horizontal).

If signals from the controller's inputs and outputs are displayed, the left bar (vertical) contains numbers as placeholders for the number of the selected inputs or outputs.

Inputs or outputs are only displayed while they have the value "TRUE".
While an input or output has the value "FALSE", only a broken gray line is displayed.

White $OUT[1..16] bin x 400.00   Red $OUT[17..32] bin x 400.00
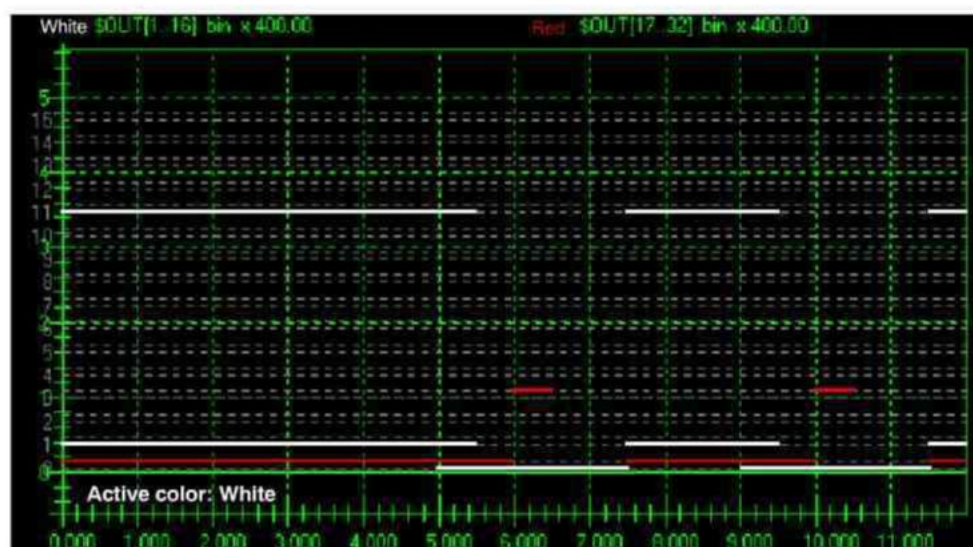
Active color: White

The "active" color is permanently displayed at the bottom left of the screen.

You can "move" through the entire trace by using the arrow keys.

Cancel   You can exit the display function again at any time by pressing the softkey "Cancel".

11.1.3 The information window

Info   Now press the softkey "Info". A window is opened displaying further information about the individual curves. The information window appears as follows for the example given above:

No.		File	Channel	Description	Color	Visible
●	Graph 0	BEW31	Channel 0	Teil-Sollwert_A1	Blue	yes
●	Graph 1	BEW31	Channel 1	Ist-Drehzahl_A2	Green	yes
○	Graph 2	BEW31	Channel 2	Schleppfehler_A3	White	yes
●	Graph 3	BEW31	Channel 3	Soll-Drehzahl_A4	Red	yes
●	Graph 4	BEW31	Channel 4	Ist-Drehzahl_A5	Magenta	yes
●	Graph 5	BEW31	Channel 5	Strom_A6	Brown	yes
●	Graph 6	BEW31	Channel 6	Motortemperatur_A7	Yellow	yes
●	Graph 7	BEW31	Channel 7	Resolver_A8	Cyan	yes

The color and the number of each curve are displayed in the first column.

The second column specifies the file from which the data for the curve have been read.

You can see the channel to which the curve has been assigned and the variable that it represents in the columns "Channel" and "Name".

The name of the color of the curve is displayed in the column "Color".

The last column indicates whether the curve is visible or hidden.

Info   Press the softkey "Info" again. The window is closed. You can switch between the two functions by using this softkey.

11.1.4 The softkey bar

The softkey bar has four levels in the function "Display".

===>

You can switch between these four levels by using the softkey "===>".
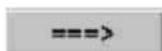
Info	Blue	Green	White	Red	—>	Cancel

Magenta	Brown	Yellow	Cyan	Channel	—>	Cancel

Zoom	Unzoom	Save	RMS	Print	—>	Cancel

VCursor 1	VCursor 2	HCursor 1	HCursor 2	Filt.OnOff	—>	Cancel

11.1.5 The color softkeys

To make it as easy as possible to read the display, a maximum of eight different colors (blue, green, white, red, magenta, brown, yellow and cyan) are shown.

Curves can be displayed or removed on the basis of their colors with the aid of the color softkeys. This is done quite simply by pressing the appropriate color softkey.

Blue

Hide the blue curve, for example, by pressing the softkey "Blue". Then open the information window. Reminder: To do so, press the softkey "Info".

No.	File	Channel	Description	Color	Visible
⊗ Graph 1	BEW31	Channel 1	v_soll_A1	No color	no
● Graph 2	BEW31	Channel 2	v_ist_A1	Green	yes

Your action has been registered in the last column (far right). "Visible" now has the value "No" for the blue curve.

Close the information window again and then make the blue curve visible once more. To do so, press the color softkey "Blue" again.

If you press color softkeys while the information window is open, color assignments will be canceled. The procedure for recovering canceled color assignments is described in the section **[Changing color assignments, Section 11.1.14]**.

Certain graphs can be removed by selecting the desired graph in the information window and pressing the "Enter" key. More detailed information on this can be found in the section **[Switching curves on and off, Section 11.1.15]**.

11.1.6 The scaling function

In the display, you are able to increase or reduce the amplitude of individual curves.

Channel

To do so, press the softkey "Channel" until the color of the desired curve is active. The active color is permanently displayed at the bottom left of the window.
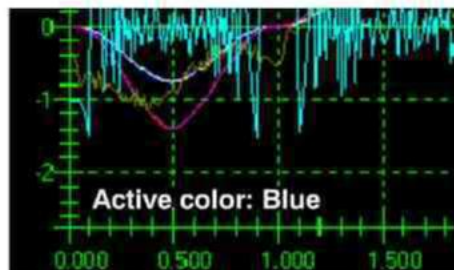
Now observe what changes occur when you press the keys "M" or "N" in the ASCII alphabetic keypad.

N
M

Pressing the key "N" in the ASCII alphabetic keypad gradually <u>increases</u> the amplitude.

Pressing the key "M" in the ASCII alphabetic keypad gradually <u>decreases</u> the amplitude.

By using this function, it is also possible to clearly display curves which only have a small deflection or which are hidden by other curves.

The current scale is given in the top area of the display.

11.1.7 The zoom function

Press the softkey "===>" repeatedly until the following softkey bar appears.

Zoom	Unzoom	Save	RMS	Print	—>	Cancel

Zoom

When the softkey "Zoom" is pressed, a white cross about five millimeters high appears in the middle of the window. This can be moved about the entire window using the arrow keys. Move it to the position of your choice and then press the Enter key. The point that is currently selected represents a corner point of the zoom window, which must now be expanded using the arrow keys. Include everything that you want enlarged in this zoom window and then press the Enter key again. The contents of the zoom window will then be enlarged on the display.

Unzoom

To undo zooming, please press the softkey "Unzoom".

11.1.8 The Save function

Press the softkey "===>" repeatedly until the following softkey bar appears.

Zoom	Unzoom	Save	RMS	Print	—>	Cancel

Save

This softkey saves the current oscilloscope display as a bitmap on the hard disk. It is saved as a BMP file in the directory "C:\KRC\Roboter\Trace\". The file name corresponds to the name of the trace or the loaded file. This file can then be viewed in a graphics program (MS Paint, Picture and Fax Viewer).

11.1.9 The r.m.s. value function

In order to determine the value that a curve represents during a certain period of time as easily as possible, the r.m.s. value function has been integrated.

Channel

To determine the r.m.s. value, you must press the softkey "Channel" to select the color used by the curve that is to be evaluated. The active color is permanently displayed at the bottom left of the window.
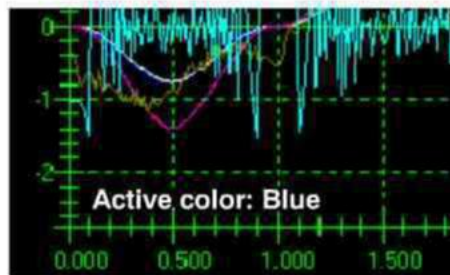
RMS

Then press the softkey "RMS". A vertical white line with the label "Evaluation of RMS" is displayed in the window
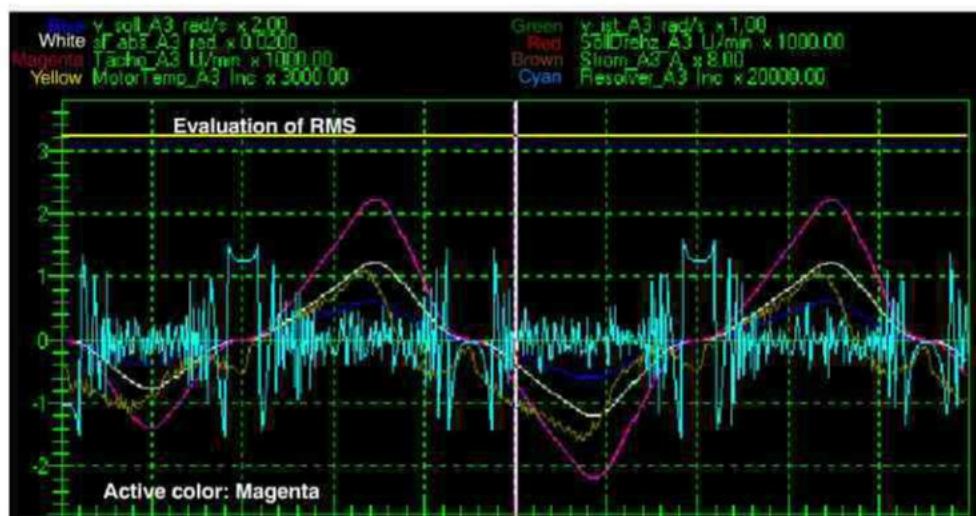
Now move this line to the start point of your r.m.s. value evaluation using the "←" and "→" arrow keys and then press the Enter key.

You can now use the "←" and "→" arrow keys to define a sort of "measuring range", which is displayed as a white box.
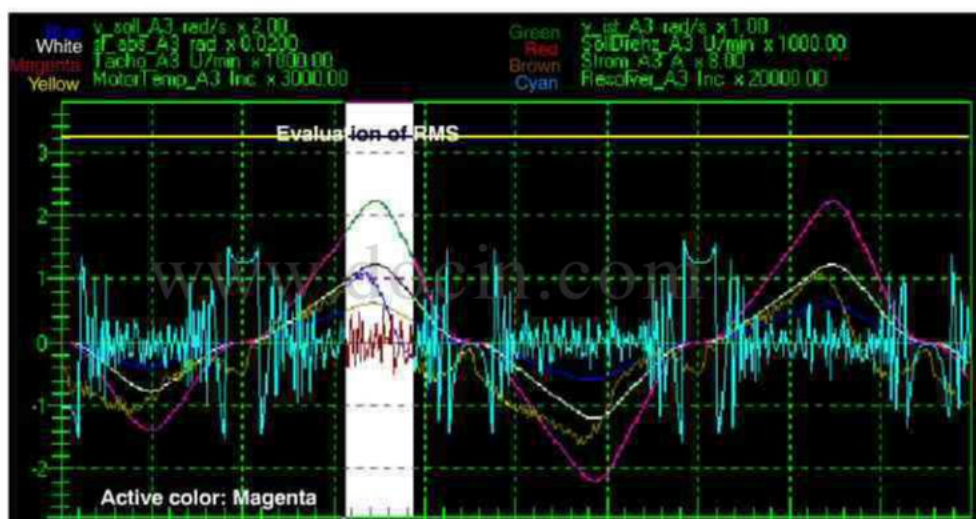
After pressing the Enter key, the result of the evaluation is displayed in the window.
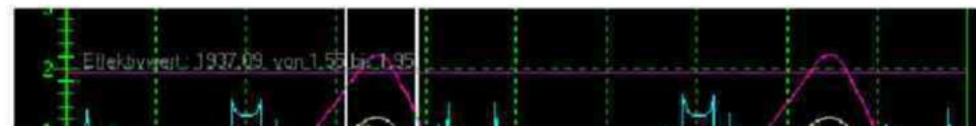
Should the text that is displayed be concealed by other curves and thus cannot be read, simply hide the other curves for the time being. Reminder: To do so, use the color softkeys.

RMS   To end the "RMS" function, press the softkey "RMS" again.

If you press the softkey "Cancel" instead, the entire display function will be ended.

11.1.10 Print

| Print |

If you would like to print out the contents of the screen, please press the softkey "Print".

> The screen is printed on the current default printer of the operating system; the printer should be set to "Landscape".

11.1.11 The cursor functions

Press the softkey "===>" repeatedly until the cursor functions appear in the softkey bar.

| VCursor 1 | VCursor 2 | HCursor 1 | HCursor 2 | Filt.OnOff | → | Cancel |

Using these functions, you can place two vertical and two horizontal lines (cursors) inside the window. This enables you to determine the value that a curve represented at a certain time quite easily.

The color of the active curve is permanently displayed at the bottom left of the window. To change it, press the softkey "===>" repeatedly until the following functions appear in the softkey bar.

| Magenta | Brown | Yellow | Cyan | Channel | → | Cancel |

| Channel |

Press the softkey "Channel" until the color of the desired curve is active.
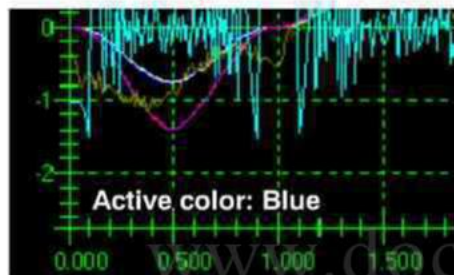
| VCursor 1 |

Change the softkey bar again and then press the softkey "VCursor1". A vertical white line is displayed in the window.
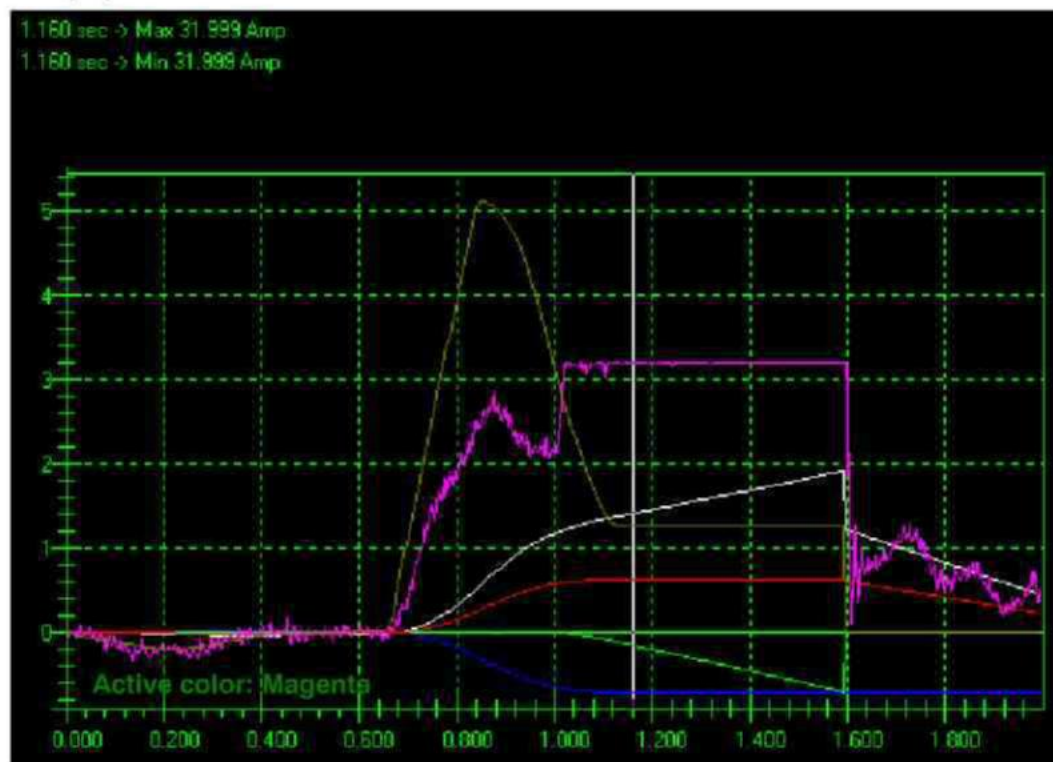
The value that the selected curve had at the time where the cursor is currently positioned is displayed at the top left of the window (two values are displayed in this illustration as the softkey "Filter off" has been selected). When inputs or outputs are displayed, the bit pattern of the selected input or output group is displayed.
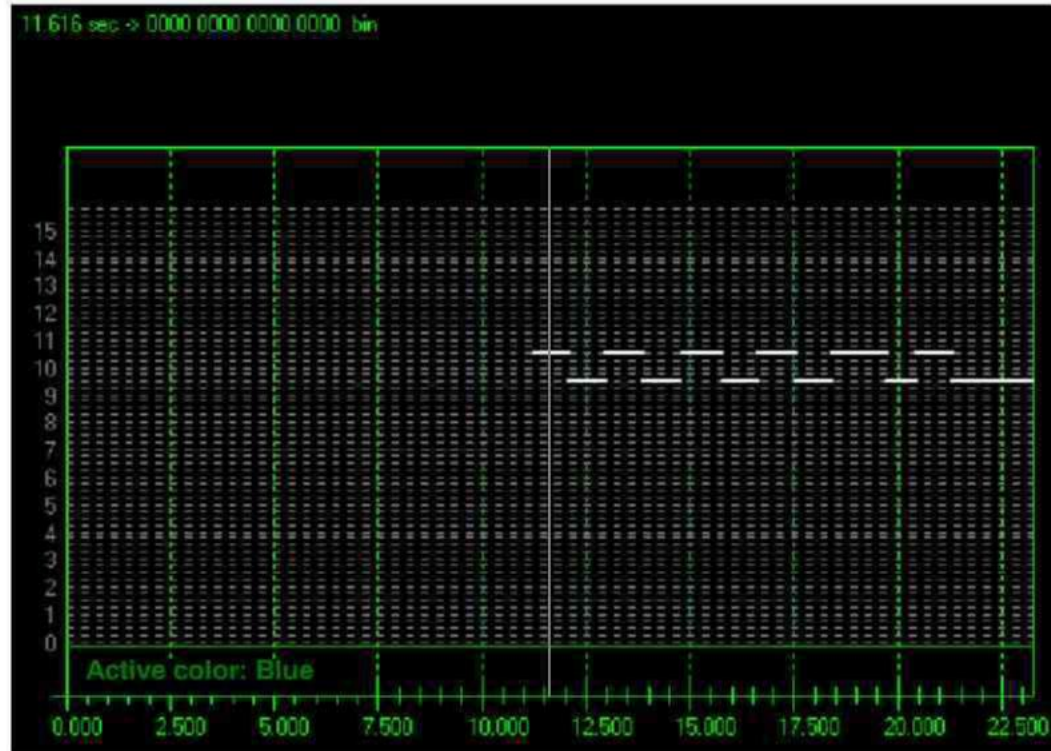
Now move the cursor using the arrow keys and observe how the top left of the display changes.

VCursor 2

Press the softkey "VCursor2". A second vertical white line (cursor) is displayed in the window.

The values for the second cursor now appear to the right of the display for the first cursor. Two values are displayed in this illustration, one below the other, as the softkey "Filter off" has been selected. When inputs or outputs are displayed, the bit pattern of the selected input or output group is shown here as well. The time difference between these two cursors is displayed on the left–hand side.

These cursors can be removed again by pressing the softkey "VCursor1" or "VCursor2" once more.

HCursor 1   If you press the softkey "HCursor1", a horizontal white line (cursor) is displayed in the window.

☞ When inputs and outputs are displayed, the function "HCursor" is not suitable for showing the numbers.
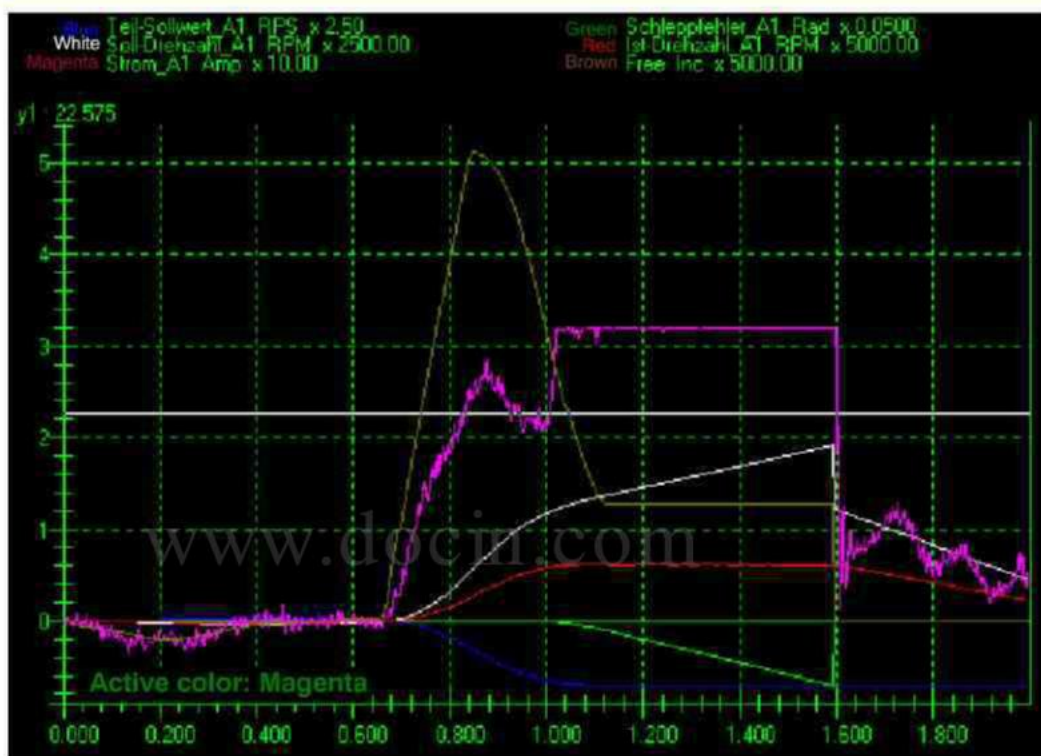
The value where the cursor is currently positioned is displayed at the top left of the window.

Now move the cursor using the arrow keys and observe how the top left of the display changes.

HCursor 2   Press the softkey "HCursor2". A second horizontal white line (cursor) is displayed in the window.

☞ When inputs and outputs are displayed, the function "HCursor" is not suitable for showing the numbers.
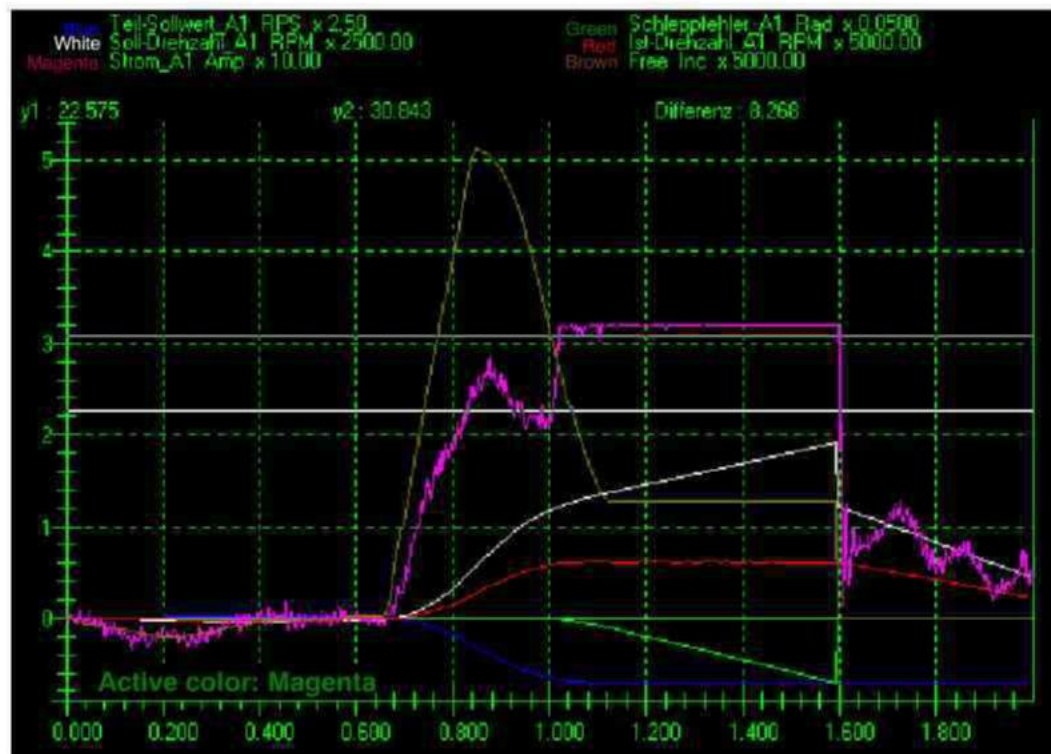
The values for the second cursor now appear to the right of the display for the first cursor. The difference between these two cursors is displayed on the left-hand side.

These cursors can be removed again by pressing the softkey "HCursor1" or "HCursor2" once more.

11.1.12 The filter function

Filter on/off By pressing this softkey, you can switch on a software filter which "smoothes" the displayed curves. This filter is switched off again by pressing this softkey once more.
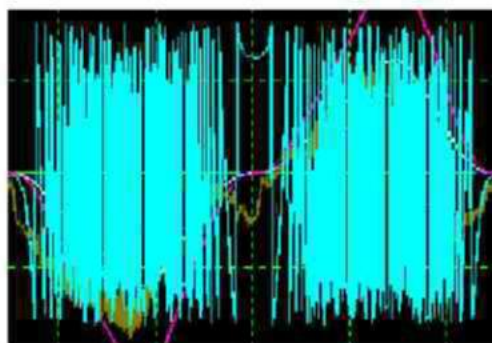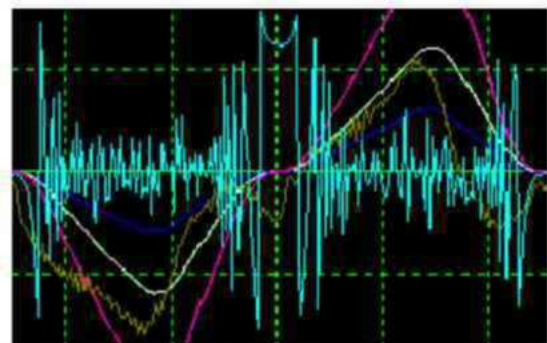
unfiltered   filtered

11.1.13 Superposing traces

To allow you to compare data from different traces with each other, the function "2nd file" has been integrated.

To do this, open the menu using the menu key "Monitor". Then select "Diagnosis". The following submenu is displayed:

```
0 I/O                ▶
1 Rob. Position      ▶
2 Cyclic Flags (Notice)
3 Flags
4 Counter
5 Timer
6 Variable           ▶
7 Diagnosis          ▶    0 Oscilloscope    ▶
8 Refresh display         1 Log book        ▶
9 Windows            ▶    2 CROSS Log book
10 Icon Edit              3 Caller Stack
                          4 Interrupts
                          5 Securitycircuit
```
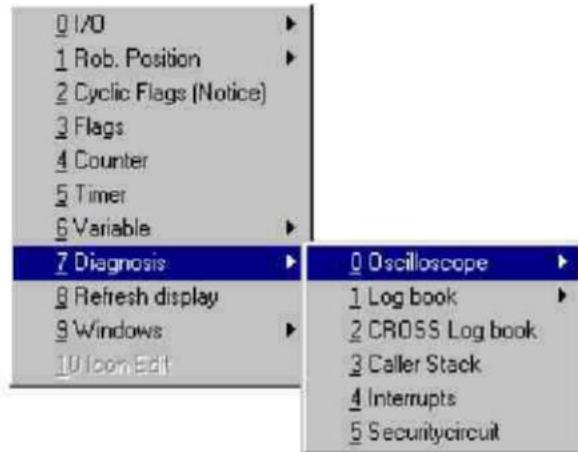
As you want to use the oscilloscope function "Show" to view traces that have already been saved, please confirm the offered selection "Oscilloscope". A further menu is opened, in which you also confirm the offered selection "Display" again.
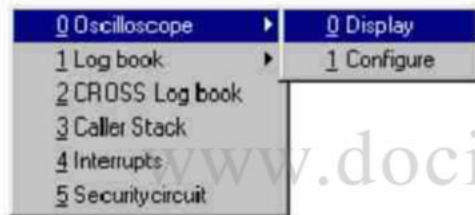
```
0 Oscilloscope       ▶    0 Display
1 Log book           ▶    1 Configure
2 CROSS Log book
3 Caller Stack
4 Interrupts
5 Securitycircuit
```

A window is opened on the display. All files which are archived in the directory `C:\KRC\ROBOTER\TRACE` and have the extension TRC are displayed here.

```
BEW11.TRC
BEW21.TRC
BEW31.TRC
BEW33.TRC
BEW41.TRC
ERRTRIG1.TRC
STATRIG1.TRC
TRACE1.trc
TRACE3.trc
```

The desired file can be selected using the arrow keys. The name of the selected file is indicated by a color highlight. Move the cursor to a file having the end digit "3". Data from the controller's inputs and outputs are recorded in this file.

2nd file

After selecting this file, please press the softkey "2nd file". Beneath the trace file list appears the message "BEW31.TRC marked for second file, please choose first file and hit "Ok".

Now use the arrow keys to move the cursor to a file with the end digit 1, for example.

Ok

After selecting this file, please press the softkey "Ok".

In the window, you can now see that the contents of these two traces are superposed on each other.
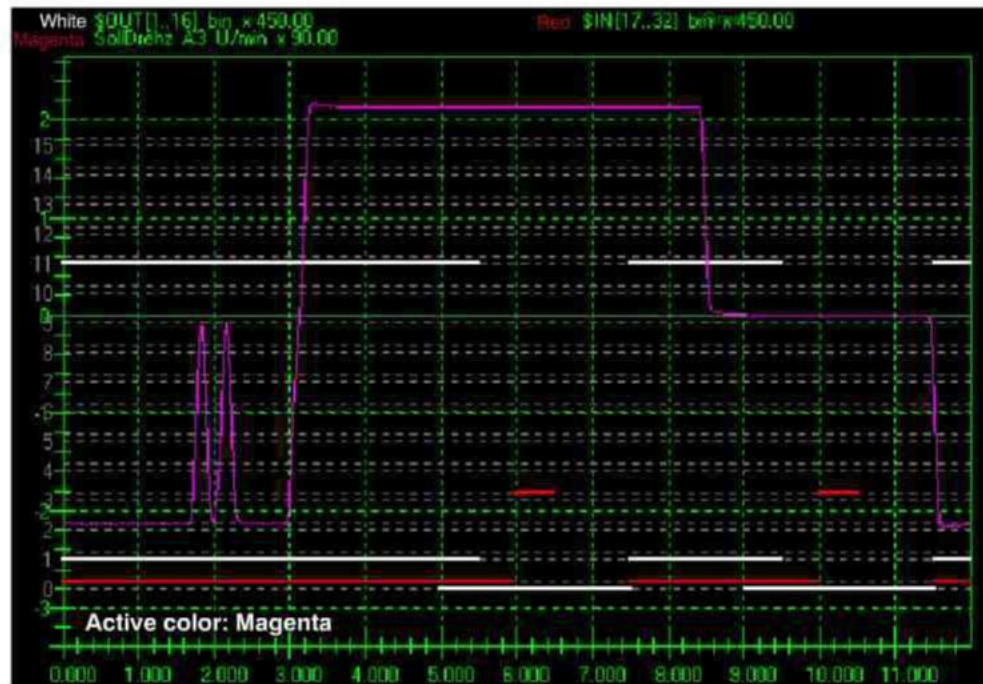
11.1.14 Changing color assignments

| Info |

The color assignments of the individual curves can be changed at any time. This is necessary, for example, if more than 8 channels are assigned and not all channels can be displayed simultaneously because there are only 8 colors available. To do so, open the information window by pressing the softkey "Info".

No.	File	Channel	Description	Color	Visible
● Graph 0	BEW31	Channel 0	Teil-Sollwert_A1	Blue	yes
● Graph 1	BEW31	Channel 1	Ist-Drehzahl_A2	Green	yes
○ Graph 2	BEW31	Channel 2	Schleppfehler_A3	White	yes
● Graph 3	BEW31	Channel 3	Soll-Drehzahl_A4	Red	yes
● Graph 4	BEW31	Channel 4	Ist-Drehzahl_A5	Magenta	yes
● Graph 5	BEW31	Channel 5	Strom_A6	Brown	yes
● Graph 6	BEW31	Channel 6	Motortemperatur_A7	Yellow	yes
● Graph 7	BEW31	Channel 7	Resolver_A8	Cyan	yes

As an example, we now want to interchange the color assignments of curves 1 (currently still blue) and 3 (currently still red).

| Blue |

Press the color softkey "Blue" to deactivate the assignment that is valid for the curve. Move the highlight to the curve with the number 3.

| Blue |

Press the color softkey "Blue" again to assign the color blue (which has just become available) to curve 3.
Move the highlight to curve 1, which is currently not assigned a color.

| Red |

Press the color softkey "Red" here to assign the color red to this curve.

| Info |

Now close the information window again.

11.1.15 Switching curves on and off

It can sometimes be necessary to completely remove individual curves from the display. To do so, open the information window by pressing the softkey "Info".

No.	File	Channel	Description	Color	Visible
● Graph 0	BEW31	Channel 0	Teil-Sollwert_A1	Blue	yes
● Graph 1	BEW31	Channel 1	Ist-Drehzahl_A2	Green	yes
○ Graph 2	BEW31	Channel 2	Schleppfehler_A3	White	yes
● Graph 3	BEW31	Channel 3	Soll-Drehzahl_A4	Red	yes
● Graph 4	BEW31	Channel 4	Ist-Drehzahl_A5	Magenta	yes
● Graph 5	BEW31	Channel 5	Strom_A6	Brown	yes
● Graph 6	BEW31	Channel 6	Motortemperatur_A7	Yellow	yes
● Graph 7	BEW31	Channel 7	Resolver_A8	Cyan	yes

Select the curve that you would like to remove from the display. The curve that is currently selected is highlighted by a color background. Now press the Enter key.

No.	File	Channel	Description	Color	Visible
⊗ Graph 0	BEW31	Channel 0	Teil-Sollwert_A1	No color	no
● Graph 1	BEW31	Channel 1	Ist-Drehzahl_A2	Green	yes
○ Graph 2	BEW31	Channel 2	Schleppfehler_A3	White	yes

Now close the information window again.

As you can see, your action has been registered. The deactivated curve is now no longer displayed.

11.2 Configure

Before you can record something with the oscilloscope, you must first tell it WHAT and HOW it is to record. For this purpose, the oscilloscope function offers a range of configuration options.

```
0 Oscilloscope    ►    0 Display
1 Log book        ►    1 Configure
2 CROSS Log book
3 Caller Stack
4 Interrupts
5 Securitycircuit
```
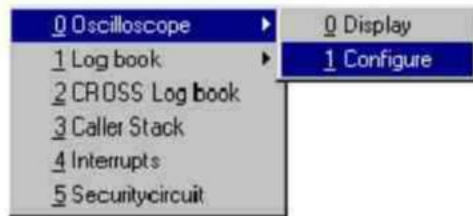
A window is opened on the display. Data which characterize the trace in greater detail must be entered here.

General

Trace Name: `TRACE`

Trace Length: `12.00` sec.

Trace Status: #T_END

Trigger Condition

Pre-Trigger (%): `50`

I/O State: `$OUT ▼` : `3` - `TRUE ▼`

`Trigger on I/O state ▼`

Trace Data

Comment:

```
```

DSE Card:
`DSE 1 ▼`

Interpolator Data:
`Commanded ▼`

I/O Group:
`I/O ▼`

Test Data:
`1: Normal ▼`

| DSE Table | I/O Table | Trigger | Start | Save | Show | Cancel |

☞ The combo boxes "Interpolator data" and "Test data" are only available at Expert level or above.

TRACE   The various **input boxes** can be selected using the "←" and "→" arrow keys. Then enter the desired values by means of the keyboard or numeric keypad.

> If you only wish to change a few of the characters in the selected entry, press the "↓" or "↑" arrow keys to remove the highlight. Then proceed using the arrow keys as usual.

The combo boxes can be opened by pressing "ALT" + "↓" or "ALT" + "↑". Alternatively, you can page through the existing combo box entries using the "↓" and "↑" arrow keys.

Softkeys:

DSE Table   The softkey "DSE Table" is used to toggle to the DSE table. Here you can determine which data (e.g. actual velocity) are recorded for specific axes.

I/O Table   The softkey "I/O Table" is used to toggle to the I/O table in which settings are made for the inputs/outputs to be recorded.
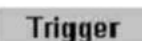
Trigger   Recording is started manually irrespective of the selected trigger condition by pressing the softkey "Trigger".

Start   Recording is started by pressing the softkey "Start". It begins as soon as the selected trigger condition is met.

Stop   Recording is stopped by pressing the softkey "Stop". All of the data that have been recorded thus far are saved.
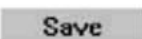
Save   The current configuration is saved by pressing the softkey "Save". It is available next time the oscilloscope function is opened.

> If a trace has been made, you do not need to save the configuration separately as it is saved automatically with the name of the trace.

Show   The softkey "Show" has the same function as the menu key "Monitor" followed by the submenu "Diagnosis" and the option "Display". Details can be found in Section 11.1.
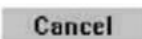
Cancel   The window for configuring the oscilloscope is closed by pressing the softkey "Cancel". The entered values will not be saved.

11.2.1 General

The name and length of the trace are specified in this window.

```
┌─General────────────────────┐
│                            │
│  Trace Name:  ┌TRACE─────┐ │
│               └──────────┘ │
│                            │
│                            │
│  Trace Length: ┌1.00─┐ sec.│
│                └─────┘      │
└────────────────────────────┘
```

Name of recording

A file name under which the trace will be saved later can be defined here. Do not use more than seven characters because a further digit is added to the file name by the system in order to distinguish different types of trace.

> **i** These trace files, with the extension TRC, can be found in the directory `C:\KRC\ROBO-TER\TRACE`.
> The numbers for the different trace types have the following meaning:
>
> | | |
> |---|---|
> | 1 | DSE data |
> | 3 | Data relating to inputs/outputs |
> | 4 | Interpolator data |
> | 5 | Test data |

Length of recording

Please enter an integer value here specifying the length of the trace in seconds.

> **i** If the entry exceeds the maximum permissible trace length (default: 999 seconds), a message is generated in the message window when the recording begins. If this happens, change the value accordingly.

> ☞ The cycle rate for recording DSE data is 2 ms. 500 data sets are therefore generated per second. Please take this volume of data into account when programming the length of the trace.

11.2.2 Trigger condition

The position in time and the trigger condition for the trace are specified in this box.

```
┌─ Trigger Condition ──────────────────────┐
│                                          │
│  Pre-Trigger (%):  [0    ]                │
│                                          │
│                                          │
│                                          │
│  ┌────────────────────────────────────┐  │
│  │ Trigger on appearance of an error ▼│  │
│  └────────────────────────────────────┘  │
└──────────────────────────────────────────┘
```

Pre-Trigger

Specify the position in time of the trace in relation to the trigger time in this box. The value between 0% and 100% that is entered refers to the programmed trace length.
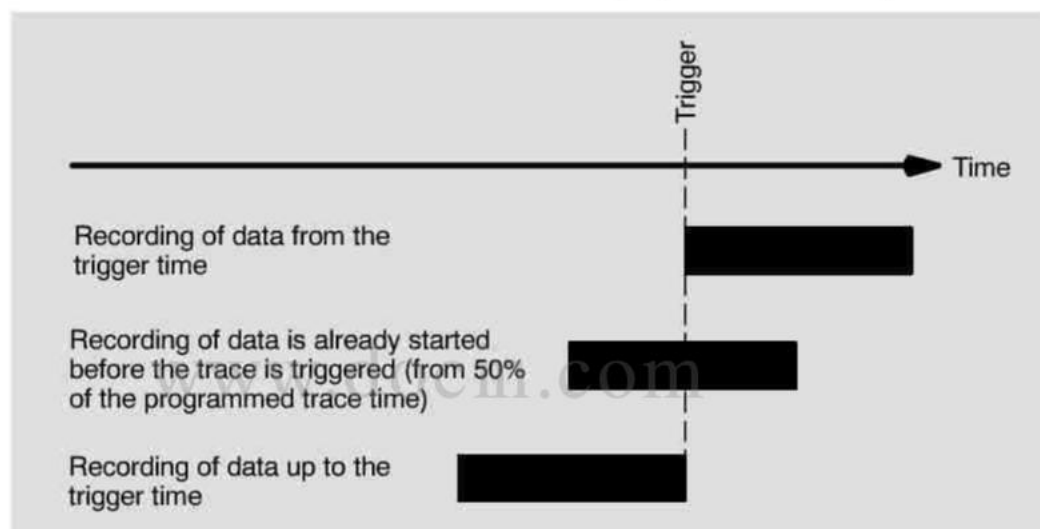
Trigger event

In this field, select the event which will trigger recording.

Trigger on I/O state
The recording starts when the defined input/output assumes the specified state. The I/O and the state must be defined.

Start by user, recording until buffer is full
The recording must be initiated manually with the softkey "Start". It continues until the set recording length has been reached.

Cyclical recording until user stop
Recording is carried out for the time specified in "Length of recording" <u>before termination</u> with the softkey "Stop" is recorded.

Trigger on error
Recording is carried out for the time specified in "Length of recording" before and after the occurrence of an error that stops the robot system. The location of this period of time depends on the value set as the trigger moment.

Trigger on motion start
The recording starts whenever the beginning of a motion instruction is reached or a motion instruction is being executed. It continues until the set recording length has been reached. The location of this recording time depends on the value set as the trigger moment.

Trigger on clearing filter
This option is intended for our service personnel only.

Trigger on DSE error
In this instance, recording is carried out for the time specified in "Length of recording" around the appearance of a DSE error that is signaled by the digital servoelectronics (e.g. "Command value out of range", "Cabinet temperature too high"). The location of this period of time depends on the value set as the trigger moment.

11.2.3 Trace status

The current working status of the oscilloscope can be seen in this field.

Trace status	Meaning
#T_WAIT	Trace is started and is waiting for the trigger condition. All of the data before the trace is triggered are recorded.
#TRIGGERED	Trace is triggered and runs for as long as specified in the boxes "Length of recording (sec)" and "Trigger moment".
#T_END	Trace is finished, the data are saved on the hard disk.

11.2.4 Trace data

This box is used to define the data to be recorded.

Comment

You can enter a comment here, e.g. relating to the oscilloscope configuration.

DSE (Digital Servo Electronics) card

Here you can select if you want to record data of DSE 1 (axes 1–8) or DSE 2 (axes 9–16). If you do not want to record any DSE data at all, please select the option "No DSE data".

> Files containing the traces of DSE data are identified by the end digit "1" in the file name.
> The cycle rate for recording DSE data is 2 ms. 500 data sets are generated per second.

DSE Tab.

Pressing the softkey "DSE Table" opens a window in which the values to be recorded are listed.

Trace Name: TRACE

$1 Bus Voltage PM1
$2 Bus Voltage PM2

Axis Name	A1	A2	A3	A4	A5	A6	E1	
Command Value	✓	✓	✓	✓	✓	✓		
Actual Value								
Following Error					✓			
Command Velocity			✓					
Actual Velocity			✓					
Actual Current			✓	✓				
Motor Temperature					✓			
Resolver					✓	✓		
Command Current								
Torque Differential								

Here you can define the values and axes for which traces are to be made. This is done by navigating with the "↓" and "↑", or "←" and "→" arrow keys. Selections are made by pressing the space bar.

Select Line	Clear Line	Clear All			I/O Table	Main

It is also possible, using the softkeys, to select or deselect all axes for a particular value, delete the entire selection, or toggle to the I/O table or main group.

> A maximum of 21 DSE channels are available at any one time.
> If more than 21 channels are configured, the results will be incorrect.

Explanation of the individual values:

Values to record	Meaning
Bus voltage PM1	Power module 1
Bus voltage PM2	Power module 2
Command value [1]	Command value from the interpolator per position control cycle
Actual value [1]	Actual value per position control cycle
Following error [1]	Difference between command position and actual position
Command velocity [1]	At the position controller output
Actual velocity [1]	Motor speed
Actual current [1]	Current sensors
Motor temperature [1]	In increments
Resolver [1]	Encoder position
Command current [1]	At the speed controller output
Torque differential [1]	Value calculated from the command/actual current

[1] For each of the channels 1...8

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I/O group

Here you can choose to record "No I/O data", "I/O data" or the 32 cyclical flags. Select the desired function in the combo box. In order to record I/Os, it is necessary to open the I/O table using the softkey "I/O Table" and define the desired input/outputs.

| I/O Table |

Trace Name: TRACE

Channels 1/2 ▾

1 $IN ▾ : 1	9 None ▾ :
2 $OUT ▾ : 1	10 None ▾ :
3 None ▾ :	11 None ▾ :
4 None ▾ :	12 None ▾ :
5 None ▾ :	13 None ▾ :
6 None ▾ :	14 None ▾ :
7 None ▾ :	15 None ▾ :
8 None ▾ :	16 None ▾ :

Move around this window as described above.
With the setting "Channels 1/2", channels 1–16 can be processed, and with the setting "Channels 3/4", channels 17–32 can be processed.
Define the individual oscilloscope channels by input/output and enter the number.

☞ Unlike with previous software versions, it is now possible to record any 16 inputs or outputs simultaneously. This means, for example, that inputs [1], [65] and [250] can be recorded at the same time.

ℹ Files containing traces of the status of inputs and outputs are identified by the end digit "3".

The cycle rate for recording the activities of inputs and outputs is 12 ms. About 85 data sets are generated per second.

Here also, it is possible, using the softkeys "DSE Table" or "Main", to toggle to the respective windows.

Interpolator data

The interpolator data include the Cartesian position of the robot (X,Y,Z,A,B,C), the path velocity and the geometric angles of axes 1–12.
You must now choose whether to record the "Actual values", "Command values" or "No data". This function is only available in "Expert" mode.

Test data

These data are analyzed by KUKA Roboter GmbH. If problems occur, the customer can contact KUKA Support and create a corresponding file for evaluation by KUKA.
This function is only available in "Expert" mode.

11.2.5 Examples of a trace

As the oscilloscope function with all the configuration and display options is complex, we want to introduce you to the use of this tool with the aid of a few examples.

Example 1

The following are to be monitored:

command speed of the drive of axis 1

actual speed of the drive of axis 1

status of outputs 1 to 16

Create a motion program which moves axis 1 and operates outputs 1 to 16.

Press the menu key "Monitor" and select the option "Diagnosis". In the submenu which opens, please confirm the selection "Oscilloscope". Now select "Configure".

In the following boxes, select these settings:

Box	Entry
Name	Trace1 (max. 7 characters)
Length of recording	12
Pre–Trigger (%)	0
	Trigger on motion start
DSE card	DSE 1
I/O group	I/O
Interpolator data	None
Test data	No test data

Press the softkey "DSE Table" to open the selection box for the DSE values to be recorded and select "Command velocity" and "Actual velocity".

Press the softkey "I/O Table" to open the selection box for the I/Os to be recorded and select "Channels 1/2". Channels 1–16 must now be defined as inputs and numbered accordingly.

Now start the motion program and then press the softkey "Start".

The command speed, the actual speed and the statuses of inputs and outputs 1 to 32 will now be recorded and saved until the data buffer is full and the trace status changes to #T–END. The files are called TRACE1.trc and TRACE3.trc.

Example 2

The signals of inputs and outputs 1 to 16 are to be recorded as soon as input 3 takes on the state "TRUE".

Box	Entry
Name	Trace2 (max. 7 characters)
Length of recording	10
Pre–Trigger (%)	0
	Trigger on I/O state
I/O state	$IN : 3 = TRUE
DSE card	No DSE data
I/O group	I/O
Interpolator data	None
Test data	No test data

Press the softkey "I/O Table" to open the selection box for the I/Os to be recorded and select "Channels 1/2". Channels 1–16 must now be defined as inputs and numbered accordingly (1–16). Select Channels "3/4", define channels 17–32 as inputs and number them (1–16).

Now start the motion program and then press the softkey "Start".

Input 3 will now be monitored for occurrence of the trigger condition. The message "#T_WAIT" is displayed in the box "Trace-status". This message changes to "#TRIGGERED" as soon as the trigger condition is fulfilled. The signals of inputs and outputs 1 to 16 will be recorded for 10 seconds from this moment onwards.

Example 3

A robot program branches to various subprograms depending on how the PLC sets specific signals. In a certain, unknown situation, the program branches to the subprogram "SP55.SRC", which is not desired in this configuration, however.

For the purpose of checking the I/O communication of the robot program with the PLC in this situation, an unassigned output (e.g. output 32) can be set in the subprogram SP55 and reset again on quitting the subprogram.

A trace can now be triggered at this output and the recorded sequence of events saved.

Box	Entry
Name	Trace3 (max. 7 characters)
Length of recording	12
Pre-Trigger (%)	90 (since the "pre-event history" is of interest)
	Trigger on I/O state
I/O state	$IN : 32 = TRUE
DSE card	No DSE data
I/O group	I/O
Interpolator data	None
Test data	No test data

Press the softkey "I/O Table" to open the selection box for the I/Os to be recorded and select "Channels 1/2". Channels 1-16 must now be defined as inputs and numbered accordingly (1-16). Select Channels "3/4", define channels 17-32 as inputs and number them (1-16).

Now start the motion program and then press the softkey "Start".

Output "32" will now be monitored with regard to this trigger condition. The message "#T_WAIT" is displayed in the box "Trace-status". This message changes to "#TRIGGERED" when the trigger condition is fulfilled. The signals for inputs and outputs 1-16 are then recorded for 10.8 seconds before the trigger moment and 1.2 seconds after the trigger moment.

Example 4

You discover that a robot program always stops at night because an error occurs in the I/O communication with the PLC. It cannot be determined whether this error is caused by the PLC program or the robot program since nothing is known about the incorrect communication at this point.

It is possible for the oscilloscope function to be started in the KRL robot program before this situation and to be ended after it. The data are overwritten every time the program is correctly executed. If the motion program is interrupted by an error message, however, the last trace is saved and the error can be analyzed with the aid of the recorded data.

Box	Entry
Name	Trace4 (max. 7 characters)
Length of recording	Length of communication between robot and PLC taken into consideration.
Pre–Trigger (%)	0
	Start by user, recording until buffer is full
DSE card	No DSE data
I/O group	I/O
Interpolator data	None
Test data	No test data

As the communication between the controller and the PLC occurs via the I/Os, all affected inputs/outputs must be recorded. These are defined in the selection box which is opened using the softkey "I/O Table".

Now save the configuration by means of the softkey "Save", and quit the oscilloscope function by pressing the softkey "Cancel".

Insert the following lines into the KRL program <u>before</u> the selected program section in order to start the trace:

```
$TRACE.MODE=#T_START
WAIT FOR $TRACE.STATE == #T_END
```

Insert the following lines into the KRL program <u>after</u> the selected program section in order to stop the trace:

```
$TRACE.MODE=#T_STOP
WAIT FOR $TRACE.STATE == #T_STOP
```

These changes can only be made at the Expert level.

As soon as the error has been located, these instructions must be removed from the program again.

12 Robot repair card

You will be sent a Repair Card along with the spare parts requested from the KUKA Robot Group.

Return the completed Repair Card to the KUKA Robot Group along with the defective exchange parts removed during the repair.

The data in the Repair Card will help us to speed up the reprocessing of the exchange parts. The returned Repair Cards provide us with statistical data that are of great importance for KUKA quality management.

Fig. 5 Repair card

Box A

Please enter in this box the name of your firm and where it is based/the location of the plant in which the affected robot system is installed.

Box B

Describe the location of the robot system.

Example: *Shop 4, UB I, IR 16 B*

Box C

The order number is assigned to the robot system by the KUKA Robot Group when the order is processed. You can either obtain this number from your purchasing team or leave this box empty. The order number will then be entered later by the KUKA Robot Group.

Box D

Please enter here the type of robot in which the defective part or module was located. The type designation can be found here:
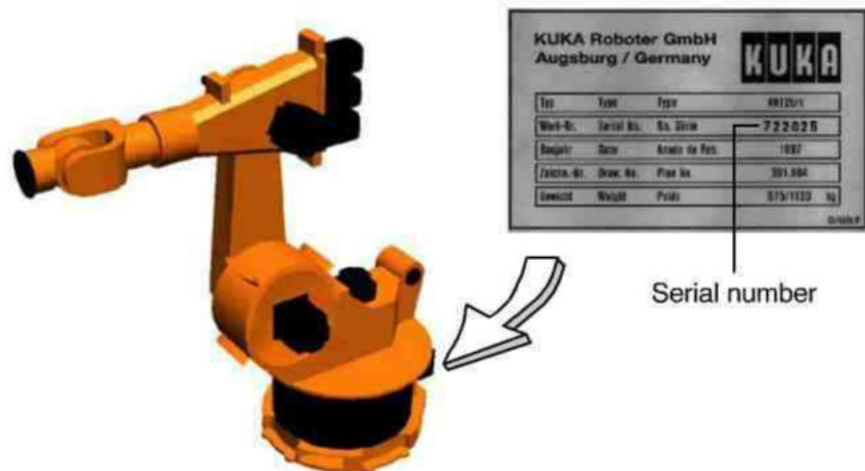
Serial number

Fig. 6 Rating plate on robot base

Box E

The serial number of the robot system can be found here:

Fig. 7 Rating plate

Box F

The serial number of the control cabinet can be found here:
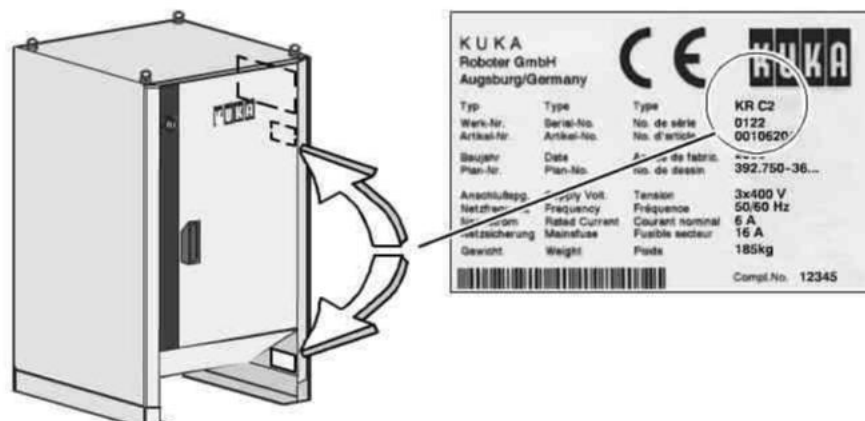
Fig. 8 Rating plate on control cabinet

Box G

The serial number of the PC controller can be found on the front of the lower swing frame inside the control cabinet:

⚠️ **For safety reasons, the cabinet door may only be opened by a qualified electrician.**
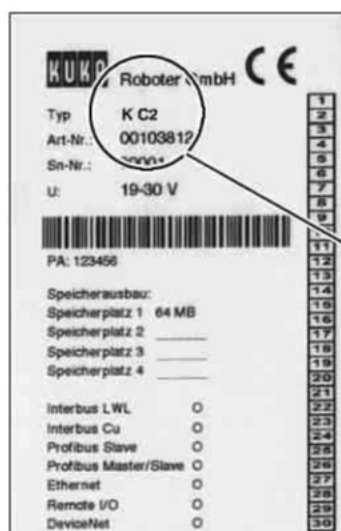
Fig. 9 Rating plate on the PC controller

Box H

Enter here the type of application for which the robot is used.

Box I

Enter here the name of the failed and replaced part.

Box J

Enter here the article number of the defective part.

Box K

Enter in this box the serial number and, if possible, the manufacturer's release of the failed part.

Box L

Enter in this box the serial number and, if possible, the manufacturer's release of the replacement part.

Box M

Enter here the duration of downtime and the time required, in minutes, for repairing the robot system.

If the failure of the part or component did not cause any downtime, please mark the box "No".

Box N

Enter, in this box, the date on which the fault occurred.
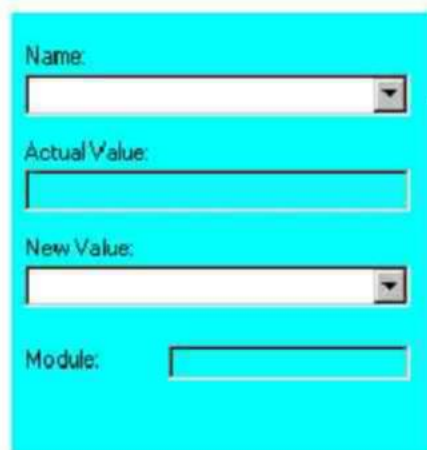
Box O

Enter, in this box, the value displayed on the operating hours meter at the time of the fault.

The number of operating hours can be obtained by dividing the value of the system variable $ROBRUNTIME by 60.

Monitor

In order to read this system variable, press the menu key "Monitor" on the user interface and select the option "Modify variable" from the menu that is opened. The status window illustrated appears in the programming window.

List boxes are opened using the keyboard shortcut **ALT+↓** .

Fig. 10   Operating hours of the robot system

Name

To display the value of a variable, position the cursor in the input box "Name", using the softkey "Name" and enter the name of the variable you wish to change, in this case $ROBRUNTIME. Then press the Enter key to confirm this.

The value of the variable is now displayed in the field "Current value".

Box P

In this box, let us know your name and the date on which the repair card was completed.

Please mark one of the two boxes to indicate whether you are a customer or an employee of the KUKA Robot Group.

Box Q

In this box you must specify the reasons for returning the part. Place a check mark in the relevant boxes.

If you would like to be informed of the results of our inspection of the returned part, enter a fax number, in the line provided below for this purpose, to which we can send you the requested information.

Box R

In this box, you should give a detailed description of the fault (e.g. error numbers, message texts, etc.).