HEIDENHAIN

Service Manual

Inverter Systems and Motors

June 2012

1 How to use this service manual

1.1 Target group

This Service Manual has been written for **specialist electricians** for service, maintenance and commissioning.

Specialists who perform work on the electrical system of a machine tool and its components must have the required **technical knowledge and competence**!

1.2 About this manual

Objective

This Service Manual **assists service personnel** in the field in **diagnosing and correcting errors** on **HEIDENHAIN inverter systems** and **HEIDENHAIN motors**.

Products described

HEIDENHAIN inverter systems **are available as regenerative and non-regenerative version**.

HEIDENHAIN motors fall into the categories of **synchronous motors for feed drives** and **asynchronous motors for main spindles** (see brochure HEIDENHAIN Motors).

Note

If you need information on linear and torque motors, contact the corresponding manufacturer.

This manual also contains information on **HEIDENHAIN interface boards** for the SIMODRIVE system.

HEIDENHAIN inverter systems and motors are designed for **digital axes and spindles** and are controlled with **PWM signals** (pulse width modulation).

These drives are mainly operated with **HEIDENHAIN controls**, e.g.:

Milling controls:	TNC 410 M, TNC 426 M, TNC 430 M, iTNC 530 (HSCI), TNC 620 (HSCI)
Lathe controls:	MANUALplus 4110, MANUALplus M, MANUALplus 620 (HSCI), CNC PILOT 4290, CNC PILOT 620 (HSCI)
Milling/turning controls:	TNC 640 (HSCI)

Contents

This manual includes:

- **Information on possible error causes**
- **Descriptions of error diagnosis**
- **Information on corrective action**
- **Theoretical explanations of functions and their correlations**

The “Overview of possible errors” on page 3 – 18 includes many references to troubleshooting descriptions.
You will find these descriptions in the chapters of this Service Manual sorted by topics.

Validity

It comprises the **service possibilities with the current hardware** at the editing date of this manual.
The servicing possibilities of your equipment may differ from those described here.
The descriptions also provide information on any peculiarities regarding service of the units.

Prerequisites

For the instructions for the field service it is assumed that ...

- **the machine had been working perfectly before the error occurred.**
- **only original spare parts are used!**

Update service This Service Manual is updated at irregular intervals.
You find the current printable version of this **SHB Inverter Systems and Motors** in **HESIS-Web Including Filebase**.
If you are not a registered customer with access to this HEIDENHAIN database, you will receive this Service Manual either on the occasion of a service training course or from your machine tool builder.

Print version If you take part in a HEIDENHAIN service training, you will receive the Service Manual in printed form.

1.3 Other service manuals

- Service Manual MANUALplusM
- Service Manual TNC 410
- Service Manual TNC 426 CB/PB/M, TNC 430 CA/PA/M
- Service Manual iTNC 530
- Service Manual iTNC 530 HSCI
- Service Manual TNC 620

1.4 Other documentation

In the following documents you find further important information:

- Machine documentation by the manufacturer
  (circuit diagrams of the machine, wiring diagrams, machine operating manual, etc.)
- User's Manuals for HEIDENHAIN controls
- HEIDENHAIN TNCguide (DVD)
- Mounting instructions by HEIDENHAIN
- Brochures of the respective HEIDENHAIN products
- PWM 9 User's Manual
- PWT Operating Instructions
- IK215 / PWM 20 Operating Instructions

Note

You can find up-to-date issues of this and other HEIDENHAIN documents quickly on our website --> www.heidenhain.de

1.5 Support

Attention

The machine manufacturer must be contacted first for error diagnosis on your machine tool!

However, support will also be provided by the Service Department of HEIDENHAIN Traunreut or by the HEIDENHAIN agencies.

You will find telephone numbers as well as e-mail addresses on the back cover of this Service Manual, or on the HEIDENHAIN website (www.heidenhain.de).

1.6 Service training

HEIDENHAIN Traunreut offers service training courses in German language.
We recommend the HEIDENHAIN Service Training Seminars for the technician who works with this Service Manual.
Please contact HEIDENHAIN Traunreut or visit our website (www.heidenhain.de).

> **Note**
>
> If required, please inquire at the HEIDENHAIN subsidiary in your country whether service training courses are offered in your language.

1.7 Meaning of the symbols used in this manual

> **Danger**
>
> Failure to comply with this information could result in most serious or fatal injuries,
> and/or in substantial material damage.

> **Attention**
>
> Failure to comply with this information could result in injuries and interruptions of operation, including material damage.

> **Note**
>
> These boxes contain important and useful information.

1.8 Safety

> **Danger**
>
> Before you start servicing:
> It is extremely important that you read the safety precautions in this manual!
> See "Safety precautions" on page 2 – 13

2 Safety precautions

2.1 Introduction

The safety precautions below are provided to ensure your personal safety and the safety of the machine tool.

Please read this information carefully before you start servicing the machine!

2.2 Please observe

Ground

Danger

Ensure that the equipment grounding conductor is continuous!
Any interruption of the protective ground can result in serious injury to persons and or property.

Zero potential

Danger

Ensure that the main switch of the control is switched off and that connected devices are not under power when you engage or disengage any connectors or terminals.
Take precautions against restart!
Use an appropriate voltage test unit to ensure that the unit is not under voltage!
Always observe that the DC-link voltage must be reduced completely!

Fundamental knowledge

Danger

In order to be able to judge the behavior of an NC controlled machine, service engineers need to have fundamental knowledge of controls, encoders, drives, electronics and mechanics.

Inappropriate use may cause considerable damage to persons or property.

Know-how and competence

Danger

Technicians who work on the electrical system of the machine must have the required know-how and competence.

Suitable tools

Danger

Use suitable tools, e.g. insulated screwdrivers and pincers!

Suitable voltage test unit

Danger

The voltage test unit used (e.g., moving coil measuring device, multimeter) including the measuring lines used must conform to the safety category Cat III / 1000 V or Cat IV / 600 V at least!

Safety precautions of the machine manufacturer

Attention

Note the safety precautions on the machine (e.g. labels, signs) and the safety precautions in the documentation of the machine manufacturer (e.g. operating instructions).

Regulations for power installations and accident prevention

Danger

Observe the national regulations for power installations and the general instructions for safety and prevention of accidents!

Vertical axes

Danger

Always secure vertical axes to prevent them from falling down before you perform tests on these axes!

Liability

Attention

HEIDENHAIN does not accept any responsibility for direct or indirect damage or injury caused to property or persons through improper use or incorrect operation of the machine!

2.3 With inverter systems, especially remember

Danger

During operation several parts of the inverter systems may be live and are thus extremely dangerous.

This includes ...

- the primary connection with 3 phases, 400 Vac +/- 10 % (may be higher in case of an error)
- the conductor bars with 565 Vdc or 650 Vdc (may be higher in case of an error)
- the motor outputs
- the connecting terminals for the braking resistor

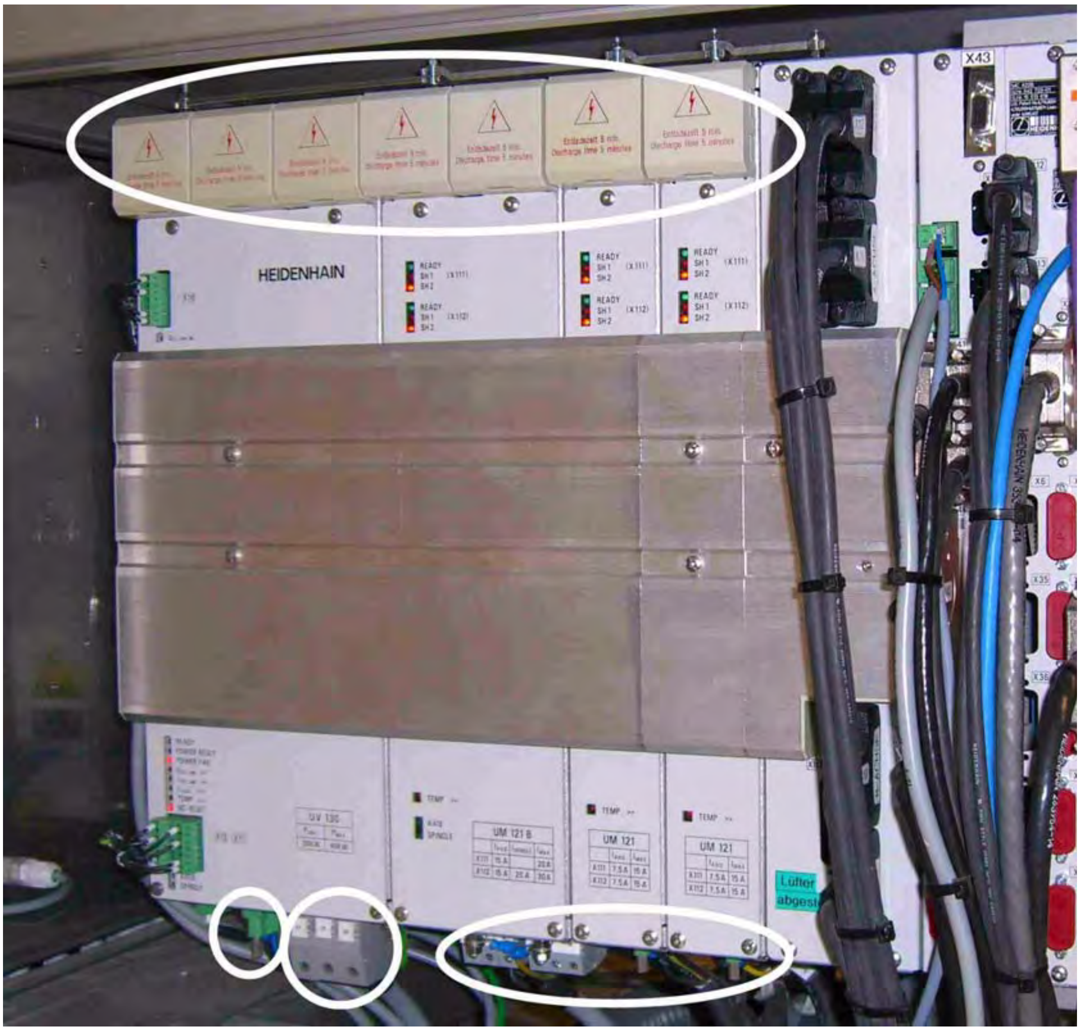


Photo: Example with UV 130 and power modules

Danger

Switch off the machine and wait at least 5 minutes; then ensure that it is not under voltage before removing the conductor bars or disconnecting the braking resistor.
See label on the protective caps!

2.4 With motors, especially remember

Danger

During operation several of the motor parts may be either live or moving and are thus extremely dangerous.

Never perform any kind of work on the motor (e.g., open the terminal box, make or break connections) while it is under power.

Attention

Temperatures of up to 145 °C may occur on the motor surfaces.

When connecting the fan, ensure that the direction of rotation is correct.
The arrow symbol on the fan housing indicates the correct direction.

Attention

After mounting the motor you must verify the trouble-free functioning of the brake.

Danger

On motors that are equipped with a feather key at the shaft end, the feather key must be secured against ejection.

You will find further **information on the safe and trouble-free handling of your motor** in the **operating instructions** that accompany each unit.

3 Errors and error messages

3.1 Introduction

Errors in the drives of machine tools usually lead to an error message on the monitors of the control.

But not all error conditions of the machine generate an error message.
Therefore, here you find an overview of errors with notes and tips on how to proceed.

Permanent and reproducible errors

An interruption in the electrical cabinet or a defective device are a permanent error.
If you can generate an error on a machine at any time, the error is reproducible.
By their very nature, permanent and reproducible errors can be located more easily.

Sporadic and non-reproducible errors

Sporadic errors may, for example, be caused by a loose connection, shielding problems or interference.
Non-reproducible errors cannot be generated reliably by certain actions. They "randomly" appear on the machine.
To investigate sporadic, non-reproducible errors, also integrated diagnosis tools in the control (e.g., an integrated log, a PLC logic diagram or an integrated oscilloscope) can be used.

Danger

In case of errors that may lead to very high currents, e.g. **ground fault or short circuit** in the drive, do not switch on the machine again!
First ensure that there are no defective units, cables, etc.
Then eliminate all ground faults and short circuits in the machine!

3.2 Overview of possible errors

The following table shows an overview of specific errors on the machine or control, possible causes of the errors as well as measures for finding these errors.
The potential measures for finding and correcting the errors are **described in more detail in the corresponding chapters**.

Error	Possible error cause	Measures for error diagnosis and/or corrective action
The machine, for example, has failed with a loud noise and cannot be switched on again.	■ Ground fault or short circuit on a device, cable, etc. ■ Grave defect of the motors or in the inverter system	■ Check the fuses ■ Visual inspection (scorch marks, humidity, severe contamination, damaged cable, etc.) ■ Is there a burnt smell? ■ Measure ground faults and short circuits, see respective descriptions in this manual ■ Replace inverters, motors, cables, accessories that are defective
When hooking up axes, an "overcurrent" error message is generated	■ Short circuit in windings of motor ■ Short circuit in the motor power cable ■ Short circuit in the voltage protection module ■ Short circuit in the power module or in the end stage	■ Check the motor for an interturn fault --> See “Inspection for winding short circuit or interruption” on page 6 – 53 ■ Check the motor for a short circuit ■ Check the voltage protection module for a short circuit--> See “Inspection for short circuit” on page 8 – 194 ■ Check power modules and end stages for short circuits ■ Replace inverters, motors, cables, accessories that are defective
The control generates error messages regarding the motor current (e.g., No motor current, Motor current too high)	■ Motor defective ■ Motor power cable defective ■ Inverter defective ■ Conductor bars for the DC-link not tightened sufficiently	■ Check the motor --> See “Error diagnosis on motors” on page 6 – 47 ■ Check the motor cable for a short circuit ■ Check power modules and end stages ■ Check the voltage protection module for a short circuit--> See “Inspection for short circuit” on page 8 – 194 ■ Tighten conductor bars with 3.5 Nm ■ Replace inverters, motors, cables, accessories that are defective
The machine is switched on but the screen of the control remains dark.	■ Phase in the primary supply is missing ■ Defective switch-mode power supply in the power supply unit (UV, UVR) or compact inverter (UE, UR) ■ Defective power supply unit UV 105 B ■ Defective PSL13x low-voltage power supply unit ■ Ribbon cable X69 defective ■ Defective 5V supply via terminal X74 ■ Defective unit that is connected to the control impairs the low voltages	■ Check the phases in the primary supply ■ Check the function of the supply unit or the compact inverter ■ Check the function of the UV 105 B ■ Check the function of the PSL 13x ■ Check the ribbon cable X69 ■ Check the 5V supply via terminal X74 ■ Disconnect suspicious units from the control and deselect it in the machine parameters --> See service manual of the respective control

Error	Possible error cause	Measures for error diagnosis and/or corrective action
The DC-link voltage Uz is not built up (the screen of the control functions).	■ Phase in the primary supply is missing ■ Interruption in the electrical cabinet, safety relays are not released ■ Defective power supply unit (UV, UVR) or compact inverter (UE, UR) ■ Defective capacitor module ■ DC-link short-circuit in the UM	■ Check the phases in the primary supply ■ Check the releases for the safety relays ■ Check the function of the supply unit or the compact inverter ■ Replace the capacitor module ■ Measure short circuits, see respective descriptions in this manual
The message **`RELAY EXTERNAL DC VOLTAGE MISSING`** does not disappear, although the key "Control voltage ON" is pressed.	■ EMERGENCY STOP chain interrupted ■ 24 Vdc supply for controls is missing ■ Control defective	■ Check the EMERGENCY STOP chain in the range of the inverter connectors X70, X71, X72 ■ See service manual of the respective control
Axes cannot be traversed	■ Drive enabling is missing ■ Inverter system is not ready for operation ■ Feed rate set to zero	■ See service manual of the respective control ■ Check whether the inverter system is ready ■ Feed rate not programmed ■ Feed rate set to zero by PLC
Axes that are enabled via an axis-release module, cannot be traversed.	■ Drive enable via axis group connector X150, 151 on the CC is missing ■ Axis-release module defective	■ Measure 24 V at X150, 151 ■ Replace axis-release module
The monitor of an iTNC 530 is frozen. The control is inoperable. The main switch must be switched off and on again. After reset of the control **`"Power fail Interrupt!"`** is entered in the log.	■ Power failure ■ Failure of one or several phases in the supply line ■ Supply voltage has fallen below minimum ■ Interruption in the electrical cabinet ■ Defective power supply unit (UV, UVR) or compact inverter (UE, UR)	■ Check the primary voltage ■ Check the fuses ■ Check the wiring of the inverter system --> See circuit diagrams of the machine manufacturer ■ Check the function of the supply unit or the compact inverter
"Oscillating" axes, sometimes involving loud noise. and/or Various error messages are generated which, however, are not substantive.	■ Poor shielding or grounding ■ Connection (short circuit) of shield potential (chassis, cable shielding) with 0 V potential of the NC power supply ■ Connectors on grounding terminal X131 of infeed/ regenerative module (Simodrive 611D) not properly wired	■ Check the grounding of your machine --> Consult your machine manufacturer. ■ Ensure that all grounding clamps are secure ■ Check the cables for damage ■ Check shieldings, covers, etc. ■ Check the grounding in connection with the HEIDENHAIN expansion boards used --> See "Error diagnosis on the inverter system" on page 7 – 71
When braking axes and spindles, the motors suddenly coast out of loop to a stop.	■ Defective braking resistor (conversion of electrical energy into heat energy not possible) ■ Defective infeed/regenerative feedback module (energy recovery not possible) ■ Interruption in the primary supply (fuses, wires, etc.; energy recovery not possible)	■ Measure braking resistor --> See "Error diagnosis on the PW braking resistor" on page 8 – 178 ■ Check the fuses ■ Wiring interrupted --> See circuit diagrams of the machine manufacturer ■ Check the function of the supply unit or the compact inverter
An axis is traversed and the error message **`I2T value of motor is too high ...`** is displayed (or a similar error message that indicates an excessive load of the drive). There is no mechanical damage!	■ Motor brake not released. ■ Mechanical stiffness occurs	■ Check whether the brake is released ■ Check the wiring of the motor system --> See circuit diagrams of the machine manufacturer. ■ If the motor brake is connected to the inverter module --> Check whether the brake output is supplied and triggered correctly. ■ Move the axis while the machine was switched off

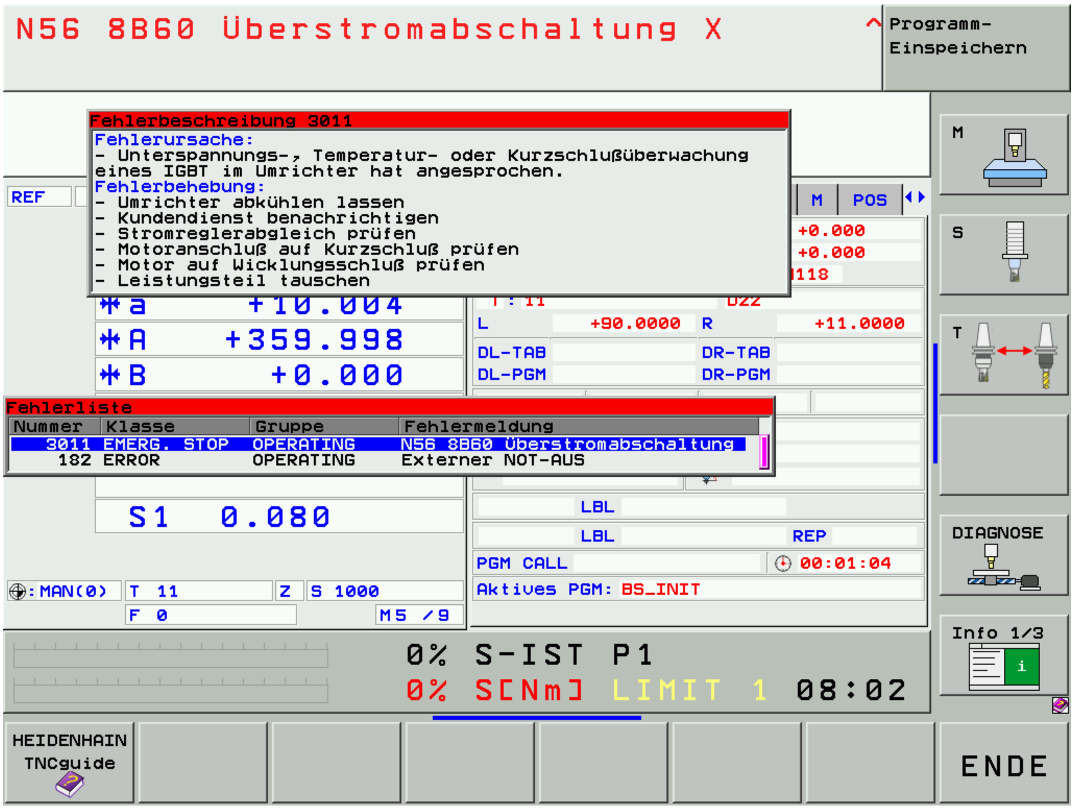
Error	Possible error cause	Measures for error diagnosis and/or corrective action
SIMODRIVE system used with CC 422: The control can be switched on. During operation the power module always transmits the **Ready** signal. The signal reporting that the power module is no longer ready is not detected in some cases.	■ "Old" HEIDENHAIN expansion board in modified SIMODRIVE power module	■ Check the constellation HEIDENHAIN expansion board and SIMODRIVE power module --> See "Compatibility of HEIDENHAIN expansion boards to SIMODRIVE power modules" on page 10 – 272
SIMODRIVE system used with CC 424 (B): After power on, the power module transmits a "**Ready**" signal to the control although the power module is not ready yet. The control reports the error **C510 Impermissible drive enable** and cannot be put into operation.	■ "Old" HEIDENHAIN expansion board in modified SIMODRIVE power module	■ Check the constellation HEIDENHAIN expansion board and SIMODRIVE power module --> See "Compatibility of HEIDENHAIN expansion boards to SIMODRIVE power modules" on page 10 – 272
SIMODRIVE system used with TNC 426 PB and TNC 430 PA: After the power module has been switched on, it constantly reports that it is ready, even if this is not the case. In certain situations the **"Drives not ready"** message can appear, even though it may no longer even be possible to switch the drives on.	■ "Old" HEIDENHAIN expansion board in modified SIMODRIVE power module	■ Check the constellation HEIDENHAIN expansion board and SIMODRIVE power module --> See "Compatibility of HEIDENHAIN expansion boards to SIMODRIVE power modules" on page 10 – 272

3.3 Error messages on the monitor of the control

HEIDENHAIN inverter systems and HEIDENHAIN motors are usually operated with HEIDENHAIN controls.

Errors on inverters and/or motors that occur when the machine is switched on or during operation are ideally shown as errors on the monitor. The operator or the service engineer obtains information on the possible causes of the error and on corrective action. In case of axis-specific errors, there is an axis symbol (e.g. X) in the error text!

Example of an NC error message on the monitor of an iTNC 530:



Note

If it is possible and makes sense, you may switch the control off and on again to observe whether the error message is generated again afterwards.

List of NC error messages

HEIDENHAIN has defined NC error messages. You can find the complete list of all NC error messages for TNC controls on the **TNCguide DVD** in several languages and sorted by error numbers.

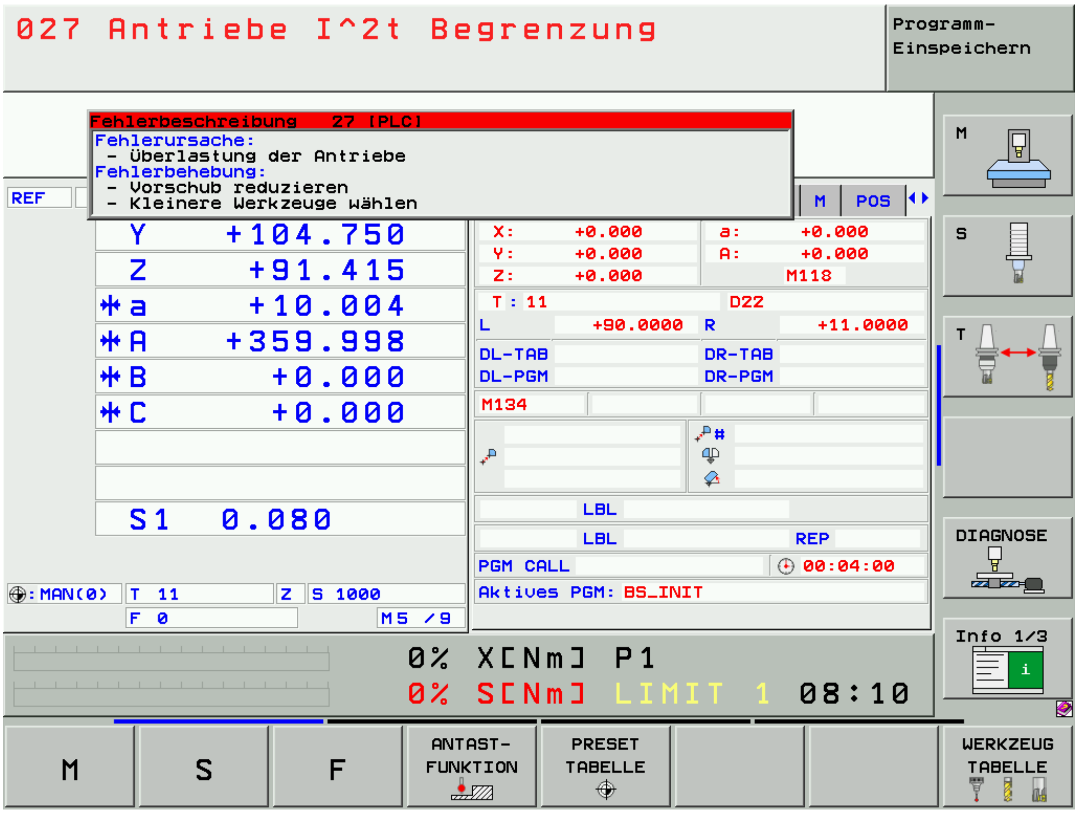
This TNCguide information is also available on our website **www.heidenhain.de**.

PLC error messages

In addition to the NC error messages defined by HEIDENHAIN, the machine manufacturer can define PLC error messages.

The manufacturer can define the machine behavior in case of a PLC error (NC stop, EMERGENCY STOP, etc.). The machine can thus be protected additionally. The operator or the service engineer obtains machine-specific information on the possible causes of the error and on corrective action together with PLC error messages.

Example of an PLC error message on the monitor of an iTNC 530:

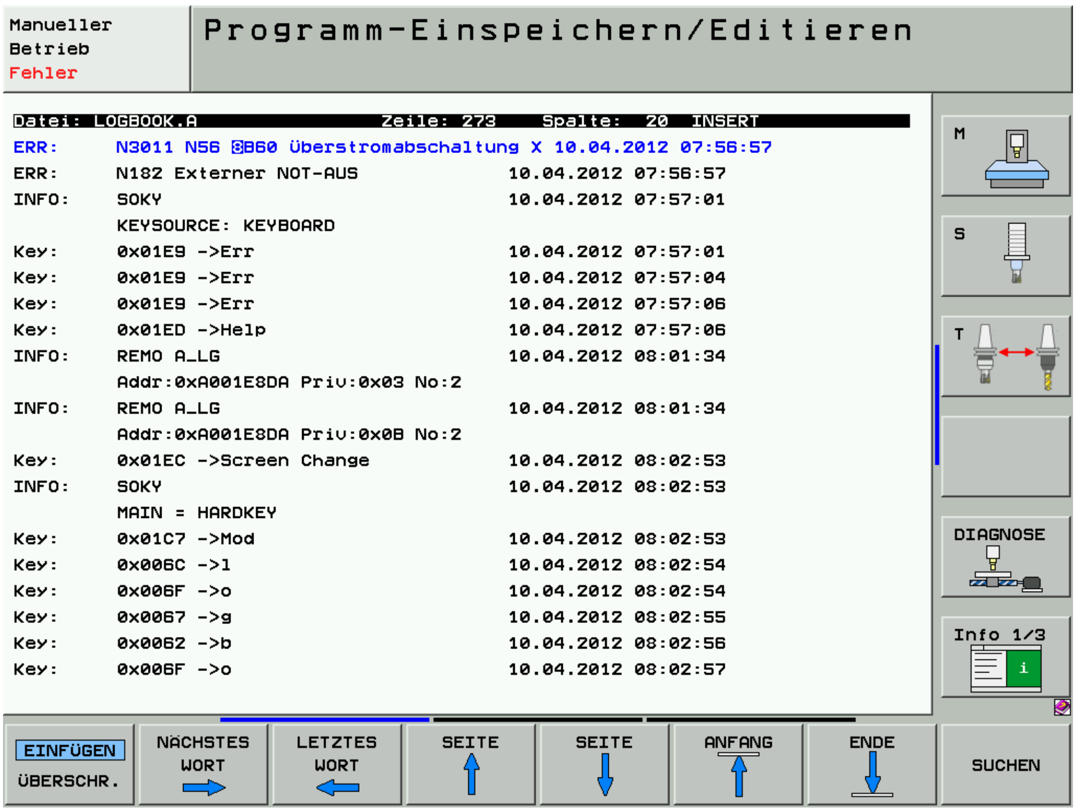


3.4 Log of the control

HEIDENHAIN controls feature a log. In these logs information, key strokes, error messages etc. are recorded.

You will find information in the respective service manuals of the controls (e.g. SHB iTNC 530)!

Example of NC error messages in the log of an iTNC 530:



4 Explanation of the LEDs

4.1 Introduction

On the front of the compact inverters there are several LEDs for functional control.
Their meaning is described in this chapter.

The two red LEDs SH 1 or STO A and SH 2 or STO B (located at every axis and spindle output stage) will be explained in detail:

> **Note**
>
> Within the framework of standardization and adaptation to the machine directives 2006/42/EC binding as of January 1, 2010, the designation of the enabling signals SH 1 (Safe Stop 1) and SH 2 (Safe Stop 2) was changed for inverter models from the current production program.
>
> The signal "**SH 1**" was renamed to "**STO A**" (Safe Torque Off - channel A) and the signal "**SH 2**" to "**STO B**" (Safe-Torque Off - channel B).

Red LED SH 1 / STO A

The old red **SH 1** LED has been superseded by the red **STO.A** LED.

- SH 1 means "Safe Stop 1" (Sicherer Halt)
- STO A means "Safe Torque Off cutout channel A"
- SH 1 / STO A is indicated by a red LED on the inverter system
- SH 1 / STO A is created by the processor of the HEIDENHAIN control.
- SH 1 / STO A is low-active, i.e. line-break proof

If the processor is not ready for operation or if an error is active, SH 1 / STO A is output.
The red SH 1 / STO A LED and the green READY LED at the inverter can not be lit a the same time.
They are mutually locked.

Red LED SH 2 / STO B

The old red **SH 2** LED has been superseded by the red **STO.B** LED.

- SH 2 means "Safe Stop 2" (Sicherer Halt 2)
- STO B means "Safe Torque Off cutout channel B"
- SH 2 / STO B is indicated by a red LED on the inverter system
- SH 2 / STO B is created by the controller of the HEIDENHAIN control.
- SH 2 / STO B is low-active, i.e. line-break proof

If an axis or spindle is not controlled, SH 2 / STO B is active and the red LED is on.
This is, for example, the case with clamped axes or if a spindle is not controlled.
SH 2 / STO B and READY are then lit at the same time.

Figure: The LEDs SH 1 / SH 2 or STO A / STO B on HEIDENHAIN UM units

4.2 Controller unit with integrated inverter

UEC 11x and UMC 11x

LED	Meaning	Signal direction	Signal
SH 1 or **STO A**	Safe Stop 1 or Safe Torque Off; no enable from control (main contactor not active, DSP error, PLC error with emergency stop, hardware or software error of MC, CC)	MC → UxC	$\overline{\text{SH1B}}$ or $\overline{\text{STO.A.x}}$
RDY	Axis/Spindle enabled	UxC → MC	RDY
SH 2 or **STO B**	Safe Stop 2 or Safe Torque Off; no drive enable from control (e.g. by the PLC, active via external signal or SH 1 or STO A)	MC → UxC	$\overline{\text{SH2}}$ or $\overline{\text{STO.B.x}}$
PWR RES.	Reset signal from UxC to the MC	UxC → MC	$\overline{\text{RES.PS}}$
READY	Inverter ready	UxC → MC	RDY
$U_{DC\text{-}LINK}$ >>	U_Z too high (> approx. 850 V); power modules are switched off	UxC → MC	$\overline{\text{ERR.UZ.GR}}$
PWR FAIL	U_Z too low, $U_Z < 410$ V (e.g. failure of a phase under load, power < 290 V)	UxC → MC	$\overline{\text{PF.PS}}$
NC RESET	Reset signal from the MC to the UxC	MC → UxC	$\overline{\text{RES.LE}}$
TEMP >>	Temperature of heat sink too high (> 100 °C)	UxC → MC	$\overline{\text{ERR.TEMP}}$
X 71 SPINDLE	Safety relay for spindle triggered	–	–
X 72 AXES	Safety relay for axes triggered	–	–

Note

On the UEC and UMC, the signals SH 1 (or STO A) and RDY are displayed with two LEDs (red and green) or by means of a multicolored LED, which changes from red to green.

4.3 Compact inverters

UE 1xx

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
SH 1 or **STO A**	Safe Stop 1 or Safe Torque Off; no enable from control (main contactor not active, DSP error, PLC error with emergency stop, hardware or software error of MC, CC)	MC, CC → UE	$\overline{\text{SH1B}}$ or $\overline{\text{STO.A.x}}$
RDY	Axis/Spindle enabled	UE → MC, CC	RDY
SH 2 or **STO B**	Safe Stop 2 or Safe Torque Off; no drive enable from control (e.g. by the PLC, active via external signal or SH 1 or STO A)	MC, CC → UE	$\overline{\text{SH2}}$ or $\overline{\text{STO.B.x}}$
PWR RES	Reset signal from UE to the MC, CC	UE → MC, CC	$\overline{\text{RES.PS}}$
READY	Inverter ready	UE → MC, CC	RDY
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 850 V); power modules are switched off	UE → MC, CC	$\overline{\text{ERR.UZ.GR}}$
PWR FAIL	U_Z too low, U_Z < 410 V (e.g. failure of a phase under load, power < 290 V)	UE → MC, CC	$\overline{\text{PF.PS}}$
NC RESET	Reset signal from MC, CC to UE	MC, CC → UE	$\overline{\text{RES.LE}}$
TEMP >>	Temperature of heat sink too high (> 100 °C)	UE → MC, CC	$\overline{\text{ERR.TEMP}}$
X 71 SP.	Safety relay for spindle triggered	–	–
X 72 AXES	Safety relay for axes triggered	–	–

Note

On the UE 1xx compact inverters, the signals SH 1 and RDY are displayed with two LEDs (red and green) or by means of a multicolored LED, which changes from red to green.

UE 2xx

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
+ 5 V	+ 5 V power supply available	–	–
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UE → MC, CC	$\overline{\text{ERR.UZ.GR}}$
TEMP >>	Temperature of heat sink too high (> 100 °C)	UE → MC, CC	$\overline{\text{ERR.TEMP}}$
AXIS FAULT	Short circuit between a phase of the motor output and U_Z (axes only)	UE → MC, CC	$\overline{\text{AXISFAULT}}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. failure of a phase under load, power < 290 V)	UE → MC, CC	$\overline{\text{PF.PS}}$
POWER RESET	Reset signal from UE to the MC	UE → MC, CC	$\overline{\text{RES.PS}}$
AXIS/SPINDLE RESET	Axes/spindle disabled by the MC	MC, CC → UE	$\overline{\text{SH2}}$
AXIS/SPINDLE READY	Inverter ready	UE → MC, CC	$\overline{\text{RDY}}$
PULSE RELEASE SPINDLE	Safety relay for spindle triggered	–	–
PULSE RELEASE AXES	Safety relay for axes triggered	–	–

UE 2xxB

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
X11x READY	Inverter ready	UE → MC, CC	RDY
X11x SH 1	DSP error, PLC error with Emergency Stop, MC hardware or software error	MC, CC → UE	$\overline{SH1B}$
X11x SH 2	No drive enable (e.g. by the PLC, active via external signal or SH1)	MC, CC → UE	$\overline{SH2}$
READY	Inverter ready	UE → MC, CC	RDY
POWER RESET	Reset signal from UE to the MC	UE → MC, CC	$\overline{RES.PS}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. failure of a phase under load, power < 290 V)	UE → MC, CC	$\overline{PF.PS}$
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UE → MC, CC	$\overline{ERR.UZ.GR}$
TEMP >> (left)	Heat sink temperature too high for axis 4 and spindle (> 100 °C)	UE → MC, CC	$\overline{ERR}$
TEMP >> (right)	Heat sink temperature too high for axis 1 to axis 3 (> 100 °C)	UE → MC, CC	$\overline{ERR}$
NC RESET	Reset signal from the MC to the UE	MC, CC → UE	$\overline{RES.LE}$
PULSE RELEASE SPINDLE	Safety relay for spindle triggered	–	–
PULSE RELEASE AXES	Safety relay for axes triggered	–	–

UE 2xxD

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
X11x READY	Inverter ready	UE → MC, CC	RDY
X11x SH 1 or **STO A**	DSP error, PLC error with Emergency Stop, MC hardware or software error	MC, CC → UE	$\overline{SH1B}$ or $\overline{STO.A.x}$
X11x SH 2 or **STO B**	No drive enable (e.g. by the PLC, active via external signal or SH1)	MC, CC → UE	$\overline{SH2}$ or $\overline{STO.B.x}$
READY	Inverter ready	UE → MC, CC	RDY
POWER RESET	Reset signal from UE to the MC	UE → MC, CC	$\overline{RES.PS}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. failure of a phase under load, power < 290 V)	UE → MC, CC	$\overline{PF.PS}$
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UE → MC, CC	$\overline{ERR.UZ.GR}$
TEMP >> (left)	Heat sink temperature too high for axis 4 and spindle (> 100 °C)	UE → MC, CC	$\overline{ERR}$
TEMP >> (right)	Heat sink temperature too high for axis 1 to axis 3 (> 100 °C)	UE → MC, CC	$\overline{ERR}$
AC FAIL	Phase missing	UR → MC, CC	$\overline{PF.PS.AC}$
NC RESET	Reset signal from the MC to the UE	MC, CC → UE	$\overline{RES.LE}$
PULSE RELEASE SPINDLE	Safety relay for spindle triggered	–	–
PULSE RELEASE AXES	Safety relay for axes triggered	–	–

UR 2xx,
UR 2xx D

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
X11x READY	Inverter ready	UR → MC, CC	RDY
X11x SH 1 or **STO A**	DSP error, PLC error with Emergency Stop, MC hardware or software error	MC, CC → UR	$\overline{\text{SH1B}}$ or $\overline{\text{STO.A.x}}$
X11x SH 2 or **STO B**	No drive enable (e.g. by the PLC, active via external signal or SH1)	MC, CC → UR	$\overline{\text{SH2}}$ or $\overline{\text{STO.B.x}}$
READY UV	Inverter ready	UR → MC, CC	RDY
POWER RESET	Reset signal from UR to the MC	UR → MC, CC	$\overline{\text{RES.PS}}$
POWER FAIL	U_Z too low, U_Z < 410 V (because the main contactor is off, for example)	UR → MC, CC	$\overline{\text{PF.PS}}$
$U_{DC\text{-}LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UR → MC, CC	$\overline{\text{ERR.UZ.GR}}$
$I_{DC\ LINK}$ >>	I_Z > 52 A, Warning signal to control at 58 A	UR → MC, CC	$\overline{\text{ERR.IZ.GR}}$
I_{LEAK} >>	Error current, e.g. through ground fault; warning signal to control	UR → MC, CC	$\overline{\text{ERR.ILEAK}}$
TEMP >> (left)	Heat sink temperature too high for axis 4 and spindle (> 100 °C)	UR → MC, CC	$\overline{\text{ERR}}$
TEMP >> (right)	Heat sink temperature too high for axis 1 to axis 3 (> 100 °C)	UR → MC, CC	$\overline{\text{ERR}}$
AC FAIL	Phase missing	UR → MC, CC	$\overline{\text{PF.PS.AC}}$
NC RESET	Reset signal from the MC to the UR 2xx	MC, CC → UR	$\overline{\text{RES.LE}}$
X 71 SPINDLE	Safety relay for spindle triggered	–	–
X 72 AXES	Safety relay for axes triggered	–	–

4.4 Power supply units

UV 120,
UVR 120D,
UVR 130D,
UV 140,
UVR 140D,
UV 150,
UVR 150,
UVR 150D,
UVR 160D,
UVR 160DW
UVR 170DW

LED	Meaning	Signal direction	Signal
POWER MODULE READY	End stage ready (only for service purposes)	–	–
POWER MODULE RESET	Reset for end stage (only for service purposes)	–	–
TEMP >>	Temperature of heat sink too high (> 95 °C)	UV → MC, CC	$\overline{\text{ERR.TEMP}}$
$U_{\text{DC LINK ON}}$	Main contactor triggered	–	–
READY UV	Power supply unit ready	UV → MC, CC	RDY.PS
POWER RESET	Reset signal from power supply unit to control	UV → MC, CC	$\overline{\text{RES.PS}}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. line power < 290 V)	UV → MC, CC	$\overline{\text{PF.PS}}$
$U_{\text{DC-LINK}}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UV → MC, CC	$\overline{\text{ERR.UZ.GR}}$
$I_{\text{DC LINK}}$ >>	Warning signal to control at overcurrent. UV 120: I_Z > 52 A[a] UVR 120D: I_Z > 52.5 A UVR 130D: I_Z > 71 A UV 140: I_Z > 103 A UVR 140D: I_Z > 105 A UV 150: I_Z > 119 A UV 150: I_Z > 103 A UVR 150D: I_Z > 126 A UVR 160D: I_Z > 196 A UVR 160DW: I_Z > 196 A UVR 170DW: I_Z > 325 A	UV → MC, CC	$\overline{\text{ERR.IZ.GR}}$
I_{LEAK} >>	Error current, e.g. through ground fault; Warning signal to control	UV → MC, CC	$\overline{\text{ERR.ILEAK}}$
AC FAIL	Phase missing	UV → MC, CC	$\overline{\text{PF.PS.AC}}$
NC RESET	Reset signal from control to power supply unit	LE, CC → UV	$\overline{\text{RES.LE}}$
X 71 SPINDLE	Safety relay for spindle triggered	–	–
X 72 AXES	Safety relay for axes triggered	–	–

a. A further increase of around 10% results in the drives being switched off.
This also applies to the other stated DC-link currents of the power supply units.

UV 130

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
READY	Power supply unit ready	UV → MC, CC	RDY.PS
POWER RESET	Reset signal from power supply unit to control	UV → MC, CC	$\overline{\text{RES.PS}}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. line power < 290 V)	UV → MC, CC	$\overline{\text{PF.PS}}$
$U_{DC\text{-}LINK}$ >>	U_Z too high (> approx. 760 V); power modules are switched off	UV → MC, CC	$\overline{\text{ERR.UZ.GR}}$
$I_{DC\ LINK}$ >>	Warning signal to control at I_Z > 75 A[a]	UV → MC, CC	$\overline{\text{ERR.IZ.GR}}$
I_{LEAK} >>	Error current, e.g. through ground fault; warning signal to control	UV → MC, CC	$\overline{\text{ERR.ILEAK}}$
TEMP >>	Temperature of heat sink too high (> 95 °C)	UV → MC, CC	$\overline{\text{ERR.TEMP}}$
NC RESET	Reset signal from control to power supply unit	LE, CC → UV	$\overline{\text{RES.LE}}$
X 72 AXES	Safety relay for axes triggered	–	–
X 71 SPINDLE	Safety relay for spindle triggered	–	–

a. A further increase of around 10% results in the drives being switched off.

UV 130D

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
READY UV	Power supply unit ready	UV → MC, CC	RDY.PS
POWER RESET	Reset signal from power supply unit to control	UV → MC, CC	$\overline{\text{RES.PS}}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. line power < 290 V)	UV → MC, CC	$\overline{\text{PF.PS}}$
$U_{DC\text{-}LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UV → MC, CC	$\overline{\text{ERR.UZ.GR}}$
$I_{DC\ LINK}$ >>	Warning signal to control at I_Z > 85.2 A[a]	UV → MC, CC	$\overline{\text{ERR.IZ.GR}}$
I_{LEAK} >>	Error current, e.g. through ground fault; warning signal to control	UV → MC, CC	$\overline{\text{ERR.ILEAK}}$
AC FAIL	Phase missing	UV → MC, CC	$\overline{\text{PF.PS.AC}}$
NC RESET	Reset signal from control to power supply unit	LE, CC → UV	$\overline{\text{RES.LE}}$
X 72 AXES	Safety relay for axes triggered	–	–
X 71SPINDLE	Safety relay for spindle triggered	–	–
TEMP >>	Temperature of heat sink too high (> 95 °C)	UV → MC, CC	$\overline{\text{ERR.TEMP}}$

a. A further increase of around 10% results in the drives being switched off.

4.5 Power modules

UM 1xx

LED	Meaning	Signal direction	Signal
READY	Power module is ready	UM → MC, CC	RDY
SH 1 or **STO A**	DSP error, PLC error with Emergency Stop, hardware or software error of the control	MC, CC → UM	$\overline{\text{SH1B}}$ or $\overline{\text{STO.A.x}}$
SH 2 or **STO B**	No drive enable (e.g. by the PLC, active via external signal or SH1)	MC, CC → UM	$\overline{\text{SH2}}$ or $\overline{\text{STO.B.x}}$
TEMP >>	Warning signal for IGBT temperature too high	UM → MC, CC	$\overline{\text{ERR}}$

4.6 HEIDENHAIN interface boards for the SIMODRIVE system

4.6.1 Boards with ribbon cable connection for the PWM interface

LED	Meaning	Signal direction	Signal
READY	Power module is ready	LT → MC, CC	RDY
SH 1	DSP error, PLC error with Emergency Stop, hardware or software error of the control	MC, CC → LT	$\overline{\text{SH1}}$
SH 2	No drive enable (e.g. by the PLC, active via external signal or SH1)	MC, CC → LT	$\overline{\text{SH2}}$

4.6.2 Boards with D-sub connection for the PWM interface

Id.Nr. 324 952-0x

LED	Meaning	Signal direction
IF	"Pulse release", power module is ready	LT → MC, CC
NB	"Not ready“, power module does not provide a ready signal	LT → MC, CC

Id.Nr. 324 952-0x

LED	Meaning	Signal direction	Signal
READY	Power module is ready	LT → MC, CC	RDY
RESET X1	No drive enable, current and speed controller are not switched on	MC, CC → LT	SH2
RESET X2	No drive enable, current and speed controller are not switched on	MC, CC → LT	$\overline{\text{SH2}}$

RESET X1 and RESET X2 correspond here to signal SH2.

5 Procedures and tips for error diagnosis in the field

5.1 Introduction

For error diagnosis on drives for machine tools **systematic procedures** have turned out to be effective.

They are described below.

Note

The diagnostic capabilities of the respective machine controls can also be helpful.

Please also note ... „Notes and tips for the field service" on page 37.

5.2 Sequence for finding errors in digital drives

A **ground fault or short circuit** is **the most severe electrical error** on the drives and must be excluded from further examination.

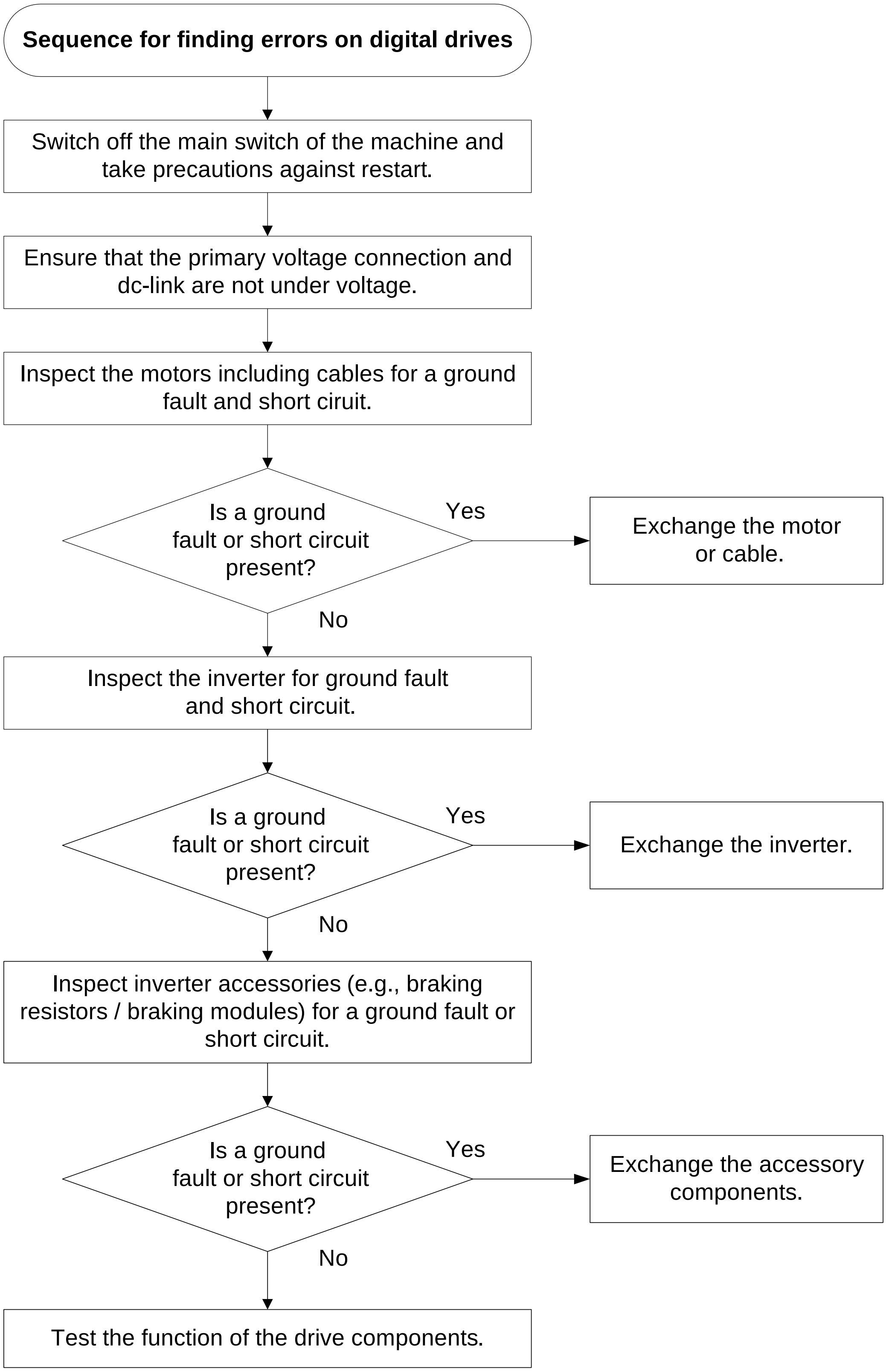
Danger

Ground faults or short circuits have to be eliminated before further investigation is possible!

A **ground fault or short circuit** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as **Leakage current in UV 1xx** or **Overcurrent cutoff** or similar error messages on the control.
- Scorch marks and/or burnt smell
- Destroyed units

Flowchart



Note

For **detailed descriptions** on how to find ground faults and short circuits, **refer to the chapters** about **corrective action on motors, inverters and accessories**.

5.3 Sequence for finding errors in the control loop

In the event of error messages related to movement, acceleration or standstill, for example:

- **Positioning error**
- **Excessive servo lag**
- **Nominal speed value too high**
- **Movement monitoring**
- **Standstill monitoring**

or in case of errors, for example:

- Poor workpiece quality
- Unusual noise during axis movements
- Unusual vibrations

... you can check machine components in a defined order to find the fault.
See flowchart in this section!

> Note
>
> If you need information on lubrication, mechanics, hydraulics, pneumatics, brakes, coupling system, please contact your machine manufacturer!
>
> For troubleshooting on the respective control and the connected units, use the corresponding service manual.

Possible effects of contaminated, loose, defective encoders

The mentioned error messages and errors in the control loop can also be caused by **contaminated, loose or defective encoders**!

For example, a contaminated field of a scanning head with 4-field scanning can degrade the on-to-off ratio which has a negative effect on the feedback control of the machine axis. As long as the on-to-off-ratio is not outside the tolerance, **no encoder error message** is generated.

If a scanning head or a motor encoder has become loose, the encoder signals may still be sufficiently evaluated. This means that **no encoder error message** is generated. During traverse, and in particular when the direction is changed and if the machine axes vibrate, the above error messages may be generated, as the machine and the encoder are no longer connected firmly.

In exceptional cases, due to defective electronics or a damaged cable, constant voltages may be supplied to the control that are within the tolerance range of the encoder specifications.
This means **no encoder error message** is generated.

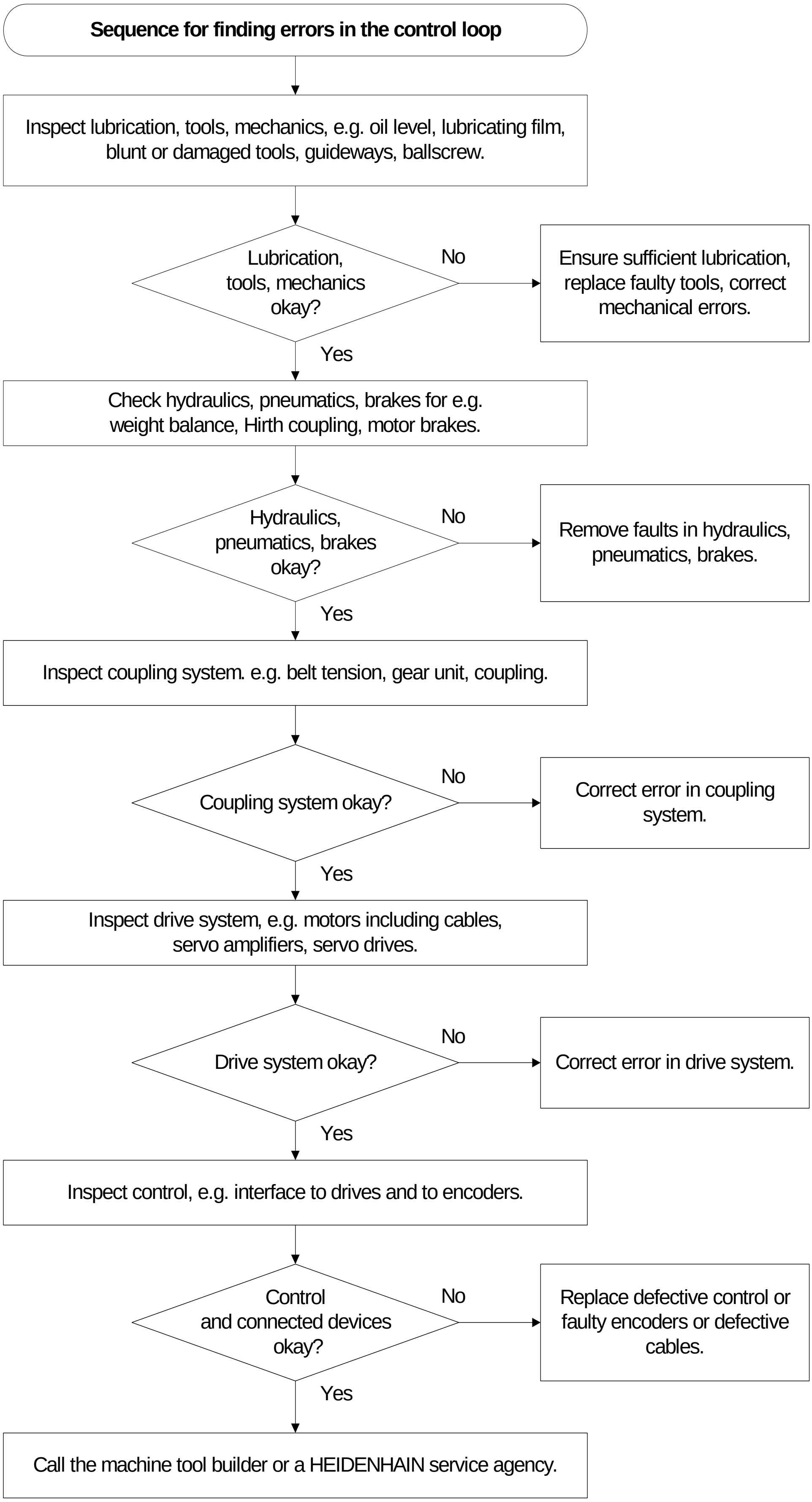
For an **analysis** you can proceed as follows:

- Increase the monitoring limits (e.g., for the servo lag). A longer distance may be traversed before an error is generated.

> Danger
>
> Increasing the monitoring limits reduces the safety of the machine!

- Now inspect the encoder signals with an appropriate measuring device (e.g., PWM 9, See "PWM 9 encoder diagnostic kit" on page 14 – 418. When the axis is moved, the signal must change (sine, cosine)!
- Observe the on-to-off ratio, the amplitude height, etc.
- **Finally, restore the original monitoring tolerances!**
- If necessary, clean or replace the encoder. The mechanics may also require reconditioning.

Flowchart



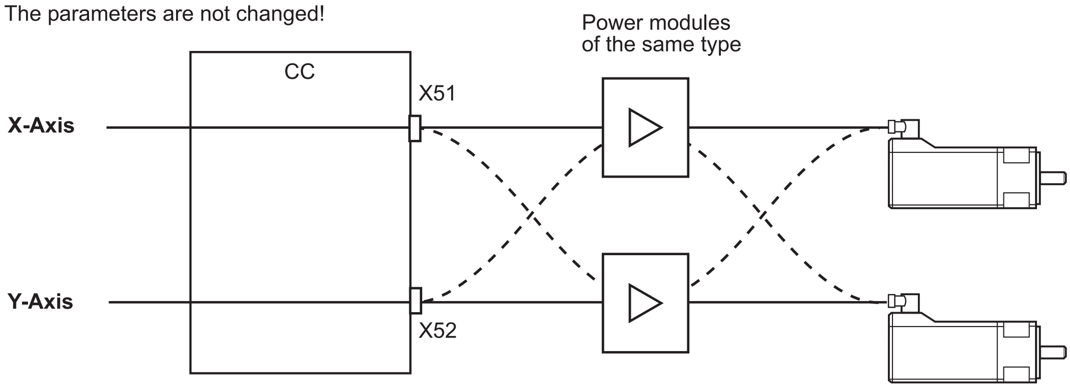
Note

Before starting any extensive inspections of the mechanics, the "electrician" can also check the components in the electrical cabinet (power modules, etc.) first.

5.4 Error localization by process of interchange

For checking **machine tool components available more than once**, such as servo amplifiers, motors or expansion cards, **the "process of interchange" is suitable**.
To do this, interfaces or identical devices are interchanged in order to find out, whether the error "moves".

Example for the interchange of power modules



- Interchange of inverters–>
  See "Interchanging power modules or output stages of the same type" on page 7 – 109,
  See "Interchanging output stages of the same type" on page 7 – 142
  See "Interchanging output stages of the same type" on page 7 – 155
  See "Exchanging output stages of the same type" on page 7 – 168
  See "Interchanging power stages of the same type" on page 7 – 173

- Interchange of expansion boards -->
  See "Interchaning the HEIDENHAIN interface boards for the SIMODRIVE 611 system" on page 7 – 172

Attention

Ensure that there are no ground faults and short circuits in the power output stages and motors you wish to exchange!

Otherwise, interfaces of the control (e.g., X51 following) or other units conncected (inverters, motors) could be damaged.

5.5 Error localization by process of exclusion

For the **"exclusion method"** probably **defective motors are separated from the power amplifiers.**Then a check is made, as to whether the previous error message or error recurs.

The "exclusion method" is usefull if an exceptionally high current already flows when the digital drives are switched on. The following error messages, for example, can then appear on the monitor of the control:

- **8B60 Overcurrent cutoff**
- **8BC0 Motor current too high**
- **8160 Actual current value too high**
- **8060 Leakage current in UV 1xx too high**
- **8B60 Error in axis module**

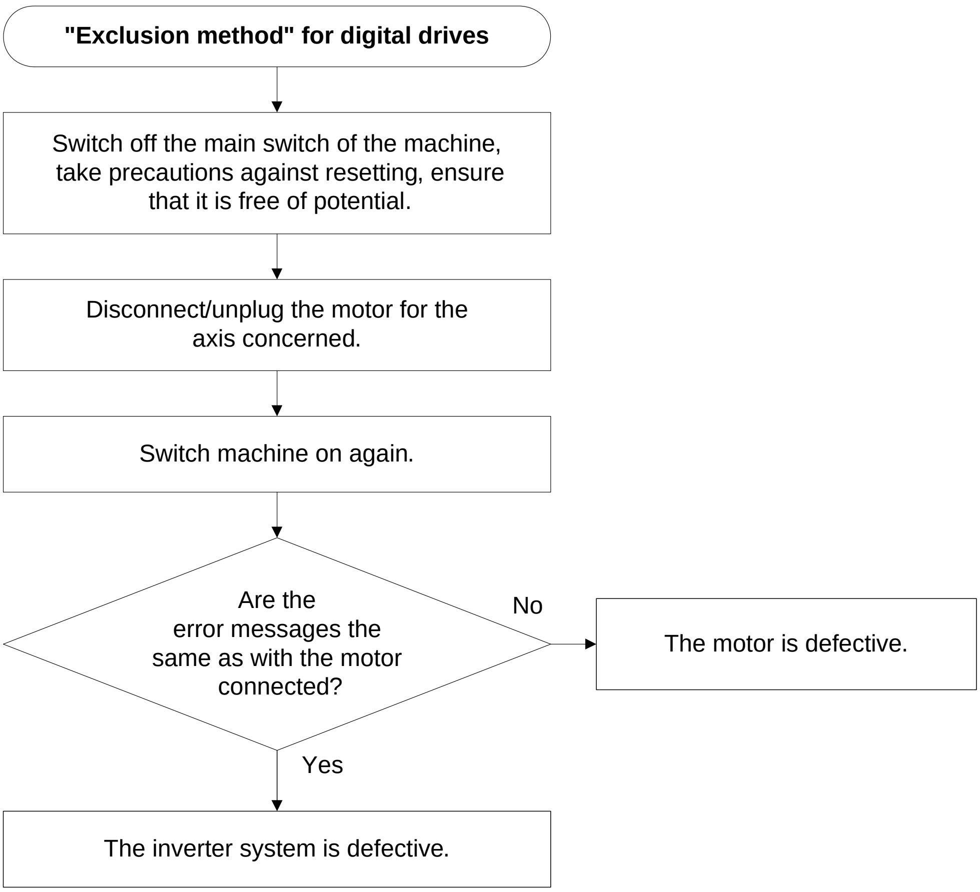
Or error messages regarding an excessive load of the drives are generated, although the machine is not yet milling.

- **8610 I2t value is too high**
- **8620 Load is too high**

Danger

If safety fuses have blown when the control was switched on, the machine should not be switched on again, before you have eliminated all possibible ground and short circuits in the electronics of the machine (e.g., on motors and power amplifiersl).

Flowchart



5.6 Notes and tips for the field service

What is the cause of this error?

- Ask the operator or technician who **worked last with or on the machine** about the detailed course of events.

Have there been any particular incidences, such as …

- A loud bang in the electrical cabinet
- Overload
- Leaky hydraulic, coolant or water lines
- Condensation on boards
- Cleaning of the machine (humidity, etc.)
- Thunderstorm
- Modifications to the machine
- Tests on the machine
- NC software update
- New service pack
- New part program
- Tool breakage
- Collision
- Power failure
- Etc.

Were there any repeated error messages indicating overload (e.g., **I2T monitoring**, **Motor temperature too high**, **Motor current too high**, **Load is too high**) or a defect (e.g., **Overcurrent cutoff**) of the drive?

Note

Tracking back the error cause together may facilitate troubleshooting.

First steps

- If possible, ask the person in charge to show you the error.
- Check together whether the error can be reproduced and always occurs reliably at a certain position.
- Secure the current condition of the machine with a backup (see service manual of the machine tool control).
- Isolate the error.

Visual inspection

Especially in the event of severe errors in the drive train, a visual check may be very helpful:

- Any tools damaged?
- Machine crash?
- Heavily contaminated devices?
- Defective cables?
- Defective tubes, sealings, threaded joints?
- Defective fuses?
- Destroyed power amplifiers?
- Defective coupling system, belt, gear, etc.?
- Fan on motor fallen off?
- Mechanical defects on motor?
- Moisture inside devices?
- Condensation on boards?
- Plug or clamp connections corroded, loose, scaled?
- Scorch marks / burnt smell?

Comparison with functioning machines or devices

If identical machines or devices are available, you can compare the functions.

This can be very helpful for troubleshooting!

DC-link conductor bars

The DC-link conductor bars must be firmly screwed in place!

> Attention
>
> DC-link conductor bars that are loosely screw tightened or are not screwed in place at all, can result in a failure or destruction of devices.

> Danger
>
> **Danger of electrical shock!**
> The units must be free of potential for the inspection of the DC-link conductor bars.
> Ensure that the machine is switched off and is not under voltage!
> Wait at least for 5 minutes (there must be no residual voltage or current available), ensure again that the unit is free of potential and remove the conductor bars.

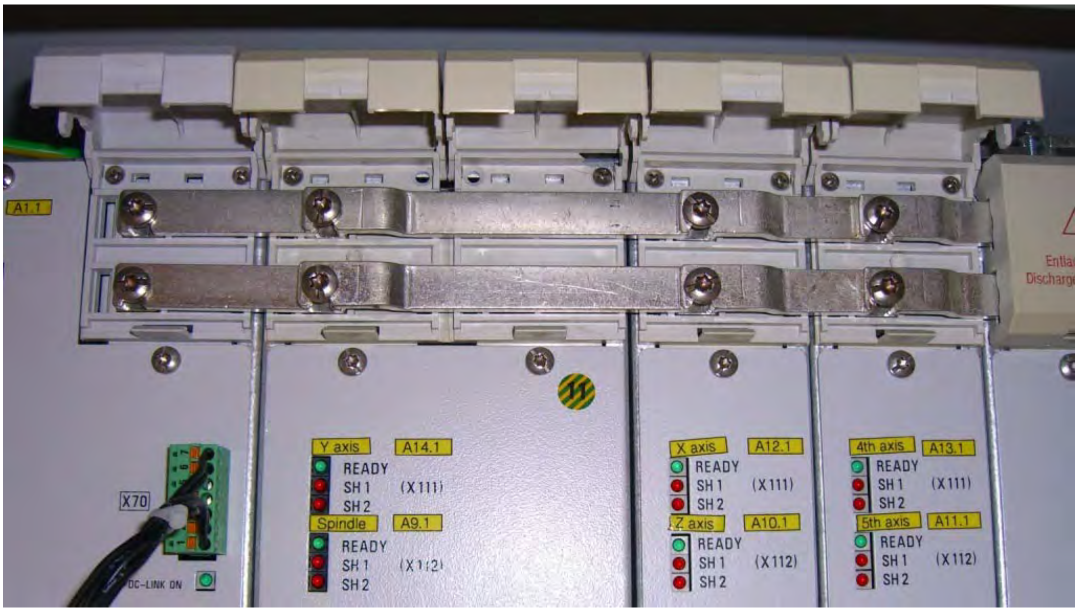


Figure: Screw tightened DC-link conductor bars

> Attention
>
> The screws for the DC-link conductor bars must be tightened with 3.5 Nm!

Cables

Defective cables may lead to interruptions and short circuits. Undefined statuses and indirect error messages may be generated.

Therefore, check in particular, whether the cables show signs of wear or were squeezed, and inspect the connection points.

Connectors and females

Observe the following instructions for connecting or disconnecting any connectors:

D-sub males or females

- Connect and disconnect straightly! Otherwise, the spring contacts in the D-sub female connectors could be widened. This may result in contact problems!

Ribbon connectors or sockets

- Connect carefully and straightly with constant pressure in order not to bend any pins.

Signal socket at the motor

- Carefully slide the nib of the connector into the notch of the signal socket and screw the connector straightly. Do not use force! Otherwise the pins could be bent or even pressed into the socket.

Terminals

Ensure that the terminals are firmly tightened.
Wires and leads must not be damaged or corroded.

> Attention
>
> Wires of motor power cables that are loosely clamped or are not clamped at all can scale and thus result in a failure or destruction of devices.

Shielding and grounding

Defective shieldings and groundings may also result in undefined errors or in a malfunction of the machine. The reason are compensating currents that are caused by potential differences.
Therefore, check the terminals, shielded cables (the shielding braid must not contact the 0 V conductor inside the cable), cover plates, grounding bars, contact plates, etc.

> Attention
>
> If HEIDENHAIN interface boards are used for the SIMODRIVE system, please check whether the grounding is implemented as prescribed. See "Exchanging HEIDENHAIN interface boards in the SIMODRIVE system" on page 10 – 267 .

Sources of interference

Also observe **possible sources of interference** that may have a negative effect on the control and its peripherals.

Interference is mainly produced by capacitive and inductive coupling from electrical conductors or from device inputs/outputs, such as ...

- Strong magnetic fields, e.g. from transformers, electric motors, magnetic clamping tables
- Relays, contactors and solenoid valves
- High-frequency equipment, pulse devices, and stray magnetic fields from switch-mode power supplies
- Adjoining welding facilities
- Power lines and leads to the above equipment

Make sure that …

- There is a minimum distance of 20 cm from the control and its leads to interfering equipment.
- There is a minimum distance of 10 cm from the control and its leads to cables that carry interference signals. For cables in metallic ducting, adequate decoupling can be achieved by using a grounded separation shield.
- The cross section of potential compensating lines is **at least 10 mm**^{2}.
- Genuine HEIDENHAIN cables, connectors and couplings are used.
- Cover plates are available for the ribbon cables.

> Note
>
> Contact the machine manufacturer if these conditions are not fulfilled!

Contamination

Pay special attention to **contaminated units** (oil, grease, dust, etc.)!

What could be the reason for the contamination?
Some examples:

- Machining of cast blanks or graphite
- Coolant or coolant vapor
- Defective filter system in the electrical cabinet (filter pads)
- Oil or oil vapor
- Oil in the compressed-air system
- Door of electrical cabinet open

Attention

The deposition of dust from the ambient air, precipitation of chemical contamination contained in the air or the natural formation of dew after switching off the machine can form a conductive layer on the live parts of electrical equipment and may cause flashovers resulting in corresponding damage.

Temperature

Use the appropriate equipment to measure, whether the **temperature is exceeded**.

What could be the reason?
Some examples:

- Climate control unit in electrical cabinet defective
- Clogged filter pads
- Defective fans
- Motors and inverters overloaded
- Defective temperature sensors
- Unfavorable mounting of components

Danger

The permissible ambient temperature in operation of the inverter systems is between 0 °C and 40 °C. Any deviation from this can impair the operating safety of the machine.

Attention

Temperatures of up to 145 °C may occur on the motor surfaces.

Humidity

Check whether **humidity** has entered the units or condensed water has spread.

What could be the reason?
Some examples:

- Incorrectly set or defective climate control unit in the electrical cabinet (the activation temperature of the climate control unit should be set to 35 °C; the switching hysteresis must not exceed 5 °C.)
- Coolant or coolant vapor
- Condensation of boards due to changes in temperature
- Defective tubes, sealings, screw connections, etc.
- Electrical cabinet not sufficiently tight

Attention

Maximum 75 % humidity allowed during continuous operation.

Checking the safety measures for the EMV

With regenerative inverter systems observe, whether ...

- a suitable HEIDENHAIN commutating reactor is used.
- a suitable HEIDENHAIN line filter was used.

Inverter	**UV 120, UVR 120 D, UR 2xx(D)**	**UVR 130 D**	**UV 140, UVR 140 D**
Suitable commutating reactor	KDR 120	KDR 130 B/C	KDR 140
Suitable line filter	EPCOS 35 A	EPCOS 80 A	EPCOS 80 A

Inverter	**UVR 150, UVR 150 D**	**UVR 160 D, UVR 160 DW**	**UVR 170DW**
Suitable commutating reactor	KDR 150	KDR 160	KDR 170
Suitable line filter	EPCOS 80 A	EPCOS 120 A	EPCOS 200 A

Note

High-frequency disturbances in the power line may occur with other commutating reactors or line filters.

Note

We recommend that you use a HEIDENHAIN three-phase capacitor to ensure additional interference suppression if you are using a line filter.
A three-phase capacitor has already been integrated in the line filters EPCOS 120 A and EPCOS 200 A, and also in the newer line filters EPCOS 35 A and EPCOS 80 A.
Contact the machine manufacturer or HEIDENHAIN.

With **motors** observe, whether ...

- Motor power cables with a length of up to **15 m** are used. If greater cable lengths are required, it might be necessary to take additional measures for interference suppression.
- The shield of the line for the holding brake is to be kept as close as possible (< 30 mm) to ground. The best solution is to fasten the shield with a metal clamp directly onto the sheet-metal housing of the electrical cabinet.

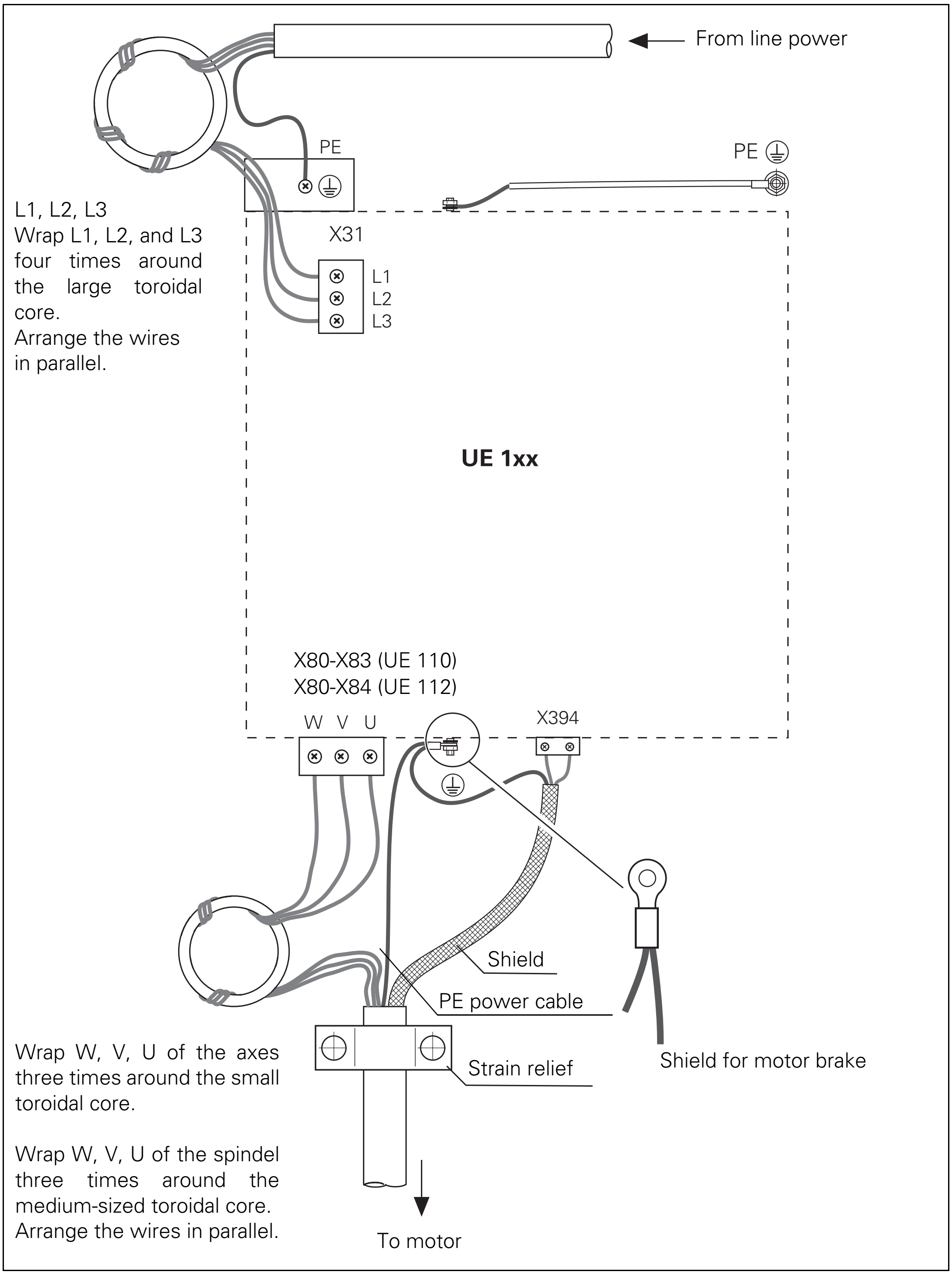
With **compact inverters** UE 1xx, UE 2xx und UE 2xx B and UE 2xx D observe, whether ...

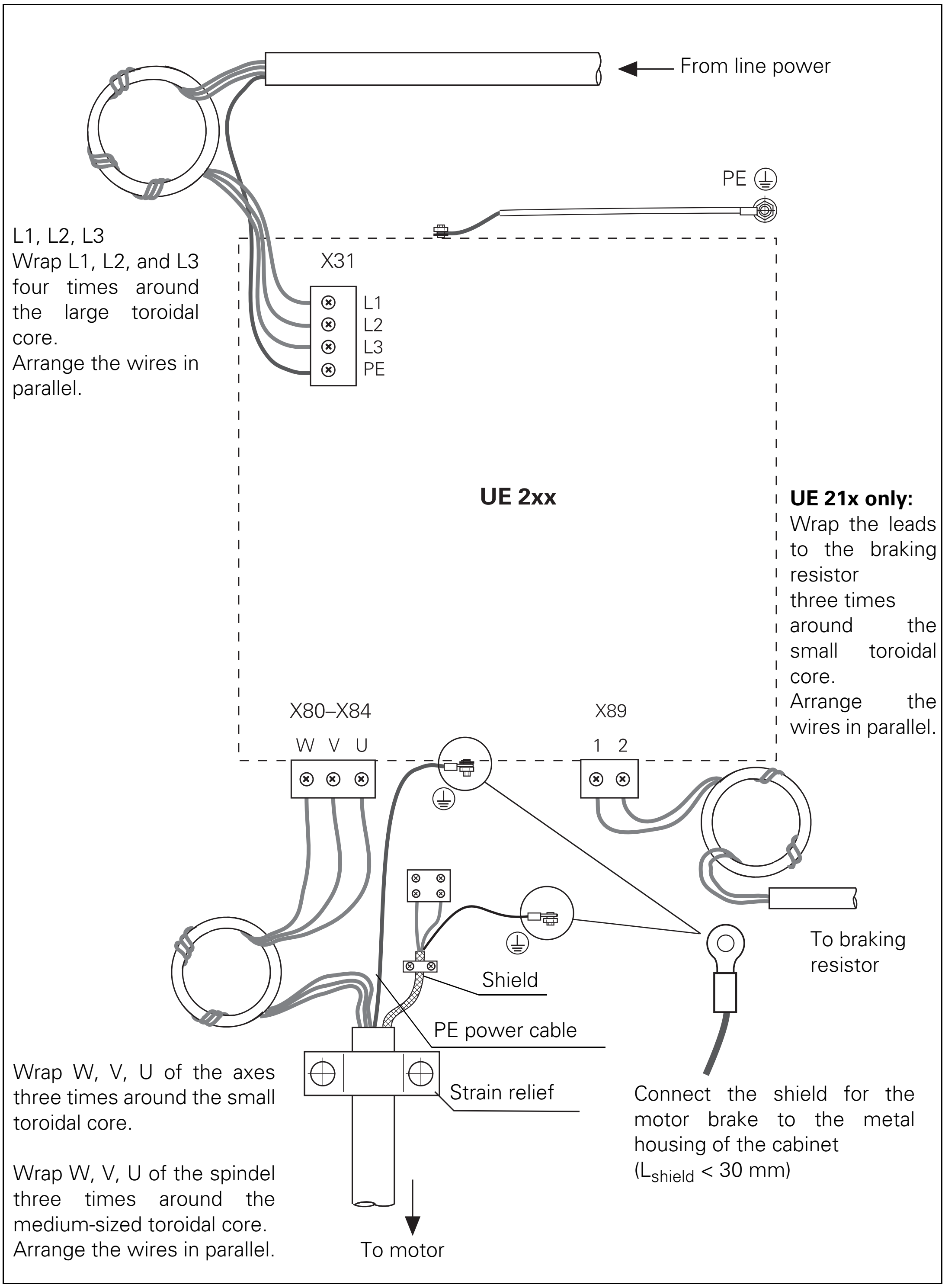
- Toroidal cores are integrated in the motor leads (X80 to X84).
- One toroidal core is integrated in the voltage supply lead (X31).
- Toroidal cores are integrated in braking resistor leads (only UE 21x)

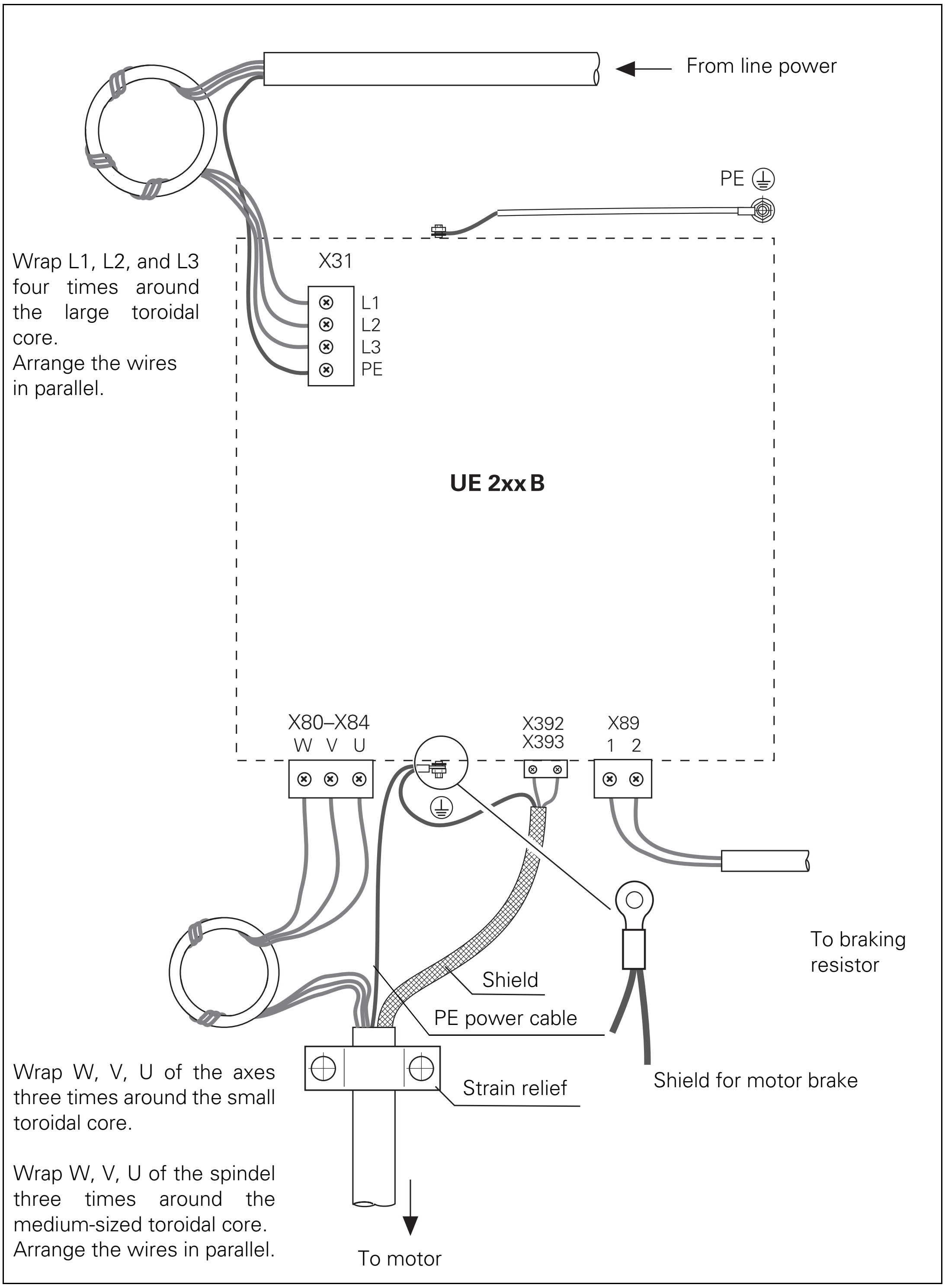
These measures serve to suppress conducted interference (power line disturbance according to EN 55011 / 55022 Class A).

Attention

If more windings are integrated in the toroidal cores than indicated, the EMC properties degrade!




From line power
PE
L1, L2, L3
Wrap L1, L2, and L3 four times around the large toroidal core.
Arrange the wires in parallel.
X31
L1
L2
L3
PE
UE 2xx
UE 21x only:
Wrap the leads to the braking resistor three times around the small toroidal core.
Arrange the wires in parallel.
X80–X84
W V U
X89
1 2
To braking resistor
Shield
PE power cable
Strain relief
Wrap W, V, U of the axes three times around the small toroidal core.
Wrap W, V, U of the spindel three times around the medium-sized toroidal core.
Arrange the wires in parallel.
Connect the shield for the motor brake to the metal housing of the cabinet (L_{shield} < 30 mm)
To motor



Note

This figure also applies for the UE 2xx D compact inverters.

Terminal on the compact inverter	**Toroidal core**
Power supply (X31)	Diameter 87 mm (309 694-02)
Braking resistor (X89)[a]	Diameter 42 mm (309 694-01)
Axes 1 to 3 (X81 to X83)	
Axis 4 (X84)	Diameter 59 mm (309 694-03)
Spindle (X80)	

a. only for UE 21x

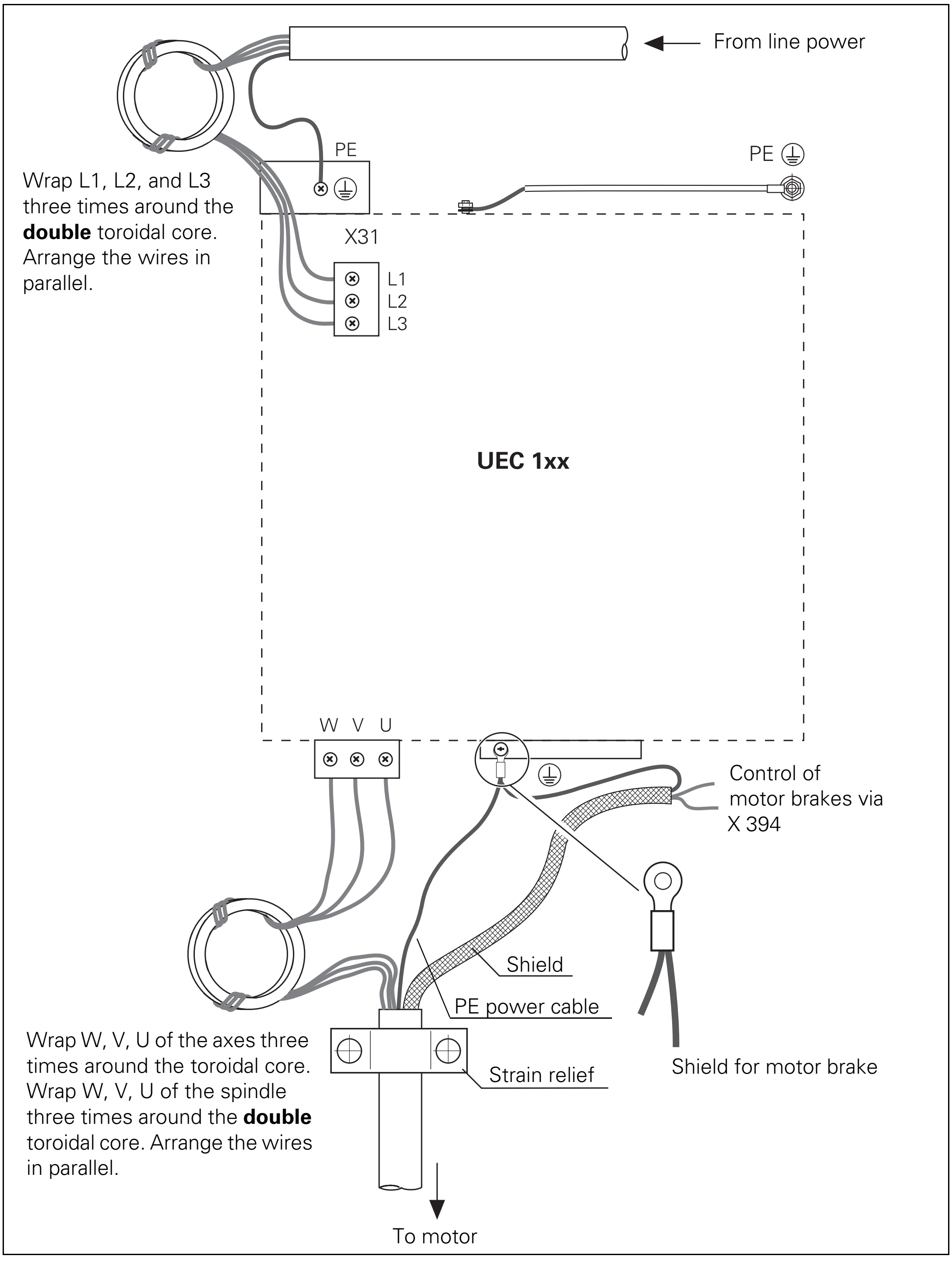
With controller units with integrated inverter UEC 1xx, pay attention whether ...

- Toroidal cores are integrated in the motor leads (X80 to X84).
- One toroidal core is integrated in the voltage supply lead (X31).

These measures serve to suppress conducted interference (power line disturbance according to EN 55011 / 55022 Class A).

Attention

If more windings are integrated in the toroidal cores than indicated, the EMC properties degrade!



Terminal on the UEC	Toroidal core	Units
Power supply (X31)	Diameter 42 mm (ID 309 694-05)	2
Spindle (X80)		2
Axes 1 to 4 (X81 to X84)		ea. 1

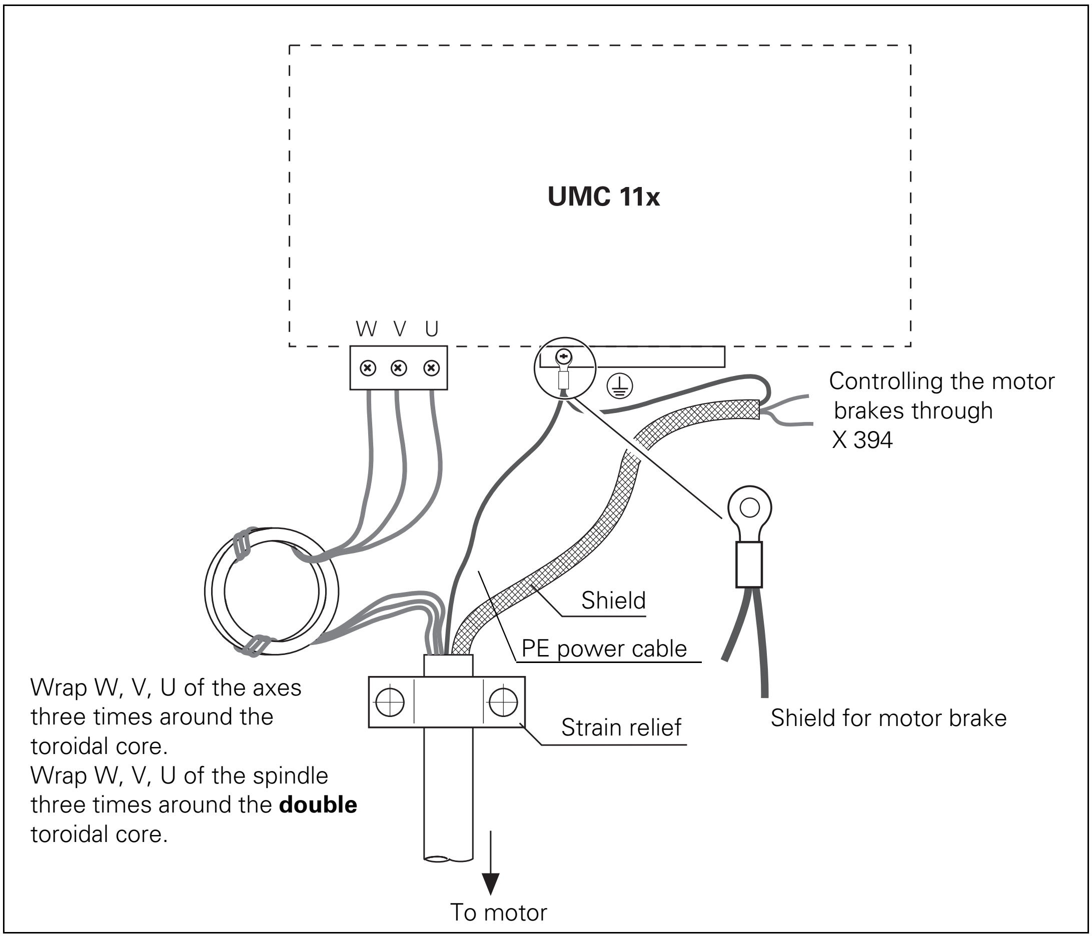
With controller units with integrated inverter UMC 1xx, pay attention whether ...

- Toroidal cores are integrated in the motor leads (X80 to X83).
- The lines are wound three times around the toroidal core.

These measures serve to suppress conducted interference (power line disturbance according to EN 55011 / 55022 Class A).

Attention

If more windings are integrated in the toroidal cores than indicated, the EMC properties degrade!



Terminal on the UMC	Toroidal core	Units
Axes 1 to 4 (X80 to X83)	Diameter 42 mm (ID 309 694-05)	ea. 1

6 Error diagnosis on motors

6.1 Safety

Motors operate with **high voltages and currents**.
They can achieve very **high speeds** with **large torque values**.

Before you perform work on the drive system of the machine, note the safety precautions in this service manual! See “Safety precautions” on page 2 – 13.

Please also note the **safety precautions of the machine manufacturer!**

6.2 Possible causes of error

No claim for completeness; contact your machine manufacturer.
If possible, write your own experience.

- Ground fault
- Short circuit in windings
- Insulation system in the motor defective
- Overload (e.g., mechanical defects, stiffness, blunt tool, insufficient lubrication)
- Excessive temperatures for a long period of time
- Defective temperature sensor
- Defective fan
- Defective rubber buffer for suspension of fan
- Contamination
- Humidity
- Damaged signal or power socket
- Damaged signal or power cable
- Motor cable defective
- Insufficient mounting of the motor encoder (e.g., loose expanding coupling)
- Insufficient or defective motor brake
- Unbalance

- Speed encoder interface on the control defective
- Evaluation of the temperature sensor in control defective
- Flashover from motor coil to temperature sensor
- No controlling of motor brake
- No power supply for fan
- Defective power module (drive)

Note

Demagnetizations on HEIDENHAIN motors have not been detected so far.

6.3 Visual inspection

Motors and respective cables are mostly mounted under the covers in the machine tool and are thus not visible. Nevertheless, a visual inspection may help you to gain conclusions that justify the effort to dismount the covers.

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential.
- If necessary, remove all machine covers. Observe all safety instructions!
- Please note the following:

  - Is the motor or the area where it is mounted heavily contaminated?
  - Does the motor show mechanical defects?
  - Has the fan become loose?
  - Has humidity ingressed the motor?
    (it may be possible that coolant flows along the cables to the motor connections)
  - Are there defective cables?
  - Are there damaged couplings, gears, belts, etc.?
  - Are there any scorch marks or a burnt smell?
  - Plug or clamp connections corroded, loose, scaled?

Photo: Defective and heavily contaminated motor

6.4 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of ...

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as **`Leakage current in UV 1xx`** or **`Overcurrent cutoff`** or similar error messages on the control.
- Humidity in the motors and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement – >See "Insulation tester" on page 14 – 412.

> Danger
>
> The insulation tester operates at high voltages.
> Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN motors **QSY** and **QAN** are tested in the field with a isolation voltage of **1000 V**.

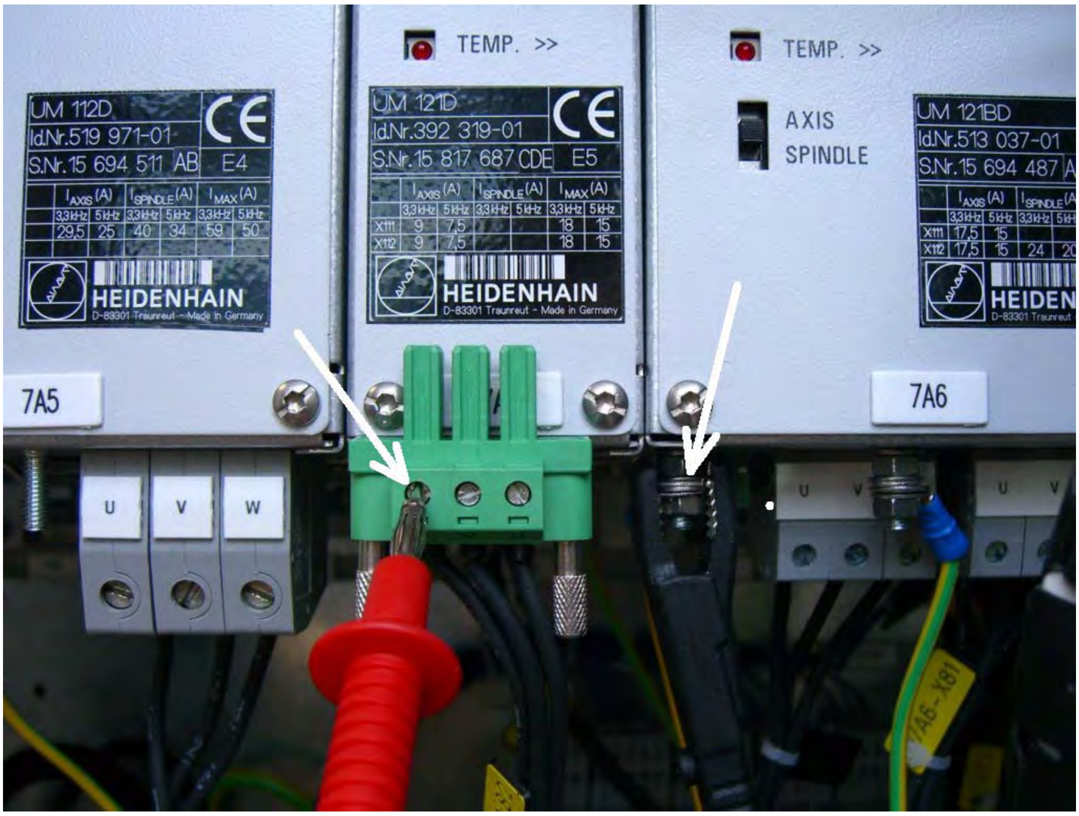
Observe the voltage specifications for the insulation test as per the corresponding manuals when checking **linear and torque motors** for ground faults (sometimes smaller than 1000 V)!

Procedure

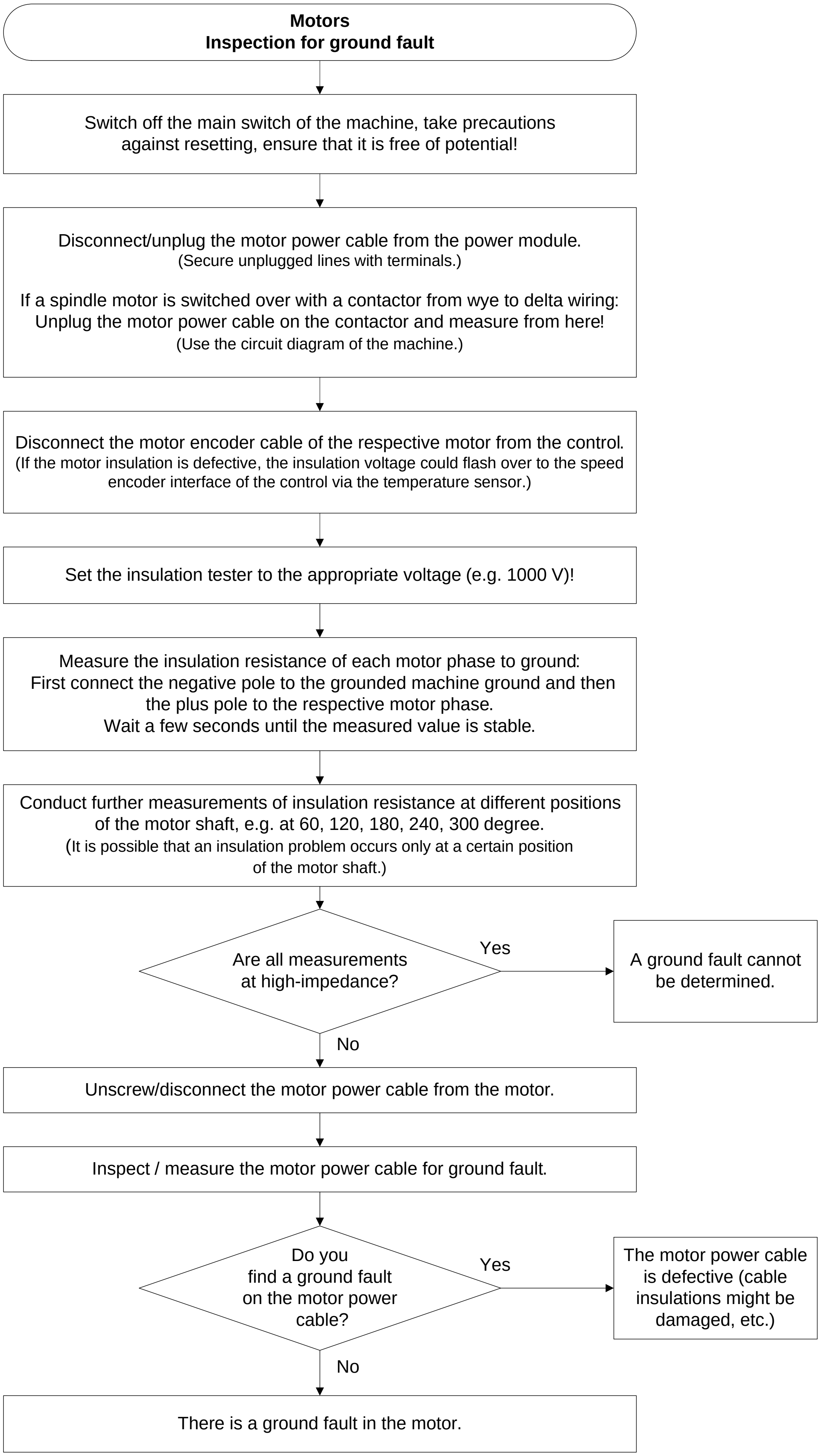
Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

> Danger
>
> **Danger of electrical shock!**
> The units must be free of potential for the following measurements.
> Ensure that the machine is switched off and is not under voltage!

Figure: Ground fault measuring



Flowchart



Motors
Inspection for ground fault
Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential!
Disconnect/unplug the motor power cable from the power module.
(Secure unplugged lines with terminals.)
If a spindle motor is switched over with a contactor from wye to delta wiring: Unplug the motor power cable on the contactor and measure from here!
(Use the circuit diagram of the machine.)
Disconnect the motor encoder cable of the respective motor from the control.
(If the motor insulation is defective, the insulation voltage could flash over to the speed encoder interface of the control via the temperature sensor.)
Set the insulation tester to the appropriate voltage (e.g. 1000 V)!
Measure the insulation resistance of each motor phase to ground:
First connect the negative pole to the grounded machine ground and then the plus pole to the respective motor phase.
Wait a few seconds until the measured value is stable.
Conduct further measurements of insulation resistance at different positions of the motor shaft, e.g. at 60, 120, 180, 240, 300 degree.
(It is possible that an insulation problem occurs only at a certain position of the motor shaft.)
Are all measurements at high-impedance?
Yes
A ground fault cannot be determined.
No
Unscrew/disconnect the motor power cable from the motor.
Inspect / measure the motor power cable for ground fault.
Do you find a ground fault on the motor power cable?
Yes
The motor power cable is defective (cable insulations might be damaged, etc.)
No
There is a ground fault in the motor.

Note

"Crosscheck":
If your insulation tester operates without power supply (i.e., is operated with accumulators) and has an insulated housing, you can perform the insulation measurement also in reverse direction as a "crosscheck". The negative pole is then connected to the motor phase, the plus pole to the grounded machine ground.

Note

The **resistance value of each phase to ground** must be at **high-impedance** (experience has shown that the measured values are in the GOhm range)!

Defined resistance values cannot be specified here as they depend on the following factors or others:

- Motor and cable type
- Temperature of the tested motor (standard temperature for the insulation measurement: 20 °C)
- Duration of the measurement (reduction of capacitive current and dielectric absorption current)
- Technical data of the insulation measuring unit

If required, you can compare the measured resistance values with the values of a dimensionally identical motor.

Note

If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
But keep in mind that you are measuring at low voltage so that flashovers, for example, of damaged cables or damaged isolation layers can hardly be detected!

Corrective action

Motors with ground faults must be replaced!
See “Exchanging the complete motor” on page 10 – 224.

Heavily contaminated motors

If you do not detect a ground fault on heavily contaminated motors, it might still be possible that unwanted leakage currents occur.
With regard to the operating safety, please send heavily contaminated motors for cleaning to a HEIDENHAIN agency.

6.5 Inspection for winding short circuit or interruption

The resistance value of the motor coils between the phases must be symmetrical!

Overload, high temperatures, etc., for a long period of time may result in short circuits in the windings of the motors.

In the event of a winding short circuit, the resistance value of the respective motor coil decreases; in the event of an interruption it increases.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- Standard commercial **multimeter** that can be set to ohm measurement.
  It is used to check the symmetry of the motor coils fast and easily.

Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

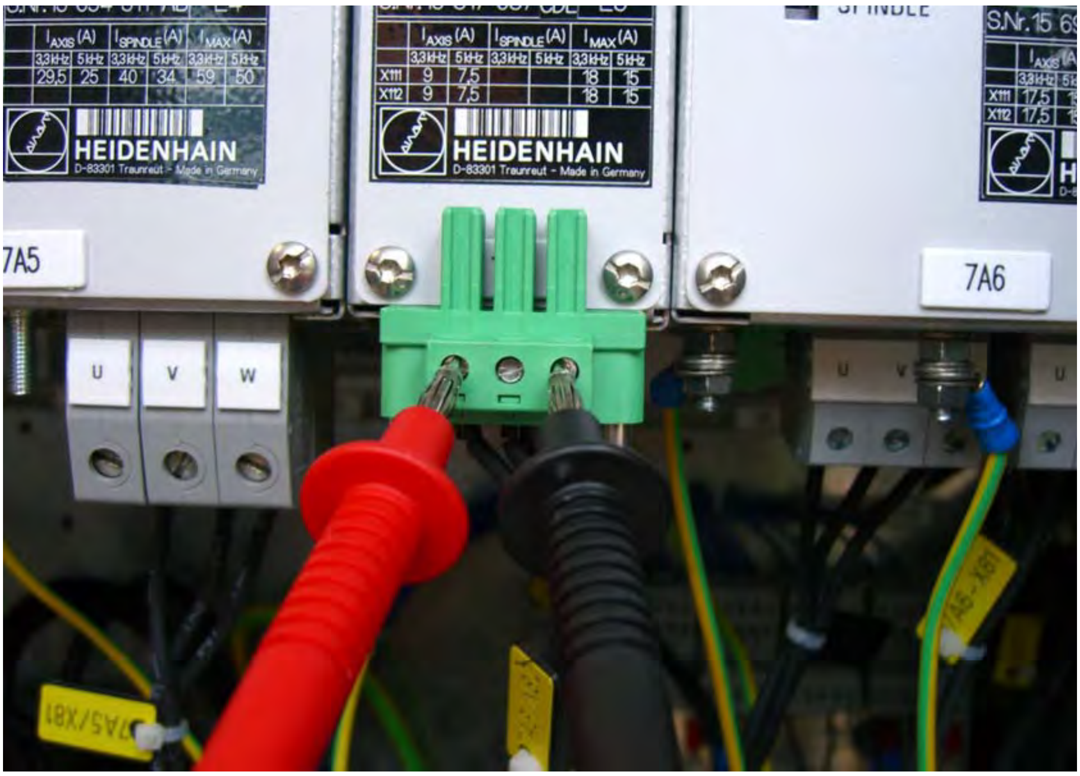
Note

Before inspecting the motors for winding short circuit, ensure that there are no ground faults.
See "Inspection for ground fault" on page 6 – 49

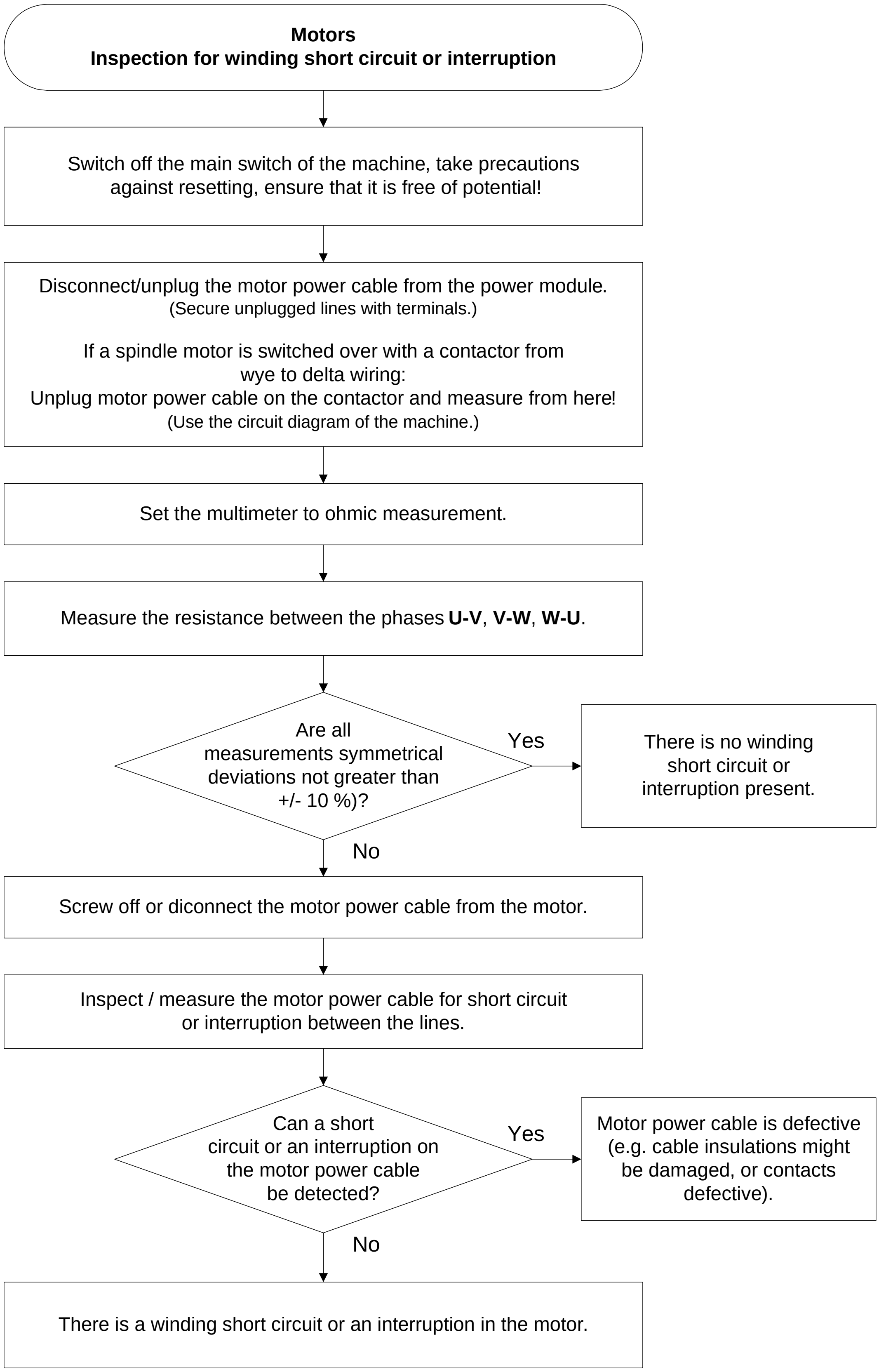
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Measuring winding short circuits



Flowchart


Motors
Inspection for winding short circuit or interruption
Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential!
Disconnect/unplug the motor power cable from the power module.
(Secure unplugged lines with terminals.)
If a spindle motor is switched over with a contactor from wye to delta wiring:
Unplug motor power cable on the contactor and measure from here!
(Use the circuit diagram of the machine.)
Set the multimeter to ohmic measurement.
Measure the resistance between the phases **U-V**, **V-W**, **W-U**.
Are all measurements symmetrical deviations not greater than +/- 10 %)?
Yes
There is no winding short circuit or interruption present.
No
Screw off or diconnect the motor power cable from the motor.
Inspect / measure the motor power cable for short circuit or interruption between the lines.
Can a short circuit or an interruption on the motor power cable be detected?
Yes
Motor power cable is defective (e.g. cable insulations might be damaged, or contacts defective).
No
There is a winding short circuit or an interruption in the motor.

Note

Up to **10 % asymmetry** of the measured resistance values is possible.
The respective motor may still be functioning, but the previous quality of the workpiece (e.g., surface) is not ensured any more.

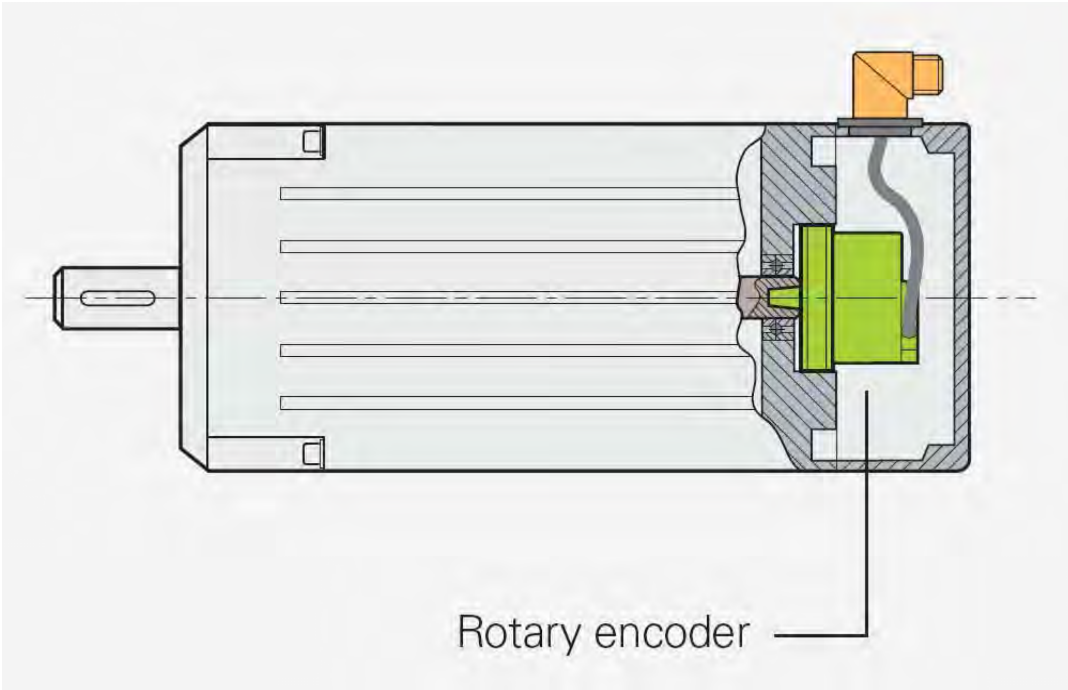
Defined resistance values cannot be specified here as they depend on the motor and cable type and the internal resistance of the multimeter.
If possible, you can compare the measured values with a dimensionally identical motor.

Corrective action

Motors with winding short circuits or interruptions must be replaced!
See “Exchanging the complete motor” on page 10 – 224.

6.6 Inspection of the motor encoder

Figure:
Motor encoder in HEIDENHAIN motor



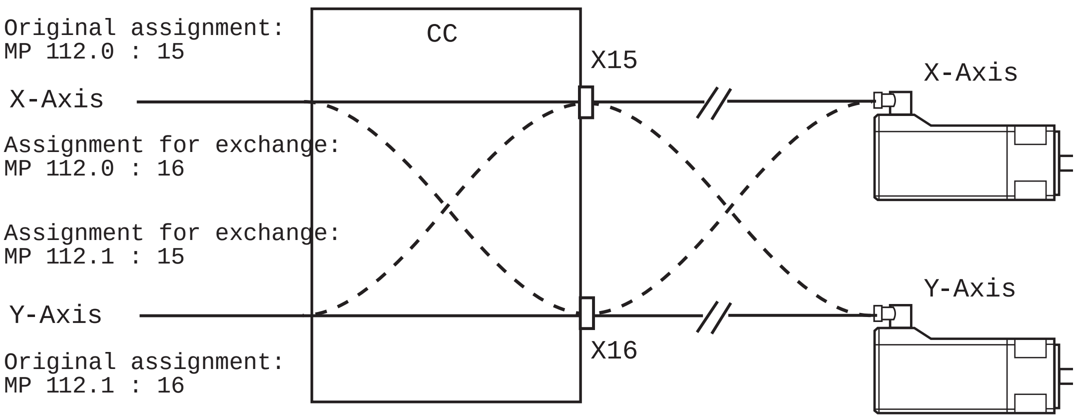
Danger

If you have found out that the **respective motor** (not the motor encoder) **is defective**, you must not use it together with other components (e.g., another power module) to perform the described tests! Connected units may be destroyed.
This could lead to damage or injury to the machine or persons.

Exchanging the interface

If the HEIDENHAIN control displays error messages regarding the speed encoder (e.g., **`motor encoder X: amplitude too small, EnDat faulty`**), exchange the speed encoder interface to find out whether the error may be found on the control or the connected motor encoder. **See service manual of the respective control**

Excerpt from the Service Manual iTNC 530:



This troubleshooting routines can help you to find a defective motor encoder.
Make sure that the motor encoder cable or the signal socket are not defective or replace these components.
--> See "Exchanging the signal socket of the motor" on page 10 – 250,
--> See "Exchanging cables and connectors" on page 10 – 262.

Corrective action

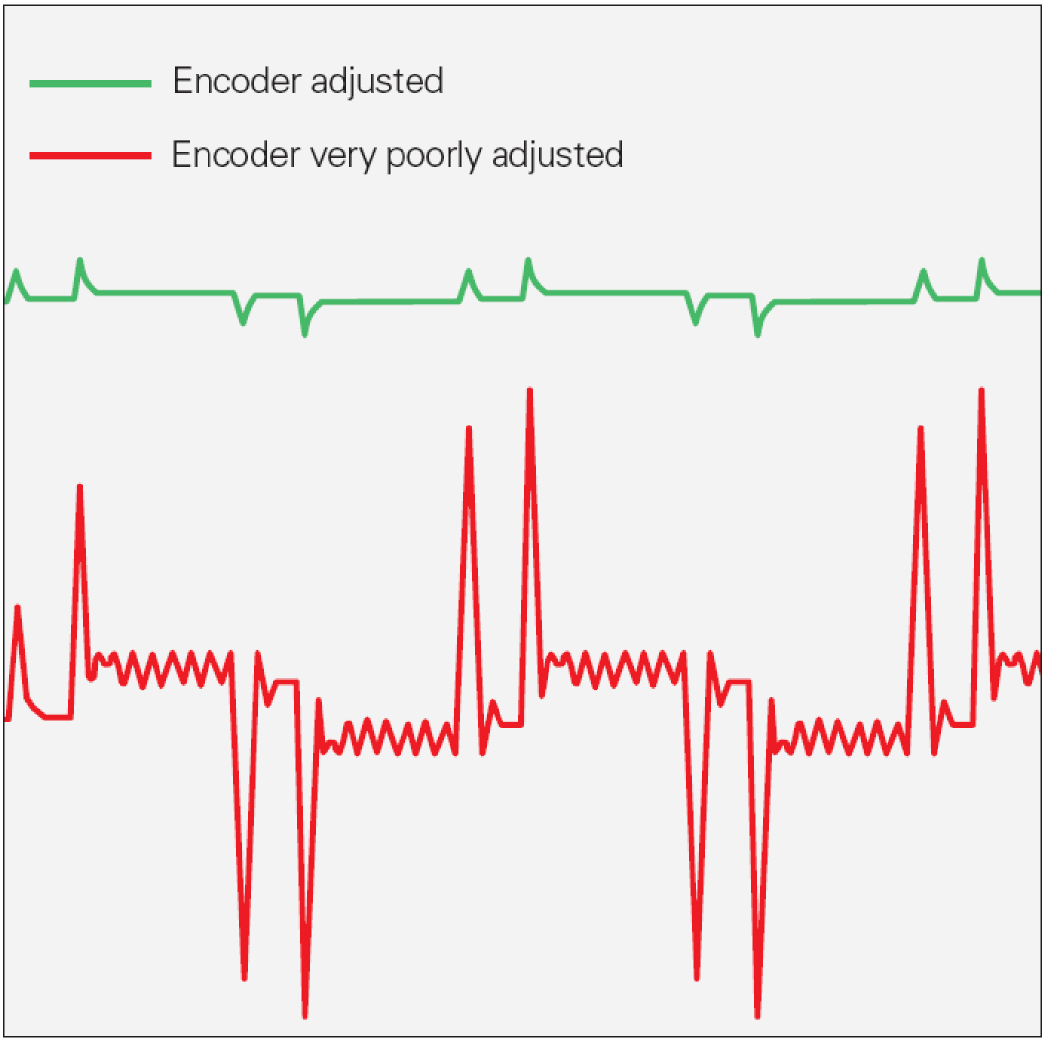
If the **motor encoder of a synchronous motor (QSY xxx) is defective**:

▶ Replace the complete motor and send it in for repair.
See "Exchanging the complete motor" on page 10 – 224.

Attention

Motor encoders in synchronous motors must be adjusted to a certain position.
This adjustment is carried out by HEIDENHAIN.
Therefore, you must not exchange the motor encoder yourself!

In addition, new motors have so-called electronic ID labels. This electronic ID label for the motor is stored in the motor encoder with EnDat interface. When you exchange the motor encoder, the electronic ID label must be written anew. This is done at HEIDENHAIN.



Motor current of adjusted and very poorly adjusted rotary encoder

If the **motor encoder of an asynchronous motor (QAN xxx) is defective**:

▶ Either replace the complete motor or the motor encoder.
See "Exchanging the motor encoder of the QAN asynchronous motor" on page 10 – 227.

Further analysis with PWM 9

For further inspection (e.g., quality of the encoder signals, edge separation, power supply) of the motor encoder, use the HEIDENHAIN measuring device PWM 9. See “PWM 9 encoder diagnostic kit” on page 14 – 418.

Danger

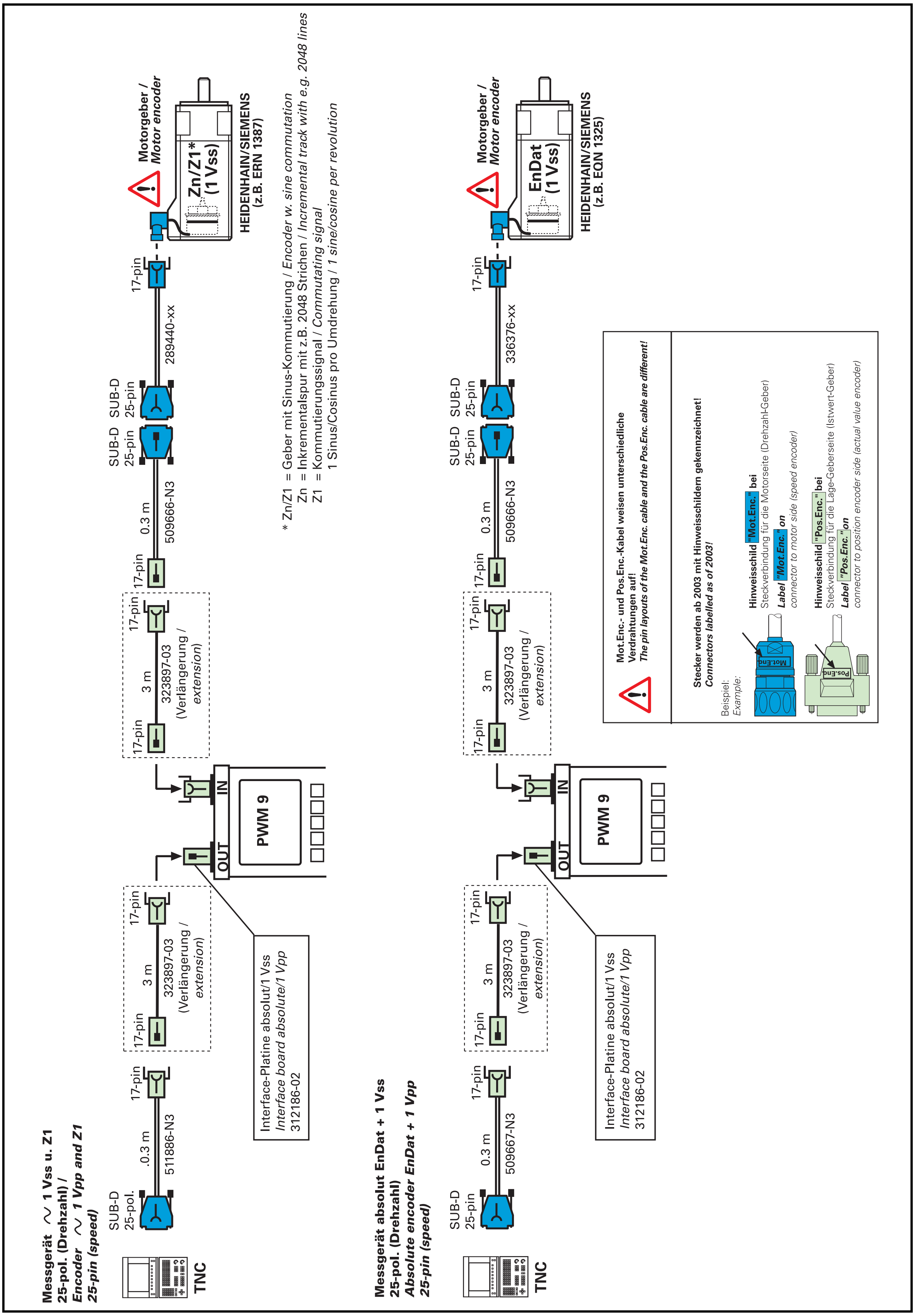
If the PWM 9 is connected in the signal path between the motor encoder and the control:
Do not change the settings of the PWM 9 (e.g., parameters, encoder voltages) and do not switch it off while the machine tool is operating!
Ignoring this may cause machine damage or personal injury!
Read the **PWM 9 User's Manual** in detail, before you use the device.

Photo: Example of a recording with the PWM 9

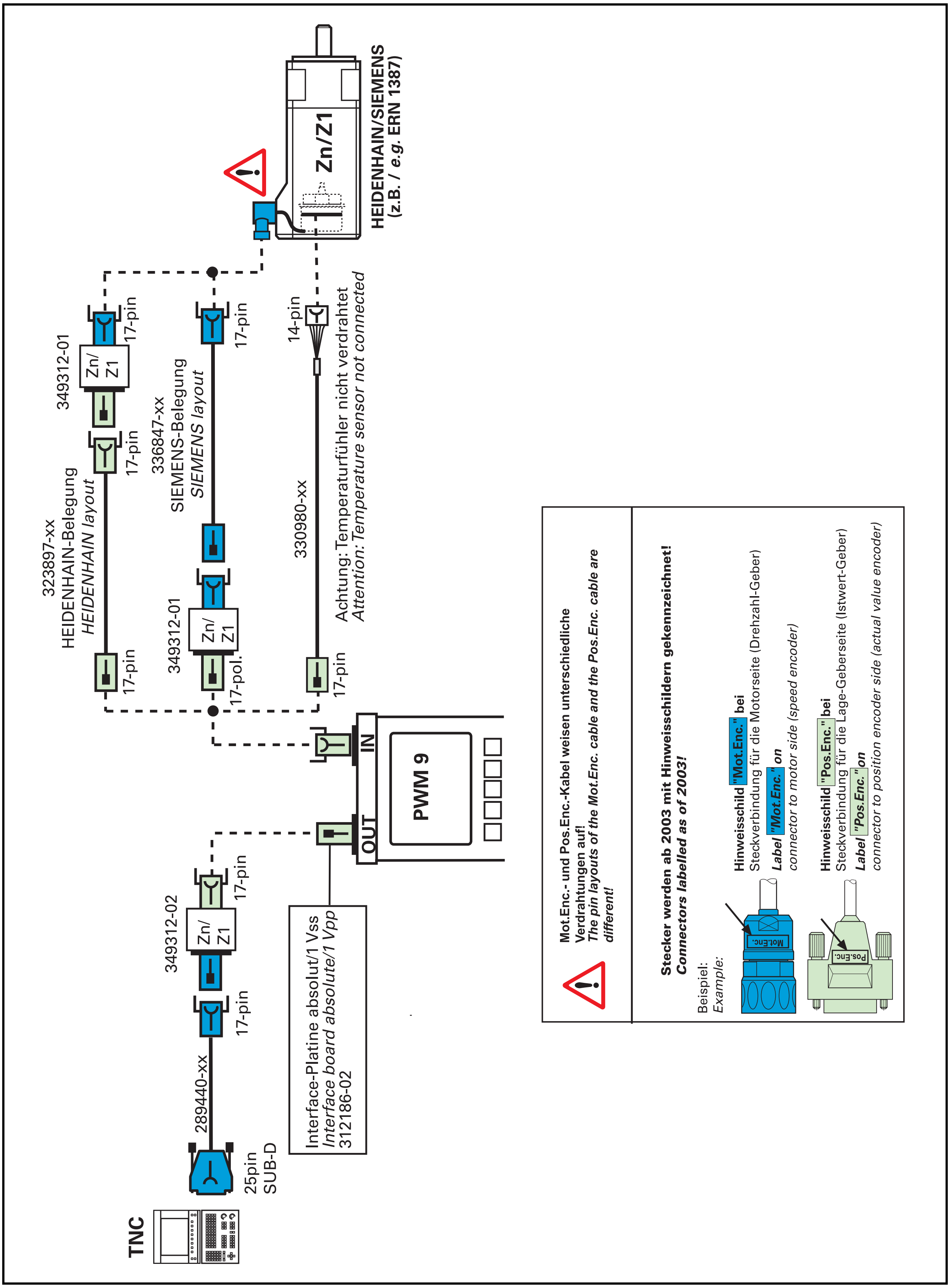
Note

During our **training courses on measuring systems** or special **PWM 9 trainings** the PWM 9 is explained in detail.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the PWM 9 correctly and efficiently.
Contact HEIDENHAIN Traunreut or your regional agency.

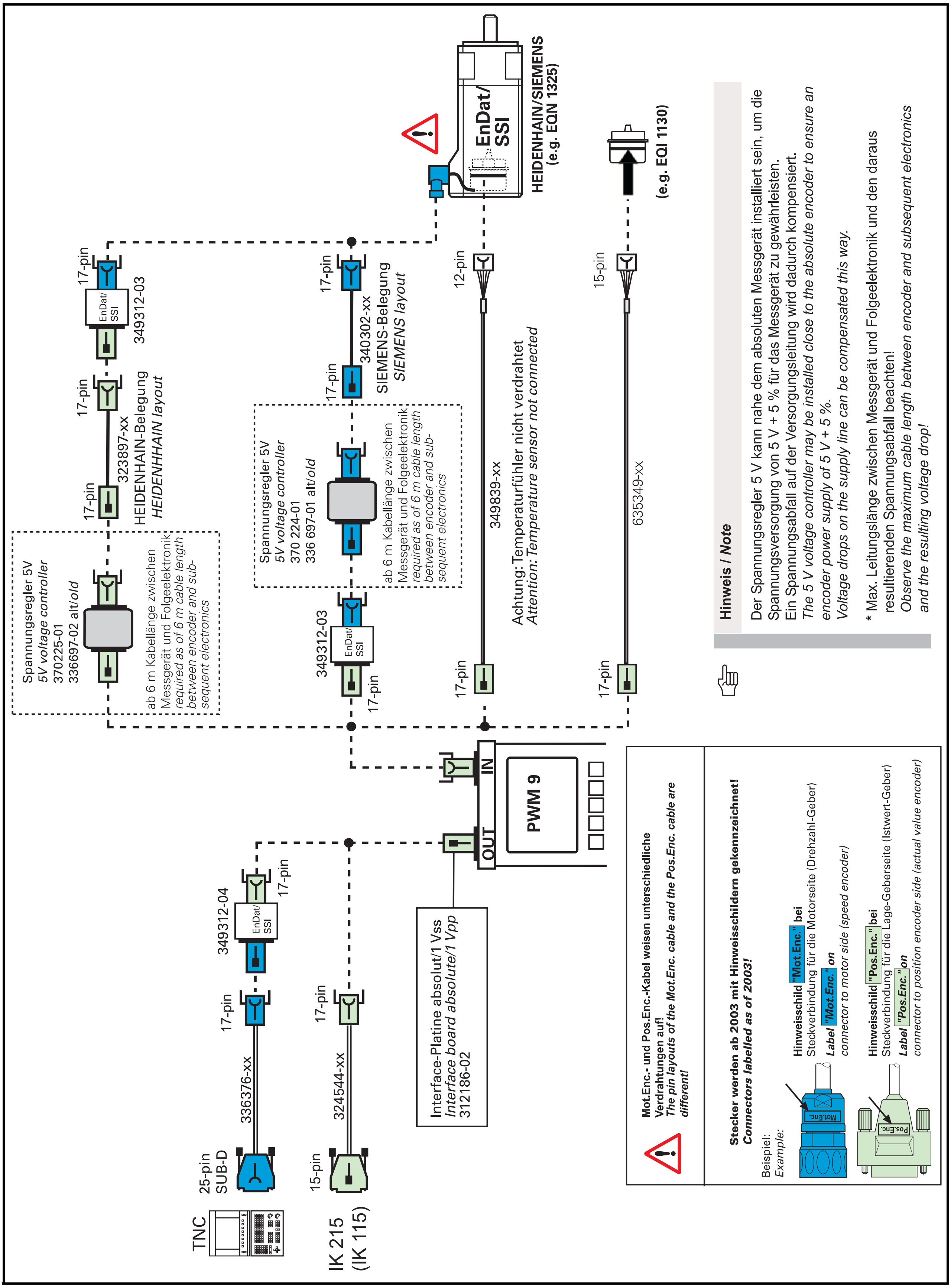
Motor with conventional encoder and EnDat encoder.
Separation of the signal path from the motor encoder to the control directly at the interface of the control (in the electrical cabinet) to connect the PWM 9 in series.
Excerpt from the PWM 9 Operating Instructions:



Motor with conventional encoder.
Separation of the signal path from the motor encoder to the control directly at the motor encoder or at the signal socket of the motor to connect the PWM 9 in series.
Excerpt from the PWM 9 Operating Instructions:



Motor with EnDat encoder.
Separation of the signal path from the motor encoder to the control directly at the motor encoder or at the signal socket of the motor to connect the PWM 9 in series.
Excerpt from the PWM 9 Operating Instructions:



Further analysis with PWT 18

For the assessment of the signal amplitude and signal quality of A and B track, the position and width of the reference mark, use the HEIDENHAIN Test Unit PWT 18.
See “Testing unit PWT 18” on page 14 – 420.

Using the PWT 18 instead of the PWM 9 has advantages and disadvantages.

Advantages:

- Small, lightweight device
- Easy handling

Disadvantages:

- The PWT has an input but no output. This means that it **cannot** be connected between motor encoder and control.
  The motor encoder can hardly be checked at "Operating speed".
- The motor shaft or the spindle must be turned manually.

Note

Every **PWT** is delivered with **operating instructions**.
A detailed explanation of the PWT is part of our **training courses on measuring systems**.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the PWT correctly and effectively.
Contact HEIDENHAIN Traunreut or your regional agency.

Photo: Example of a recording with the PWT 18:
A conventional motor encoder (Zn track) in the spindle motor is here connected to the PWT 18 via the motor encoder cable and the adapter cable ID 533055-01. The spindle is turned manually while the machine is switched off.

Note

An EnDat motor encoder (EnDat 2.1) can be connected to the PWT 18 with the same adapter cable ID 533055-01. The A/B signal can be evaluated but EnDat encoders do not have a reference signal.

Further analysis with the IK 215

Use the IK 215 interface card for inspecting and testing an EnDat motor encoder.
See "IK 215 adjusting and testing package" on page 14 – 421.

Danger

If the IK 215 is connected in the signal path between the encoder and the control component:
Do not change the settings of the IK 215 (e.g., parameters, encoder voltages) and do not switch it off while the machine tool is operating!
Ignoring this may cause machine damage or personal injury.
Read the **operating instructions** of the IK 215 in detail, before you use the device.

Note

A detailed explanation of the device is part of our **training courses on measuring systems**.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the IK 215 correctly and effectively.
Contact HEIDENHAIN Traunreut or your regional agency.

Further analysis with the PWM 20

You can also use the new PWM 20 for inspecting and testing EnDat motor encoders. See "PWM 20 encoder diagnostic kit" on page 14 – 422.

Danger

If the PWM 20 is connected in the signal path between the encoder and the control:
Do not change the settings of the PWM 20 (e.g., parameters, encoder voltages) and do not switch it off while the machine tool is operating!
Ignoring this may cause machine damage or personal injury.
Read the **operating instructions** of the PWM 20 in detail, before you use the device.

Note

A detailed explanation of the device is part of our **training courses on measuring systems**.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the PWM 20 correctly and efficiently.
Contact HEIDENHAIN Traunreut or your regional agency.

6.7 Inspection of the fan

HEIDENHAIN spindle motors are equipped with fans.

Observe whether:

- The fan moves properly and in the right direction (see arrow on the housing).
- The fan rubs against the housing.
- The fan has come loose from its mounting position (e.g., defective rubber buffers)

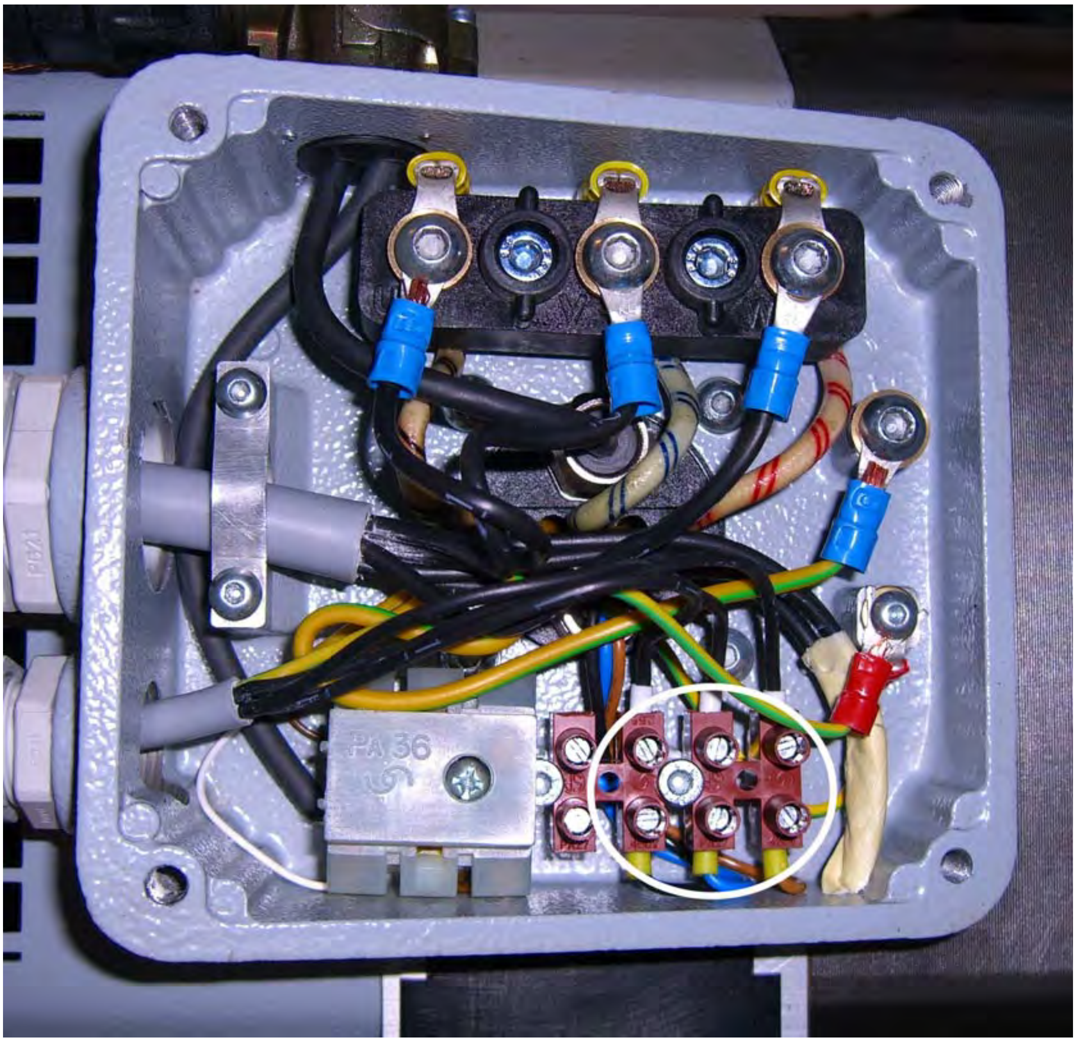
Danger

Danger of electrical shock!
The device will be under voltage while the following measurement is performed.
Please proceed carefully!

Measure whether:

- 400 Vac are available between the 3 phases at the fan connection in the terminal box.

Figure: Measuring the fan voltage



Corrective action

Inquire with the machine manufacturer or HEIDENHAIN for spare parts (fan, fan guard incl. mounting plate and rubber buffer, etc.) and replace the defective component.
--> See "Exchanging the fan of a spindle motor" on page 10 – 252,
--> See "Exchanging the fan guard of the spindle motor" on page 10 – 257.

6.8 Inspection of the temperature sensor

If the control repeatedly outputs error messages regarding the motor temperature although the motor is not overheated, the temperature sensor might be defective.

On HEIDENHAIN motors the KTY 84-130 resistor probe with positive temperature coefficient is used as temperature sensor. It is integrated in the stator winding.

The lines of the temperature sensor are lead through the motor at the signal socket.

KTY 84-130 value table

T [°C]	R[Ohm]	T[°C]	R[Ohm]	T[°C]	R[Ohm]
-40	355	70	824	190	1654
-30	386	80	880	200	1739
-20	419	90	939	210	1825
-10	455	100	1000	220	1914
0	493	110	1063	230	2006
10	533	120	1129	240	2099
20	576	130	1197	250	2195
25	598	140	1268	260	2293
30	621	150	1340	270	2392
40	688	160	1415	280	2490
50	718	170	1493	290	2584
60	769	180	1572	300	2668

Procedure

Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Measurement on the D-sub connector of the motor encoder cable

- Screw off the 25-pin D-sub connector of the motor encoder cable from the speed encoder interface of the control.
- Use an ohm measuring device.
- Connect the plus pole (red line) of your measuring device to PIN 13 and the negative pole (black line) to PIN 25 of the D-sub connector.
- Measure whether the resistance value corresponds to the temperature of the motor (see value table).

Photo: Measurement of the temperture sensor on the D-sub connector of the motor encoder cable

Measurement at the signal socket of the motor

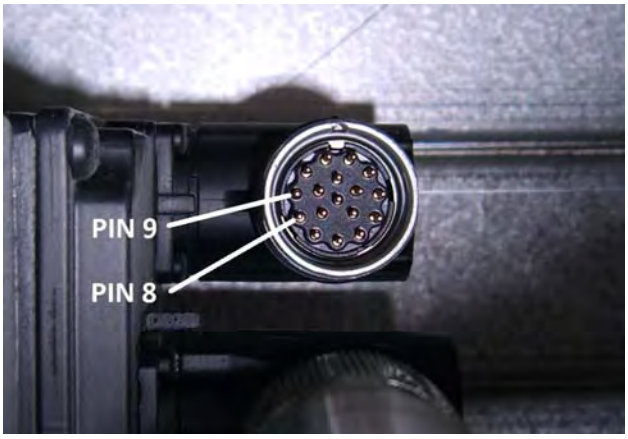
If possible, measure directly at the signal socket of the axis motor:

▶ Unscrew the motor encoder cable from the signal socket of the motor.

▶ Use an ohm measuring device.

▶ Connect the plus pole (red line) of your measuring device to PIN 8 and the negative pole (black line) to PIN 9 of the round connector.

▶ Measure whether the resistance value corresponds to the temperature of the motor (see value table).



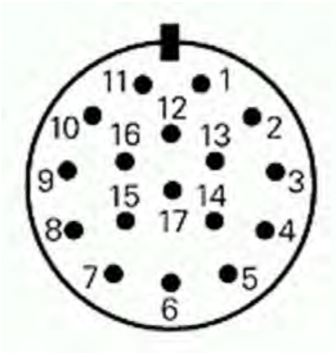


Photo: Measurement of the temperature sensor directly at the signal socket of the motor

Measurement in the terminal box of the motor

If possible, measure directly at the spindle motor.

▶ Open the terminal box where the temperature sensor is connected.

▶ If required, screw off the protective cover to perform the measurement on the terminals for the temperature sensor.

▶ Use an ohm measuring device.

▶ Connect the plus pole (red line) of your measuring device to the terminal with the brown or yellow wire and the negative pole (black line) to the terminal with the white wire.

▶ Measure whether the resistance value corresponds to the temperature of the motor (see value table).

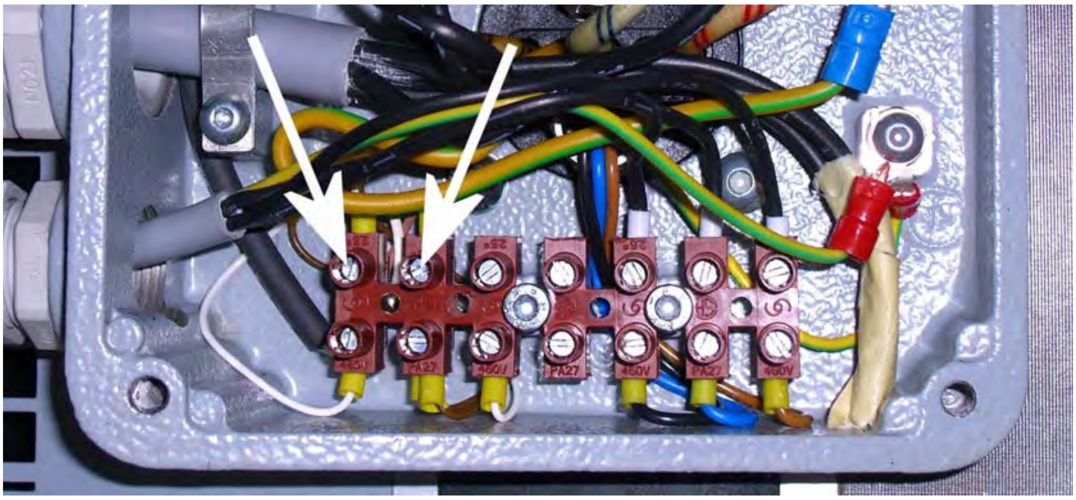


Photo: Measurement of the temperature sensor directly at the terminal box of the spindle motor

Corrective action

On the **spindle motor**, connections may be changed to a **reserve temperature sensor**. See "Changing connections to the reserve temperature sensor" on page 10 – 260.

The **axis motor** is not equipped with a reserve temperature sensor. --> The complete motor must be replaced!

6.9 Inspection of the motor brakes

Many HEIDENHAIN axis motors are equipped with motor brakes.

The holding brake is powered with direct current. It serves to hold the motor shaft at standstill.

The control lines for the motor brake are lead in the motor power cable.

If the braking power is outside the specification, for example, a slumping of vertical axes or a frequent generation of the error message **`Standstill monitoring`** may be caused.

Motor brake test

A motor brake test is available on the HEIDENHAIN control iTNC 530 with current hardware and software. See Service Manual iTNC 530.

> Danger
>
> Vertical axes might fall down.
> Consult the machine manufacturer before performing the motor brake test!

Trigger voltage

The motor brake is activated with 24 V direct current:

- Always comply with the safety precautions!
- Use a voltage measuring device and measure whether 24 V (± 10%) are available at the moment when the brake is to be released **automatically**.

> Danger
>
> If you want to apply 24 V to the motor brake **manually** for testing purposes, please regard that vertical axes might fall down!
> Support the hanging axes befor testing the motor brake!
> Also ensure that the 24 V are connected with the correct polarity or the brake will not be released.

Ohmic measurement

The motor brake is triggered by a coil that builds up a magnetic field.
The control lines for the motor brake are lead in the motor power cable.

To control the ohmic resistance of this coil proceed as follows:

> Danger
>
> **Danger of electrical shock!**
> The units must be free of potential for the following measurements.
> Ensure that the machine is switched off and is not under voltage!

- Switch off the machine.
- Disconnect the control lines for the motor brake from the HEIDENHAIN inverter or disconnect it where it was connected by the machine manufacturer.
- Use an ohm measuring device.
- Measure at the lines whether the resistance value corresponds to the power of the motor brake (see value table).

Motor	Resistance of motor brake
QSY 1A, 1C, 1E	approx. 48 ohms
QSY 11, 12, 13, 14	approx. 29 ohms
QSY 2C, 2E, 2G, 2J	approx. 24 ohms
QSY 21, 22, 23, 24	approx. 24 ohms
QSY 041 B	approx. 60 ohms
QSY 55 C	approx. 80 ohms
QSY 071B	approx. 40 ohms
QSY 090B	approx. 34 ohms
QSY 093B	approx. 34 ohms
QSY 96A, 96C, 96G	approx. 48 ohms
QSY 112B	approx. 34 ohms
QSY 112C, 112D	approx. 18 ohms
QSY 116C, 116E	approx. 40 ohms
QSY 116J, 116J EcoDyn	approx. 28 ohms
QSY 130C, 130C EcoDyn, 130E, 130E EcoDyn	approx. 40 ohms
QSY 155A, 155B, 155B EcoDyn, 155C, 155C EcoDyn, 155D, 155D EcoDyn, 155E, 155F, 155F EcoDyn	approx. 23 ohms
QSY 190C, 190D, 190F, 190K	approx. 14 ohms
QSY 190C EcoDyn, 190D EcoDyn, 190F EcoDyn, 190K EcoDyn	approx. 17 ohms
QSY 524, 526	approx. 80 ohms
QSY 722, 724	approx. 17 ohms

Figure: Value table of the resistance values of the motor brakes

Corrective action

Motor brakes cannot be replaced on site!
The respective motor must be sent to the machine manufacturer or HEIDENHAIN for inspection or repair.
See “Exchanging the complete motor” on page 10 – 224.

6.10 Inspection for unbalance

Out-of-balance behaviour of the motor may be noted by vibrations, insufficient surface quality of the workpiece, etc.

Note

Exclude other causes of error, for example, faulty tools, insufficient belt tension, defective coupling, insufficient optimization of the machine, mechanical wear.

Corrective action

An unbalance of the motor outside the specification can only be inspected and corrected at the manufacturer's site, if necessary.
See “Exchanging the complete motor” on page 10 – 224.

7 Error diagnosis on the inverter system

7.1 Safety

Inverter systems operate at **high voltages and currents!**

Before you perform work on the drive system of the machine, note the safety precautions in this service manual! See “Safety precautions” on page 2 – 13.

Please also note the **safety precautions of the machine manufacturer!**

7.2 Possible causes of error

No claim for completeness; contact your machine manufacturer!
If possible, write your own experience!

- Ground fault
- Short circuit in the unit
- Missing primary voltage (e.g., line fuse has blown)
- EMERGENCY STOP chain interrupted (see circuit diagram of the machine)
- Normally-closed contact chain interrupted (see circuit diagram of the machine)
- Missing releases (e.g., protective door open or door sensor defective)
- Enabling contactor for axes / spindle in the inverter defective
- Contamination
- Humidity (e.g., leaky hoses, condensation caused by an incorrectly set climate control unit in the electrical cabinet)
- Overload
- Screws and washers which have fallen into the unit
- Temperature in the electical cabinet too high
- Defective temperature sensor
- Defective rectifier
- Defective output stage (IGBT)
- Defective fan
- Defective bus cable (X69, X79, X111, X112, e.g., damaged when the cover plate was mounted)
- Defective connector
- Defective braking resistor
- Grounding insufficient

- Defective axis or spindle motor
- Defective PWM output on the control
- Evaluation of the temperature sensor in control defective

7.3 Visual inspection

A visual inspection of the inverter system can be performed fast and easily.

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential.
- Open the door of the electrical cabinet. Observe all safety instructions!
- Please note the following:

  - Are the inverter components heavily contaminated?
  - Has humidity entered the inverter system?
    (it may be possible that coolant flows along the cables into the electrical cabinet)?
  - Are there defective cables?
  - Are the boards condensed?
  - Are pressure tubings or screw connections for water-cooled devices leaky?
  - Are there any scorch marks or a burnt smell?
  - Are there destroyed units?
  - Are plug or clamp connections corroded, loose, scaled?

Photo: Heavily contaminated inverter

7.4 Criteria for water-cooled inverters

Keep the following in mind when mounting and operating water-cooled HEIDENHAIN inverter components and water-cooled HEIDENHAIN power modules:

- The **tightening torque** for connecting the hose to the coupling joint on the HEIDENHAIN components is max. 20 Nm. The hose and the coupling joint must be steadied from each side by using two wrenches (WAF 22).
- The **bend radius** of the coolant hose is > 100 mm.
- The **cooling circuit** must be **closed**.
- **Temperature** of the coolant: 20°C < coolant / water < 40°C.

Danger

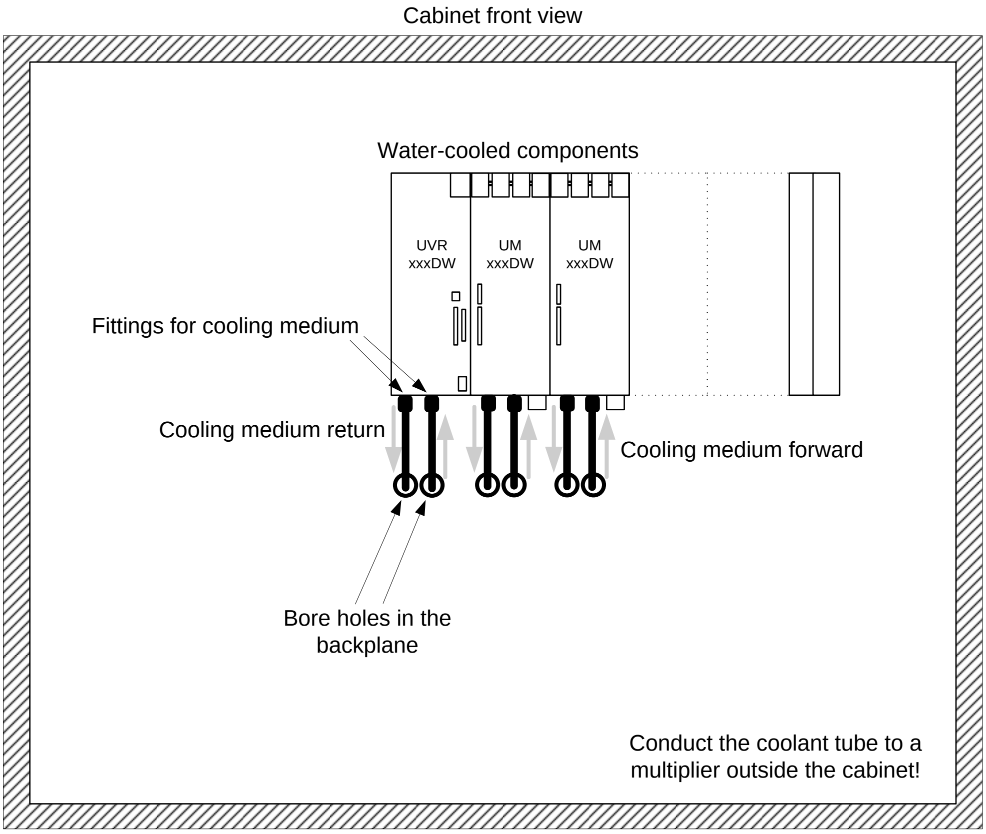
The temperature of the coolant must be no more than 5°K less than the ambient temperature of the components to be cooled in order to avoid condensation in the electronic components.

- **Maximum coolant pressure** = 5 bars.
  A pressure reducer can be used, if required.
- Minimum **coolant flow rate** = 3l/min.
  HEIDENHAIN recommends a flow rate of 6l/min.
- **Filter fineness** < 100 µm
  Contaminations of the coolant can thus be avoided.
- **pH value** of the coolant is approx. 7.
  For optimum service life of the coolant hoses.
- If **water is used as coolant**:
  Use a **corrosion protection**!
  HEIDENHAIN recommends, e.g., Waterdos CAN11 with a ratio of 1% to 2%.
  In case of microbiological infestation, we recommend Waterdos CIT 48.
  Anti-freezes should only be used for equipment actually endangered by frost. In such cases an anti-freeze with anti-corrosion additive should be used, such as Waterdos FKN28.
- The **diameter of the hole** for leading the hose through the rear wall of the electrical cabinet must be > 28 mm.
  Make sure that the coolant hose is not damaged by the edges of the hole (use plastic ducts if required).
- **Ensure that coolant hoses must not rest on sharp edges**
  in order to avoid a damage of the hose. A permanently safe operation of the water cooling system can only be ensured if this is adhered to.

When selecting and using a coolant, one must consider the **materials** with which the coolant will come into contact in the coolant circuit. When using water-cooled components and the corresponding accessories from HEIDENHAIN, they are the following materials:

Heat sink:	Aluminum EN AW-6060 (AlMgSi)
Turbulator:	V2A
Armatures:	Steel, zinc-plated
Coolant hose:	EPDM

The following figure illustrates the connection of the water cooling system to the corresponding components:



When exchanging water cooled inverters, observe the following:

Attention

The replacement of water-cooled components must only be performed after consultation with a person responsible for the coolant system of the machine or trained specialists.
Follow the **instructions of the machine manufacturer** regarding the coolant system of the machine!

- You need to empty the coolant circuit completely outside the electrical cabinet before screwing off the pressure tubing from the inverter.
- Before installation, the seals at the ends of the pressure hoses must be inspected.
  They must not be damaged and have to be in the correct position!
- After correct connection, the coolant circuit must be ventilated.

Danger

Check the complete cooling circuit for tightness before putting the components into service (max. pressure of coolant = 5 bar)!
Water may not penetrate into electrical units or into the electrical cabinet!

7.5 Error diagnosis on the UV, UVR power supply unit

7.5.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of ...

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff` or similar error messages on the control.
- Humidity in the inverters and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

Note

Before inspecting the inverter system for ground faults, ensure that there are no ground faults on the motors. See "Inspection for ground fault" on page 6 – 49.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault to protect the following equipment.

Load switching

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault the charging of the DC-link is aborted.
The charging contactor drops.

Potential dividers

Potential dividers for the DC-link voltage measurement are integrated in all power supply modules (UV, UVR). These potential dividers are included when the insulation resistance is measured to ground. This may lead to measuring results in the kohm range!
Apart from the measurement of the DC-link voltage, the phase voltage of regenerative inverters is measured; consequently such inverters are always of lower impedance to ground than non-regenerative models. The measured resistance, however, should not fall below 30 kohm!

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement -- >See "Insulation tester" on page 14 – 412.

Danger

The insulation tester operates at high voltages!
Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN inverters may be measured in the field with a maximum isolation voltage of **500 V**!

Attention

A higher test voltage could damage the inverter!

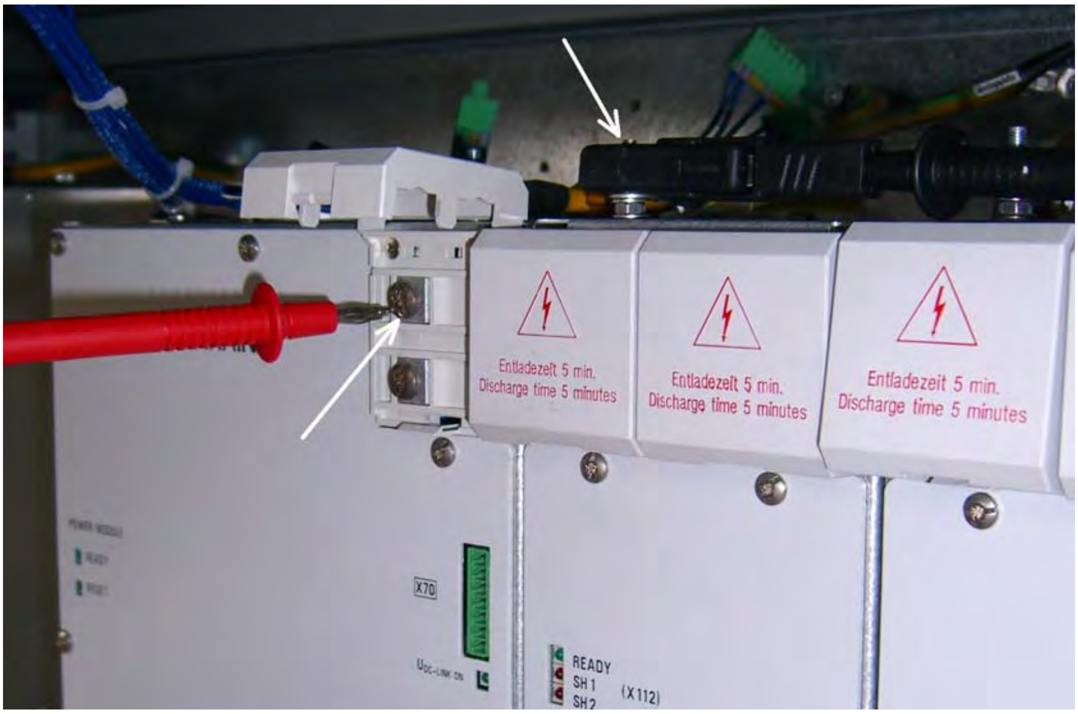
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

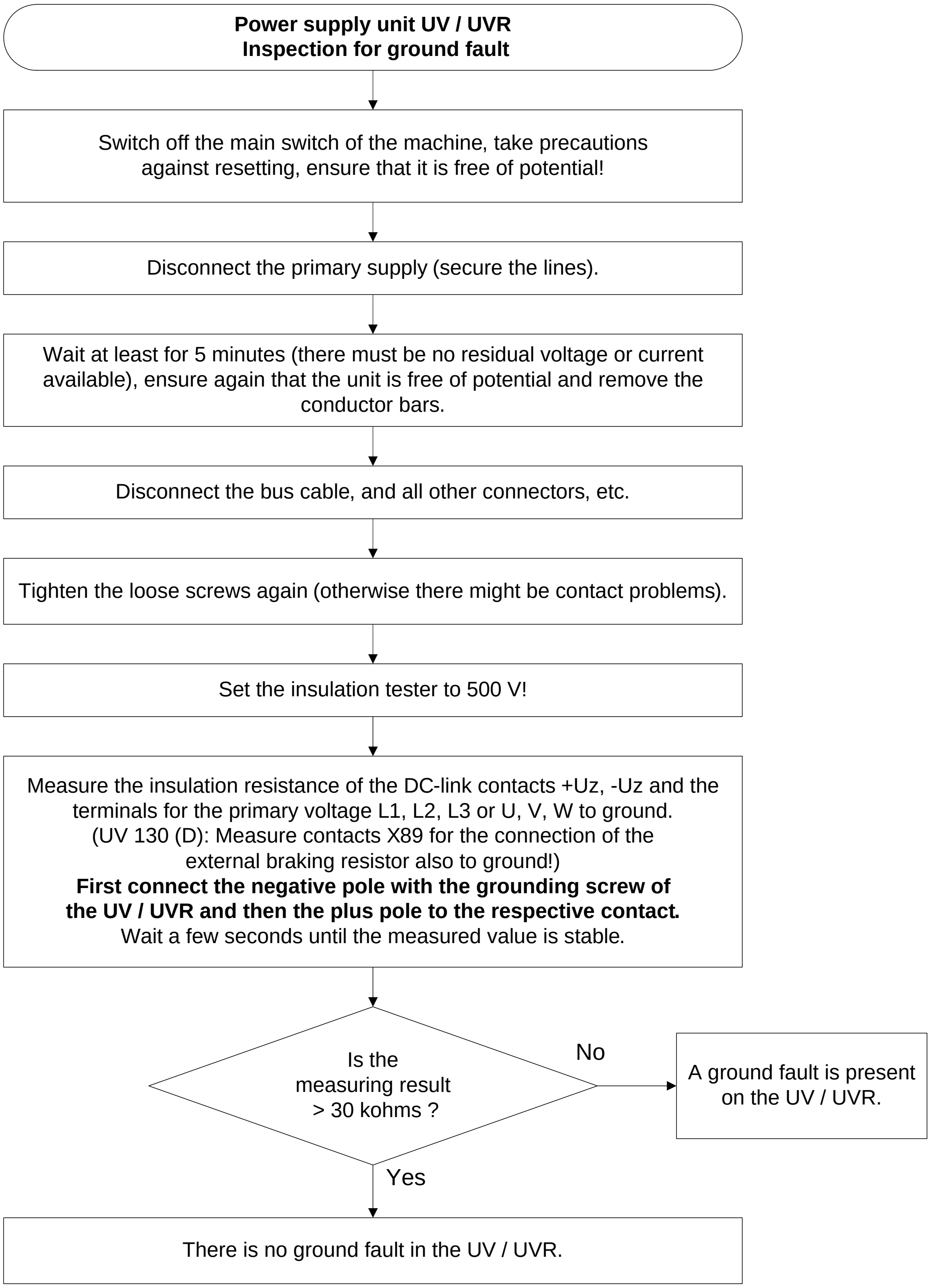
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Ground fault measuring



Flowchart



Note

"Crosscheck":
If your insulation tester operates without power supply (i.e., is operated with accumulators) and has an insulated housing, you can perform the insulation measurement also in reverse direction as a "crosscheck". The negative pole is then connected to the respective contact, the plus pole to the grounding screw.

Note

Defined resistance values cannot be specified here as they depend on the following factors or others:

- Temperature of the tested inverter (standard temperature for the insulation measurement: 20 °C)
- Duration of the measurement (reduction of capacitive current and dielectric absorption current)
- Technical data of the insulation measuring unit

If required, you can compare the measured resistance values with the values of a dimensionally identical inverter.

Note

If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
But keep in mind that you are measuring at low voltage so that flashovers in the inverter can hardly be detected!

Corrective action

Inverters with ground faults must be replaced!
See “Exchanging the complete inverter” on page 10 – 221.

Heavily contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on heavily contaminated inverters (the contamination can be seen best in the area of the fan).

Note

With rising air humidity, the probability of unwanted leakage currents increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.5.2 Inspection for short circuit or interruption

A short circuit is a severe electrical error and must be excluded from further inspections.

A **short circuit** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as **`Leakage current in UV 1xx`** or **`Overcurrent cutoff`**
- Scorch marks and/or burnt smell
- Destroyed units

> **Note**
>
> Before inspecting the inverter system for short circuits, ensure that there are no ground faults. See "Inspection for ground fault" on page 7 – 75.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault or short circuit to protect the following equipment.

Load switching

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault or short circuit, the charging of the DC-link is aborted.
The charging contactor drops.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- Standard commercial multimeter that can be set to "diode test".

Diode measurement

The diodes in the bridge rectifiers play an important role in the following measurements.

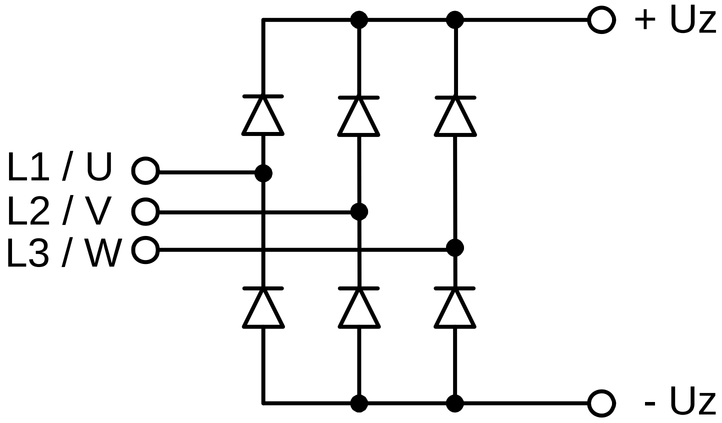
The DC-link voltage of non-controlled bridge rectifiers for non-regenerative power supply units (UV 130, UV 130 D) is generated with rectifier diodes.

The DC-link voltage of controlled bridge rectifiers for regenerative power supply units is generated with IGBTs (Isolated Gate Bipolar Transistor) that are combined with an antiparallel connected diode.

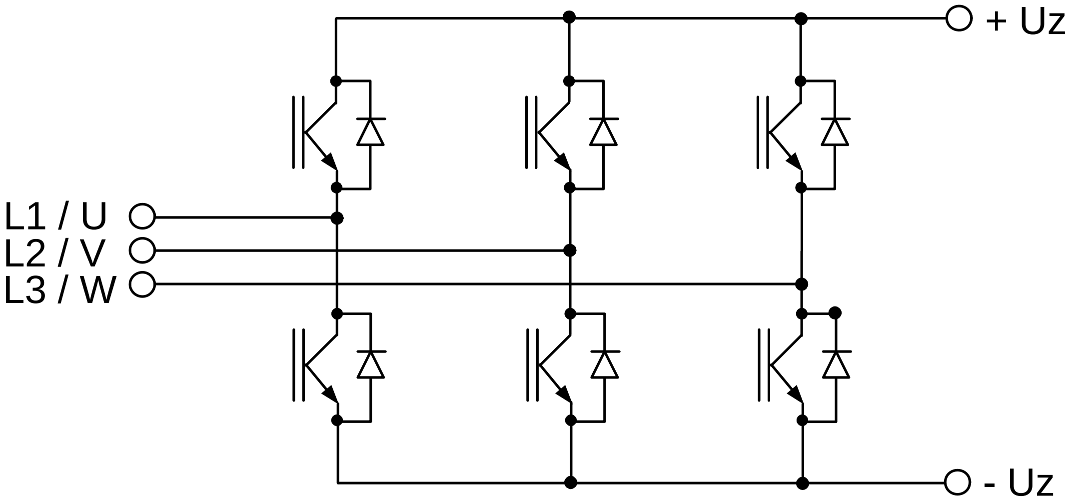
When measuring the diodes, the diffusion voltage (forward voltage) of these diodes is measured.

If a diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the IGBT also functions!

Block diagram: Non-controlled bridge rectifier



Block diagram: Controlled bridge rectifier with IGBTs



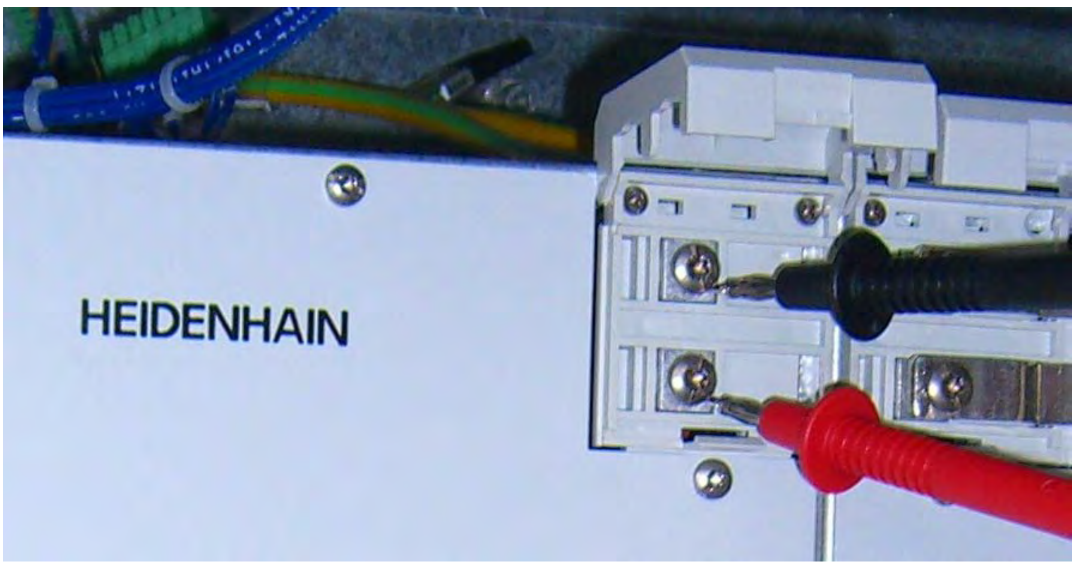
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

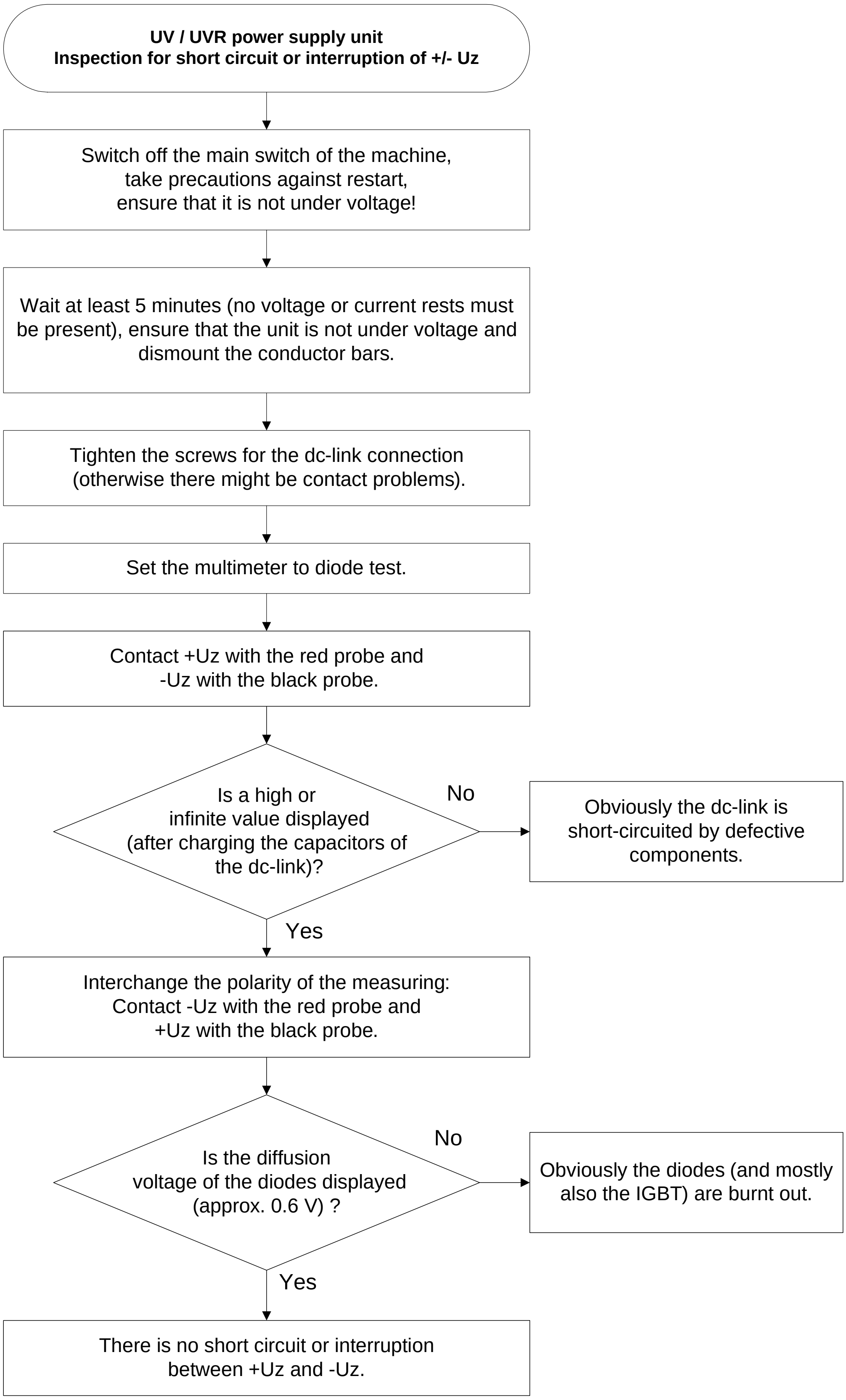
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Diode measurement



Flowchart: Short circuit or interruption between +Uz and -Uz



Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

What cannot be measured?

Please note that the following cannot be determined when performing these measurements:

- Short circuits in the gates of the IGBTs as they cannot be accessed from the outside and thus cannot be measured.
- General electronical defects.
- Whether the devices function 100 % (this can only be detected during operation).
- Whether devices that are contaminated but are still functioning, might fail soon.

Corrective action

Inverters with short circuits or interruptions must be replaced!
See “Exchanging the complete inverter” on page 10 – 221.

Heavily contaminated inverters

If you do not detect a short circuit, it might still be possible that there will be short circuits in the device in case the inverter is heavily contaminated (the contamination can be seen best in the area of the fan).

> Note
>
> With rising air humidity, the probability of short circuits increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.5.3 Checking the fuses

Many power supply units are equipped with fuses that can be accessed from the outside (4 ampere, slow).

They are located on the top surface of the unit.

They protect the charging circuit and the incorporated switching power supply for the generation of low voltages.

Figure: Location of the fuses

If your power supply unit is equipped with fuses accessible from outside:

- Switch off the machine.
- Check the fuses.
- Replace them, if required.

7.5.4 Checking the braking resistor switch in the UV 130 (D)

If the DC-link voltage increases, for example, while braking the axes or spindles, the external braking resistor of the UV 130 / UV 130D is switched on. It converts electrical energy into heat.

An IGBT (Isolated Gate Bipolar Transistor) serves as switch. This IGBT is combined with an antiparallel connected diode that can be measured from outside.

Diode measurement

When measuring the diodes, the diffusion voltage (forward voltage) of this diode is measured.

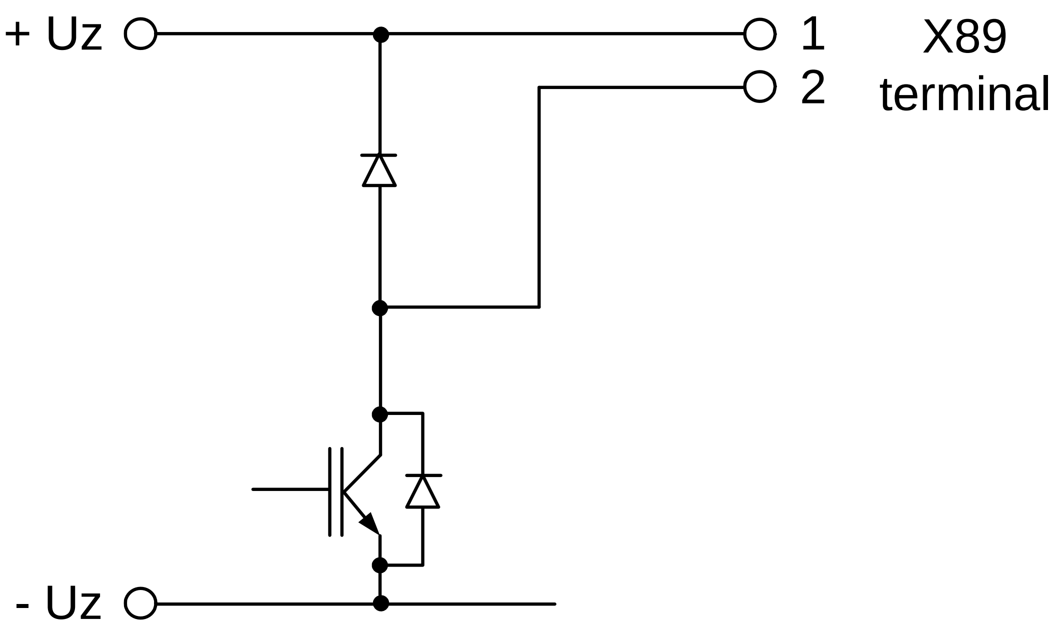
If the diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the IGBT also functions!

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential –> See “Voltage tester” on page 14 – 412
- Standard commercial multimeter that can be set to "diode test".

Block diagram

UV 130, UV 130D:
An external braking resistor is connnected to X89 (two braking resistors may also be connected in parallel).



Pin layout

Figure: UV 130, assignment of X89

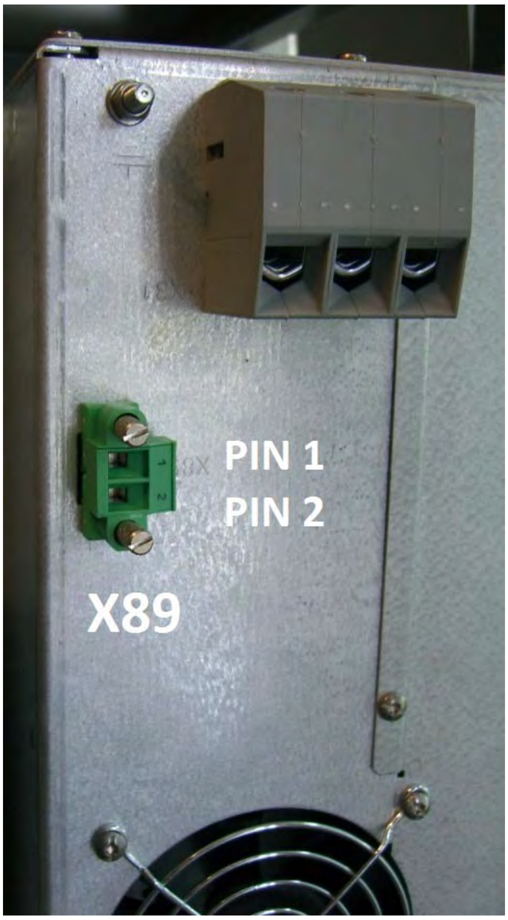


Figure: UV 130D, assignment of X89

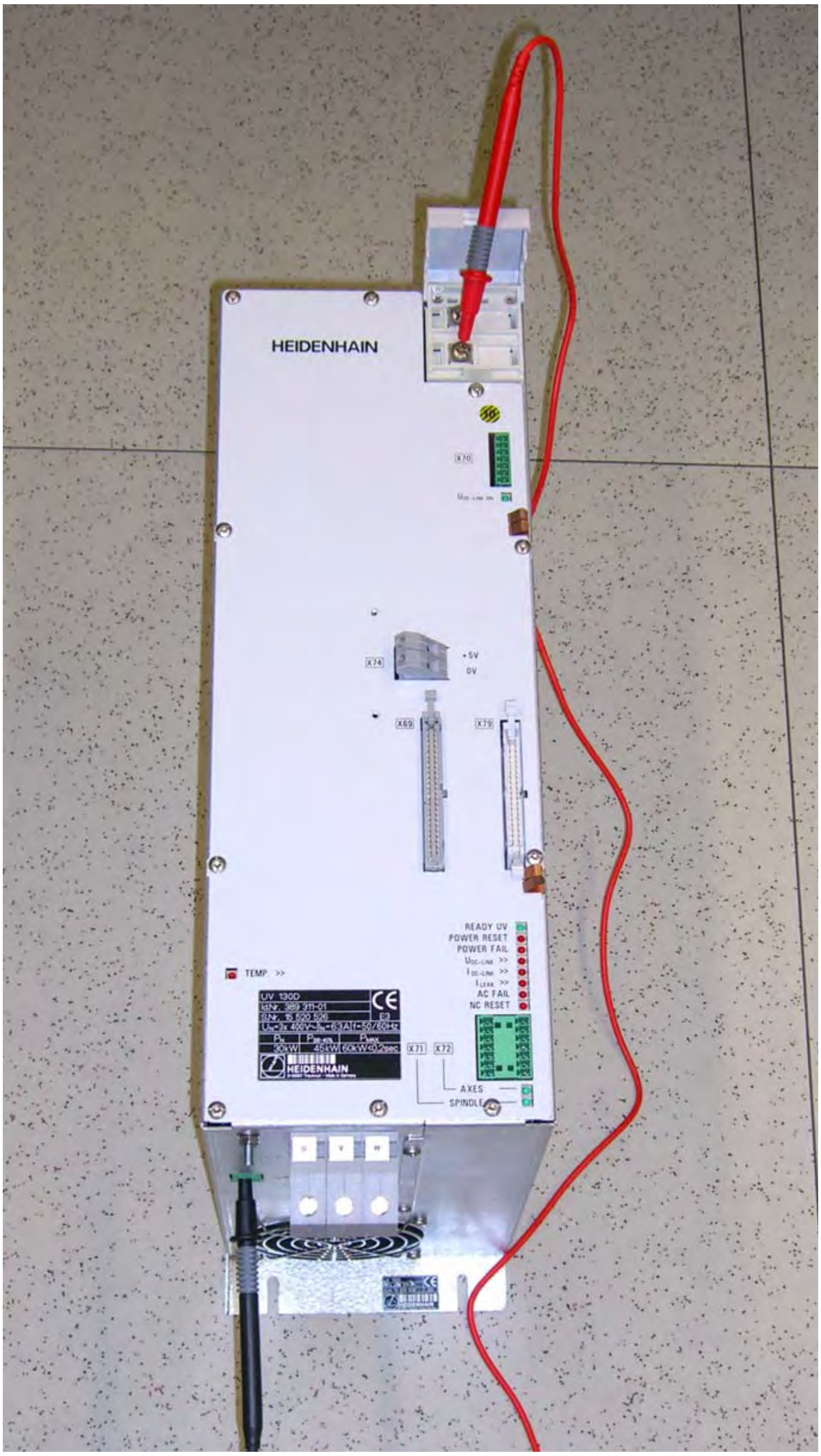
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

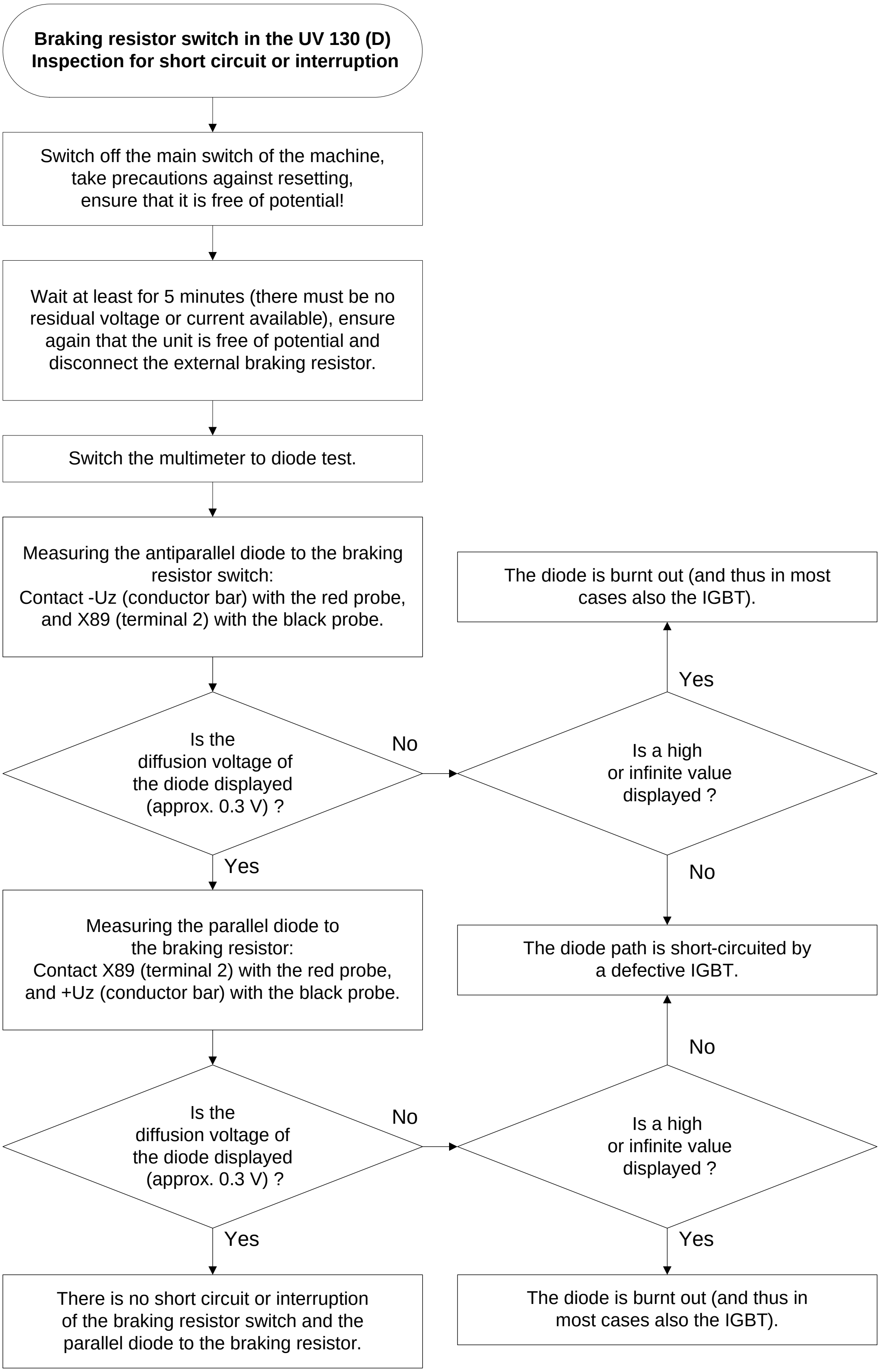
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Measuring of braking resistor switch



Flowchart: Short circuit or interruption of the braking resistor switch



Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

7.5.5 Checking the LEDs

▶ Switch on the machine.

Following green LEDs on the power supply unit must be lit:

- **POWER MODULE READY** (not on UV 130)
- **U DC LINK ON**
- **READY UV** (on UV 130: READY)

Red LEDs must not be lit!

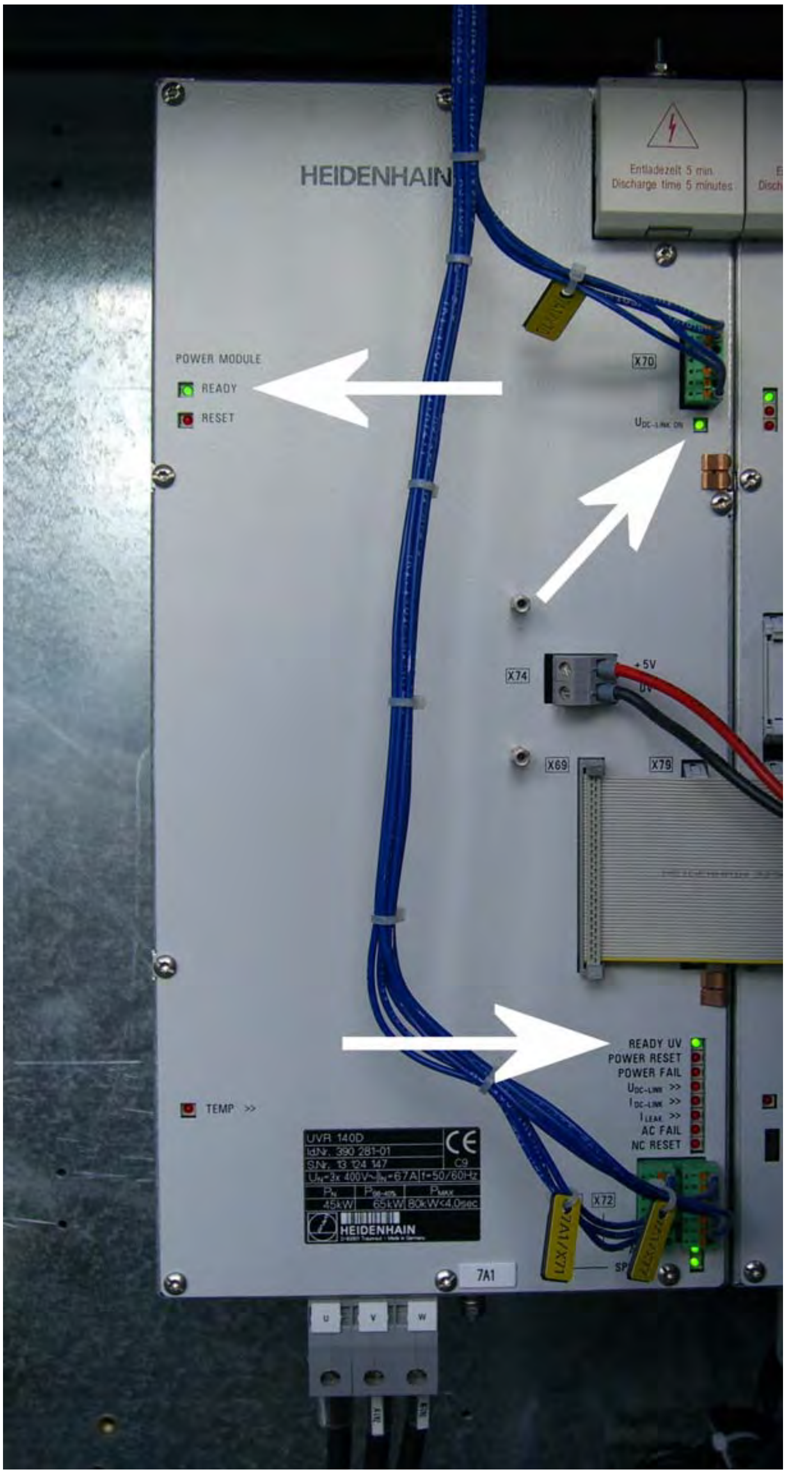


Photo: Green LEDs on the UVR 140D power supply unit

If the mentioned green LEDs are not lit:

▶ Check the voltages. See "Checking the voltages" on page 7 – 89.

7.5.6 Checking the voltages

To ensure that the power supply module can operate, it must be supplied with **400 Vac primary voltage** +/– **10 %** at 3 phases.

The charging contactor inside the power supply unit is triggered with **24 V direct current on pin 3 of connector X70**.

On the DC-link conductor bars under the cover plates **565 Vdc** are available (on non-regenerative devices, depending on the primary voltage) or **650 Vdc** on regenerative devices.

Primary voltage

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

> Danger
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See “Voltage tester” on page 14 – 412.
> Proceed carefully and concentratedly!

- Press the EMERGENCY STOP button and switch on the main switch.

> Note
>
> When performing the following measurements on regenerative units the DC-link should not have been built up yet.
> Reason:
> There are square-wave voltages on the primary phases of an active infeed/regenerative module which might have a negative effect on the measuring results.

- Measure the phases U-V, V-W, W-U at the terminal X31.
  The voltage should be 400 Vac +/- 10 %.
- Measure U, V and W to the ground.
  The voltage should be 230 Vac +/- 10 %.

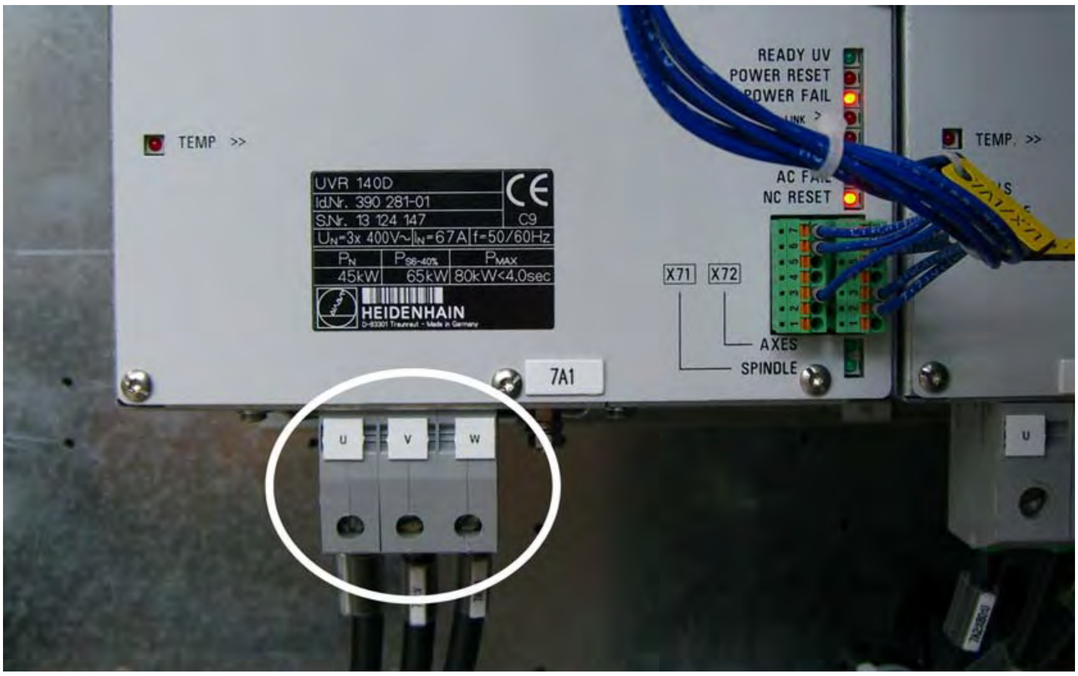


Photo: Primary voltage connector on the UVR 140 D power supply unit

In the event of unbalances of > 10 % or if one or several phases are missing:

- Trace the phases to the main switch of the machine and to the fuses.

24 V control voltage for the charging contactor

The DC-link voltage is built up via a charging contactor that is triggered on contactor X70 with 24 V direct current.

- Cancel the EMERGENCY STOP button and switch on the machine.
- Measure whether 24 V control voltage is available on contact 3 (refer to contact 2 or 0 V) of connector X70.

Figure: Connector X70 on the UVR 140 D power supply unit

> **Note**
>
> On connectors with screw terminals, you can measure on the screw head but on connectors with spring terminals there are hardly any measuring possibilities. Measure at another location in the electrical cabinet (see circuit diagrams of the machine).

If 24 V are not available:

- Check whether all EMERGENCY STOP buttons are canceled.
- Check whether the machine has activated the hardware limit switches.
- Use the circuit diagram of the machine to trace the control voltage.

DC-link voltage

When the machine is switched on, the DC-link voltage must have built up!

- Always comply with the safety precautions!

Danger

Danger to life due to high voltages and currents!
Use a suitable voltage test unit for the following measurement.
See "Voltage tester" on page 14 – 412.
Proceed carefully and concentratedly!

- Measure carefully on the conductor bars whether **approx. 565 Vdc** (on non-regenerative inverter systems, depending on the primary voltage) or **650 Vdc** (on regenerative inverter systems) are available.

Note

If the needle tip probes are thin and long, you do not have to open the protective covers over the conductor bars for measuring. You can contact the conductor bars between the gaps of the cover caps!

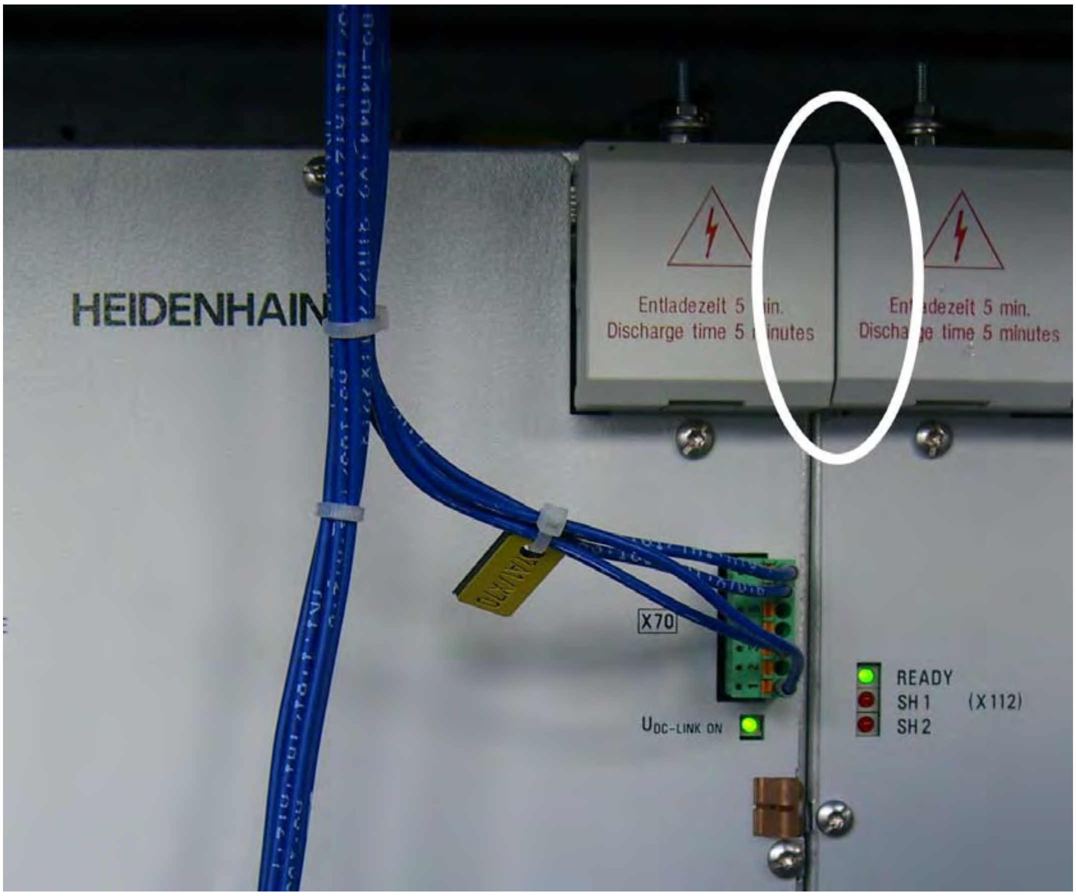


Figure: Protective covers over the conductor bars

If the DC-link voltage is not available:

- Disconnect the power supply unit from the other units and check the functions. See "Testing the UV/UVR without connected units" on page 7 – 92.

Testing the UV/ UVR without connected units

An exact statement about the functions of the power supply unit can be made if the UV, UVR is operated without connected devices (UM, UP, CC, PW, etc.):

- Switch off main switch of the machine and take precautions against resetting.
- Ensure that X31 (primary voltage 400 Vac) and the DC-link are free of potential.
- Wait at least for 5 minutes (there must be no residual voltage or current available), ensure again that the unit is free of potential and remove the conductor bars.
- Tighten the screws for the DC-link (otherweise there might be contact problems in the event of subsequent measurements).
- Disconnect the following connectors from the UV/UVR:
  X70, X71, X72 (enabling connector),
  X69 (supply bus),
  X79 (unit bus),
  X89 (braking resistor),
  X90 (24V supply for fan in braking resistor).
- Disconnect and insulate the following wires:
  X74 (5V power supply)

> Note
>
> If ground fault and short circuit examinations have been made before, the power supply unit is already disconnected from the periphery.

- Insert the connector with a bridge from contact 1 to 3 in X70 (see enabling connector).
- For safety reasons, close the door of the electrical cabinet.
- Switch on the machine and wait a few seconds.
- Open the door of the electrical cabinet again.
- Observe the LEDs on the power supply unit:
  The green LEDs **U DC-LINK ON**, **READY UV** (**READY** on UV 130) and **POWER MODULE READY** (not available on UV 130) should be lit.
  The red LED **POWER FAIL** should not be lit!
- Measure the DC-link voltage carefully.

If Uz is present, the UV/UVR is obviously in order. Test the function during operation!

If Uz is not present, the power supply unit is defective.

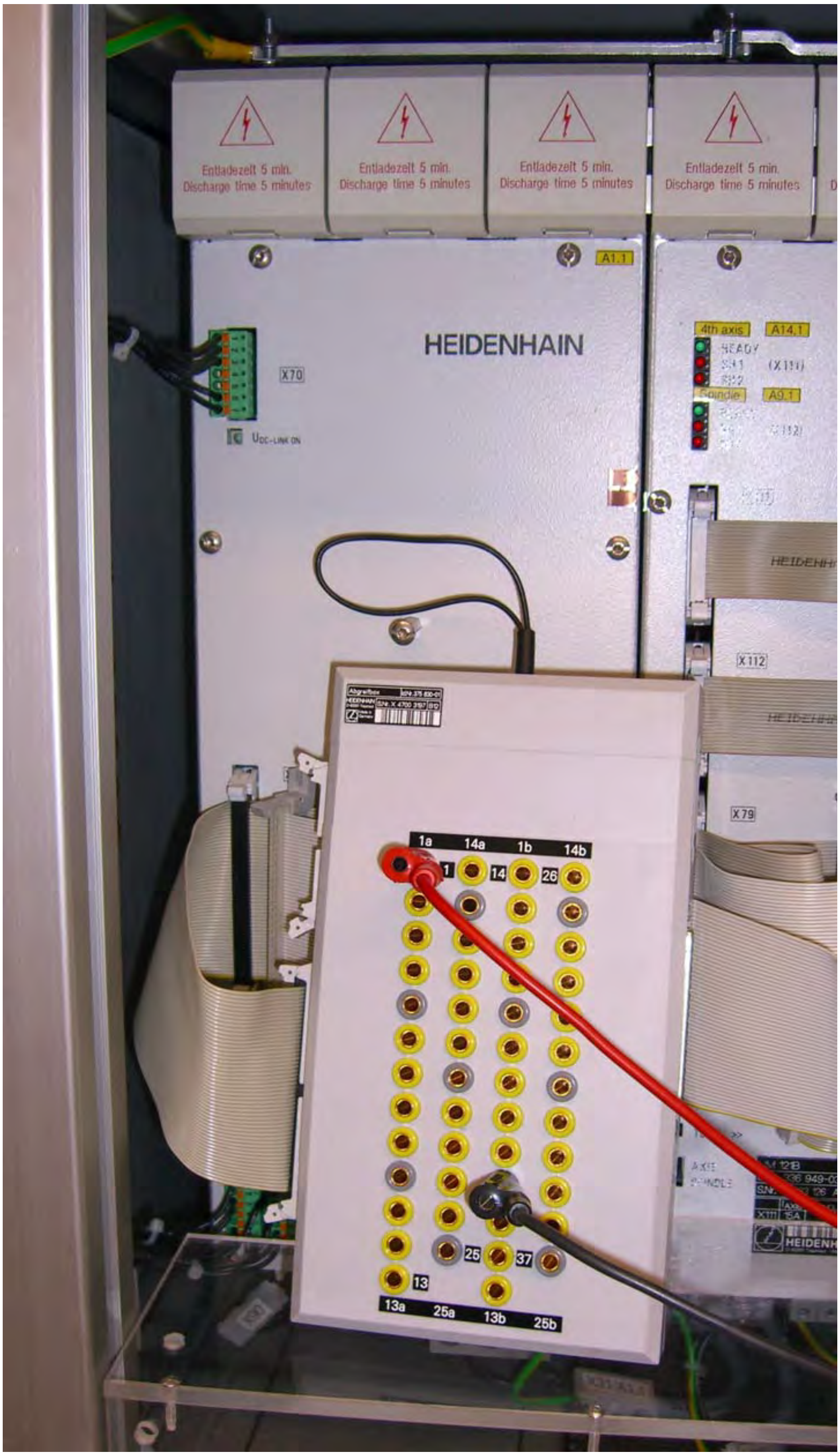
Enabling connector

You need the shown connector with bridge from contact 1 to 3 for the described error diagnosis. You can use the original connector if you have marked, unclamped and secured the wires before. You may also order the 7-pin connector ID 282143-02 from HEIDENHAIN and insert a bridge.

Figure:
UV without connected units

Setup with test adapter

If you have a test adapter (See "Test adapter" on page 14 – 414) you can observe **low voltages and signal conditions during operation** on the power supply bus X69 and unit bus X79.



> Danger
>
> Only **one** interface may be inspected on the test adapter!

7.6 Error diagnosis on the UM power module

7.6.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of ...

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff` or similar error messages on the control.
- Humidity in the inverters and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

> Note
>
> Before inspecting the inverter system for ground faults, ensure that there are no ground faults on the motors. See "Inspection for ground fault" on page 6 – 49.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault to protect the following equipment.

Load switching

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault the charging of the DC-link is aborted.
The charging contactor drops.

Voltage balancing

1-axis modules UM 11x (B, BD, D, DW):
For reasons of EMC and voltage balance, suppression circuits to ground have been mounted.
These suppression circuits are included when the insulation resistance is measured to ground. This may lead to measuring results in the kohm range!
The measured resistance, however, should not fall below 300 kohm!

2-axis modules UM 12x (B, BD, D):
The above suppression circuits are not mounted in these modules.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement -- >See "Insulation tester" on page 14 – 412.

> Danger
>
> The insulation tester operates at high voltages!
> Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN inverters may be measured in the field with a maximum isolation voltage of **500 V**!

> Attention
>
> A higher test voltage could damage the inverter!

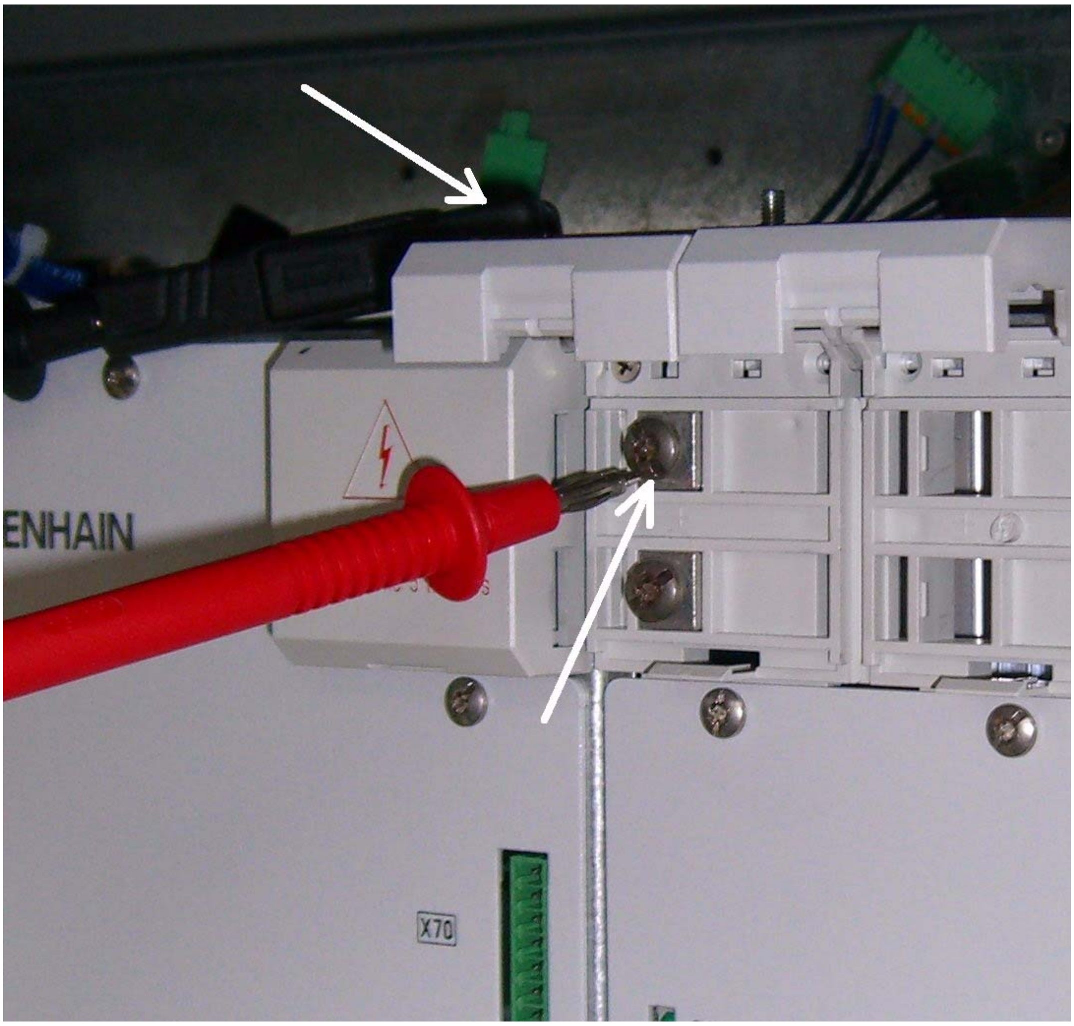
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

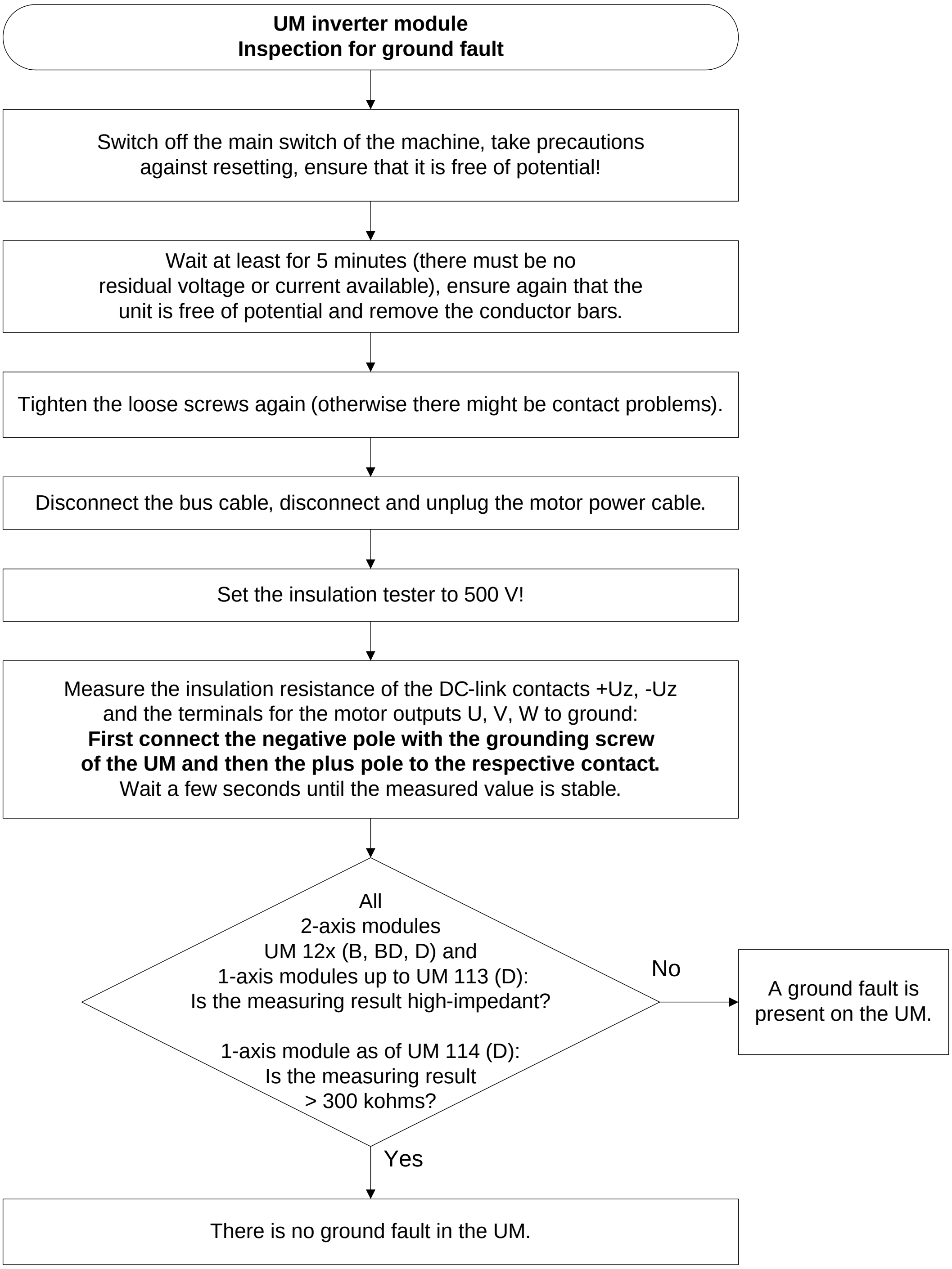
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Ground fault measuring



Flowchart



Note

"Crosscheck":
If your insulation tester operates without power supply (i.e., is operated with accumulators) and has an insulated housing, you can perform the insulation measurement also in reverse direction as a "crosscheck". The negative pole is then connected to the respective contact, the plus pole to the grounding screw.

Note

On all UMs the resistance value of the above-mentioned connections to ground must be at high-impedance (experience has shown that the measured values are in the GOhm range)!

Defined resistance values cannot be specified here as they depend on the following factors or others:

- Temperature of the tested inverter (standard temperature for the insulation measurement: 20 °C)
- Duration of the measurement (reduction of capacitive current and dielectric absorption current)
- Technical data of the insulation measuring unit

If required, you can compare the measured resistance values with the values of a dimensionally identical inverter.

Note

If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
But keep in mind that you are measuring at low voltage so that flashovers in the inverter can hardly be detected!

Corrective action

Inverters with ground faults must be replaced!
See "Exchanging the complete inverter" on page 10 – 221.

Heavily contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on heavily contaminated inverters (the contamination can be seen best in the area of the fan).

Note

With rising air humidity, the probability of unwanted leakage currents increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.6.2 Inspection for short circuit or interruption

A short circuit is a severe electrical error and must be excluded from further inspections.

A **short circuit** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff`
- Scorch marks and/or burnt smell
- Destroyed units

> **Note**
>
> Before inspecting the inverter system for short circuits, ensure that there are no ground faults. See "Inspection for ground fault" on page 7 – 95.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault or short circuit to protect the following equipment.

Load switching

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault or short circuit, the charging of the DC-link is aborted.
The charging contactor drops.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412.
- Standard commercial multimeter that can be set to "diode test".

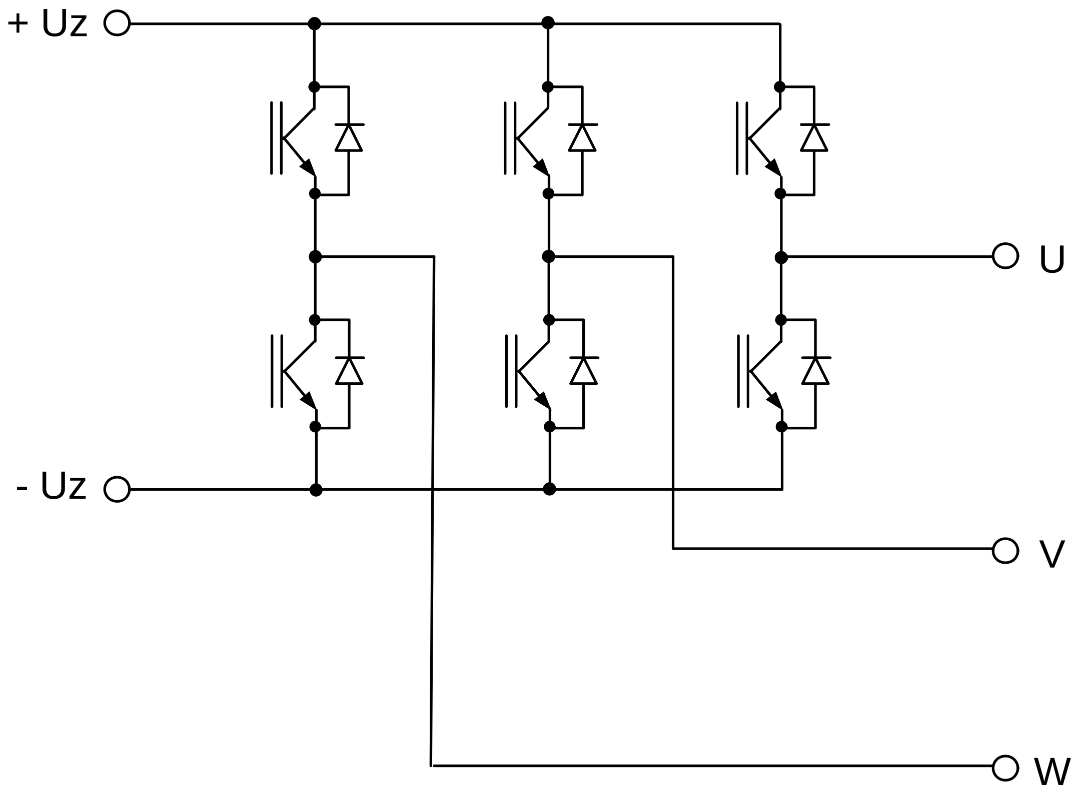
Diode measurement

The diodes in the output stages that are connected antiparallel to each IGBT (Isolated Gate Bipolar Transistor) play an important role for the following measurements.

When measuring the diodes, the diffusion voltage (forward voltage) of these diodes is measured.

If a diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the IGBT also functions!

Block diagram: IGBT end stage



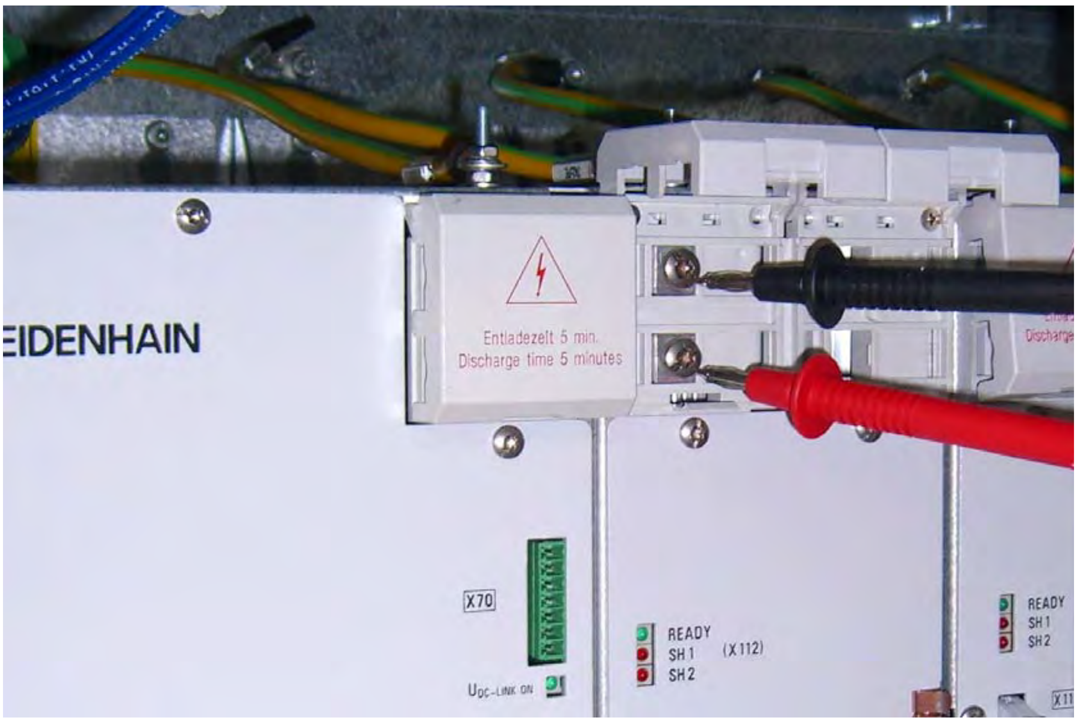
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

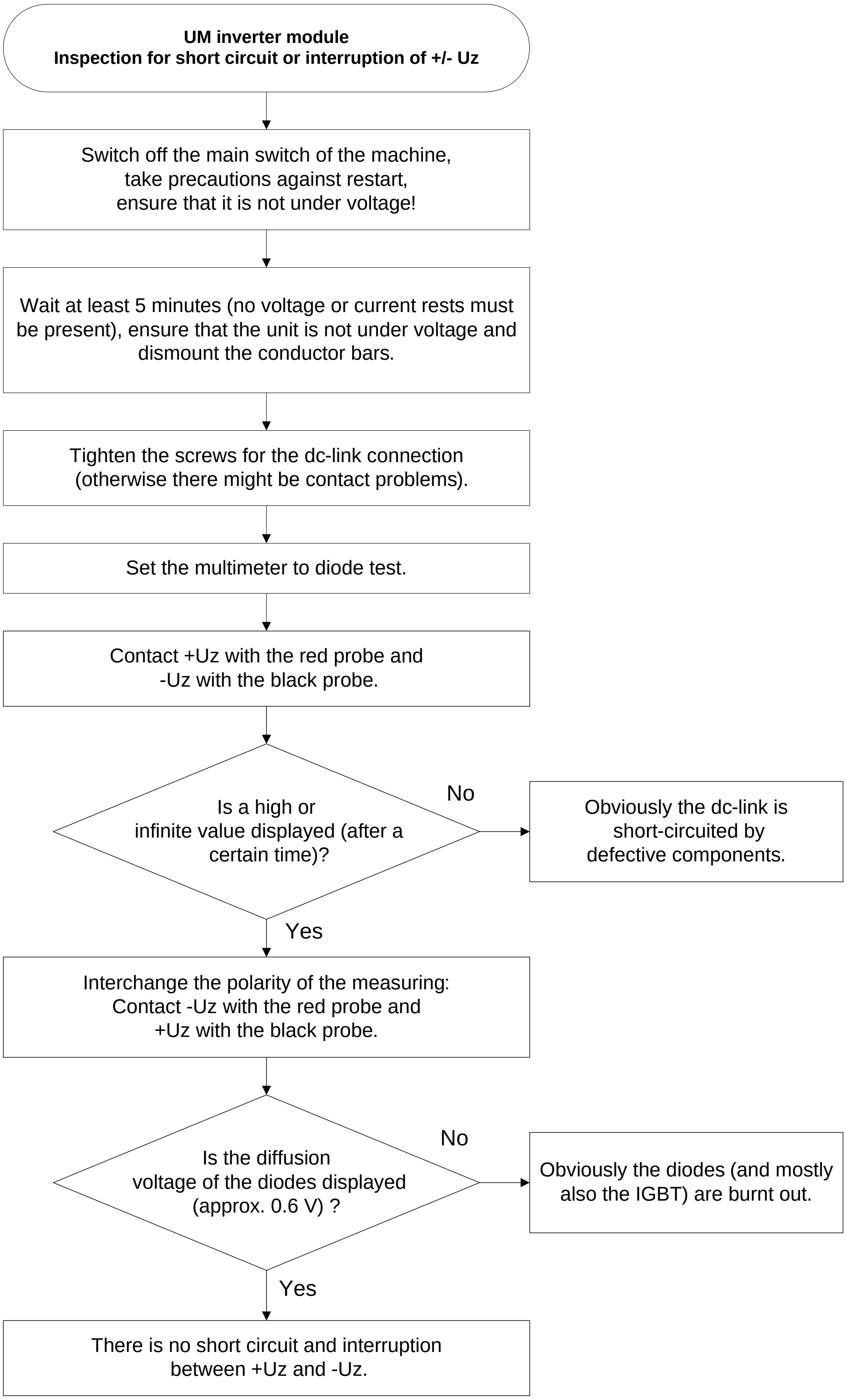
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Diode measurement ± Uz



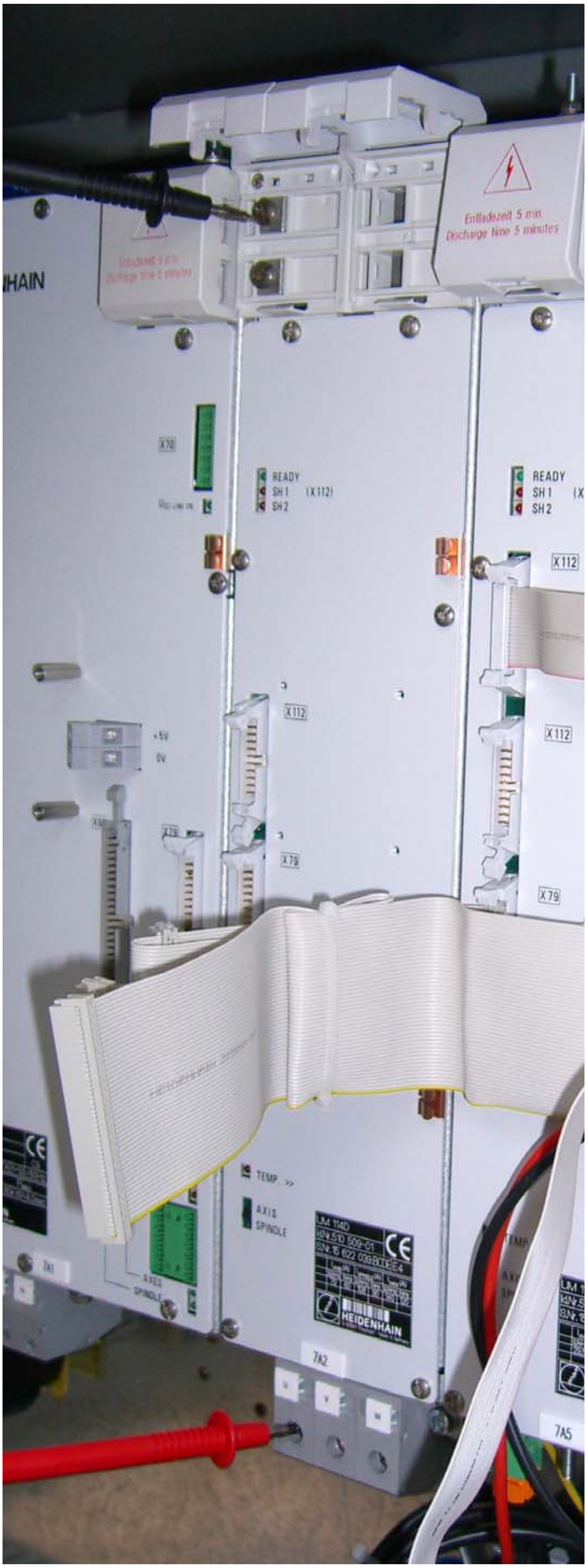
Flowchart: Short circuit or interruption between +Uz and -Uz



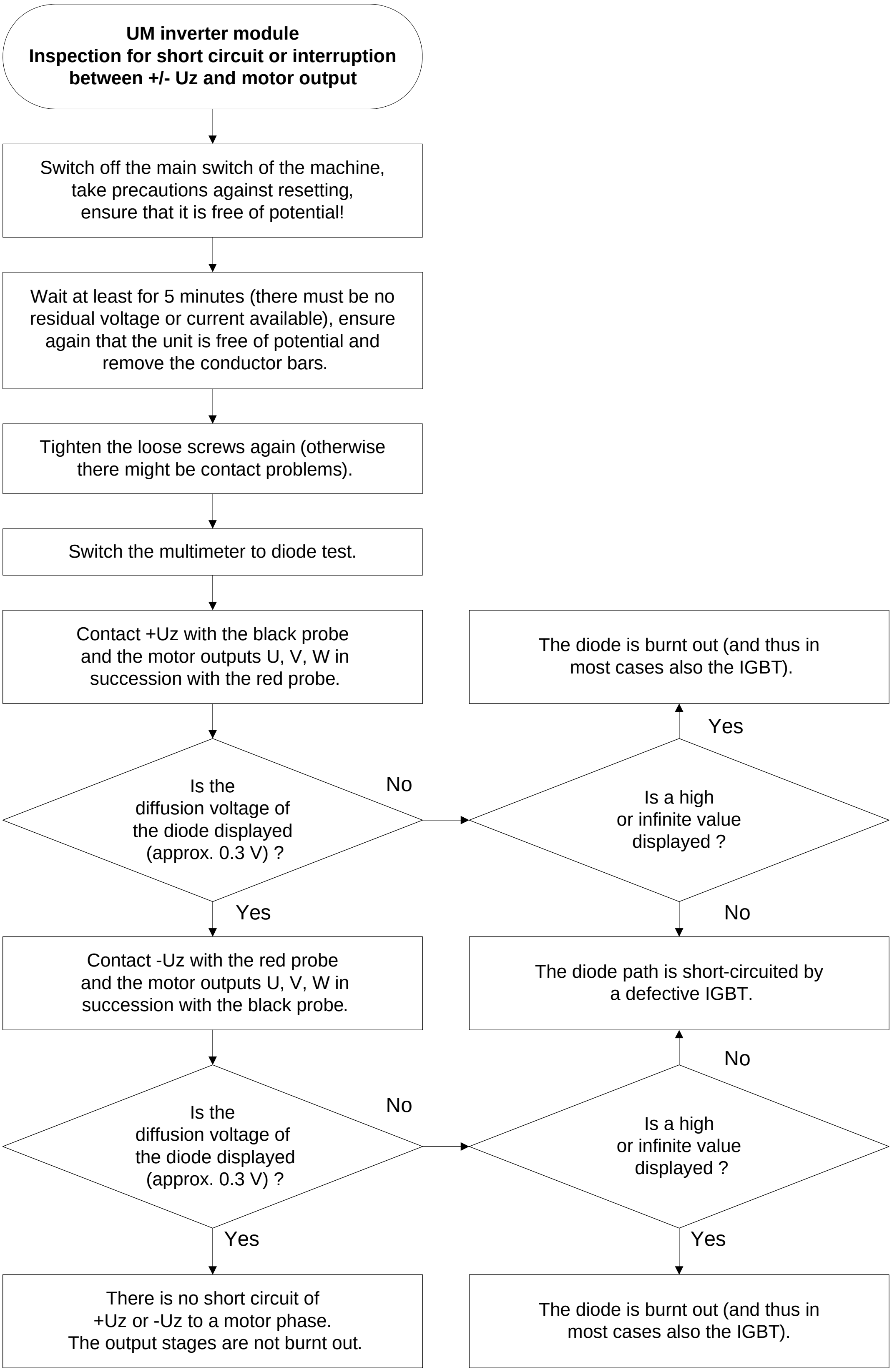
Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

Figure: Diode measurement ± Uz on motor output



Flowchart: Short circuit or interruption between ± Uz and motor output



Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

What cannot be measured?

Please note that the following cannot be determined when performing these measurements:

- Short circuits in the gates of the IGBTs as they cannot be accessed from the outside and thus cannot be measured.
- Defective current sensors or general electronical defects.
- Whether the devices function 100 % (this can only be detected during operation).
- Whether devices that are contaminated but are still functioning, might fail soon.

Corrective action

Inverters with short circuits or interruptions must be replaced!
See “Exchanging the complete inverter” on page 10 – 221.

Heavily contaminated inverters

If you do not detect a short circuit, it might still be possible that there will be short circuits in the device in case the inverter is heavily contaminated (the contamination can be seen best in the area of the fan).

Note

With rising air humidity, the probability of short circuits increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.6.3 Checking the LEDs

▶ Switch on the machine.

▶ Move the respective axis or turn the spindle.

The green LED **READY** must be lit for the output stage concerned!

As long as the axis or the spindle are operating, the red LEDs **SH 1 / STO A** and **SH 2 / STO B** must not be lit!

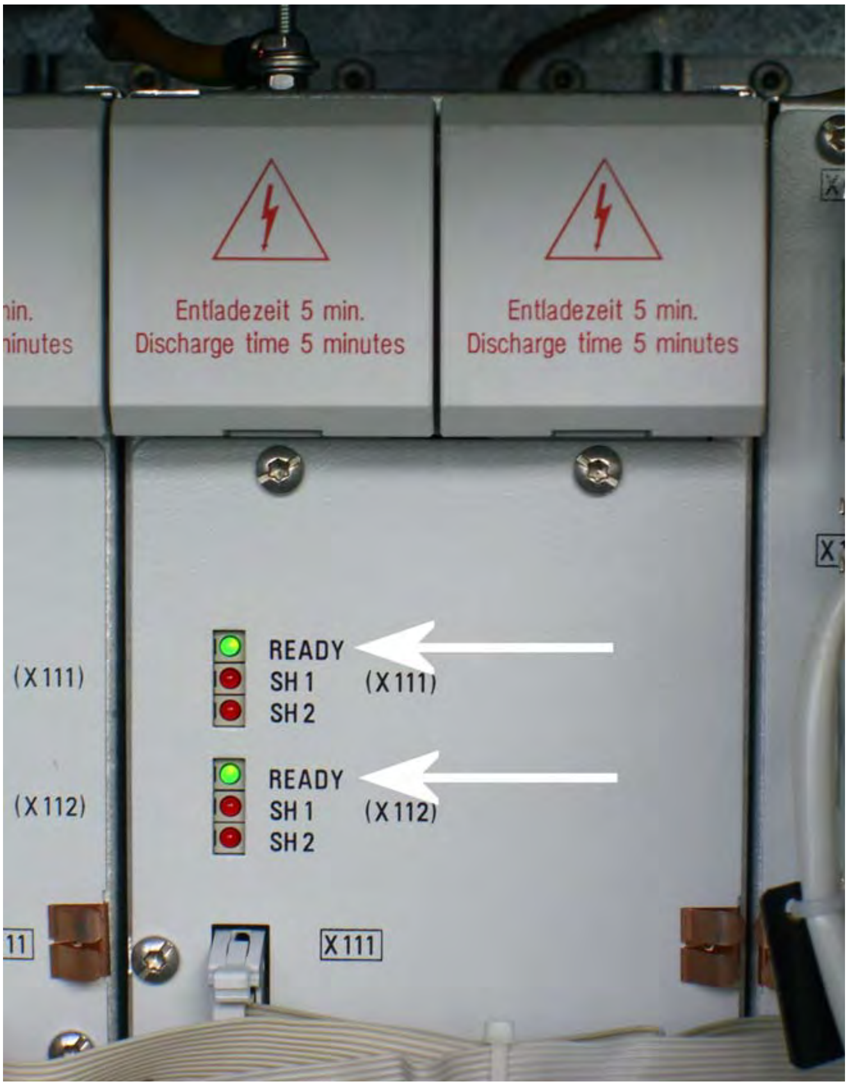


Photo: Green LEDs on the UM 121 B power module

If the green LEDs **READY** are not lit:

▶ Check the enable relays on the power supply unit. See next page.

Note

The inverter modules receive enabling signals for the axes and spindle(s) via the unit bus X79.

The enabling signals are triggered by two safety relays inside the power supply unit.

These safety relays are released externally at the connectors X71 and X72 on the power supply unit.

If a 24 V power supply voltage is available, the green LEDs AXES and SPINDLE are lit.

▶ Check whether the green LED SPINDLE (X71) and the green LED AXES (X72) is lit.

Figure: LEDs for axiss and spindle enable on the UVR 140 D power supply unit

If the mentioned green LEDs on the power supply unit **are lit**, but the green READY-LEDs at the output stages not:

▶ Check the unit bus cable and connector X79.

> **Attention**
>
> The unit bus cable must only be connected to devices that are free of potential. Otherwise the inverters might be destroyed!

▶ Check the respective PWM bus cable and connector. If necessary, try out another PWM bus cable.

> **Attention**
>
> The PWM bus cable must only be connected to devices that are free of potential. Otherwise the inverters might be destroyed!

If the green LEDs SPINDLE and AXES **are not lit:**

▶ Check whether 24 V are available on pin 3 (refer to pin 2) on the respective enabling connector.

If 24 V are not available:

▶ Check whether the protective doors are closed, the permissive buttons are pressed, etc.
Use the circuit diagram of the machine and try to find the interruption.

7.6.4 Checking the voltages

DC-link voltage

When the machine is switched on, the DC-link voltage must have built up!

- Always comply with the safety precautions!

Danger

Danger to life due to high voltages and currents!
Use a suitable voltage test unit for the following measurement.
See "Voltage tester" on page 14 – 412.
Proceed carefully and concentratedly!

- Measure carefully on the conductor bars whether **approx. 565 Vdc** (on non-regenerative inverter systems, depending on the primary voltage) or **650 Vdc** (on regenerative inverter systems) are available.

Note

If the needle tip probes are thin and long, you do not have to open the protective covers over the conductor bars for measuring. You can contact the conductor bars between the gaps of the cover caps!

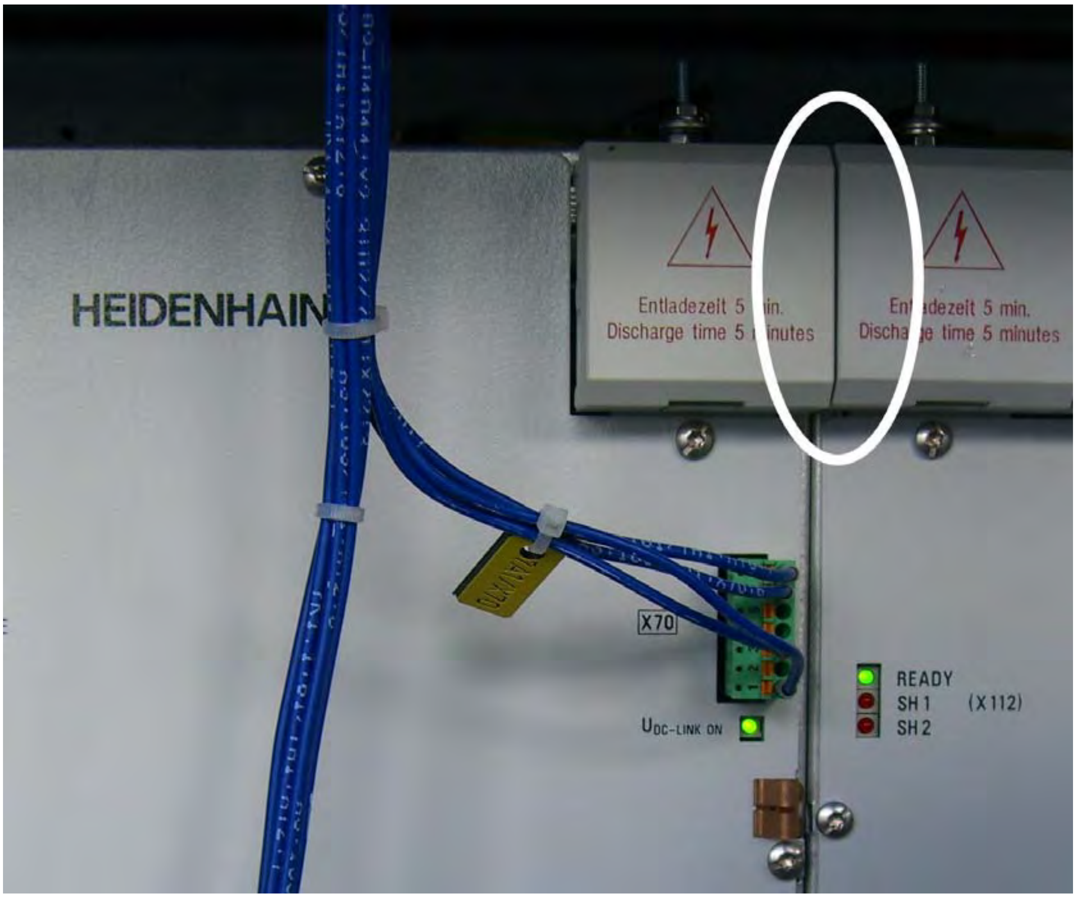


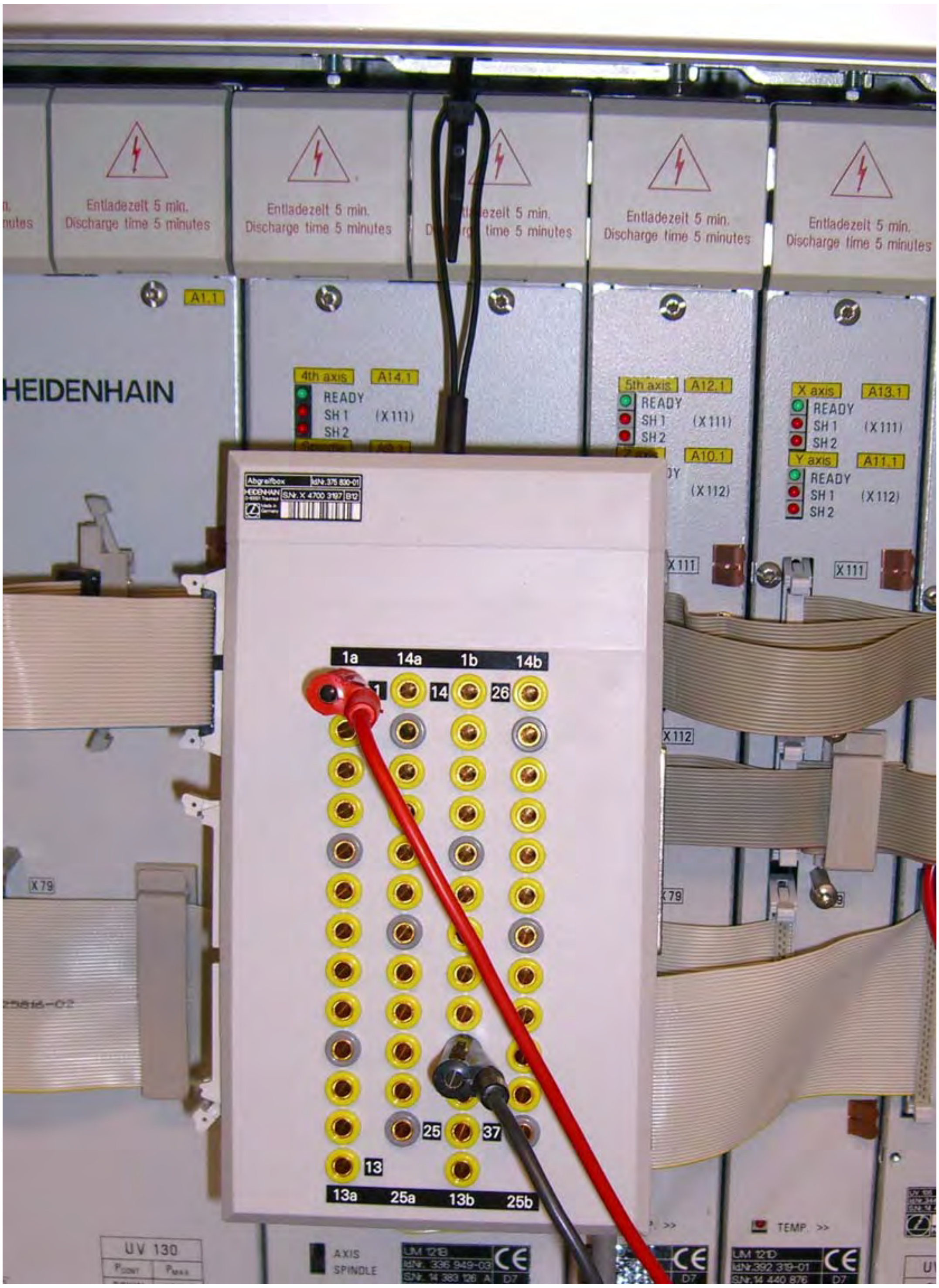
Photo: Protective covers over the conductor bars

If the DC-link voltage is not available:

- Examine the UV or UVR power supply unit. See "Checking the voltages" on page 7 – 89.

Setup with test adapter

If you have a test adapter (See “Test adapter” on page 14 – 414) you can observe the **low voltages and signal conditions during operation** on the unit bus X79 and the PWM ribbon cable X111, X112.



> **Danger**
>
> Only **one** interface may be inspected on the test adapter!

7.6.5 Interchanging power modules or output stages of the same type

Use this error detection routine to find out **(without changing machine parameters)** whether a faulty axis can be traversed with ...

- a dimensionally identical power module (UM) or
- an output stage with equal power (2-axis-module, compact inverter)

Danger

If you want to use **other types of power stages or output stages** , we strongly recommend contacting your machine manufacturer or HEIDENHAIN. Otherwise you could cause damage or injury to machine or persons!

Use one of the following:

- Either the power stage or output stage of a functioning axis
- Or a replacement unit

Attention

If you strongly suspect that the motor of the axis to be examined causes a ground fault or a short circuit (penetration of humidity, etc.), you must not connect it to another power stage as it could be destroyed!
First check the motor for ground faults and short circuits. See "Inspection for ground fault" on page 6 – 49, See "Inspection for winding short circuit or interruption" on page 6 – 53.

Danger

Always secure vertical axes from falling down before you perform this test!

Danger

Danger of electrical shock!
Make sure that the main switch of the machine is switched off and that all connectors and terminals are free of potential before you engage or disengage them.

Assumed configuration for two 1-axis modules

UM 111: **X111** (PWM connection of channel 1) connected with **X51** (iTNC, X axis)

X81 (motor connection of channel 1) connected with motor **X axis**

UM 111: **X111** (PWM connection of channel 1) connected with **X52** (iTNC, Y axis)

X81 (motor connection of channel 1) connected with motor **Y axis**

Assumed configuration for one 2-axis module

UM 121:

X111 (PWM connection of channel 1) connected with **X51** (iTNC, X axis)

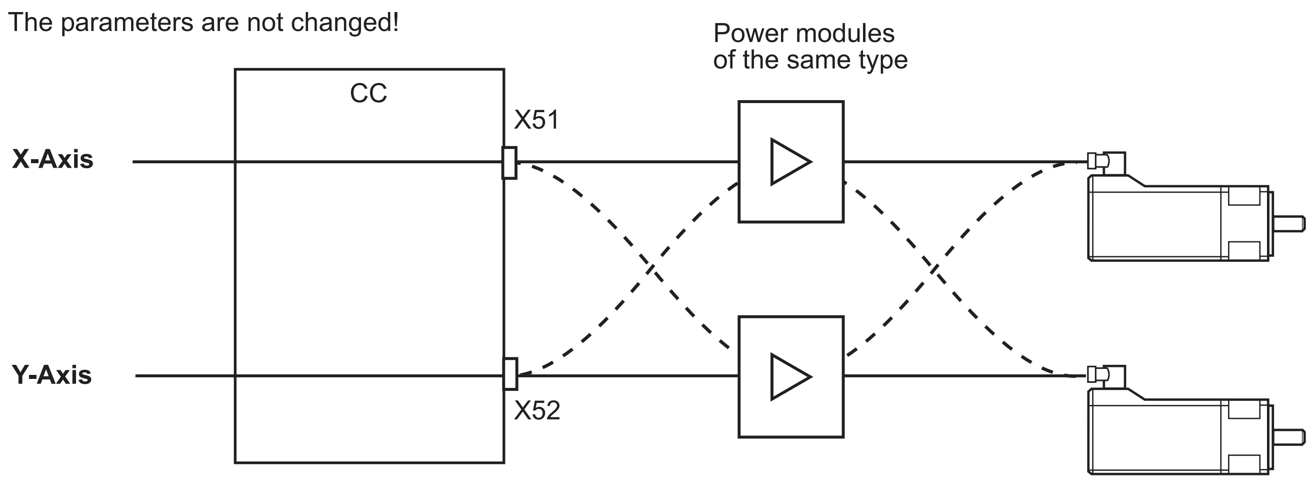
X112 (PWM connection of channel 2) connected with **X52** (iTNC, Y axis)

X81 (motor connection of channel 1) connected with motor **X axis**

X82 (motor connection of channel 2) connected with motor **Y axis**

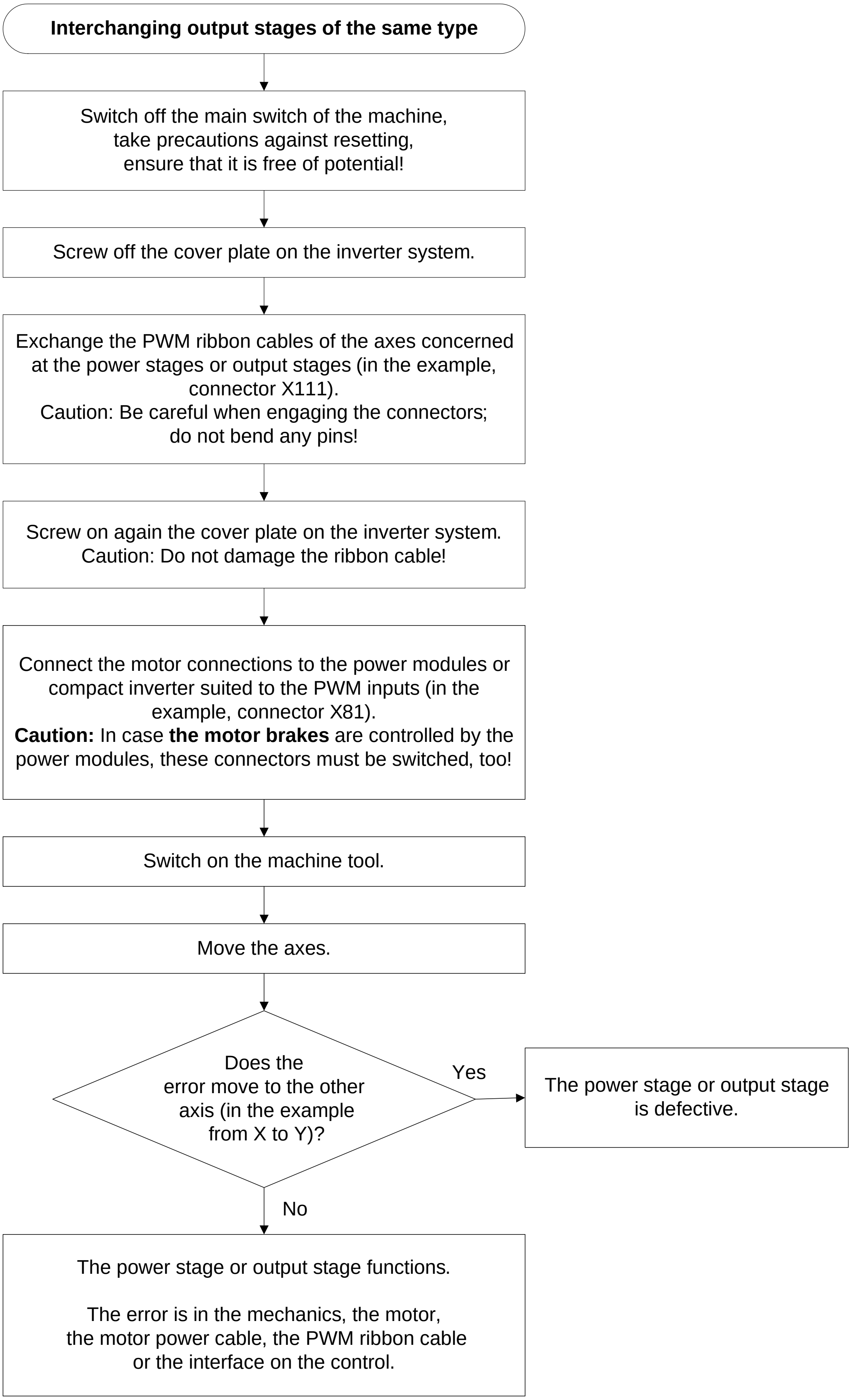
In this example there is an error in the X axis:

Block diagram for two 1-axis modules



> **Attention**
>
> If motor brakes are connected to the power modules, they must also be interchanged (X392 --> See “Connector designations and pin layouts” on page 12 – 301)!
> Motor brakes can be connected to current HEIDENHAIN inverter modules and compact inverters. The motor brake is also powered with 24 V via connector X344 on the inverter. The trigger signals for the motor brakes are transmitted via the PWM bus.

Flowchart for two 1-axis modules

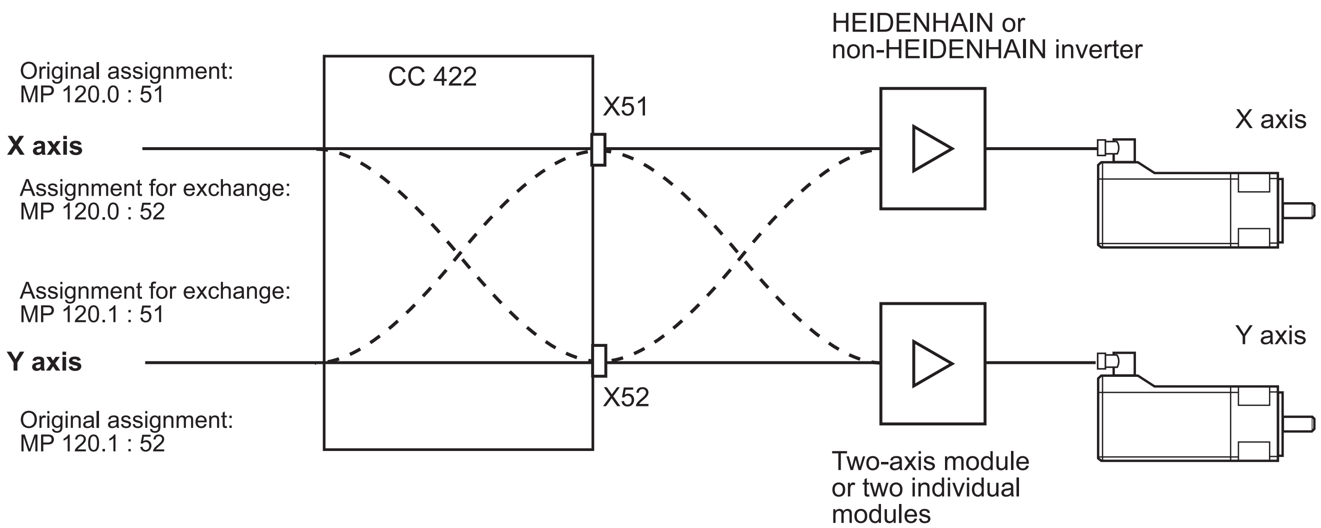


7.6.6 Interchanging the PWM outputs

Use this error detection routine to find out whether the PWM output of the control is defective or the connected inverter module.

The procedure depends on the control type. The machine parameters must be changed.
Use the respective **Service Manual for the HEIDENHAIN control** (e.g., SHB iTNC 530).

Block diagram from the Service Manual iTNC 530:



7.7 Error diagnosis on the UE, UR compact inverter

7.7.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of ...

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff` or similar error messages on the control.
- Humidity in the inverters and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

> **Note**
>
> Before inspecting the inverter system for ground faults, ensure that there are no ground faults on the motors. See "Inspection for ground fault" on page 6 – 49.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault to protect the following equipment.

Load switching

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault the charging of the DC-link is aborted.
The charging contactor drops.

Potential dividers

Potential dividers for the DC-link voltage measurement are integrated in the compact inverters (UR, UE xxx B, except UE xxx). These potential dividers are included when the insulation resistance is measured to ground. This may lead to measuring results in the kohm range!
Apart from the measurement of the DC-link voltage, the phase voltage of regenerative inverters is measured; consequently such inverters are always of lower impedance to ground than non-regenerative models. The measured resistance, however, should not fall below 30 kohm!

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement -- >See "Insulation tester" on page 14 – 412.

> **Danger**
>
> The insulation tester operates at high voltages!
> Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN inverters may be measured in the field with a maximum isolation voltage of **500 V**!

> **Attention**
>
> A higher test voltage could damage the inverter!

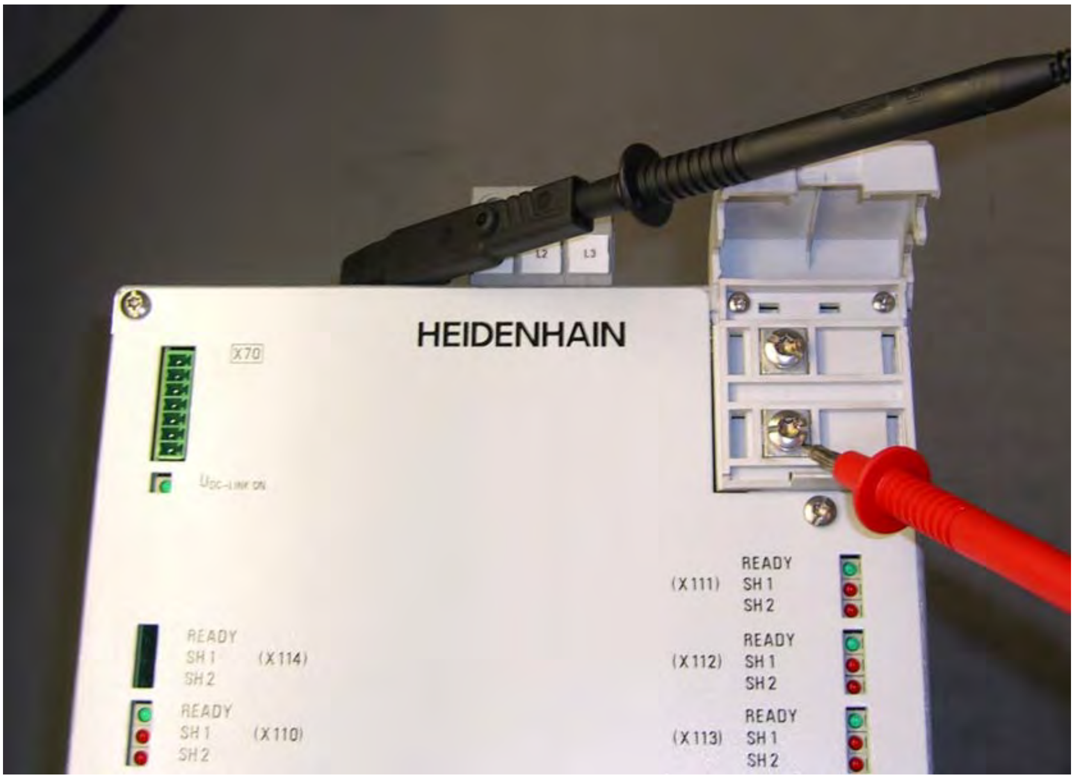
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

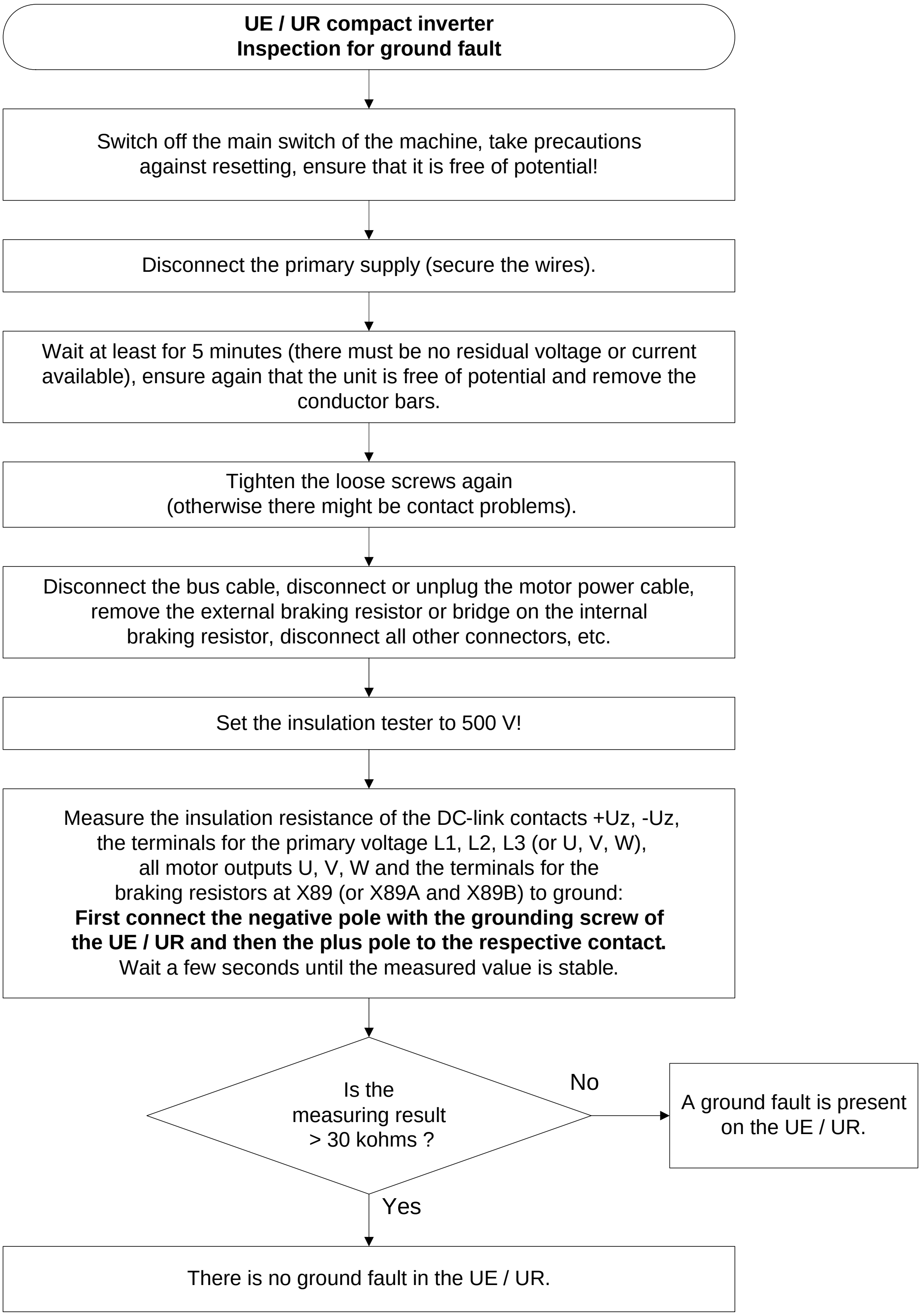
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Ground fault measuring



Flowchart



Note

"Crosscheck":
If your insulation tester operates without power supply (i.e., is operated with accumulators) and has an insulated housing, you can perform the insulation measurement also in reverse direction as a "crosscheck". The negative pole is then connected to the respective contact, the plus pole to the grounding screw.

Note

Defined resistance values cannot be specified here as they depend on the following factors or others:

- Temperature of the tested inverter (standard temperature for the insulation measurement: 20 °C)
- Duration of the measurement (reduction of capacitive current and dielectric absorption current)
- Technical data of the insulation measuring unit

If required, you can compare the measured resistance values with the values of a dimensionally identical inverter.

Note

If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
But keep in mind that you are measuring at low voltage so that flashovers in the inverter can hardly be detected!

Corrective action

Inverters with ground faults must be replaced!
See "Exchanging the complete inverter" on page 10 – 221.

Heavily contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on heavily contaminated inverters (the contamination can be seen best in the area of the fan).

Note

With rising air humidity, the probability of unwanted leakage currents increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.7.2 Inspection for short circuit or interruption

A short circuit is a severe electrical error and must be excluded from further inspections.

A **short circuit** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff`
- Scorch marks and/or burnt smell
- Destroyed units

Note

Before inspecting the inverter system for short circuits, ensure that there are no ground faults. See "Inspection for ground fault" on page 7 – 113.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault or short circuit to protect the following equipment.

Load switching

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault or short circuit, the charging of the DC-link is aborted.
The charging contactor drops.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- Standard commercial multimeter that can be set to "diode test".

Diode measurement

The diodes in the bridge rectifiers and output stages play an important role in the following measurements.

The DC-link voltage of non-controlled bridge rectifiers for non-regenerative compact inverters is generated by rectifier diodes.

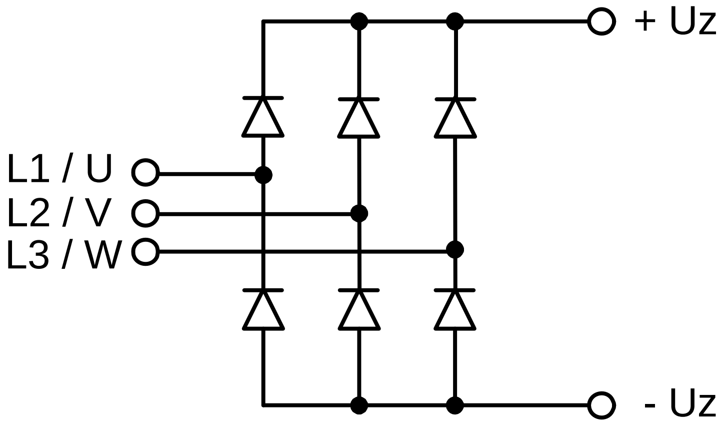
The DC-link voltage of controlled bridge rectifiers for regenerative compact inverters is generated with IGBTs (Isolated Gate Bipolar Transistor). Every IGBT is combined with an antiparallel connected diode.

IGBTs with diodes that are connected antiparallel are integrated in the output stages.

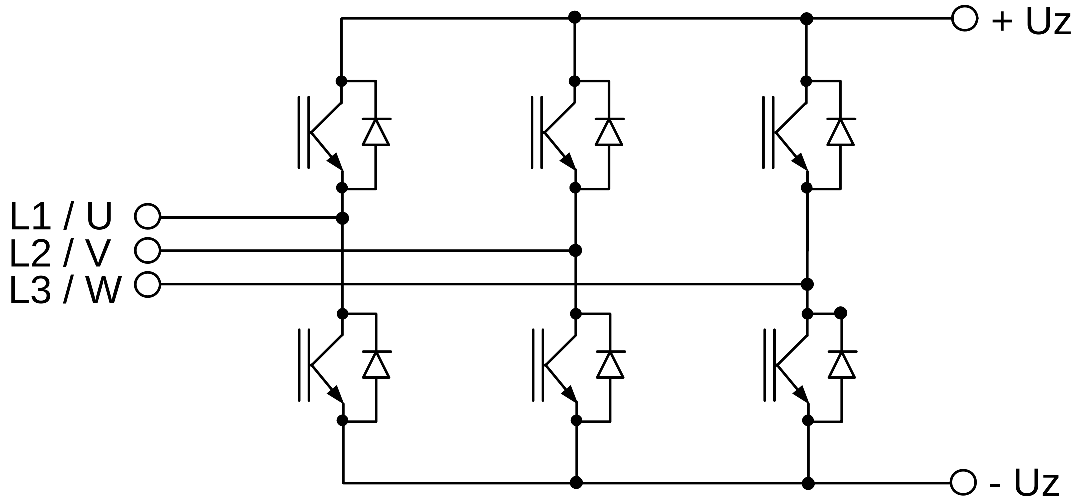
When measuring the diodes, the diffusion voltage (forward voltage) of these diodes is measured.

If a diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the IGBT also functions!

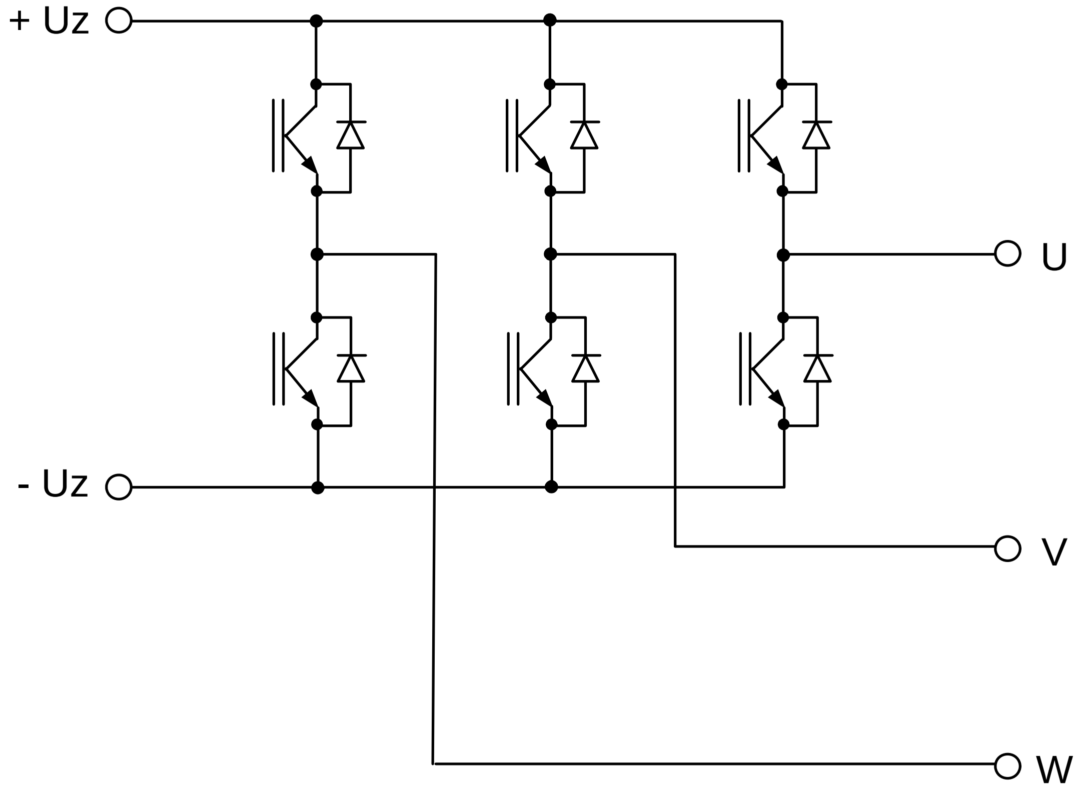
Block diagram: Non-controlled bridge rectifier



Block diagram: Controlled bridge rectifier with IGBTs



Block diagram: IGBT end stage



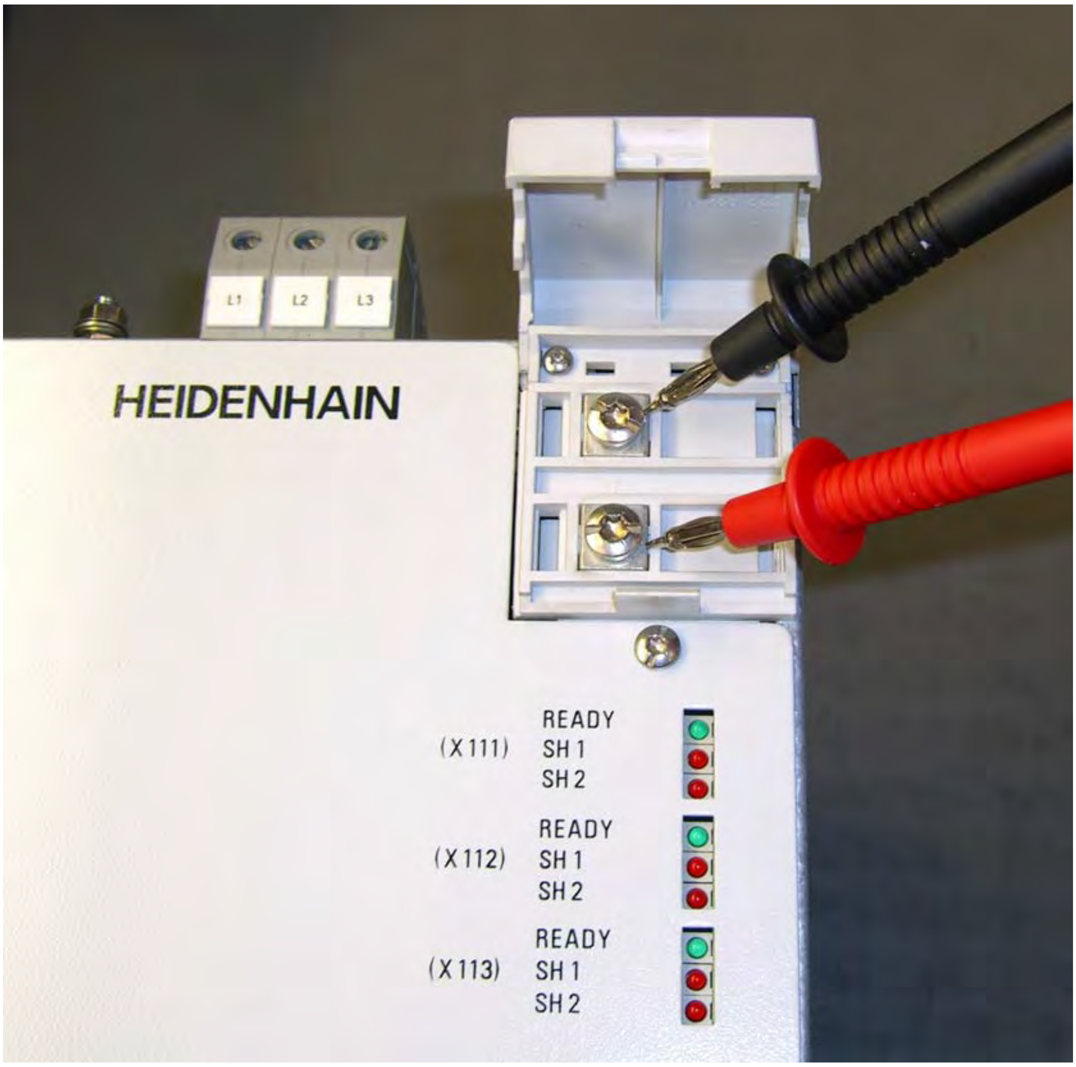
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

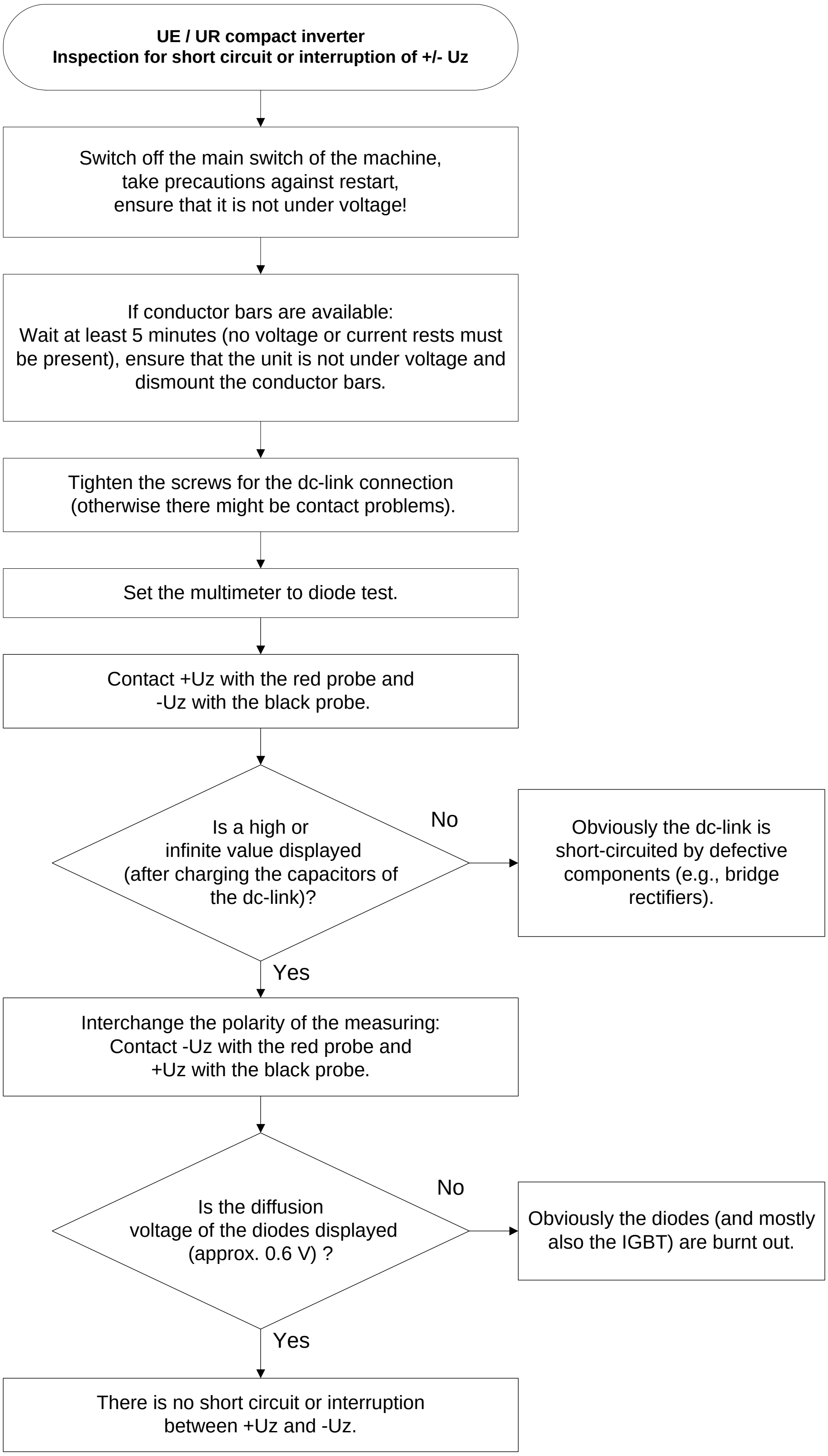
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Diode measurement ± Uz



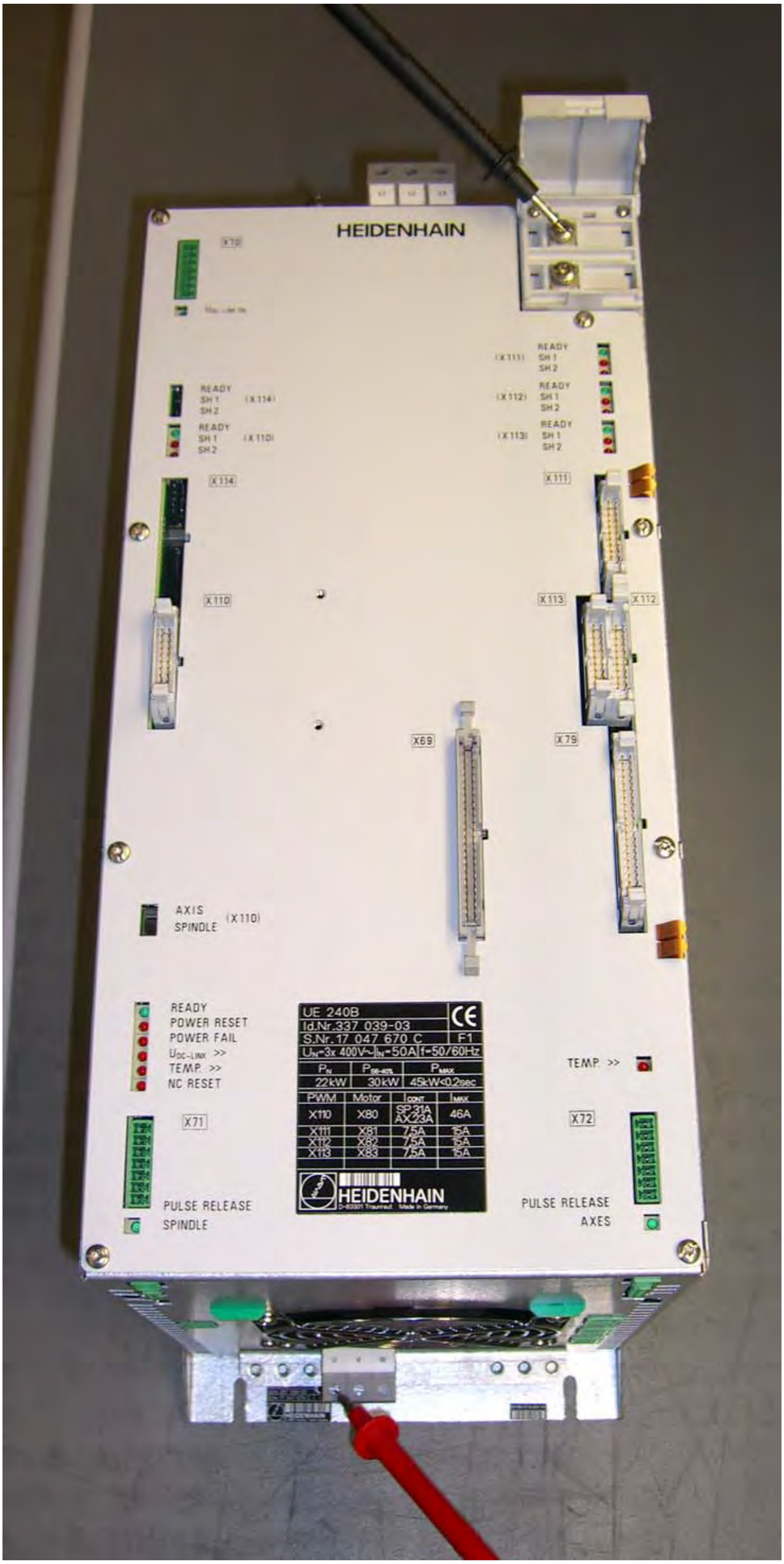
**Flowchart:
Short circuit or interruption between +Uz and -Uz**



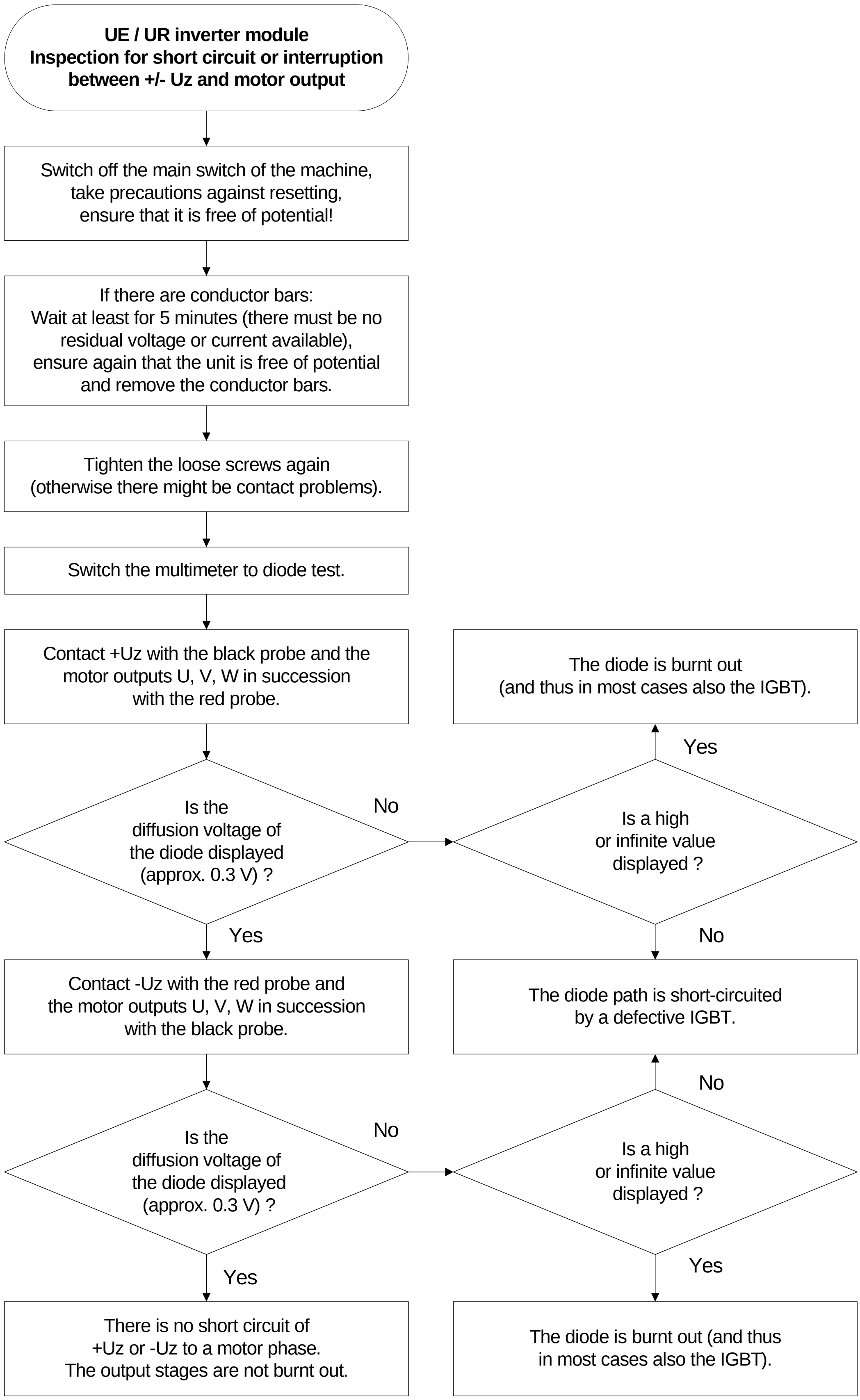
Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

Figure: Diode measurement ± Uz on motor output



Flowchart: Short circuit or interruption between ± Uz and motor output



Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

What cannot be measured?

Please note that the following cannot be determined when performing these measurements:

- Short circuits in the gates of the IGBTs as they cannot be accessed from the outside and thus cannot be measured.
- Defective current sensors or general electronical defects.
- Whether the devices function 100 % (this can only be detected during operation).
- Whether devices that are contaminated but are still functioning, might fail soon.

Corrective action

Inverters with short circuits or interruptions must be replaced!
See “Exchanging the complete inverter” on page 10 – 221.

Heavily contaminated inverters

If you do not detect a short circuit, it might still be possible that there will be short circuits in the device in case the inverter is heavily contaminated (the contamination can be seen best in the area of the fan).

> Note
>
> With rising air humidity, the probability of short circuit increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.7.3 Checking the fuses

Many compact inverters are equipped with fuses that can be accessed from the outside (4 ampere, slow).

They are located on the top surface of the unit.

They protect the charging circuit and the incorporated switching power supply for the generation of low voltages.

Photo: Location of the fuses

If your power supply unit is equipped with fuses accessible from outside:

- Switch off the machine, take precautions against restart and ensure that it is free of potential.
- Check the fuses.
- Replace them, if required.

7.7.4 Checking the internal braking resistor

The UE 210, UE 211, UE 212, UE 210B, UE 211B, UE 212B, UE 210D, UE 211D and UE 212D compact inverters are equipped with integrated braking resistors.

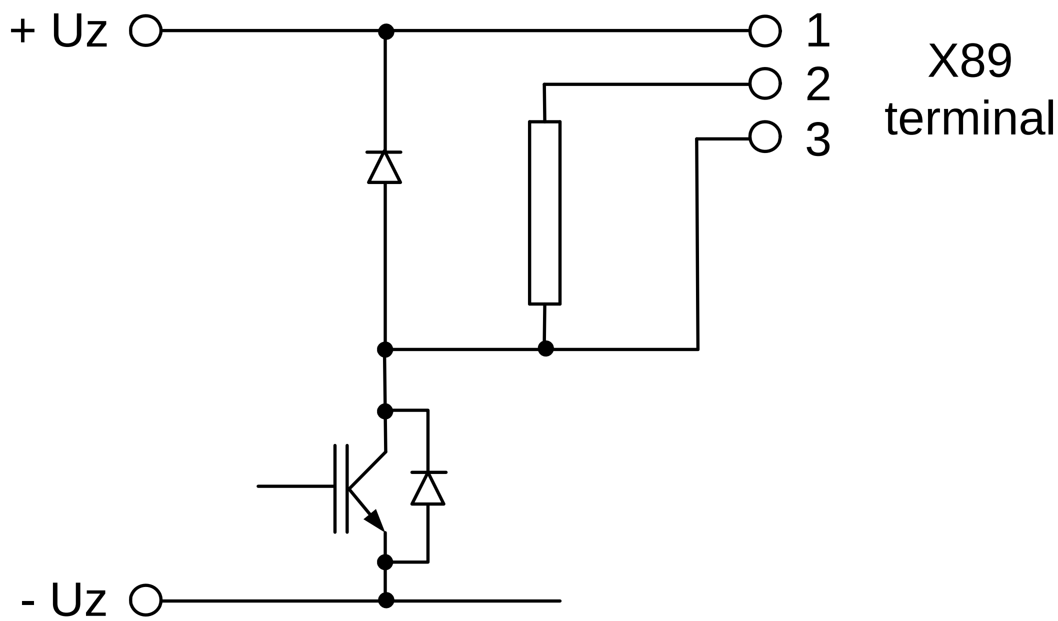
The resistance value is **21 ohm ± 10 %** and can be measured from outside.

Required measuring devices

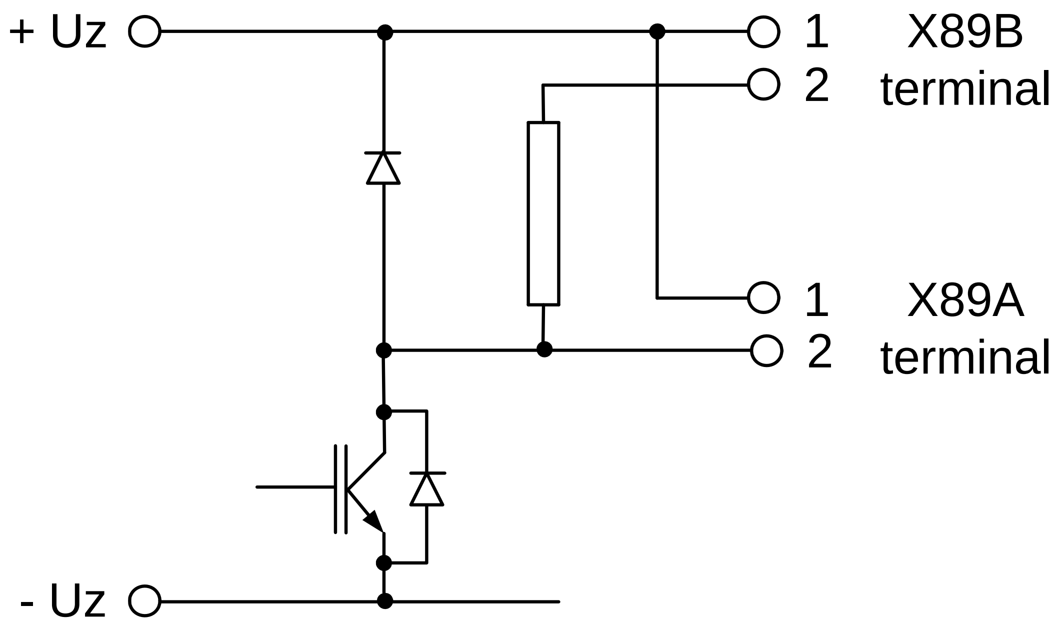
- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- Standard commercial multimeter

Block diagrams

UE 210, 211, 212:
For the operation of the internal braking resistor, a bridge is mounted between terminal 1 and 2 on connector X89. An external braking resistor would be connected to terminal 1 and 3. The bridge for the internal braking resistor must not be mounted in that case!



UE 210B, 211B, 212B, 210D, 211D, 212D:
For the operation of the internal braking resistor, a bridge is mounted between terminal 1 and 2 on connector X89B. An external braking resistor would be connected to terminal 1 and 2 on connector X89A. The bridge for the internal braking resistor must not be mounted in that case!



Resistance values

Compact inverters	Resistance value of the internal braking resistor
UE 210, 211, 212	21 Ω ± 10%
UE 210B, 211B, 212B	21 Ω ± 10%
UE 210D, 211D, 212D	18 Ω ± 10%

Pin layout

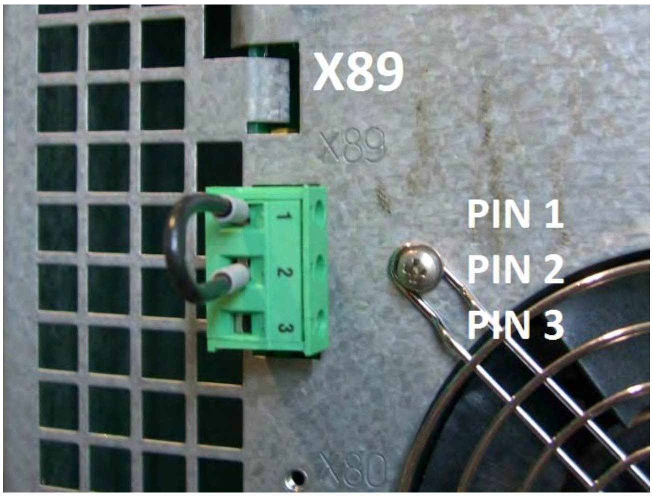


Figure: UE 210, 211, 212, assignment of X89

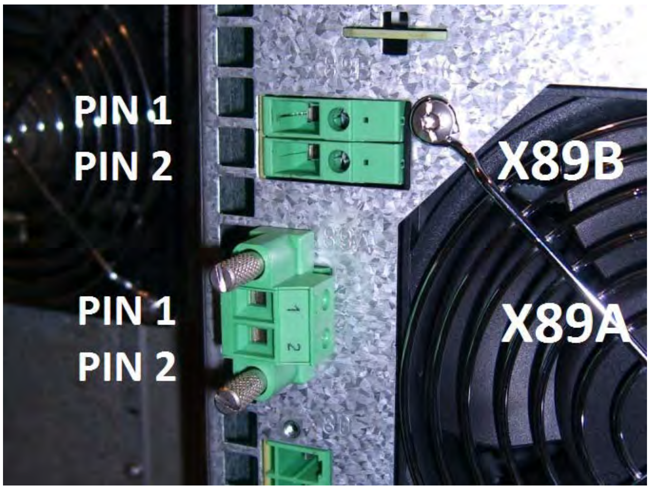


Figure: UE 210B, 211B, 212B, assignment of X89 and X89B

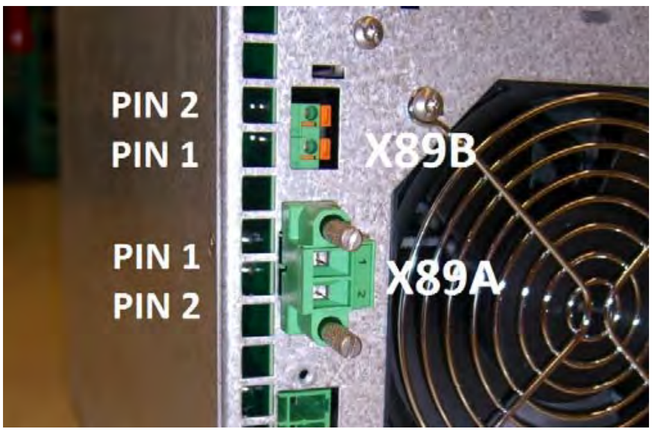


Figure: UE 210D, 211D, 212D, assignment of X89A and X89B

Procedure

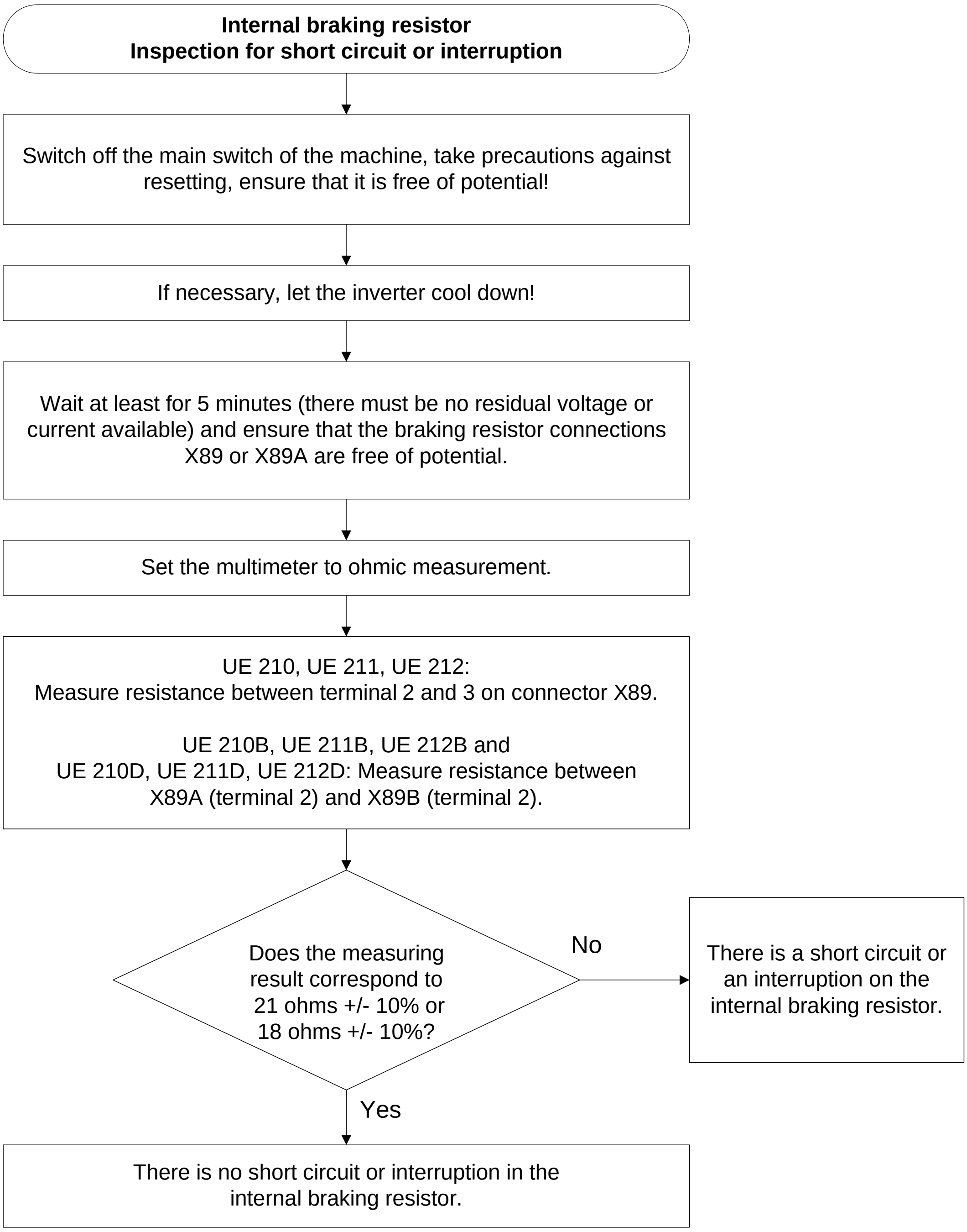
Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Measurement of internal braking resistor

Flowchart
Resistance value



7.7.5 Checking the braking resistor switch

If the DC-link voltage increases, for example, while braking the axes or spindles, the internal or external braking resistor of non-regenerative compact inverters is switched on. It converts electrical energy into heat.

An IGBT (Isolated Gate Bipolar Transistor) serves as switch. This IGBT is combined with an antiparallel connected diode that can be measured from outside.

Diode measurement

When measuring the diode, the diffusion voltage (forward voltage) of this diode is measured.

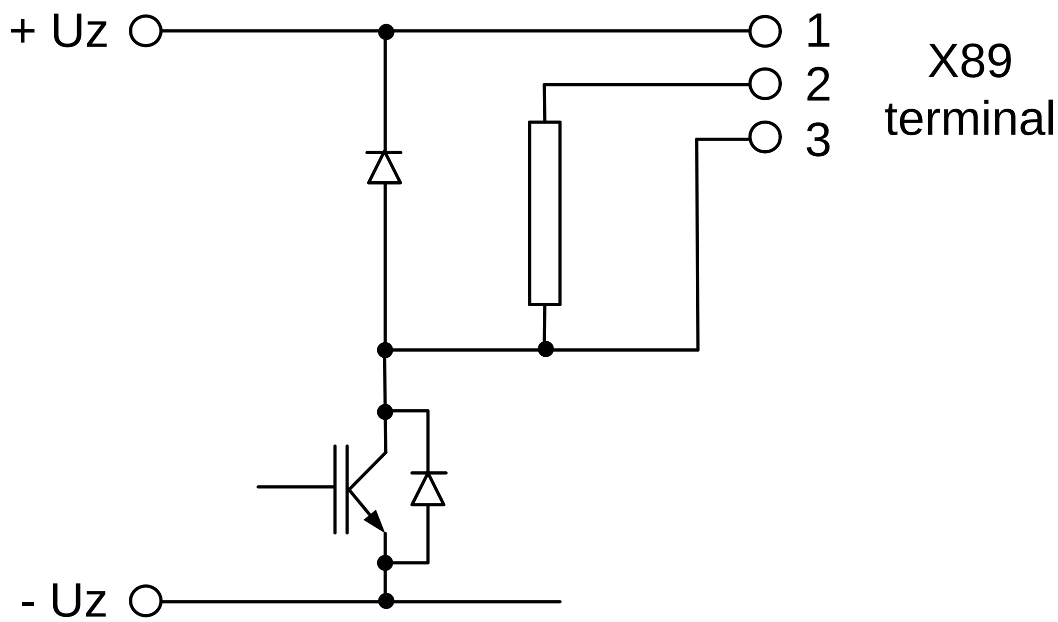
If the diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the IGBT also functions!

Required measuring devices

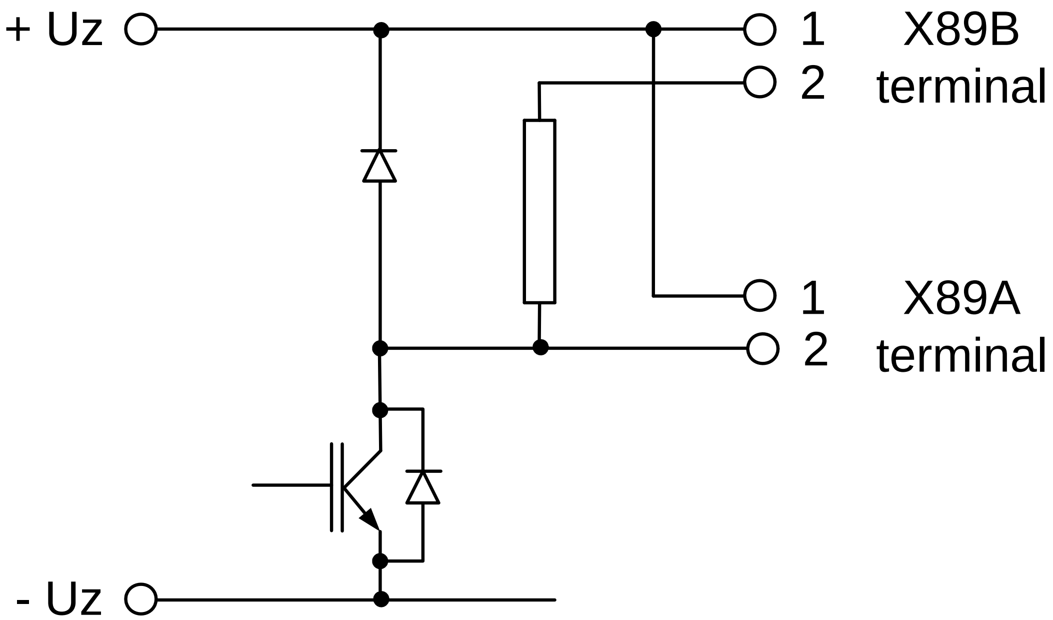
- Appropriate **voltage test unit** to ensure that the unit is free of potential –> See "Voltage tester" on page 14 – 412
- Standard commercial multimeter that can be set to "diode test".

Block diagrams

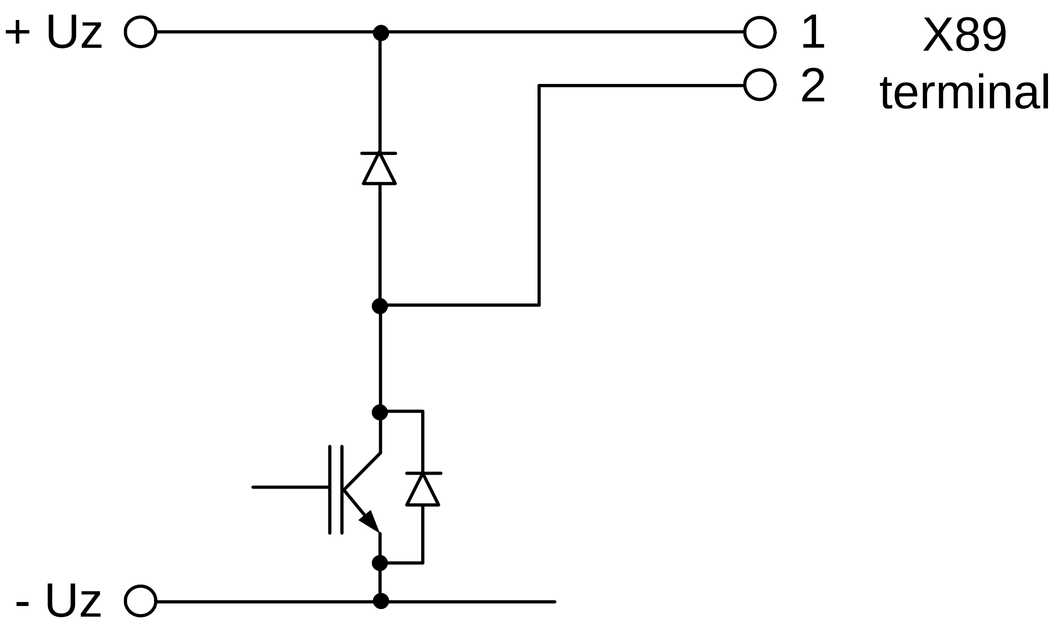
UE 210, 211, 212:
For the operation of the internal braking resistor, a bridge is mounted between terminal 1 and 2 on connector X89. An external braking resistor would be connected to terminal 1 and 3. The bridge for the internal braking resistor must not be mounted in that case!



UE 210B, 211B, 212B, 210D, 211D, 212D:
For the operation of the internal braking resistor, a bridge is mounted between terminal 1 and 2 on connector X89B. An external braking resistor would be connected to terminal 1 and 2 on connector X89A. The bridge for the internal braking resistor must not be mounted in that case!



UE 230, 240, 242, 230B, 240B, 242B, 230D, 240D, 242D:
An external braking resistor is connnected (two braking resistors may also be connected in series or parallel).



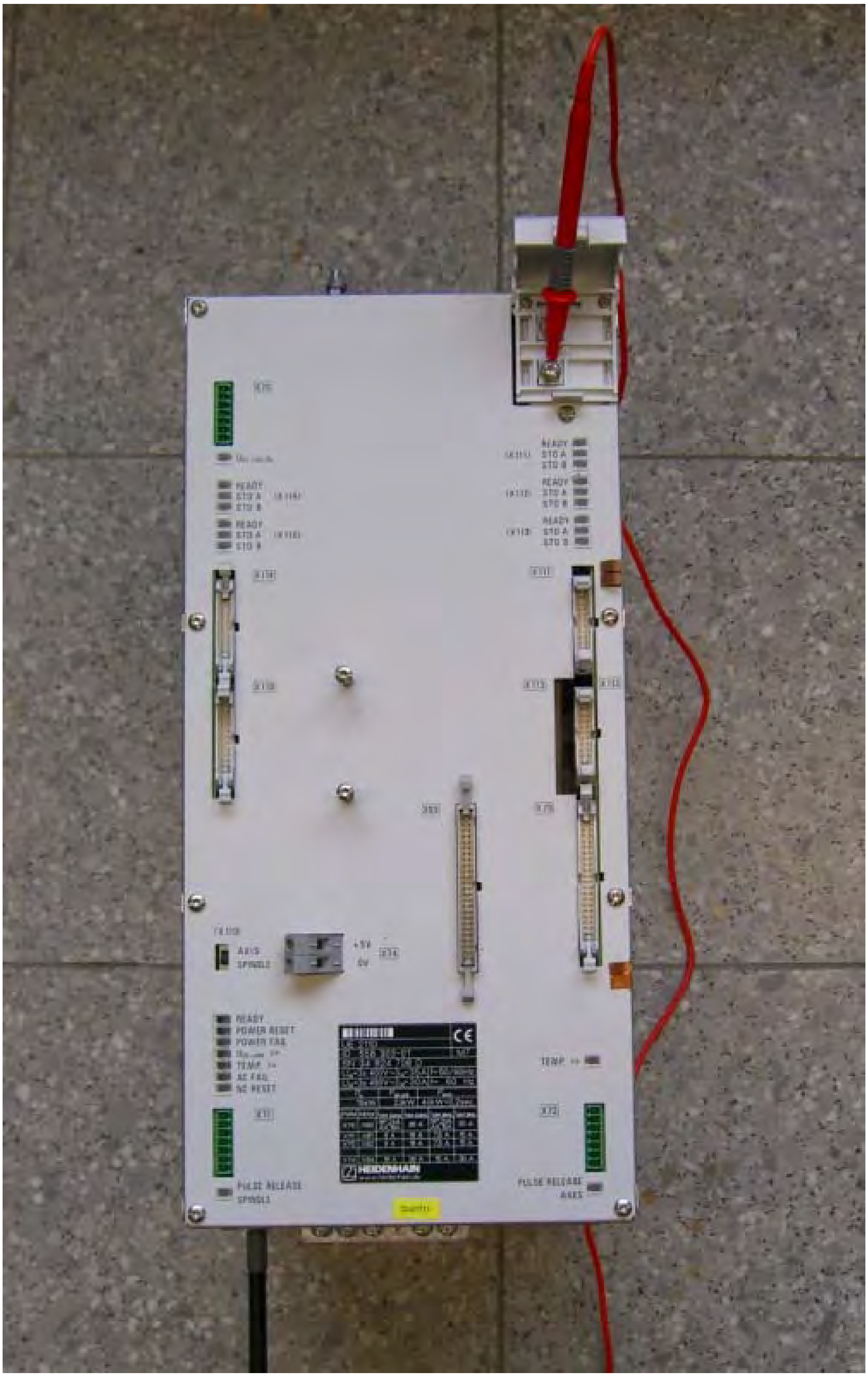
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

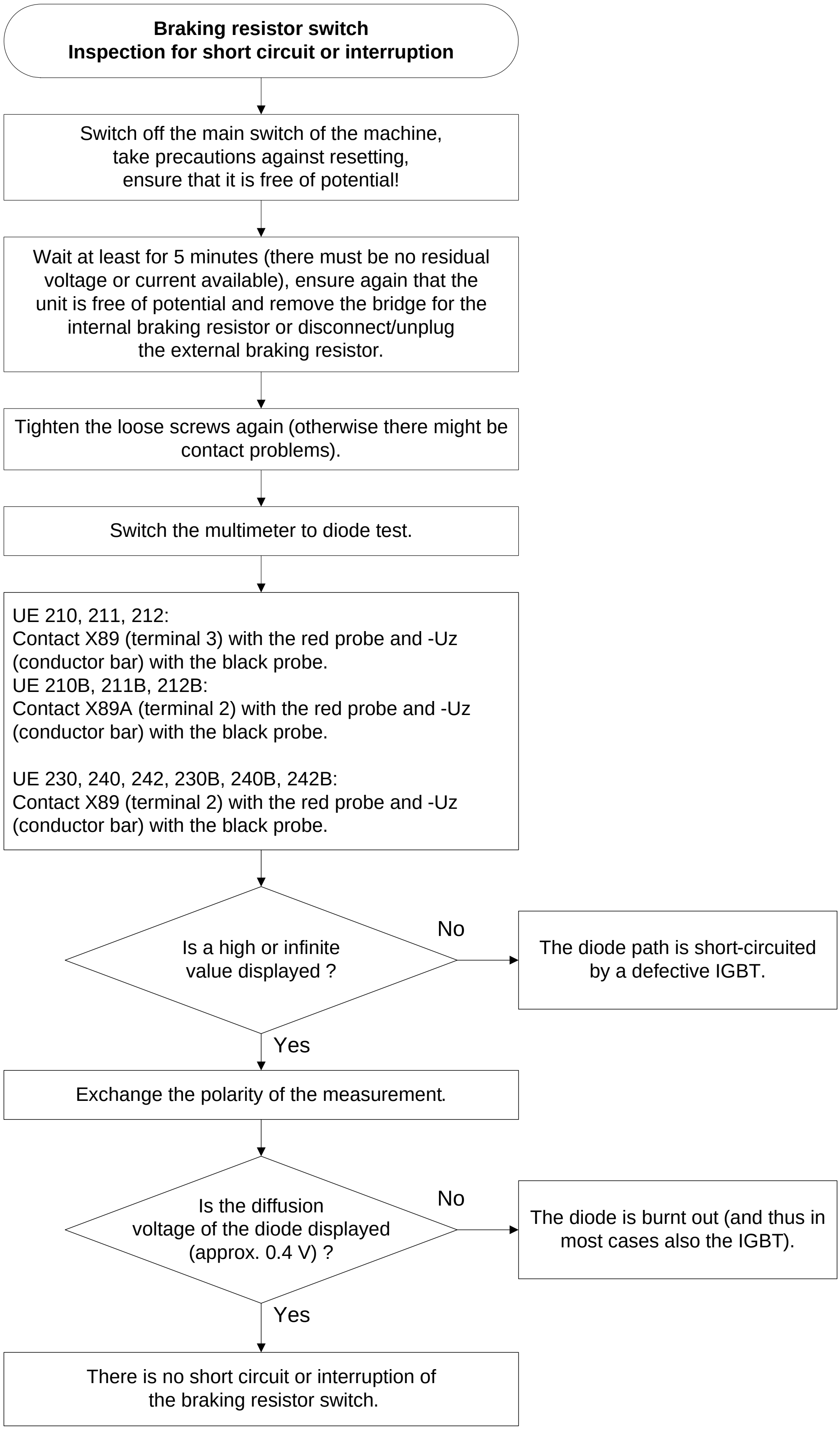
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Measuring of braking resistor switch



Flowchart:
Short circuit or interruption of the braking resistor switch



Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

7.7.6 Checking the LEDs

▶ Switch on the machine.

Following green LEDs on the compact inverter must be lit:

- **U DC LINK ON**
- **READY** (on UE 1xx, UE 2xxB)
- **READY UV** (on UR 2xx, UR 2xxD)

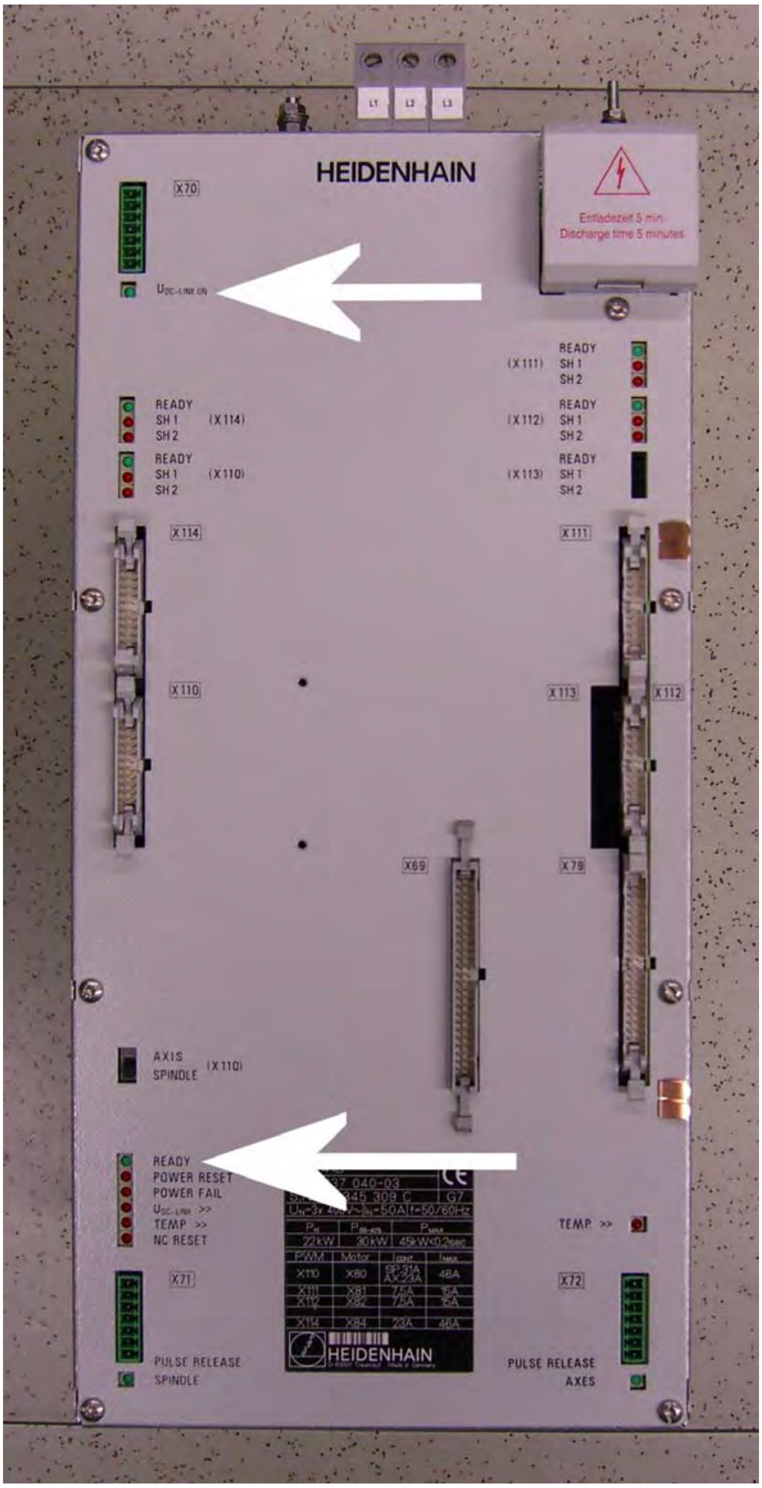


Photo: Green LEDs on the UE 241 B compact inverter

If the mentioned green LEDs are not lit:

▶ Check the voltages. See “Checking the voltages” on page 7 – 136.

▶ Move the respective axis or turn the spindle.

The green LED **READY** must be lit for the output stage concerned!

As long as the axis or the spindle are operating, the red LEDs **SH 1 / STO A** and **SH 2 / STO B** must not be lit!

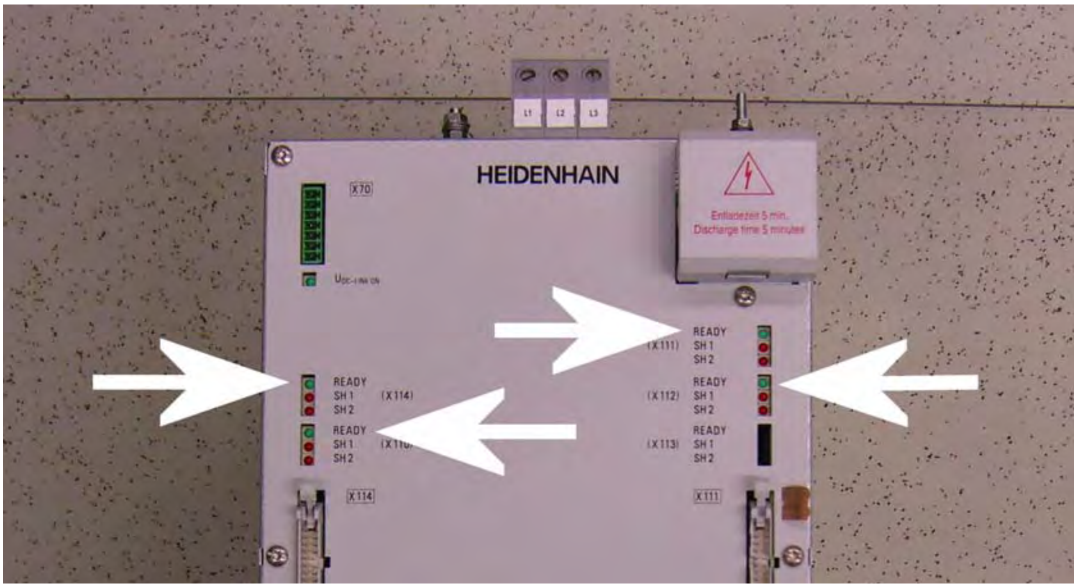


Photo: Green LEDs on the UE 241 B compact inverter

If the mentioned green LEDs are not lit:

▶ Check whether the green LED **SPINDLE** (X71) and the green LED **AXES** (X72) is lit.

> **Note**
>
> The enabling signals for the output stages are enabled by two safety relays inside the compact inverter.
>
> These safety relays are released externally on the connectors X71 and X72 on the compact inverter.
>
> If a 24 V power supply voltage is available, the green LEDs AXES and SPINDLE are lit.

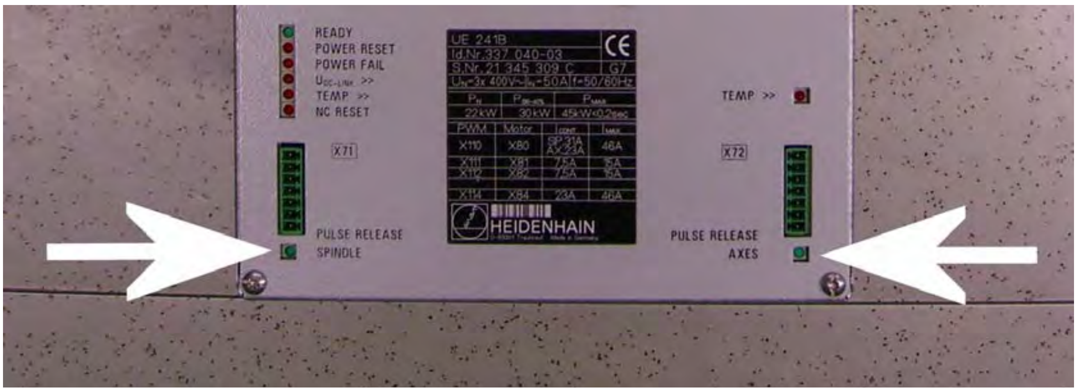


Photo: LEDs for axis and spindle release on the UE 241 B compact inverter

If the mentioned release LEDs are lit, but the green READY-LEDs at the output stages not:

- Check the respective PWM bus cable and connector. If necessary, try out another PWM bus cable.

Attention

PWM bus cables must only be connected to devices that are free of potential. Otherwise the inverters might be destroyed!

If the green LEDs SPINDLE and AXES are not lit:

- Check whether 24 V are available on pin 3 (refer to pin 2) on the respective enabling connector.

If 24 V are not available:

- Check whether the protective doors are closed, the permissive buttons are pressed, etc.
  Use the circuit diagram of the machine and try to find the interruption.

7.7.7 Checking the voltages

To ensure that the compact inverter can operate, it must be supplied with **400 Vac primary voltage** +/– **10 %** at 3 phases.

The charging contactor inside the compact inverter is triggered with **24 V direct current on pin 3 of connector X70**.

If available:
On the DC-link conductor bars under the cover plate **565 Vdc** are available (on non-regenerative devices, depending on the primary voltage) or **650 Vdc** on regenerative devices.

Primary voltage

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

Danger

Danger to life due to high voltages and currents!
Use a suitable voltage test unit for the following measurement.
See "Voltage tester" on page 14 – 412.
Proceed carefully and concentratedly!

- Press the EMERGENCY STOP button and switch on the main switch.

Note

When performing the following measurements on regenerative units the DC-link should not have been built up yet. Reason:
There are square-wave voltages on the primary phases of an active infeed/regenerative module which might have a negative effect on the measuring results.

- Measure the phases U-V, V-W, W-U (or L1-L2, L2-L3, L3-L1) on terminal X31.
  The voltage should be 400 Vac +/– 10 %.
- Measure U, V, W (or L1, L2, L3) to the ground.
  The voltage should be 230 Vac +/- 10 %.

Figure: Primary connection on the UE 241 B compact inverter

In the event of unbalances of > 10 % or if one or several phases are missing:

- Trace the phases to the main switch of the machine and to the fuses.

24 V-control voltage for the charging contactor

The DC-link voltage is built up via a charging contactor that is triggered on contactor X70 with 24 V direct current.

- Cancel the EMERGENCY STOP button and switch on the machine.

7-pin connector:

- Measure whether 24 V control voltage is available on contact 3 (refer to contact 2 or 0 V) of connector X70.

5-pin connector:

- Measure whether 24 V control voltage is available on contact 2 (refer to 0 V) of connector X70.

Figure: Connector X70 on the UE 241 B compact inverter

> **Note**
>
> On connectors with screw terminals, you can measure on the screw head but on connectors with spring terminals there are hardly any measuring possibilities. Measure at another location in the electrical cabinet (see circuit diagrams of the machine).

If 24 V are not available:

- Check whether all EMERGENCY STOP buttons are canceled.
- Check whether the machine has activated the hardware limit switches.
- Use the circuit diagram of the machine to trace the control voltage.

DC-link voltage

When the machine is switched on, the DC-link voltage must have built up!
Many compact inverters feature a DC-link connection to operate an additional UM via conductor bars.

▶ Always comply with the safety precautions!

Danger

Danger to life due to high voltages and currents!
Use a suitable voltage test unit for the following measurement.
See “Voltage tester” on page 14 – 412.
Proceed carefully and concentratedly!

▶ Measure carefully on the conductor bars whether **approx. 565 Vdc** (on non-regenerative inverter systems, depending on the primary voltage) or **650 Vdc** (on regenerative inverter systems) are available.

Note

If the needle tip probes are thin and long, you do not have to open the protective covers over the conductor bars for measuring. You can contact the conductor bars between the gaps of the cover caps!

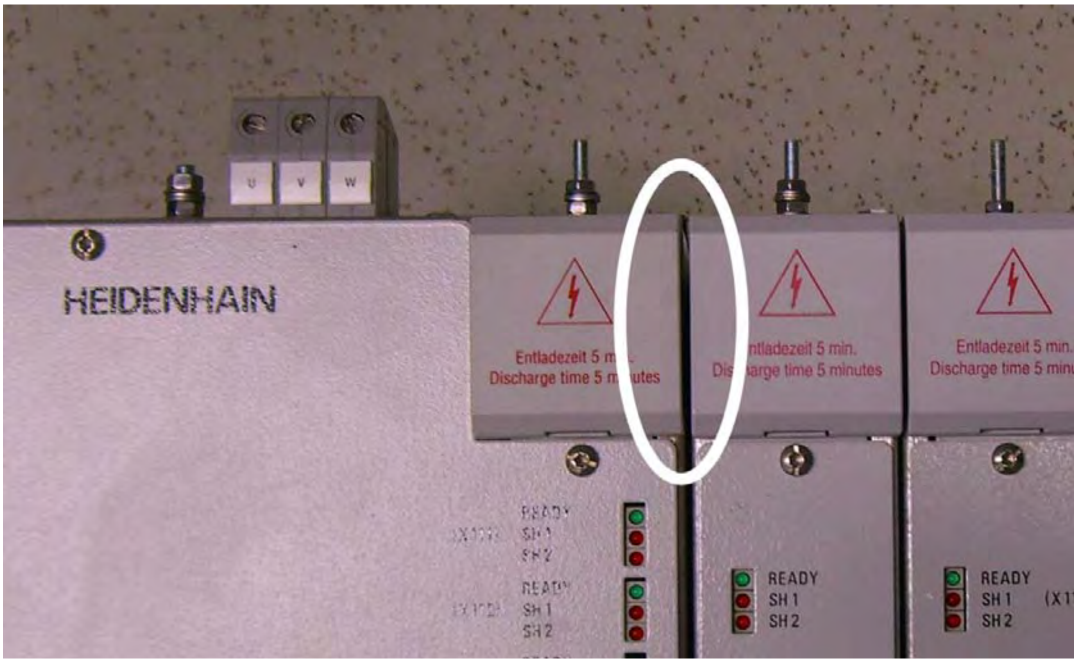


Photo: Protective covers over the conductor bars

If the DC-link voltage is not available:

▶ Disconnect the inverter from the other units and check the functions. See “Testing the UE, UR without connected units” on page 7 – 139.

Testing the UE, UR without connected units

An exact statement about the functions of the compact inverter can be made if the UE/UR is operated without connected devices (UM, UP, CC, PW, etc.):

- Switch off main switch of the machine and take precautions against resetting.
- Ensure that X31 (primary voltage 400 Vac) and the DC-link are free of potential.
- Wait at least for 5 minutes (there must be no residual voltage or current available), ensure again that the unit is free of potential and remove the conductor bars.
- Tighten the screws for the DC-link (otherweise there might be contact problems in the event of subsequent measurements).
- Disconnect the following connectors (if available) from the UE/UR:

  X70, X71, X72 (enabling connector),
  X69 (supply bus),
  X79 (unit bus),
  X89 (braking resistor),
  X90 (24V supply for fan in braking resistor),
  X111-114 (PWM connectors)

- Disconnect and insulate the following wires:

  X74 (5 V power supply),
  X80-84 (motor connections)

Note

If ground fault and short circuit examinations have been made before, the compact inverter is already disconnected from the periphery.

- Insert the connector with bridge in X70 (see enabling connector).
- For safety reasons, close the door of the electrical cabinet.
- Switch on the machine and wait a few seconds.
- Open the door of the electrical cabinet again.
- Observe the LEDs on the compact inverter:
  The green LEDs **U DC-LINK ON**, **READY** or **READY UV** (if available) should be lit.
  The red LED **POWER FAIL** should not be lit!
- Measure the DC-link voltage carefully.

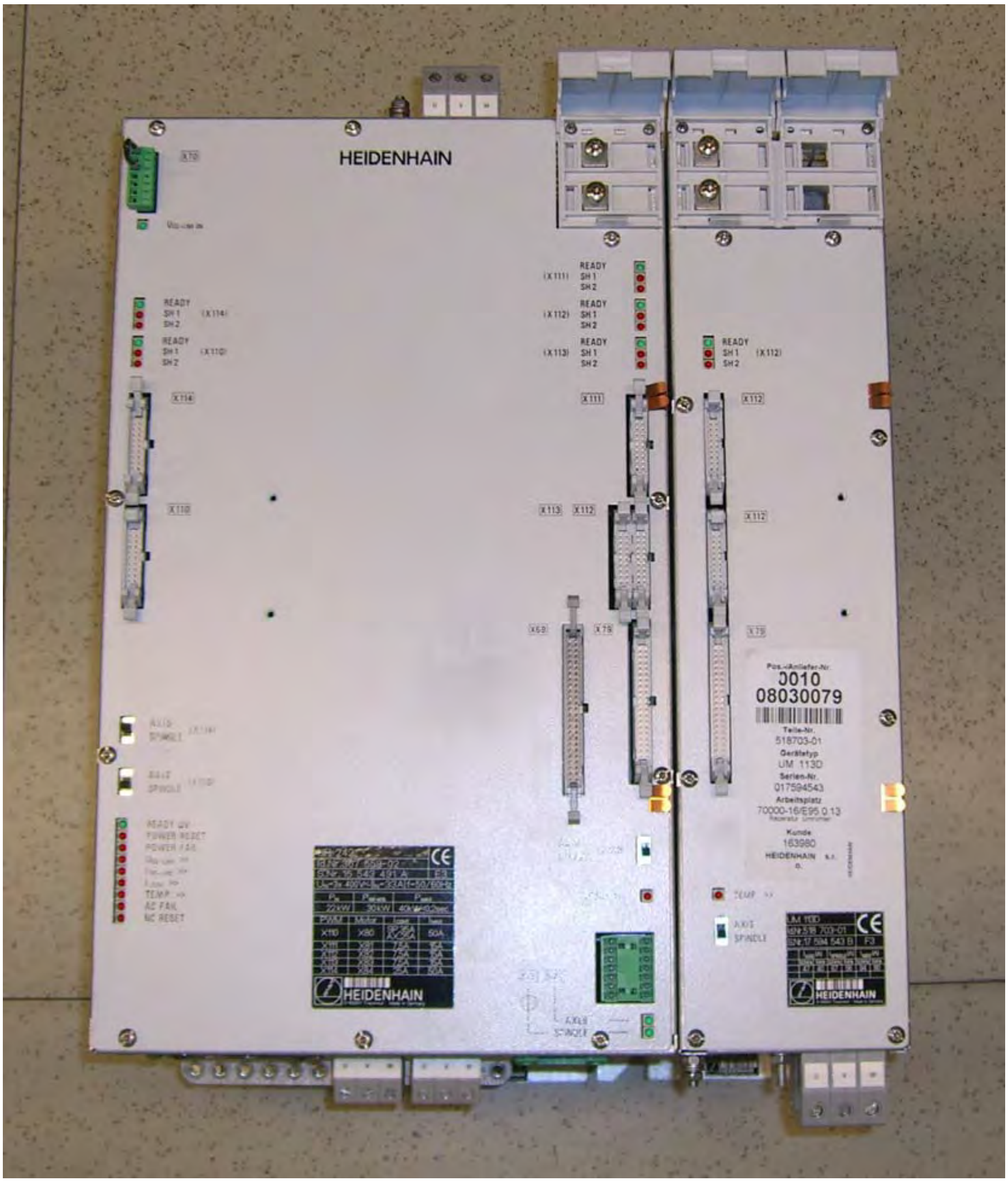
If Uz is present, the UE/UR is obviously in order. Test the function during operation.

If Uz is not present, the compact inverter is defective.

Enabling connector

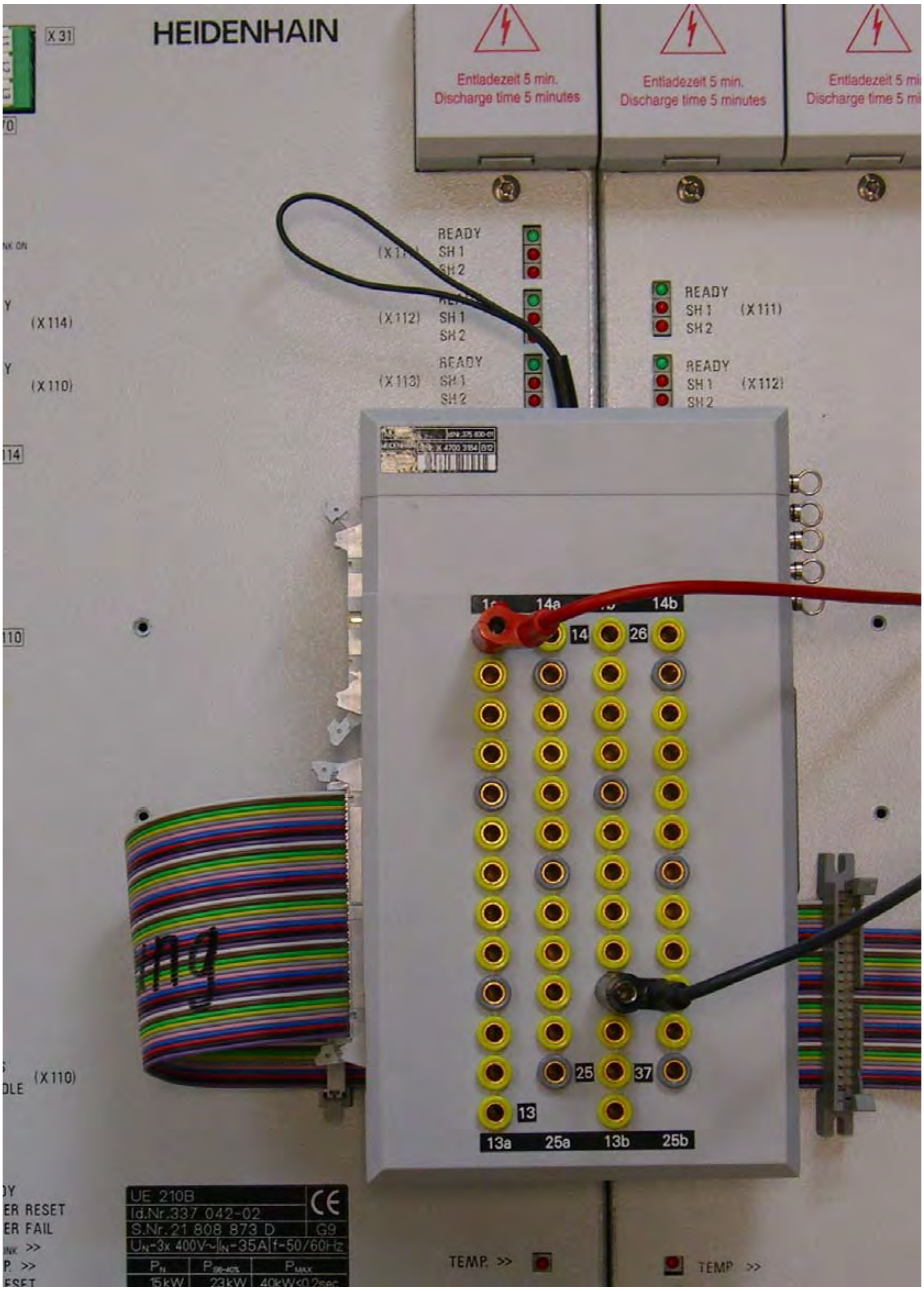
For the 7-pin socket the shown connector with a bridge from contact 1 to 3 is required. The bridge on the 5-pin connector connects contact 1 and 2.
You can use the original connector if you have marked, unclamped and secured the wires before.
You may also order the 7-pin connector ID 282143-02 from HEIDENHAIN and insert a bridge.
The 5-pin connector has the ID 266364-07.

Figure:
UR without connected units



Setup with test adapter

If you have a test adapter (See "Test adapter" on page 14 – 414) you can observe the **low voltages and signal conditions during operation** on the unit bus X69, the unit bus X79 and the PWM ribbon cable X111 - X114.



Danger

Only **one** interface may be connected to the test adapter!

7.7.8 Interchanging output stages of the same type

Use this error detection routine to find out **(without changing machine parameters)** whether a faulty axis can be traversed with an output stage with equal power:

> **Danger**
>
> If you want to use **output stages with different power**, we strongly recommend contacting your machine manufacturer or HEIDENHAIN. Otherwise you could cause damage or injury to machine or persons!

Use one of the following:

- The output stage of a functioning axis
- A free output stage with equal power
- A connected UM with equal power

> **Attention**
>
> If you strongly suspect that the motor of the axis to be examined causes a ground fault or a short circuit (penetration of humidity, etc.), you must not connect it to another output stage as it could be destroyed!
> First check the motor for ground faults and short circuits. See “Inspection for ground fault” on page 6 – 49, See “Inspection for winding short circuit or interruption” on page 6 – 53.

> **Danger**
>
> Always secure vertical axes from falling down before you perform this test!

> **Danger**
>
> Danger of electrical shock!
> Make sure that the main switch of the machine is switched off and that all connectors and terminals are free of potential before you engage or disengage them.

Assumed configuration

UE 242 B: **X110** (PWM connection) connected with **X56** (iTNC, spindle)

X111 (PWM connection of channel 1) connected with **X51** (iTNC, X axis)

X112 (PWM connection of channel 2) connected with **X52** (iTNC, Y axis)

X113 (PWM connection of channel 3) connected with **X53** (iTNC, Z axis)

X114 (PWM connection of channel 4) connected with **X54** (iTNC, C axis)

X80 (motor connection) connected with motor **spindle**

X81 (motor connection of channel 1) connected with motor **X axis**

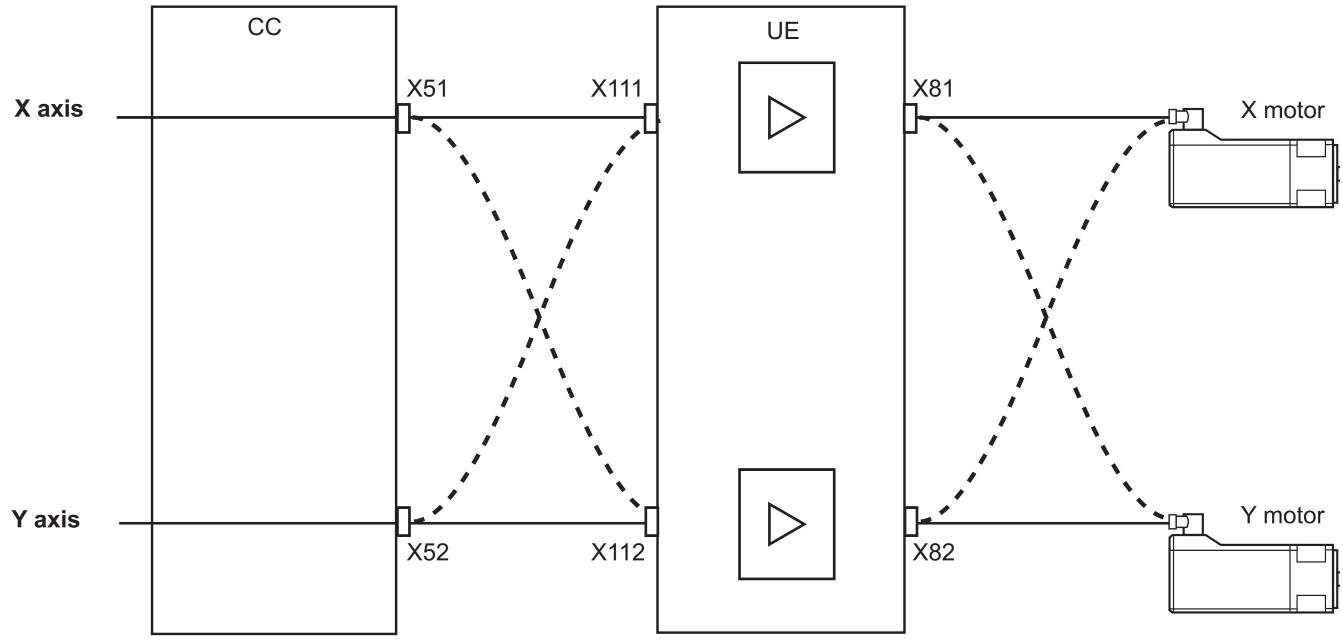
X82 (motor connection of channel 2) connected with motor **Y axis**

X83 (motor connection of channel 3) connected with motor **Z axis**

X84 (motor connection of channel 4) connected with motor **C axis**

In this example there is an error in the X axis:

Block diagram



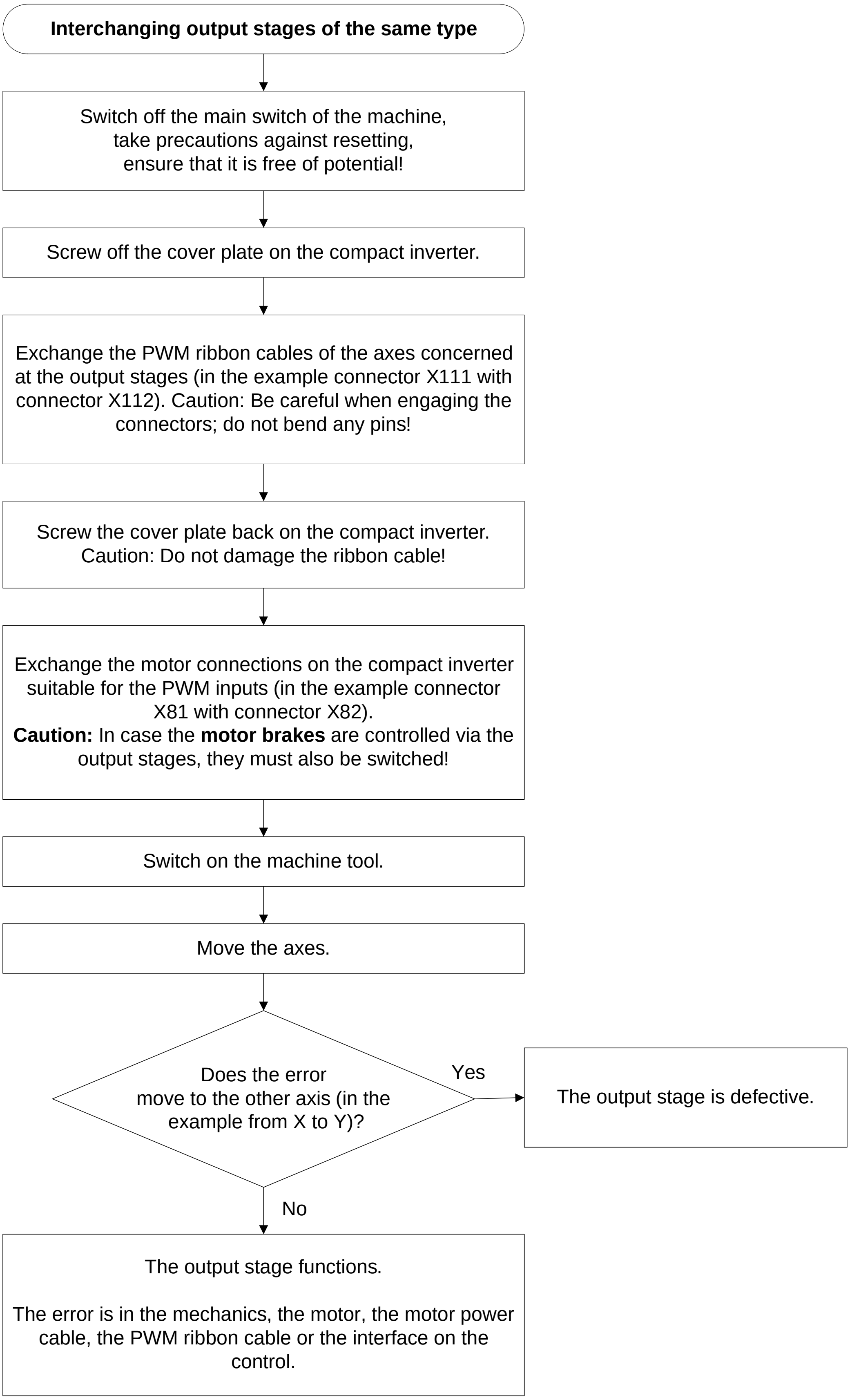
Attention

If motor brakes are connected to the power modules, they must also be interchanged (X392, X393, X394, depending on the model. --> See "Connector designations and pin layouts" on page 12 – 301)!
Motor brakes can be connected to current HEIDENHAIN inverter modules and compact inverters. The motor brake is also powered with 24 V via connector X344 on the inverter. The trigger signals for the motor brakes are transmitted via the PWM bus.

Note

With UE 2xx (with internal ribbon cable) in combination with a control LE 41x M (with internal ribbon cable connectors) it is not possible to change connection of PWM interfaces.
With UE 2xx (with internal ribbon cable) in combination with a UV 102 and a control with external PWM interfaces, it is only conditionally possible to change connection of PWM interfaces.
The PWM ribbon cables to be exchanged must be long enough.

Flowchart

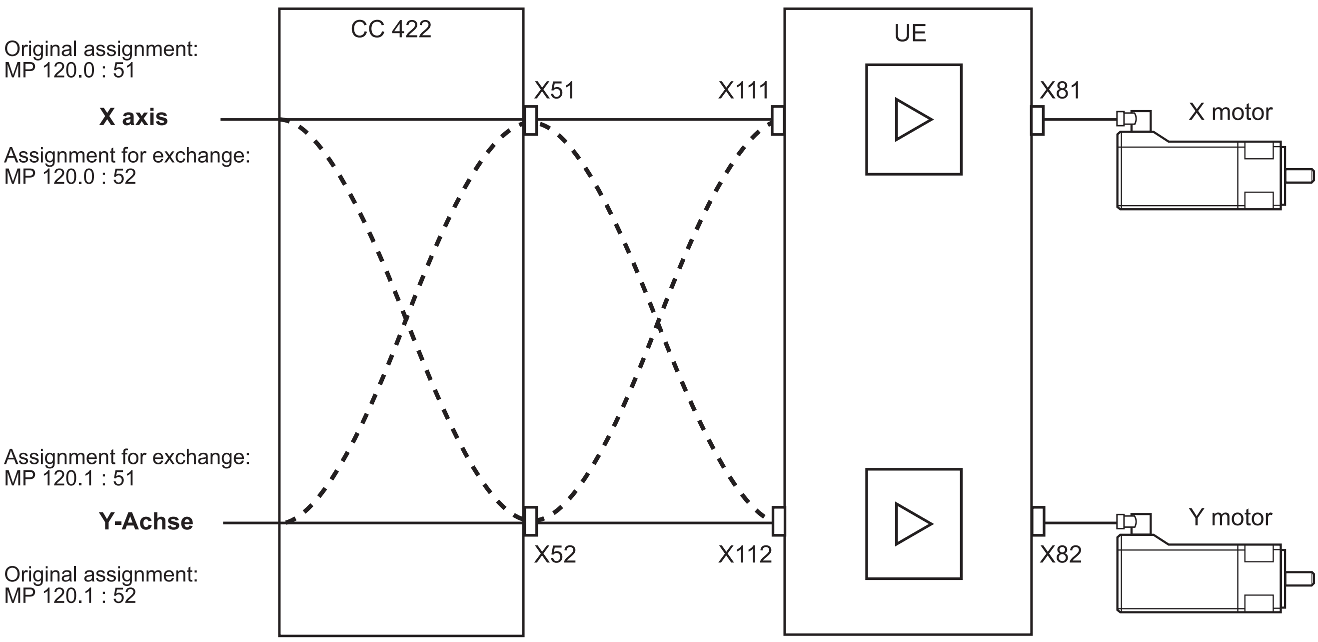

Interchanging output stages of the same type
Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential!
Screw off the cover plate on the compact inverter.
Exchange the PWM ribbon cables of the axes concerned at the output stages (in the example connector X111 with connector X112). Caution: Be careful when engaging the connectors; do not bend any pins!
Screw the cover plate back on the compact inverter. Caution: Do not damage the ribbon cable!
Exchange the motor connections on the compact inverter suitable for the PWM inputs (in the example connector X81 with connector X82).
Caution: In case the motor brakes are controlled via the output stages, they must also be switched!
Switch on the machine tool.
Move the axes.
Does the error move to the other axis (in the example from X to Y)?
Yes
The output stage is defective.
No
The output stage functions.
The error is in the mechanics, the motor, the motor power cable, the PWM ribbon cable or the interface on the control.

7.7.9 Interchanging the PWM outputs

Use this error detection routine to find out whether the PWM output of the control is defective or the connected output stage in the compact inverter.

The procedure depends on the control type. The machine parameters must be changed.
Use the respective **Service Manual for the HEIDENHAIN control** (e.g., SHB iTNC 530).

Block diagram from the Service Manual iTNC 530:



Note

With UE 2xx (with internal ribbon cable) in combination with a control LE 41x M (with internal ribbon cable connectors) it is not possible to change connection of PWM interfaces.
With UE 2xx (with internal ribbon cable) in combination with a UV 102 and a control with external PWM interfaces, it is only conditionally possible to change connection of PWM interfaces.
The PWM ribbon cables to be exchanged must be long enough.

7.8 Error diagnosis on the UEC controller unit with integrated inverter

7.8.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff` or similar error messages on the control.
- Humidity in the inverters and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

Note

Before inspecting the inverter system for ground faults, ensure that there are no ground faults on the motors. See "Inspection for ground fault" on page 6 – 49.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault to protect the following equipment.

Potential dividers

Potential dividers for the DC-link voltage measurement are integrated in UECs.
These potential dividers are included when the insulation resistance is measured to ground.
This may lead to measuring results in the kohm range!
The measured resistance, however, should not fall below 100 kohm!

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement -- >See "Insulation tester" on page 14 – 412.

Attention

The **insulation tester** used for measuring ground faults on the UEC must not work with line power supply.
It must be operated with batteries or accumulators and have an insulated housing.
The insulation measurements described can thus be performed in two directions.
When measuring in one direction, the plus pole is located on the respective contact; when measuring in the opposite direction, on the grounding screw.

Danger

The insulation tester operates at high voltages!
Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN inverters may be measured in the field with a maximum isolation voltage of **500 V**!

Attention

A higher test voltage could damage the inverter!

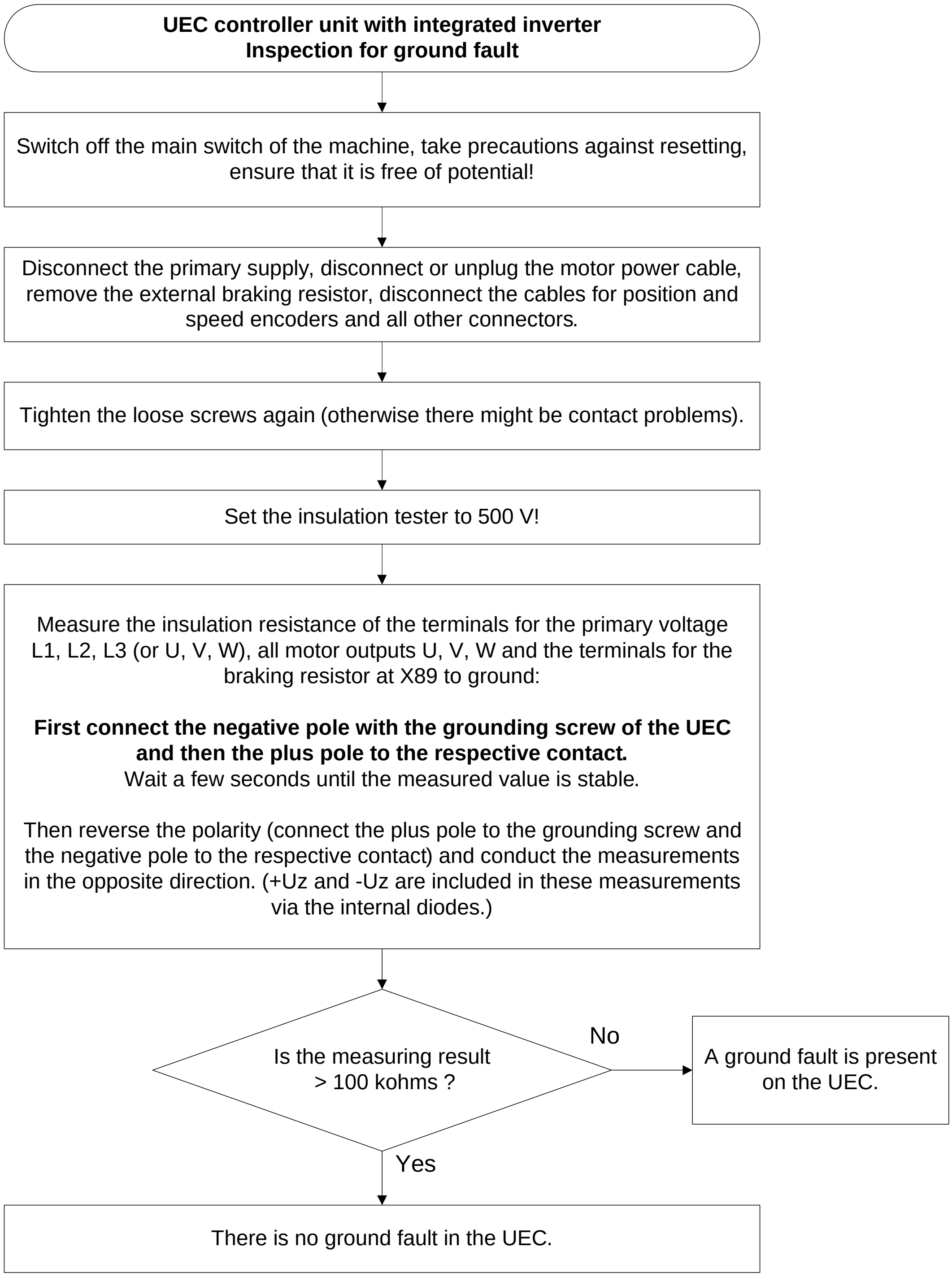
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

> Danger
>
> **Danger of electrical shock!**
> The units must be free of potential for the following measurements.
> Ensure that the machine is switched off and is not under voltage!

Figure: Ground fault measuring

Flowchart



Note

Defined resistance values cannot be specified here as they depend on the following factors or others:

- Temperature of the tested inverter (standard temperature for the insulation measurement: 20 °C)
- Duration of the measurement (reduction of capacitive current and dielectric absorption current)
- Technical data of the insulation measuring unit

If required, you can compare the measured resistance values with the values of a dimensionally identical inverter.

Note

If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
But keep in mind that you are measuring at low voltage so that flashovers in the inverter can hardly be detected!

Corrective action

Inverters with ground faults must be replaced!
See “Exchanging the complete inverter” on page 10 – 221.

Heavily contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on heavily contaminated inverters (the contamination can be seen best in the area of the fan).

Note

With rising air humidity, the probability of unwanted leakage currents increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.8.2 Inspection for short circuit or interruption

The controller unit with integrated UEC 11x inverter cannot be inspected for short circuit or interruption in the field!
The required access to the +Uz and -Uz poles is not available.

7.8.3 Checking the internal braking resistor

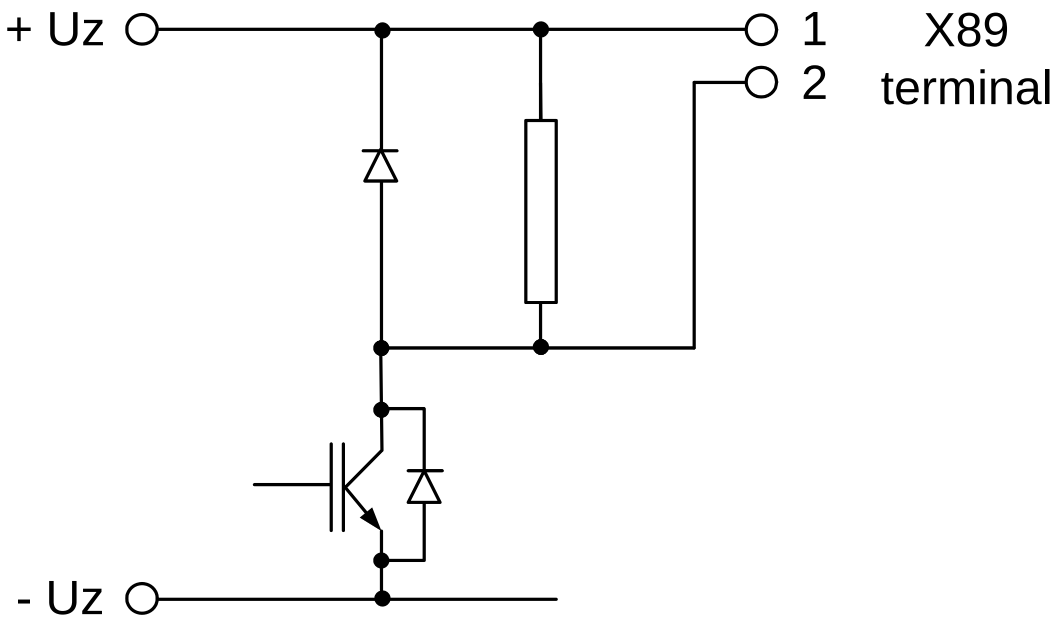
UECs are equipped with integrated braking resistors.

The resistance value is **18 ohm ± 10 %** and can be measured from outside.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- Standard commercial multimeter

Block diagram



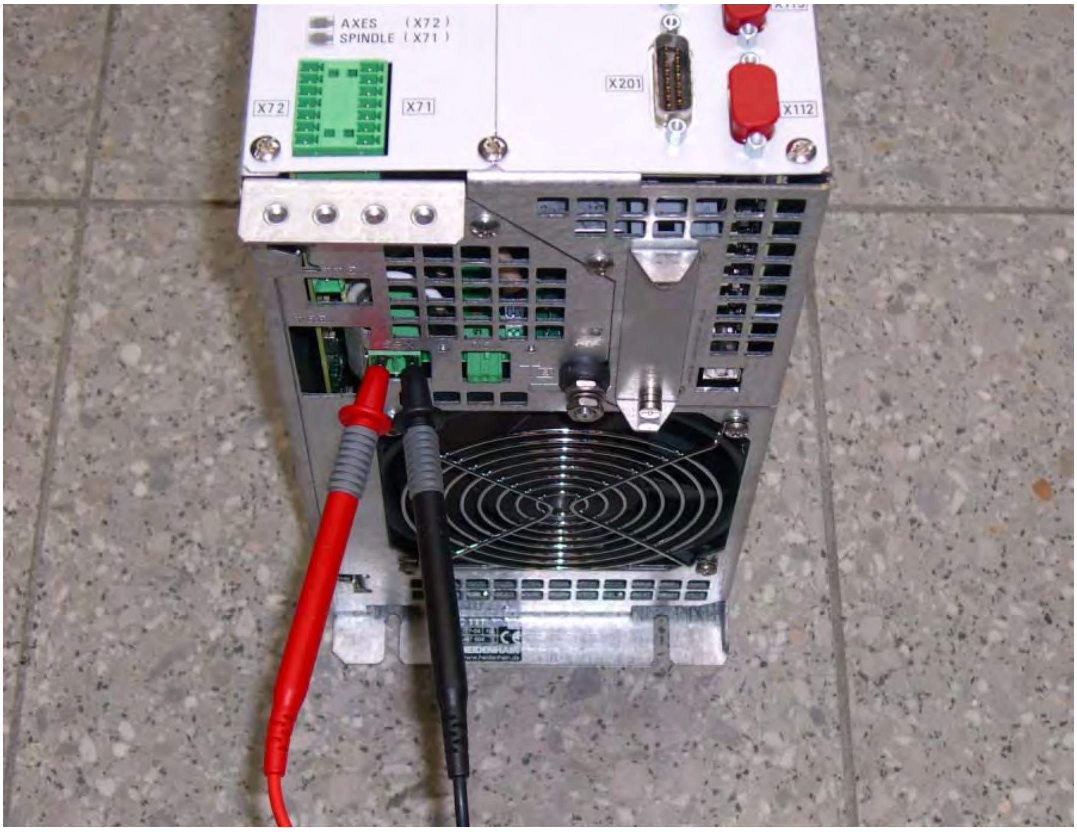
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

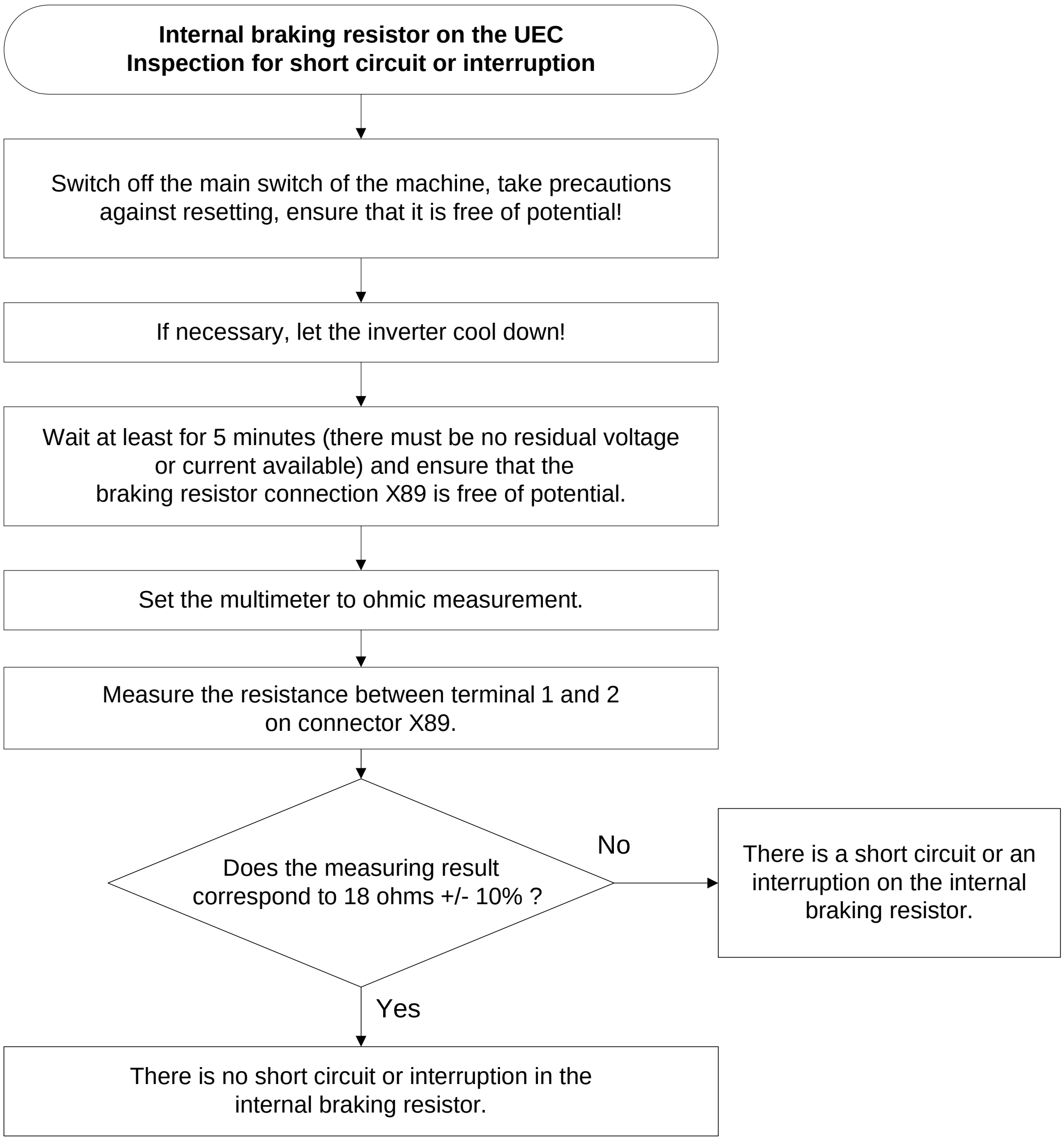
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Measurement of internal braking resistor



Flowchart
Resistance value



7.8.4 Checking the braking resistor switch

The braking-resistor switch (IGBT with antiparallel diode) of the UEC 11x cannot be inspected in the field! The required access to the -Uz pole is not available.

7.8.5 Checking the LEDs

▶ Switch on the machine.

The green LED **READY** (on the lower LED row) must be lit.

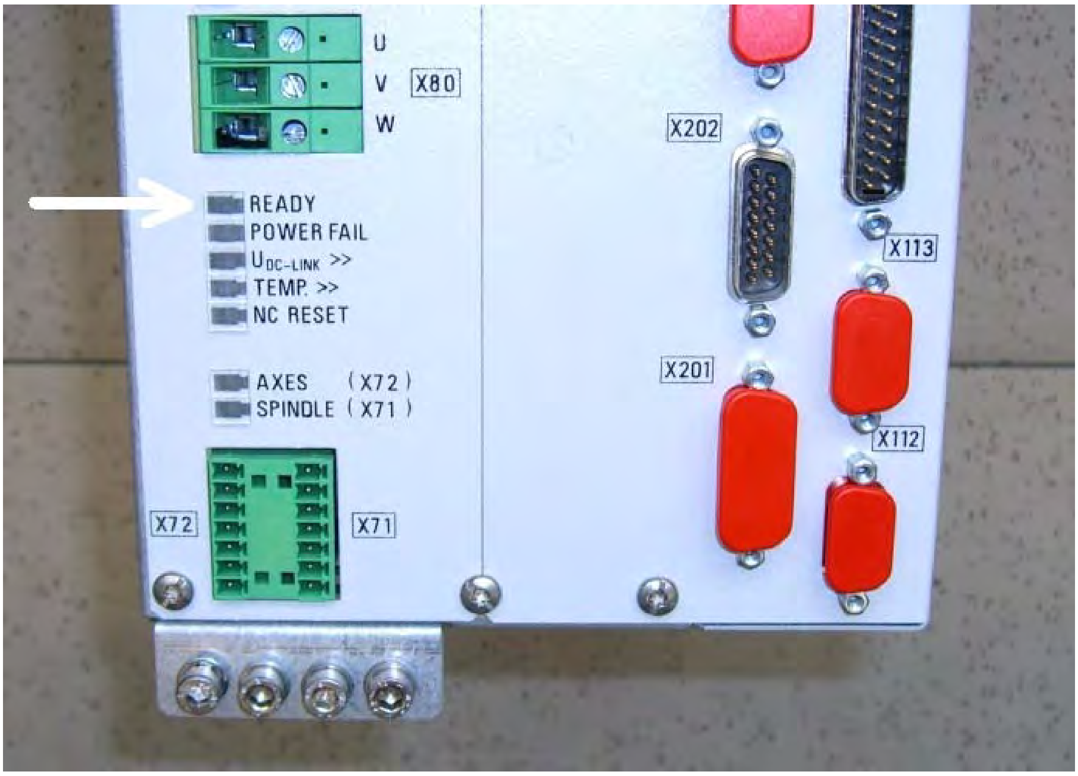


Figure: Green READY LED on the UEC

If the green LED READY is not lit:

▶ Check the voltages. See "Checking the voltages" on page 7 – 136.

▶ Move the respective axis or turn the spindle.

The green LED **READY** must be lit for the output stage concerned!

As long as the axis or the spindle are operating, the red LEDs **STO A** and **STO B** must not be lit!

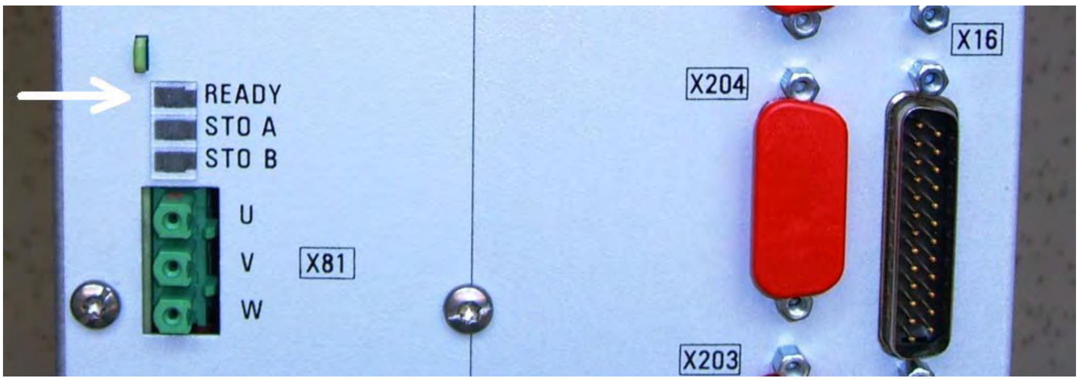


Figure: Green LEDs on the UEC

If the mentioned green LEDs are not lit:

▶ Check whether the green LED **SPINDLE** (X71) and the green LED **AXES** (X72) is lit.

Note

The enabling signals for the output stages are enabled by two safety relays inside the UEC.

These safety relays are released externally on the connectors X71 and X72 on the UEC.

If a 24 V power supply voltage is available, the green LEDs AXES and SPINDLE are lit.

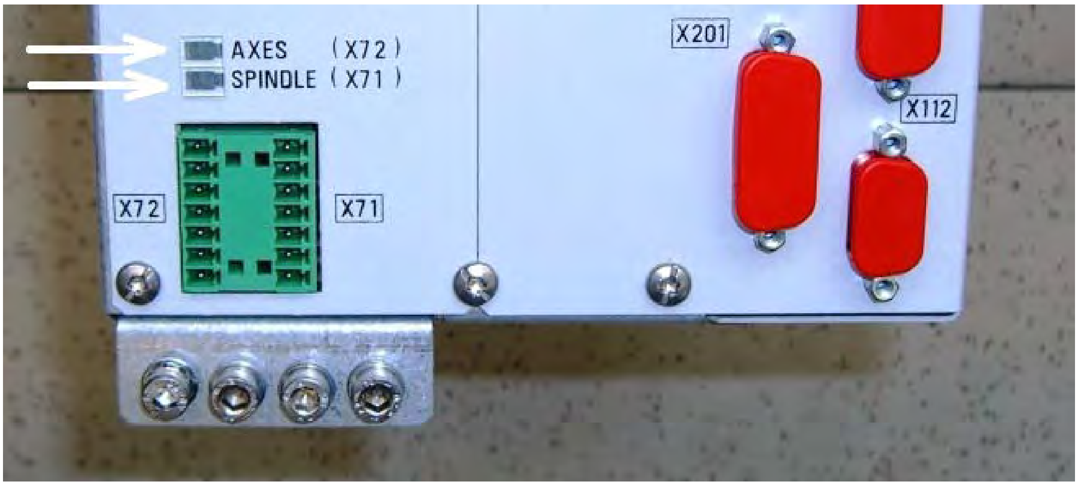


Photo: LEDs for axis and spindle release on the UEC

If the green LEDs SPINDLE and AXES are not lit:

▶ Check whether 24 V are available on pin 3 (refer to pin 2) on the respective enabling connector.

If 24 V are not available:

▶ Check whether the protective doors are closed, the permissive buttons are pressed, etc. Use the circuit diagram of the machine and try to find the interruption.

7.8.6 Checking the primary voltage

To ensure that the UEC can operate, it must be supplied with **primary voltage 400 Vac ± 10%** (or 480 V~ ± 10%) at 3 phases.

Note

On the DC-link in the UEC housing, **565 Vdc** (depending on the primary voltage) are then available.

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

Danger

Danger to life due to high voltages and currents!
Use a suitable voltage test unit for the following measurement.
See "Voltage tester" on page 14 – 412.
Proceed carefully and concentratedly!

- Press the EMERGENCY STOP button and switch on the main switch.
- Measure the phases U-V, V-W, W-U (or L1-L2, L2-L3, L3-L1) on terminal X31.
  The voltage should be 400 Vac +/– 10 % (or 480 V~ ± 10%).
- Measure U, V, W (or L1, L2, L3) to the ground.
  The voltage should be 230 V~ ± 10% (or 277 V~ ± 10%).

Figure: Primary voltage connection on UEC

In the event of unbalances of > 10 % or if one or several phases are missing:

- Trace the phases to the main switch of the machine and to the fuses.

7.8.7 Interchanging output stages of the same type

The drive-control board and the output stages are integrated in the housing of the UEC.
If motor outputs are to be interchanged for error diagnosis, complete axes must be interchanged on the UEC.
This is possible with axes using output stages of the same type, as well as for axes of different end stages, and axes and spindles on different end stages. See Service Manual iTNC 530 HSCI.

7.9 Error diagnosis on the UMC controller unit with integrated inverter

7.9.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff` or similar error messages on the control.
- Humidity in the inverters and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

> Note
>
> Before inspecting the inverter system for ground faults, ensure that there are no ground faults on the motors. See "Inspection for ground fault" on page 6 – 49.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault to protect the following equipment.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement -- >See "Insulation tester" on page 14 – 412.

> Danger
>
> The insulation tester operates at high voltages!
> Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN inverters may be measured in the field with a maximum isolation voltage of **500 V**!

> Attention
>
> A higher test voltage could damage the inverter!

Procedure

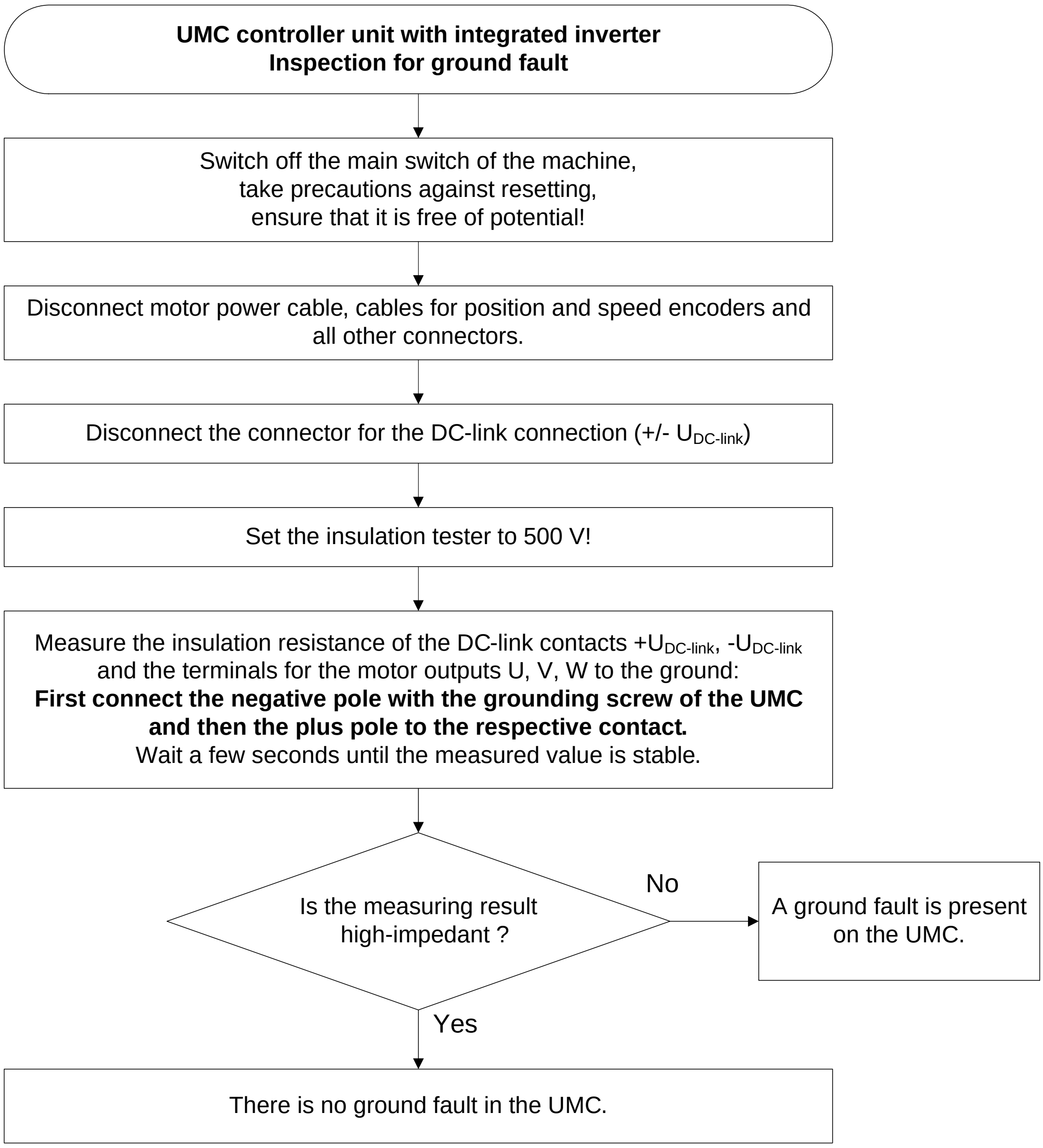
Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Ground fault measuring

Flowchart



Note

"Crosscheck":
If your insulation tester operates without power supply (i.e., is operated with accumulators) and has an insulated housing, you can perform the insulation measurement also in reverse direction as a "crosscheck". The negative pole is then connected to the respective contact, the plus pole to the grounding screw.

Note

Defined resistance values cannot be specified here as they depend on the following factors or others:

- Temperature of the tested inverter (standard temperature for the insulation measurement: 20 °C)
- Duration of the measurement (reduction of capacitive current and dielectric absorption current)
- Technical data of the insulation measuring unit

If required, you can compare the measured resistance values with the values of a dimensionally identical inverter.

Note

If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
But keep in mind that you are measuring at low voltage so that flashovers in the inverter can hardly be detected!

Corrective action

Inverters with ground faults must be replaced!
See “Exchanging the complete inverter” on page 10 – 221.

Heavily contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on heavily contaminated inverters (the contamination can be seen best in the area of the fan).

Note

With rising air humidity, the probability of unwanted leakage currents increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.9.2 Inspection for short circuit or interruption

A short circuit is a severe electrical error and must be excluded from further inspections.

A **short circuit** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff` or similar error messages on the control.
- Humidity in the inverters and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

> Note
>
> Before inspecting the inverter system for short circuits, ensure that there are no ground faults. See "Inspection for ground fault" on page 7 – 95

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault or short circuit to protect the following equipment.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- Standard commercial **multimeter** that can be set to **"diode test"**.

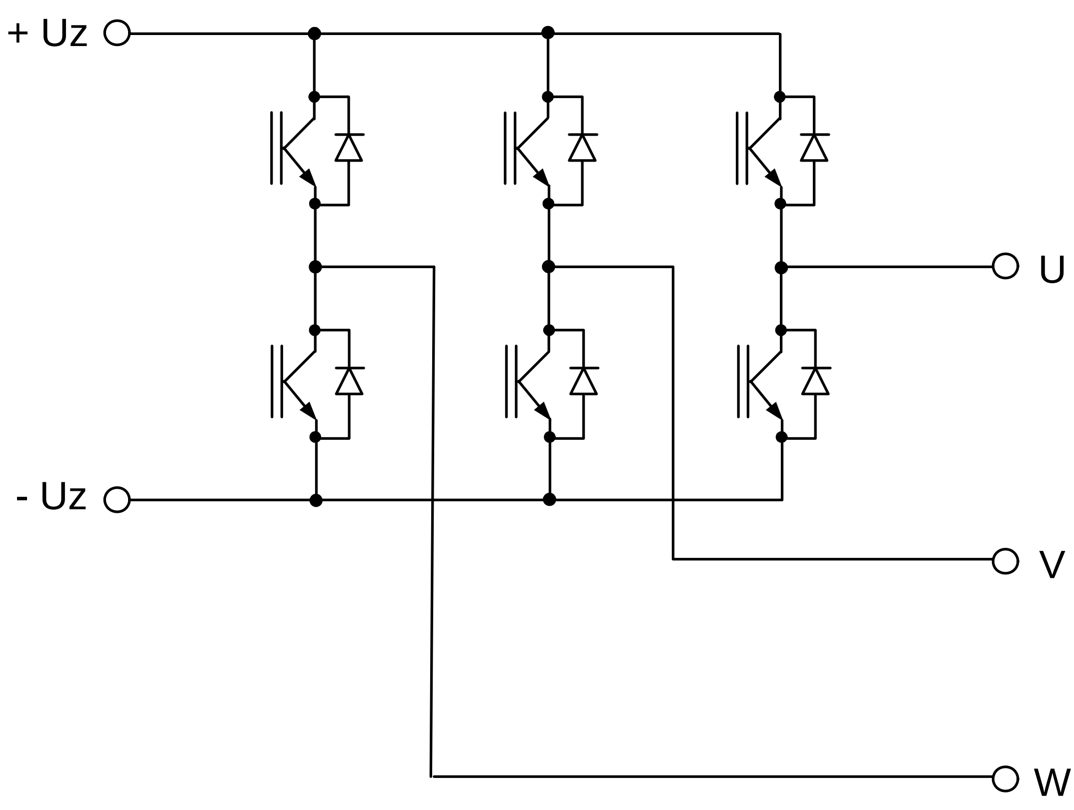
Diode measurement

The diodes in the output stages that are connected antiparallel to each IGBT (Isolated Gate Bipolar Transistor) play an important role for the following measurements.

When measuring the diodes, the diffusion voltage (forward voltage) of these diodes is measured.

If a diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the IGBT also functions!

Block diagram: IGBT end stage



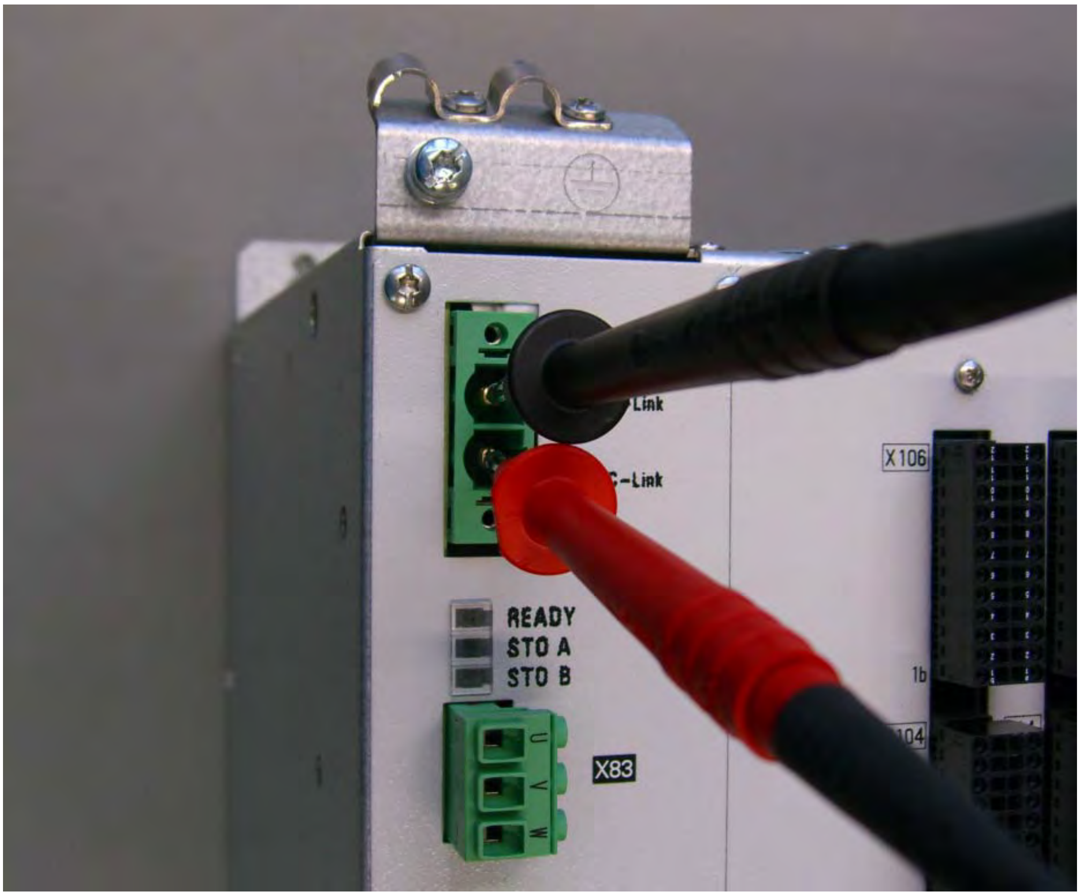
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

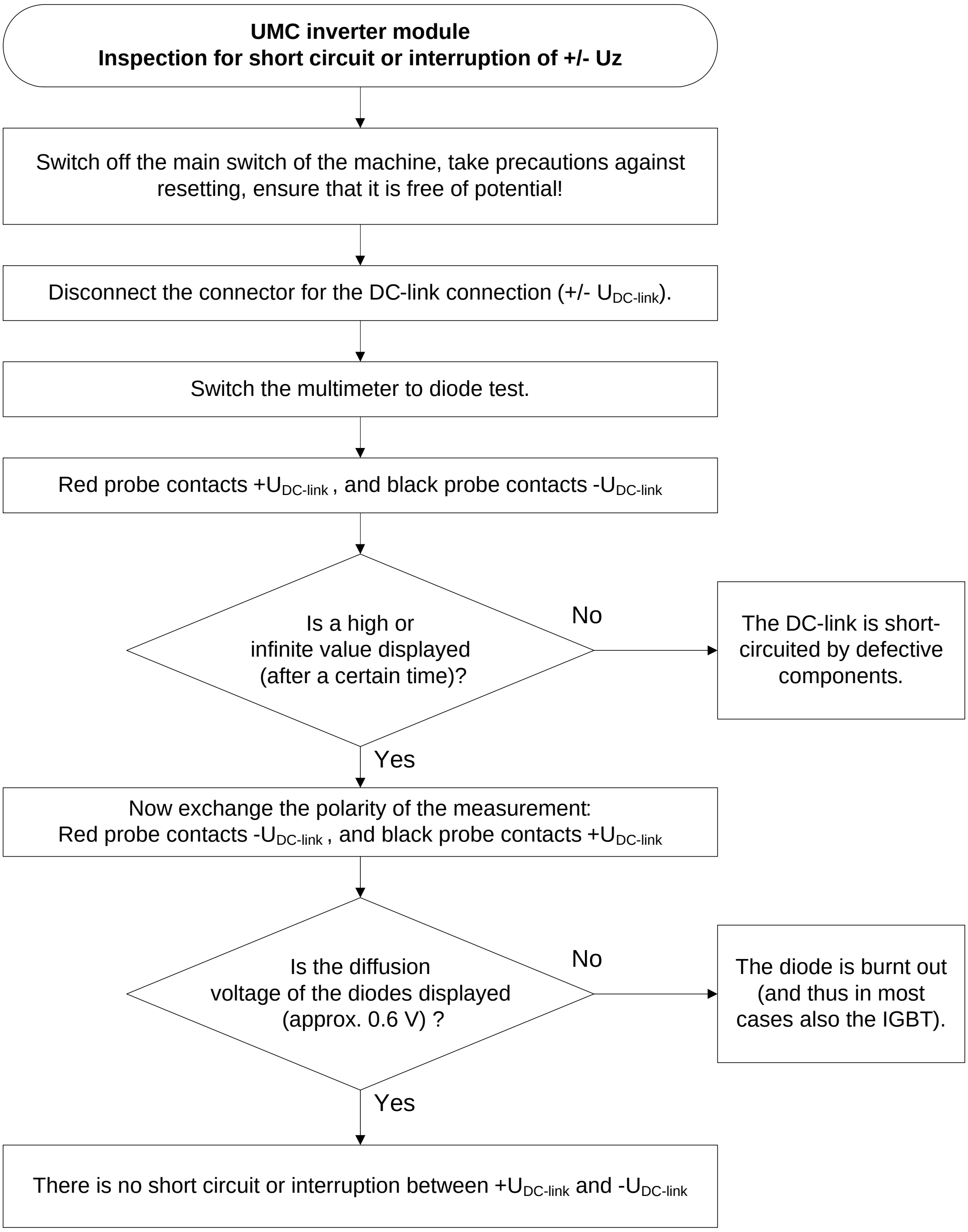
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Figure: Diode measurement ± Uz



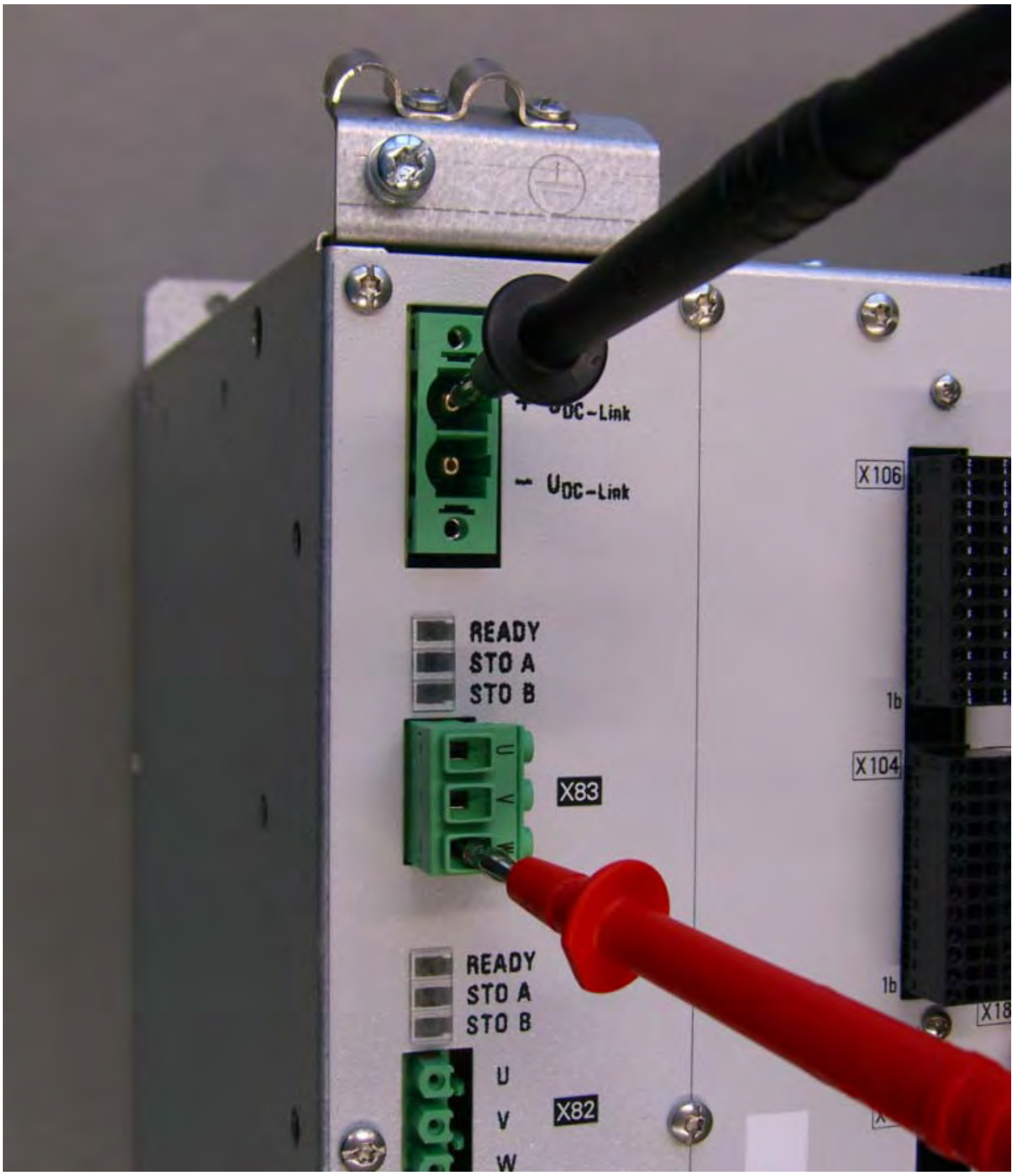
Flowchart: Short circuit or interruption between +Uz and -Uz



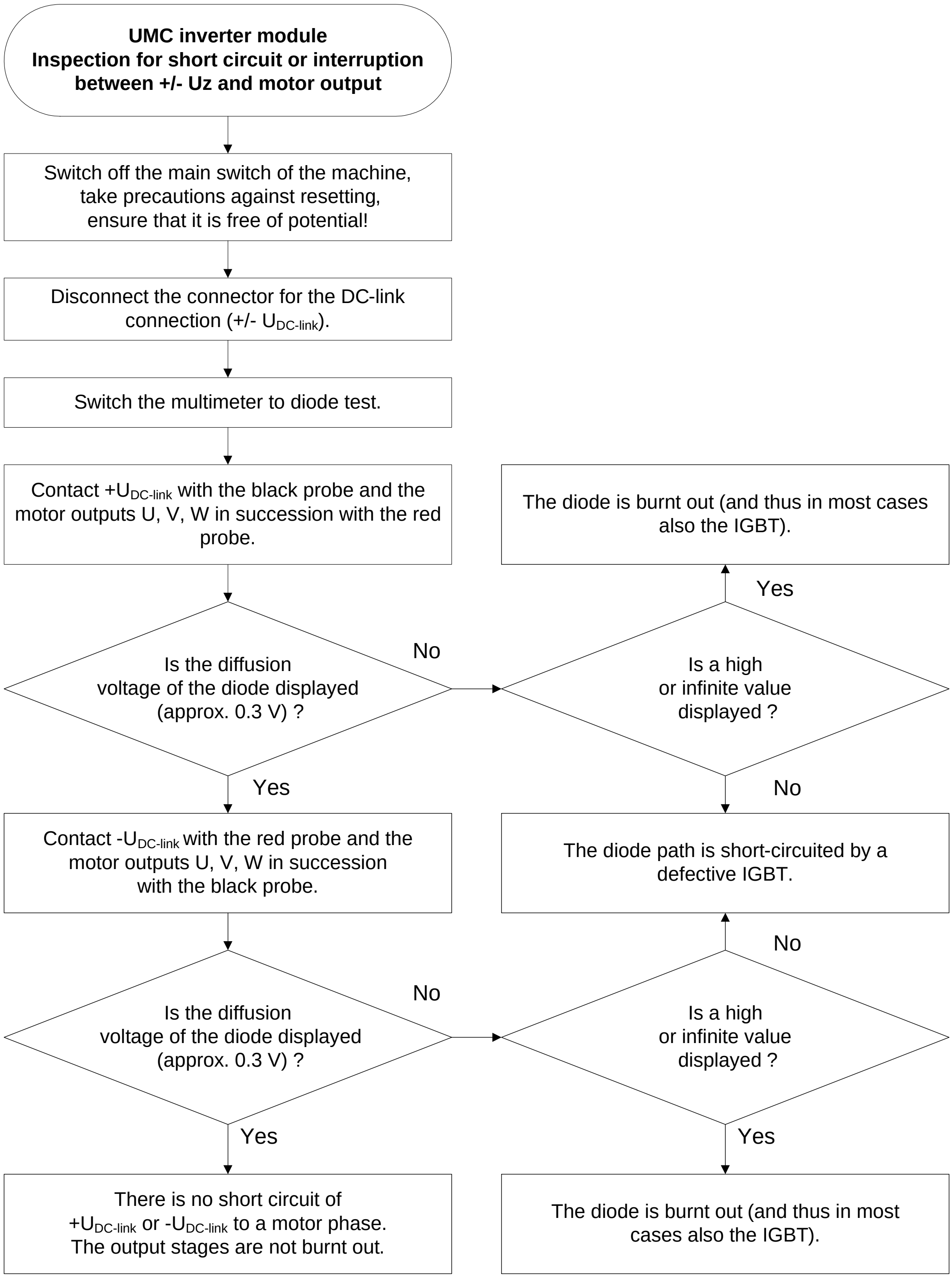
Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic curve of the diode.
Only rough values can be specified here.

Figure:
Diode measurement ± Uz on motor output



Flowchart: Short circuit or interruption between ± Uz and motor output



Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

What cannot be measured?

Please note that the following cannot be determined when performing these measurements:

- Short circuits in the gates of the IGBTs as they cannot be accessed from the outside and thus cannot be measured.
- Defective current sensors or general electronical defects.
- Whether the devices function 100 % (this can only be detected during operation).
- Whether devices that are contaminated but are still functioning, might fail soon.

Corrective action

Inverters with short circuits or interruptions must be replaced!
See "Exchanging the complete inverter" on page 10 – 221!

Heavily contaminated inverters

If you do not detect a short circuit, it might still be possible that there will be short circuits in the device in case the inverter is heavily contaminated (the contamination can be seen best in the area of the fan).

Note

With rising air humidity, the probability of short circuits increases.

With regard to the operating safety, please send heavily contaminated inverters for cleaning to a HEIDENHAIN agency.

7.9.3 Checking the LEDs

▶ Switch on the machine.

▶ Move the respective axis or turn the spindle.

The green LED **READY** must be lit for the output stage concerned!

As long as the axis or the spindle are operating, the red LEDs **STO A** and **STO B** must not be lit!

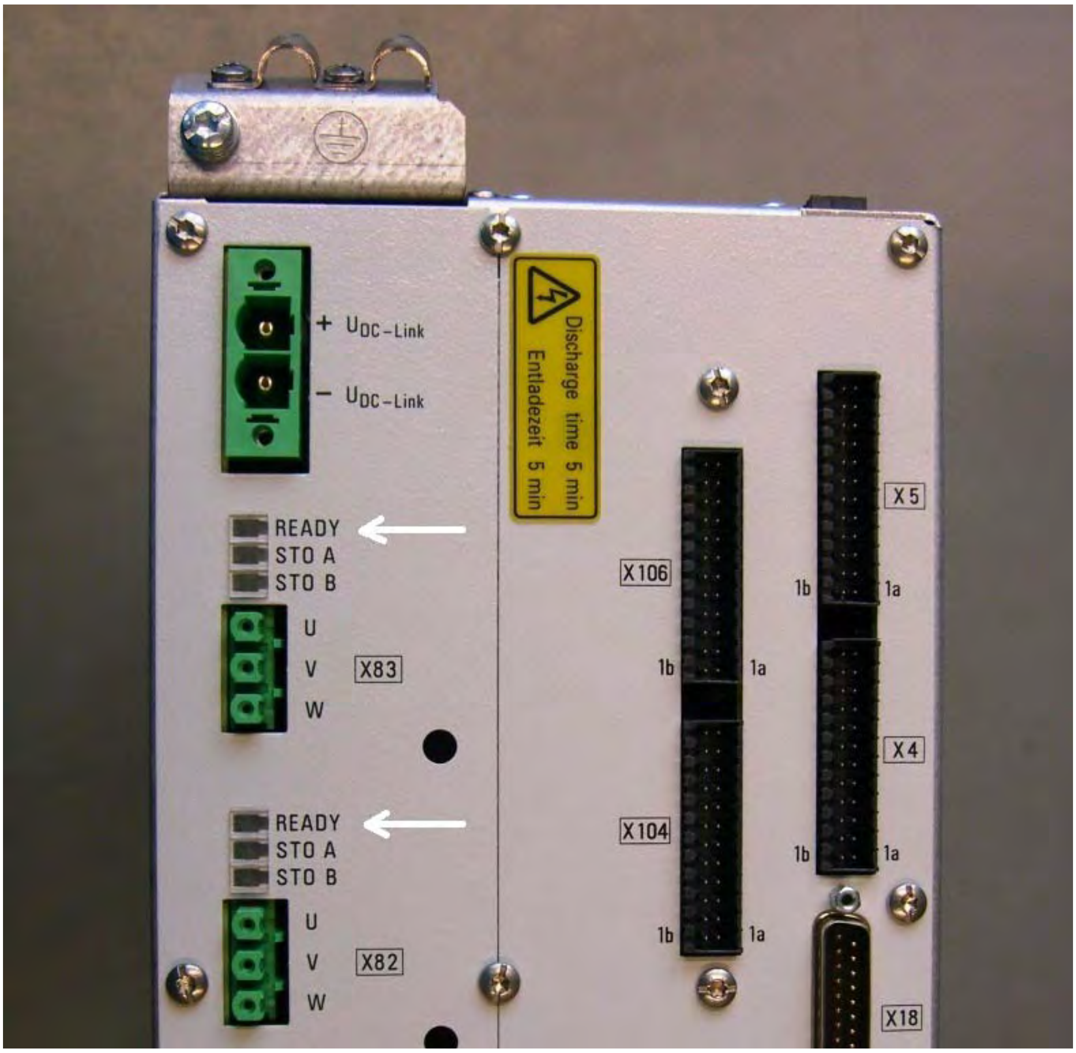


Figure: Green LEDs on the UMC 111

If the green LEDs **READY** are not lit:

▶ Check whether the protective doors are closed, the permissive buttons are pressed, etc.

▶ Check the enables. See circuit diagram of the machine!

7.9.4 Checking the voltages

DC-link voltage

When the machine is switched on, the DC-link voltage must have built up!

▶ Always comply with the safety precautions!

> **Danger**
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See "Voltage tester" on page 14 – 412.
> Proceed carefully and concentratedly!

▶ Measure carefully on the DC-link connection whether **approx. 565 Vdc** (on non-regenerative inverter systems, depending on the primary voltage) or **650 Vdc** (on regenerative inverter systems) are available.

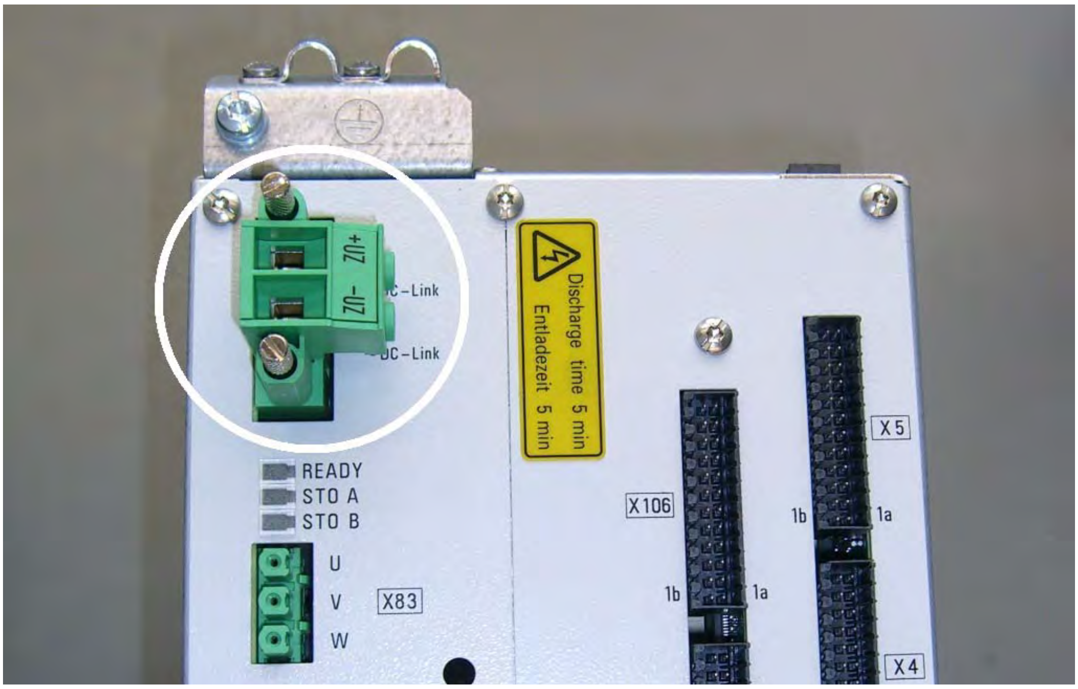


Figure: DC-link connection on the UMC

If the DC-link voltage is not available:

▶ Examine the power supply unit UV, UVR, UE, UR, etc.

24 V voltage

The UMC is powered with 24 V DC voltage on connector X103.

▶ Measure the voltage.

Figure: 24 V connection on the UMC

If the 24 V voltage is not available:

▶ Examine the power supply unit PSL 130, PSL 135, etc.

7.9.5 Exchanging output stages of the same type

The drive-control board and the output stages are integrated in the housing of the UMC.
If motor outputs are to be interchanged for error diagnosis, also the position and speed inputs must be interchanged on the UMC.
The output stages of the UMC are the same type.
See Service Manual iTNC 530 HSCI.

7.10 Error diagnosis on non-HEIDENHAIN inverter systems

7.10.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of ...

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages regarding leakage current, overcurrent or similar error messages on the control.
- Humidity in the inverters and plug and clamp connections
- Wear of cables
- Heavy contamination on the motors
- Scorch marks and/or burnt smell
- Destroyed units

> Note
>
> Before inspecting the inverter system for ground faults, ensure that there are no ground faults on the motors. See “Inspection for ground fault” on page 6 – 49.

Instruction of the manufacturer

Read the manufacturer's instruction on inverters for information on the inspection procedure of ground faults!

7.10.2 Inspection for short circuit or interruption

A short circuit is a severe electrical error and must be excluded from further inspections.

A **short circuit** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages regarding leakage current, overcurrent, etc.
- Scorch marks and/or burnt smell
- Destroyed units

> Note
>
> Before inspecting the inverter system for short circuits, ensure that there are no ground faults. See “Inspection for ground fault” on page 7 – 169.

Instruction of the manufacturer

Read the manufacturer's instruction on inverters for information on the inspection procedure of short circuits!

7.10.3 Checking the displays on the infeed/regenerative module of the non-HEIDENHAIN manufacturer

- ▶ Switch on the machine.
- ▶ Check the displays (LED, LCD, etc.) for the required operating status of the power supply unit. See **manufacturer manual**.

If the required operating status of the power supply unit is not reached:

- ▶ Check the voltages. See “Checking the voltages” on page 7 – 171.

7.10.4 Checking the LEDs on the HEIDENHAIN expansion boards

Now observe the displays on the HEIDENHAIN expansion boards:

- Move the respective axis or turn the spindle.

The green LED **READY** (or IF) on the respective expansion board in the output stage of the non-HEIDENHAIN inverter must be lit!

When the axis or the spindle are still operating, the red LEDs **SH 1** and **SH 2** (or RESET X1, RESET X2 or NB) must not be lit!

Photo: LEDs on the HEIDENHAIN expansion boards

If the mentioned green LEDs are not lit:

- Check the releases on the power supply unit.
  Check whether the protective doors are closed, the permissive buttons are pressed, etc.
  Use the circuit diagram of the machine and try to find the interruption.
- Check the unit bus cable and the respective connectors.

> **Attention**
>
> The unit bus cable must only be connected to devices that are free of potential. Otherwise the inverters might be destroyed!

- Check the respective PWM bus cable and connector. If necessary, try out another PWM bus cable.

> **Attention**
>
> The PWM bus cable must only be connected to devices that are free of potential. Otherwise the inverters might be destroyed!

7.10.5 Checking the voltages

To ensure that the power supply module (e.g., infeed/regenerative module) can operate, it must be supplied with **primary voltage** on 3 phases.

The DC-link voltage is then available on the conductor bars under the cover plates.

Primary voltage

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

> Danger
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See “Voltage tester” on page 14 – 412.
> Proceed carefully and concentratedly!

- Use the **manufacturer's manual** for measuring the primary voltage on the power supply unit.

If one or more phases are missing:

- Trace the phases to the main switch of the machine and to the fuses.

Control voltages for charging and enabling contactors

In general, the DC-link voltage is only built up if control voltages for charging contactors are available in the power supply unit.

- Use the **manufacturer's manual** for measuring the control voltages on the respective connectors.

If control voltages are missing:

- Check whether all EMERGENCY STOP buttons are canceled.
- Check whether the machine has activated the hardware limit switches.
- Use the circuit diagram of the machine to trace the control voltage.

DC-link voltage

When the machine is switched on, the DC-link voltage must have built up!

- Always comply with the safety precautions!

> Danger
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See “Voltage tester” on page 14 – 412.
> Proceed carefully and concentratedly!

- Use the **manufacturer's instructions** for measuring the DC-link voltage carefully on the conductor bars.

7.10.6 Interchaning the HEIDENHAIN interface boards for the SIMODRIVE 611 system

If a SIMODRIVE 611 system is used in connection with the HEIDENHAIN control, there are HEIDENHAIN expansion boards in the Siemens drive modules to adapt the PWM signals.

Boards of the same type

Before using other drive modules for examination of faulty axes, you may exchange dimensionally identical expansion boards.
Observe the following:

- The machine is not under power when you exchange the boards.
- Boards of the same type are exchanged (1-axis module or 2-axis module, galvanically isolated or not galvanically isolated --> See “Exchanging HEIDENHAIN interface boards in the SIMODRIVE system” on page 10 – 267).
- The grounding is correct . See “Exchanging HEIDENHAIN interface boards in the SIMODRIVE system” on page 10 – 267.

Boards of different types

If you do not have boards of the same type, under certain circumstances you may exchange boards for 1-axis modules for boards for 2-axis modules and vice versa.
"Stumbling blocks" may be:

- Some 2-axis module boards (ID number smaller than 359002-xx) require the corresponding enabling signals of the control on every PWM interface. If such a board is inserted in a 1-axis module and one PWM interface is not assigned, the entire board is not enabled.
- If a 1-axis module board is inserted in a 2-axis module for test purposed, the corresponding axis can be inspected (if the other axis is to be inspected, the motor output on the power stage must be reconnected).
- For these tests it might be necessary to deselect the axes that cannot be controlled in the machine parameter list. With some machines this might be difficult.
  If necessary, ask the machine manufacturer!

> Attention
>
> Boards with metallic isolation of HEIDENHAIN PWM signals to the Siemens interface must not be replaced by boards without metallic isolation and vice versa!
>
> Please ensure that interface boards **with and without metallic isolation must not be used together!**
>
> See “Exchanging HEIDENHAIN interface boards in the SIMODRIVE system” on page 10 – 267.

> Attention
>
> "Older" HEIDENHAIN expansion boards may not be operated with modified SIMODRIVE power modules.
> See “Compatibility of HEIDENHAIN expansion boards to SIMODRIVE power modules” on page 10 – 272.

7.10.7 Interchanging power stages of the same type

Use this error detection routine to find out **(without changing machine parameters)** whether a faulty axis can be traversed with an identical output stage.

Use one of the following:

- The power module of a functioning axis
- Or a replacement unit

Attention

If you strongly suspect that the motor of the axis to be examined causes a ground fault or a short circuit (penetration of humidity, etc.), you must not connect it to another power stage as it could be destroyed!
First check the motor for ground faults and short circuits. See "Inspection for ground fault" on page 6 – 49, See "Inspection for winding short circuit or interruption" on page 6 – 53.

Danger

Always secure vertical axes from falling down before you perform this test!

Danger

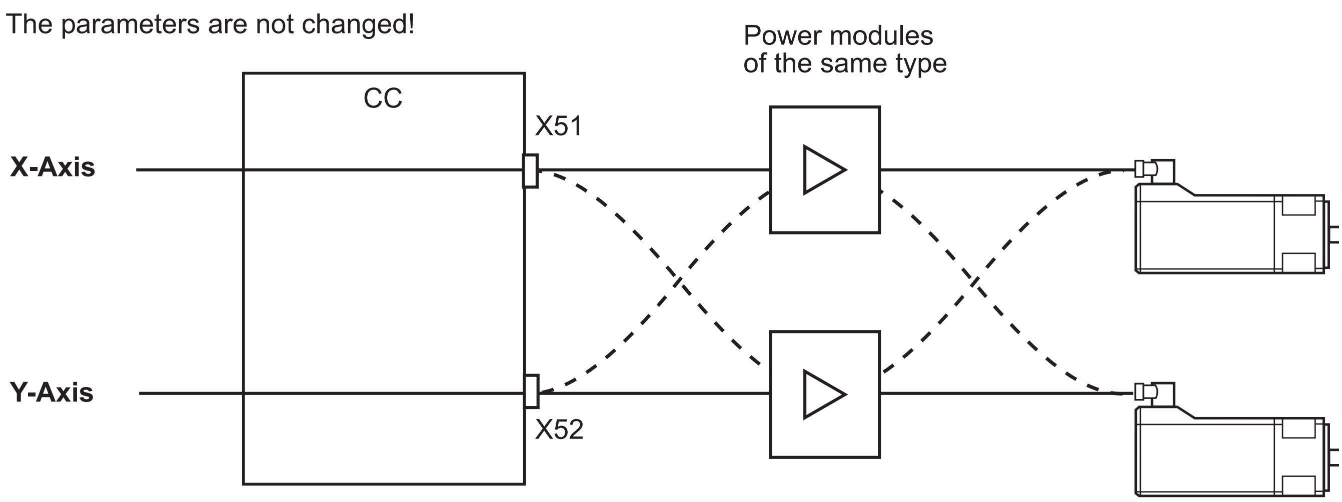
Danger of electrical shock!
Make sure that the main switch of the machine is switched off and that all connectors and terminals are free of potential before you engage or disengage them.

Instruction of the manufacturer

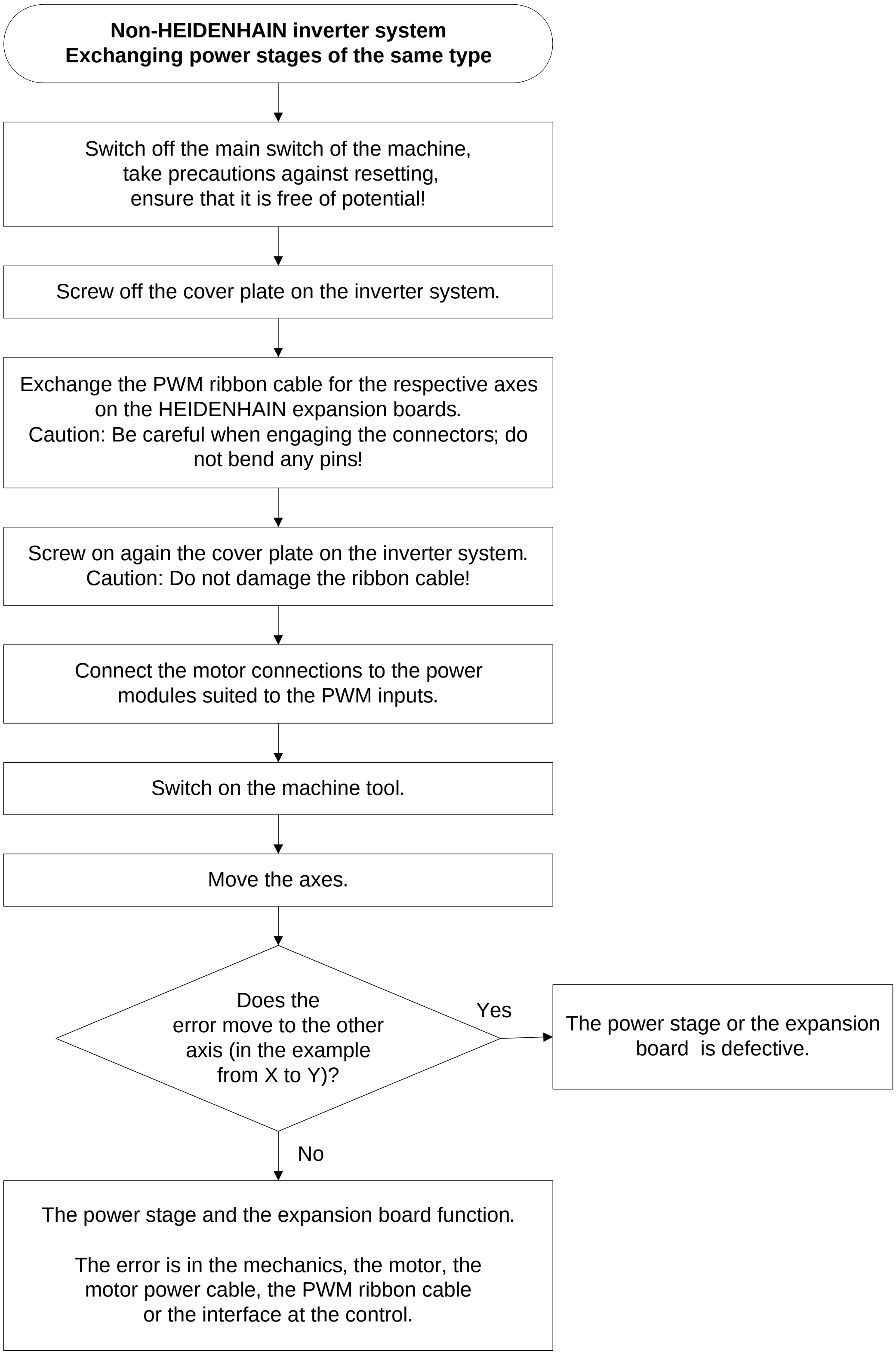
Read the manufacturer's instruction on inverters for information on the replacement procedure of power modules!

In this example there is an error in the X axis:

Block diagram for two 1-axis modules



Flowchart for two 1-axis modules

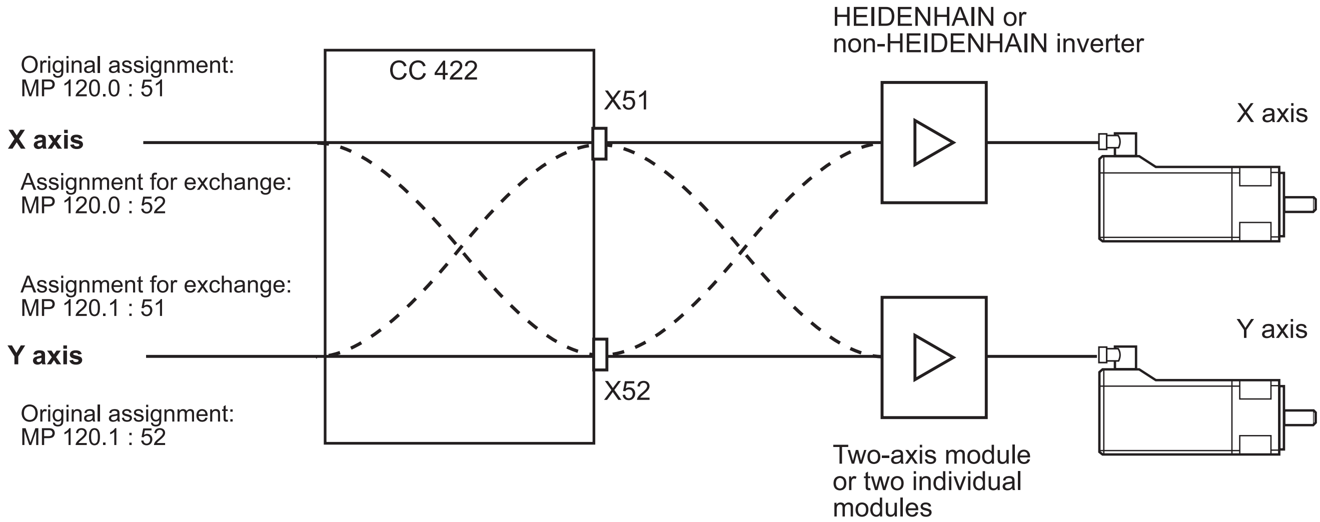


7.10.8 Interchange of the PWM outputs

Use this error detection routine to find out whether the PWM output of the control is defective or the connected power module.

The procedure depends on the control type. The machine parameters must be changed.
Use the respective **Service Manual for the HEIDENHAIN control** (e.g., SHB iTNC 530).

Block diagram from the Service Manual iTNC 530:



8 Error diagnosis on accessories

8.1 Safety

Inverter systems and motors operate at **high voltages and currents!**

Before you perform work on the drive system of the machine, note the safety precautions in this service manual! See “Safety precautions” on page 2 – 13.

Please also note the **safety precautions of the machine manufacturer!**

Danger

On the surface of **braking resistors temperatures > 150 °C** are possible!

8.2 Possible causes of error

No claim for completeness; contact your machine manufacturer!
If possible, write your own experience!

- Ground fault
- Short circuit in windings
- Short circuit in the unit
- Overload
- Excessive temperatures for a long period of time
- Defective temperature sensor
- Defective fan
- Contamination
- Humidity
- Corroded contacts
- Damaged cable
- Evaluation of the temperature sensor in control defective
- No power supply for fan

8.3 Visual inspection

A visual inspection of components of the inverter system can be performed fast and easily.

Please note the following:

- Is the device or the area where it is mounted heavily contaminated?
- Are there chips in the braking resistor?
- Has a wire in the braking resistor burnt out and now contacts the housing?
- Has humidity entered the device system?
  (it may be possible that coolant flows along the cables into the electrical cabinet)
- Are there defective cables?
- Are pressure tubings or screw connections for water-cooled devices leaky?
- Are there any scorch marks or a burnt smell?

8.4 Error diagnosis on the PW braking resistor

8.4.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff`
- Scorch marks and/or burnt smell
- Destroyed units

Note

Before inspecting the braking resistor for ground faults, ensure that there are no ground faults on the motors and the inverter system. See “Inspection for ground fault” on page 6 – 49 and See “Inspection for ground fault” on page 7 – 75.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault to protect the following equipment.

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault the charging of the DC-link is aborted.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See “Voltage tester” on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement -- >See “Insulation tester” on page 14 – 412.

Danger

The insulation tester operates at high voltages!
Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN braking resistors are measured in the field with an isolation voltage of 1000 V.

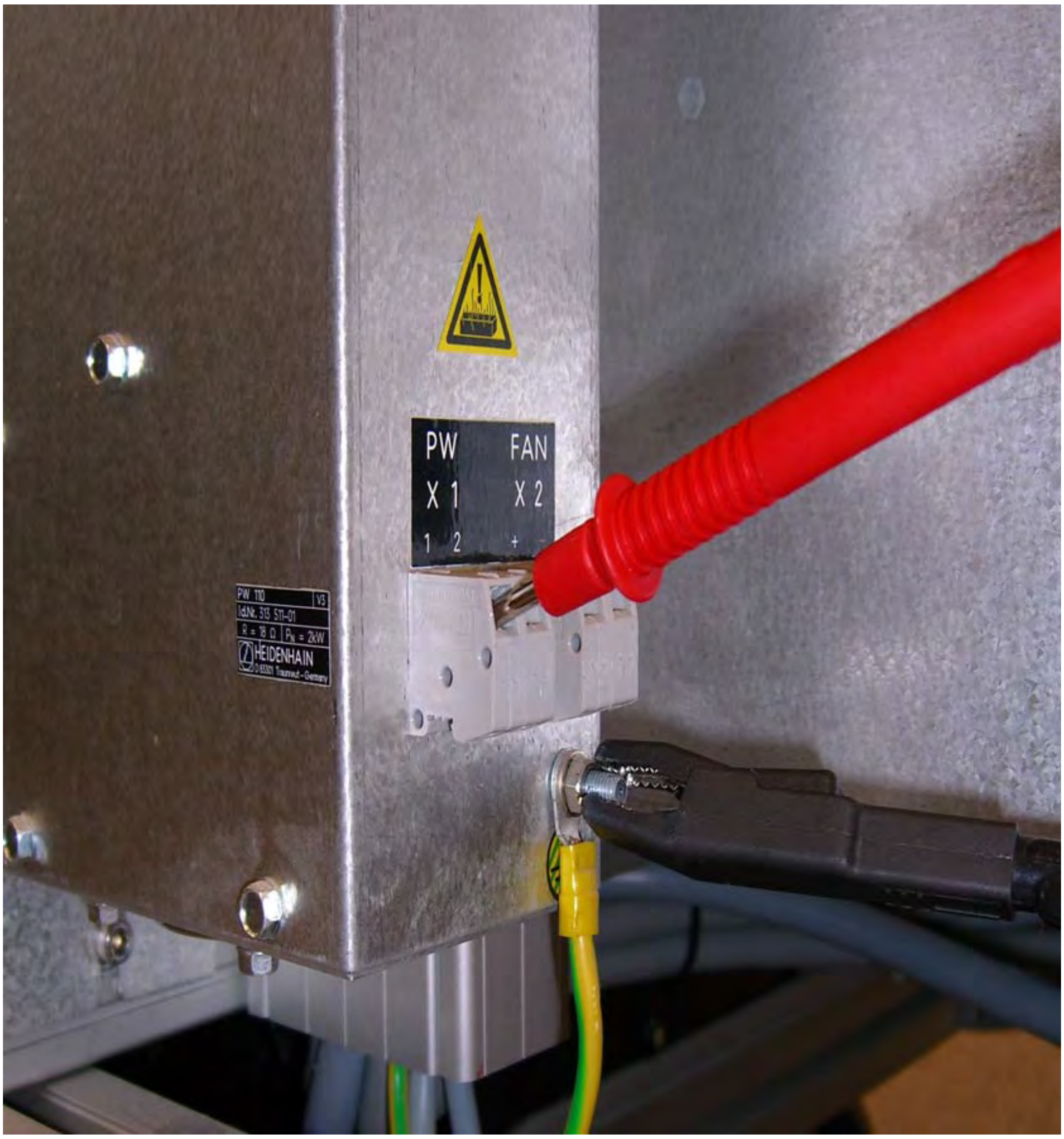
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

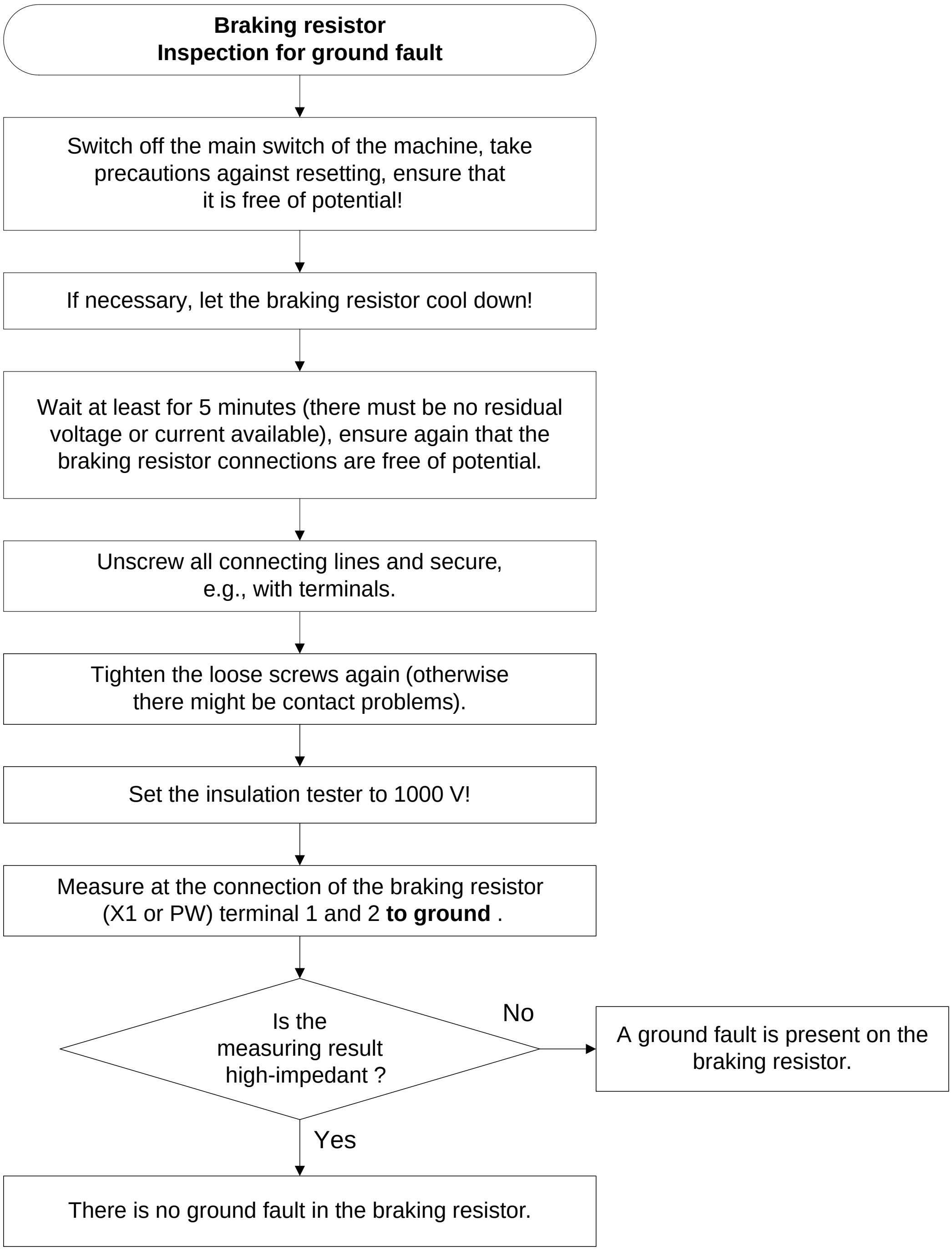
> Danger
>
> **Danger of electrical shock!**
> The units must be free of potential for the following measurements.
> Ensure that the machine is switched off and is not under voltage!

> Danger
>
> On the surface of **braking resistors temperatures > 150 °C** are possible!

Figure:
Ground fault measuring with insulation tester



Flowchart



Note

"Crosscheck":
If your insulation tester operates without power supply (i.e., is operated with accumulators) and has an insulated housing, you can perform the insulation measurement also in reverse direction as a "crosscheck". The negative pole is then connected to the respective contact, the plus pole to the grounding screw.

> Note
>
> It is not possible to define resistance values as, for example, they depend on the contact position of the resistance wire on the housing or where a chip causes a ground fault.
> High-impedance results depend on the specifications of the insulation tester, among other things.
> If required, you can compare the measured values with a dimensionally identical braking resistor.

> Note
>
> If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
> But keep in mind that you are measuring at low voltage so that flashovers in the braking resistor can hardly be detected!

Corrective action

Braking resistors with ground faults must be replaced!

Heavily contaminated braking resistors

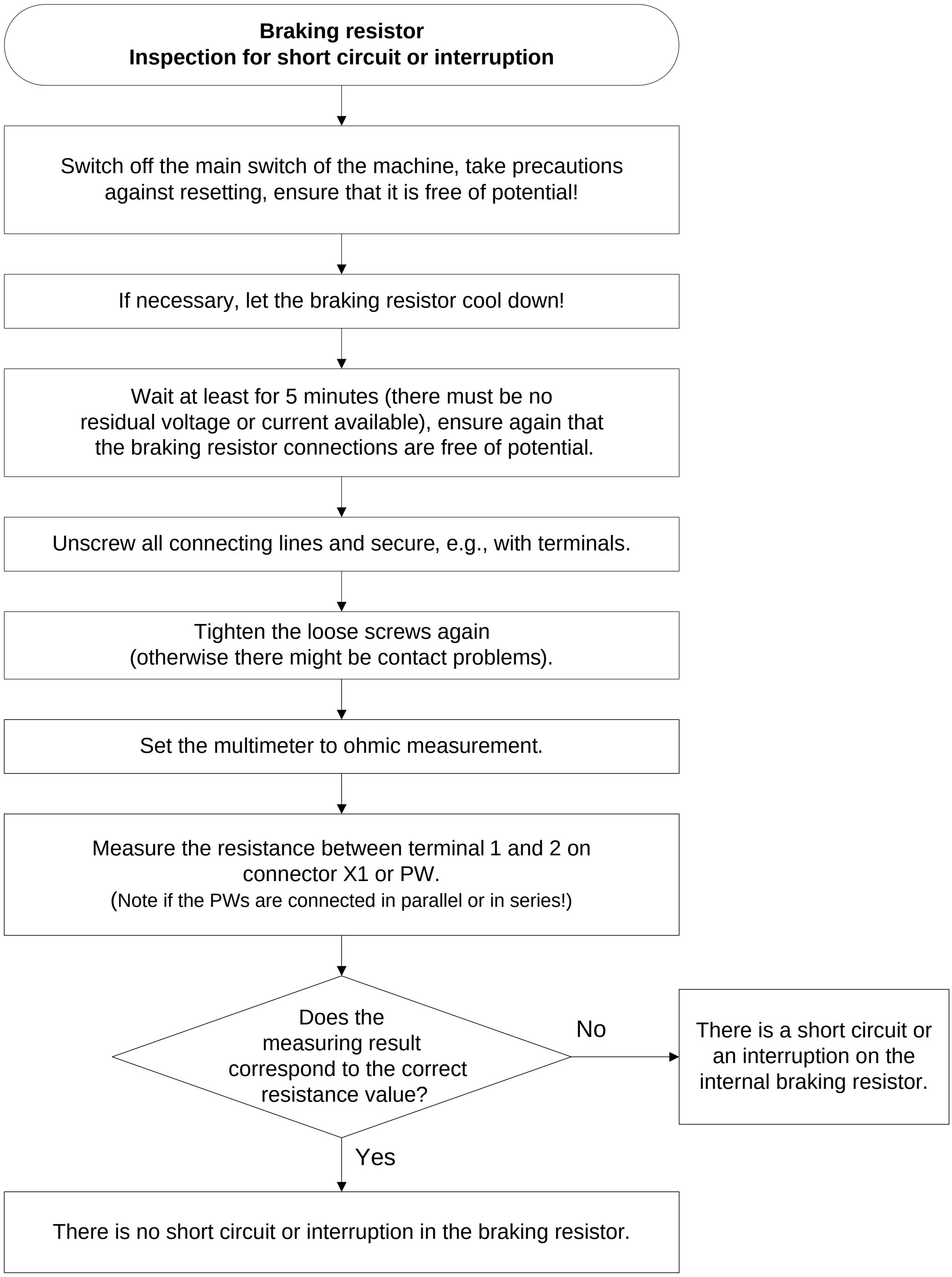
If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur in the event of heavily contaminated braking resistors.

> Note
>
> With rising air humidity, the probability of unwanted leakage current increases.

With regard to the operating safety, please send heavily contaminated braking resistors for cleaning to a HEIDENHAIN agency.

8.4.2 Checking the resistance value

Flowchart



Resistance values

Braking resistor	Resistance value
PW 110	18 Ω ± 10%
PW 110 B	18 Ω ± 10%
PW 120	10 Ω ± 10%
PW 210	18 Ω ± 10%
PW 211	10 Ω ± 10%

8.4.3 Checking the fan

Danger

On the surface of **braking resistors temperatures > 150 °C** are possible!

The PW 110, PW 110 B and PW 120 braking resistors are equipped with fans.

- Observe whether the fan is running properly.
- Measure whether 24 Vdc are available between the terminals on the fan connection X2 (FAN).

8.4.4 Checking the temperature switch

Danger

On the surface of **braking resistors temperatures > 150 °C** are possible!

The PW 110 B, PW 120, PW 210 and PW 211 braking resistors feature temperatur switches.

If the braking resistor is "cold", the switch is closed (resistance approaches zero),
If the braking resistor is "hot", the switch opens (resistance approaches infinity).

Note

The temperature switch of the braking resistor could be integrated such in the circuit diagram of the machine that the machine cannot be put into operation again after a severe braking procedure when the braking resistor is hot. See circuit diagram of the machine.

- Switch off the machine.
- PW 110 B and PW 120:
  Remove the original wires on X3 (TEMP) of the braking resistor.
- PW 210 and PW 211:
  Remove the protective cover and remove the original wires on T1 and T2 of the braking resistor.
- Tighten the loose screws again (otherwise there might be contact problems).
- Use an ohmmeter to measure whether the switch is closed when the braking resistor is "cold" (resistance approaches zero, regard the measuring lines).

Figure: Terminals for temperature switch with PW 110B

8.5 Error diagnosis on the braking resistor module UP 1x0

8.5.1 Inspection for ground fault

A ground fault is a severe electrical error and must be excluded from further inspections.

A **ground fault** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as `Leakage current in UV 1xx` or `Overcurrent cutoff`
- Scorch marks and/or burnt smell
- Destroyed units

> Note
>
> Before inspecting the braking resistor module for ground faults, ensure that there are no ground faults on the motors and the inverter system. See “Inspection for ground fault” on page 6 – 49 and See “Inspection for ground fault” on page 7 – 75.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault to protect the following equipment.

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault the charging of the DC-link is aborted.

Potential dividers

Potential dividers for the DC-link voltage measurement are integrated in all braking resistor modules (UP). These potential dividers are included when the isolation voltage is measured to ground. This may lead to measuring results in the kohm range!
The measured resistance, however, should not fall below 30 kohm!

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See “Voltage tester” on page 14 – 412
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement -- >See “Insulation tester” on page 14 – 412.

> Danger
>
> The insulation tester operates at high voltages!
> Handle this measuring system with care and only after you have read the operating instructions!

Isolation voltage

HEIDENHAIN braking resistor modules may be measured in the field with a maximum isolation voltage of 500 V!

> Attention
>
> A higher test voltage could damage the braking resistor module!

Procedure

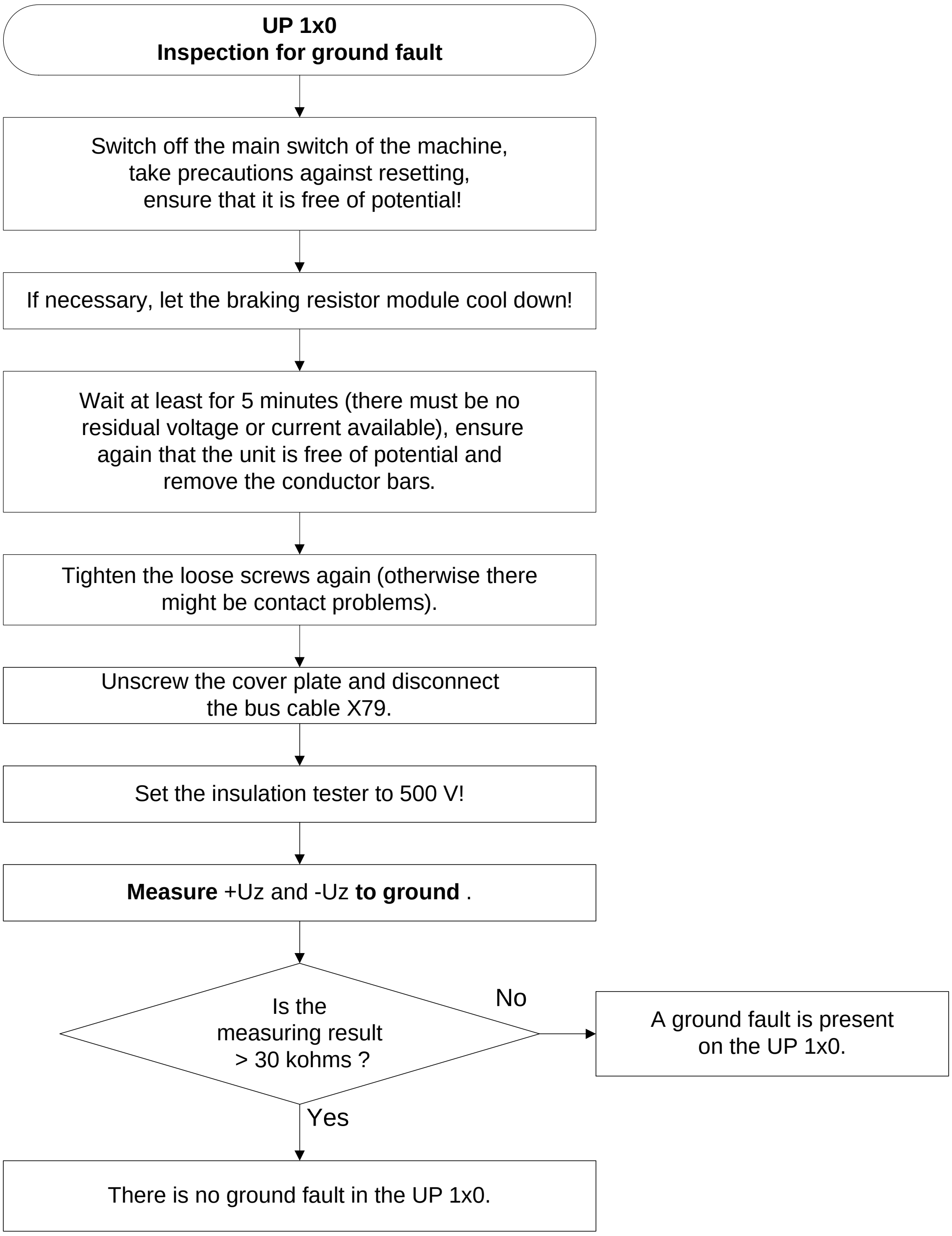
Danger

Danger of electrical shock!
The units must be free of potential for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Danger

On the surface of **braking resistors temperatures > 150 °C** are possible!

Flowchart



Note

"Crosscheck":
If your insulation tester operates without power supply (i.e., is operated with accumulators) and has an insulated housing, you can perform the insulation measurement also in reverse direction as a "crosscheck". The negative pole is then connected to the respective contact, the plus pole to the grounding screw.

Note

Defined resistance values cannot be specified here as they depend on the specifications of the insulation tester among others. If required, you can compare the measured values with a dimensionally identical UP.

Note

If you do not have an insulation tester, you can detect a bolted ground fault also with a multimeter with ohm measurement.
But keep in mind that you are measuring at low voltage so that flashovers in the UP can hardly be detected!

Corrective action

Braking resistor modules with ground faults must be replaced!

Heavily contaminated UPs

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur in the event of heavily contaminated UPs.

Note

With rising air humidity, the probability of unwanted leakage current increases.

With regard to the operating safety, please send heavily contaminated UPs for cleaning to a HEIDENHAIN agency.

8.5.2 Inspection for short circuit

A short circuit is a severe electrical error and must be excluded from further inspections.

A **short circuit** may be suspected in case of:

- Blowing fuses (semiconductor fuses for the primary voltage supply in the electrical cabinet of the machine tool or in a sub-distribution)
- Error messages, such as **`Leakage current in UV 1xx`** or **`Overcurrent cutoff`**
- Scorch marks and/or burnt smell
- Destroyed units

> Note
>
> Before inspecting the inverter system for short circuits, ensure that there are no ground faults. See "Inspection for ground fault" on page 8 – 184.

Fast line fuses

The line fuses of the primary supply (gRL type, fast semiconductor fuses) should blow immediately in the event of a ground fault or short circuit to protect the following equipment.

Following HEIDENHAIN inverters are equipped with a modified charging circuit (with improved ground fault protection):

- UVR
- UR
- UV xxx D
- UV 120, ID 344504-02
- UV 140, ID 335009-03

In the event of a ground fault or short circuit, the charging of the DC-link is aborted.

Required measuring devices

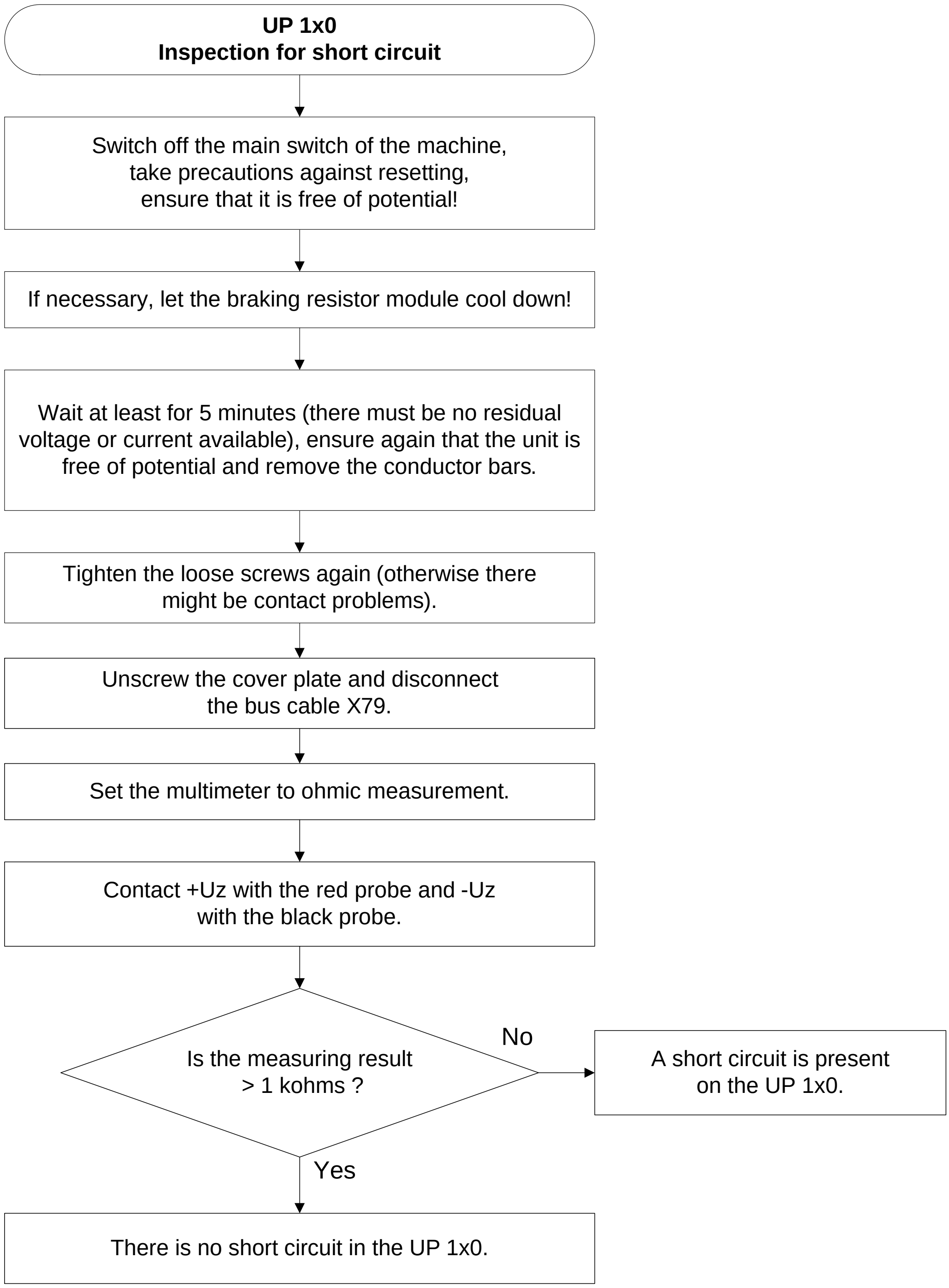
- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See "Voltage tester" on page 14 – 412
- Standard commercial multimeter

Procedure

> Danger
>
> **Danger of electrical shock!**
> The units must be free of potential for the following measurements.
> Ensure that the machine is switched off and is not under voltage!

> Danger
>
> On the surface of **braking resistors temperatures > 150 °C** are possible!

Flowchart: Short circuit in the UP 1x0



Corrective action

Braking resistor modules with short circuits must be replaced!

Heavily contaminated UPs

If you do not detect a short circuit, it might still be possible that short circuits occur in the event of heavily contaminated UPs.

> Note
>
> With rising air humidity, the probability of short circuits increases.

With regard to the operating safety, please send heavily contaminated UPs for cleaning to a HEIDENHAIN agency.

8.5.3 Checking the resistance value

This examination is only possible when the UP 1x0 is open.

Removing and opening the UP 1x0

- Switch off the machine and take precautions against restart.
- Check whether there is zero potential at +/- Uz.

Danger

On the surface of **braking resistors temperatures > 150 °C** are possible!

- If necessary, let the braking resistor module cool down.

Danger

Wait at least 5 minutes before you unscrew the conductor bars (there is a corresponding warning on the cover caps of the conductor bars)!
Use an appropriate voltage tester to check whether the DC-link voltage is zero!

- Open the protective covers and unscrew the conductor bars.
- Unscrew the grounding bars or ground lead on the top of the UP 1x0.
- Unscrew the cover plate and disconnect the bus cable X79.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift UP 1x0 slightly and remove it towards you.
- Remove the side plate.
Caution: One screw is located under the cover of the connector of the conductor bar!

Checking the resistance value

- Measure on the lines for the resistor that are screwed in parallel whether the value is **9 ohms ± 10%** (UP 110) or **3.6 ohms ± 10%** (UP 120).

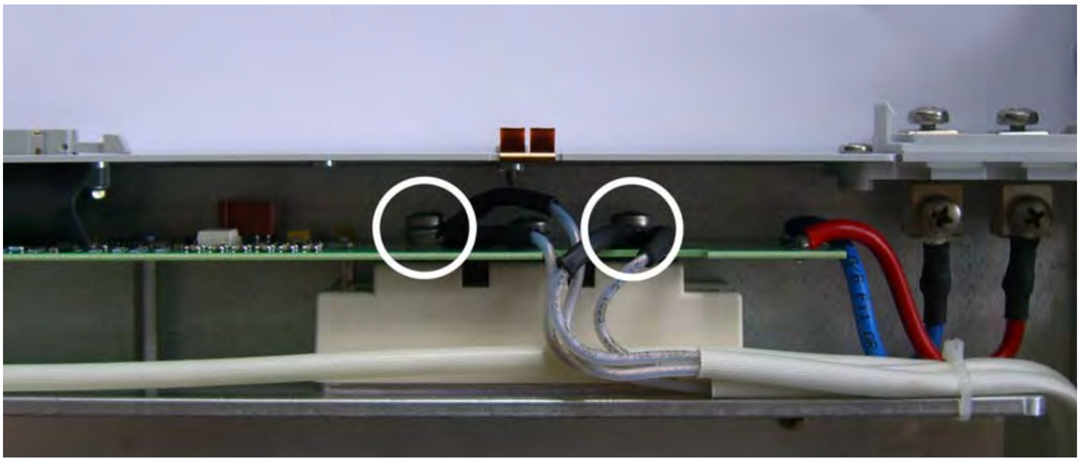


Figure: Open UP 110 breaking resistor module

8.5.4 Checking the braking resistor switch

If the DC-link voltage increases while braking the axes and spindles and the energy recovery into the power supply system does not function, the UP 1x0 (if available) switches on the mounted braking resistor as of a certain voltage threshold. Electrical energy is now converted into heat.

An IGBT (Isolated Gate Bipolar Transistor) serves as switch. This IGBT is combined with an antiparallel connected diode which can be measured.

Diode measurement

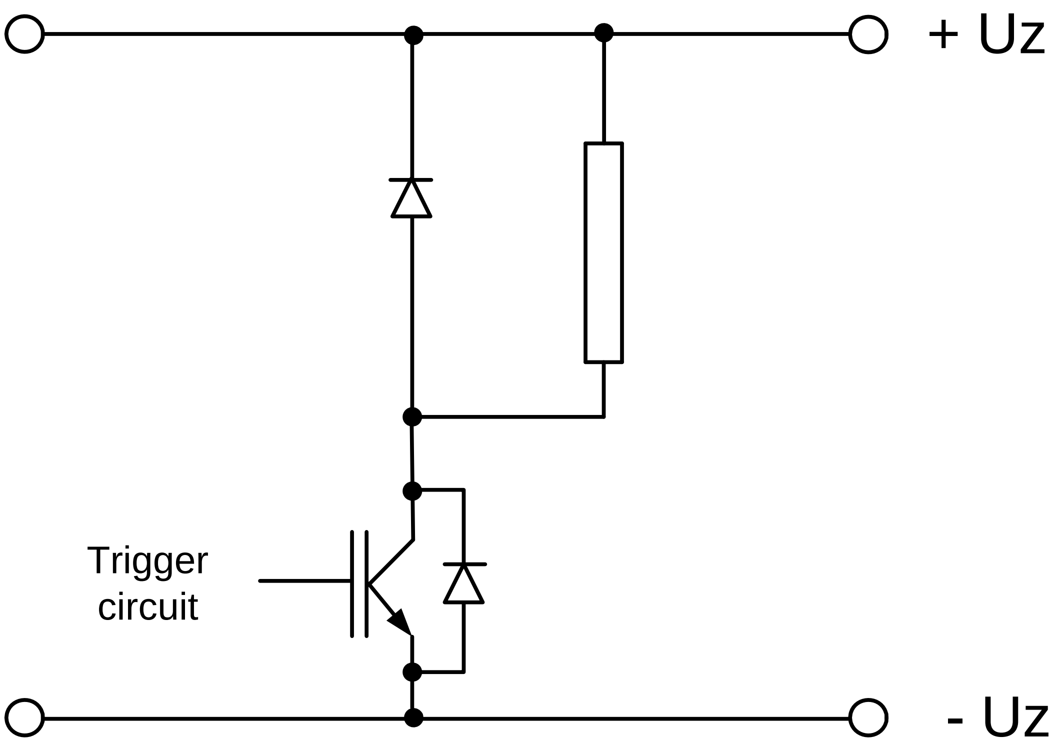
When measuring the diode, the diffusion voltage (forward voltage) of this diode is measured.

If the diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the braking resistor switch also functions!

Required measuring devices

- Appropriate voltage test unit to ensure that the unit is free of potential
- Standard commercial multimeter that can be set to "diode test".

Block diagram

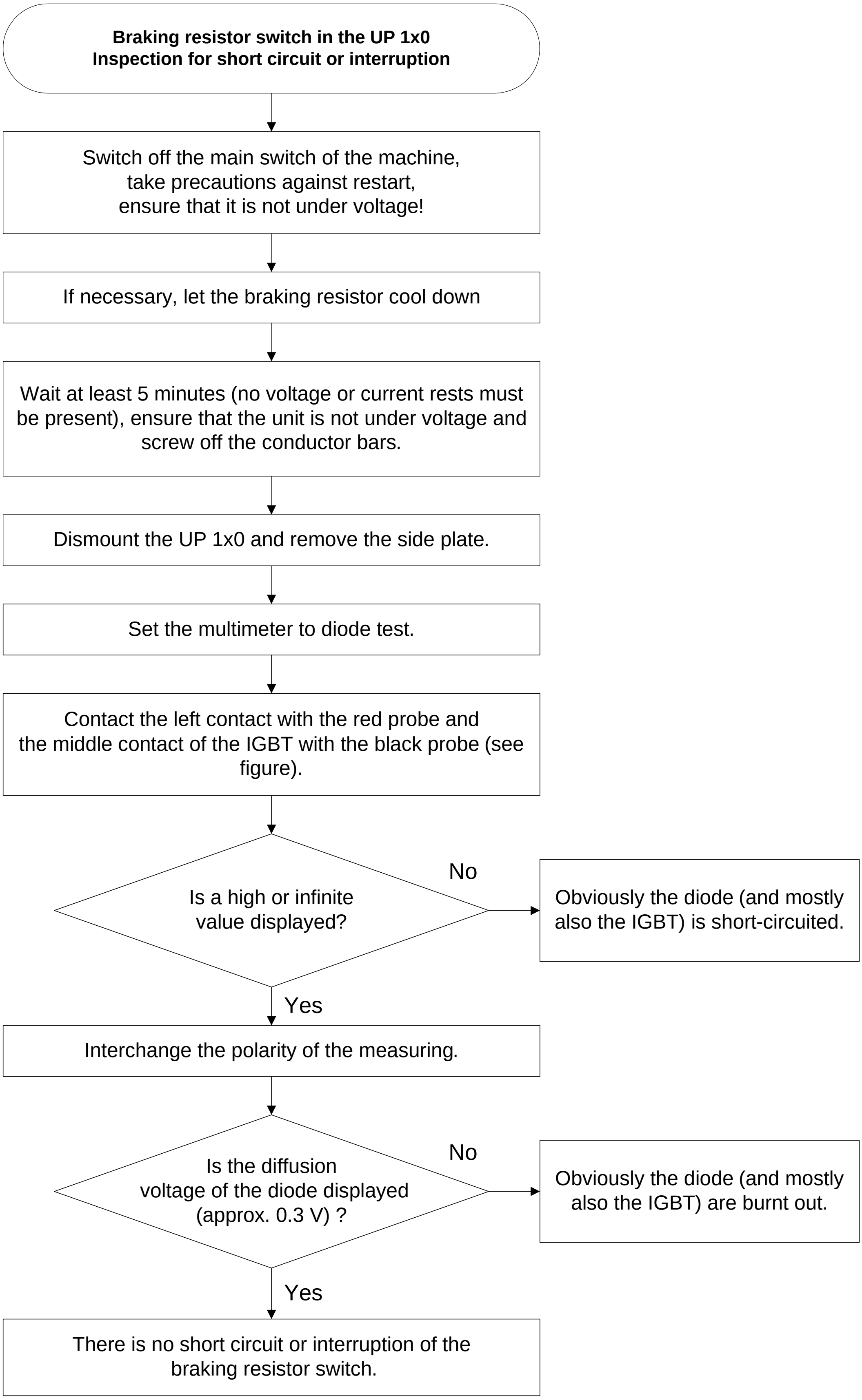


Procedure

This examination is only possible when the UP 1x0 is open.

> Danger
>
> On the surface of **braking resistors temperatures > 150 °C** are possible!

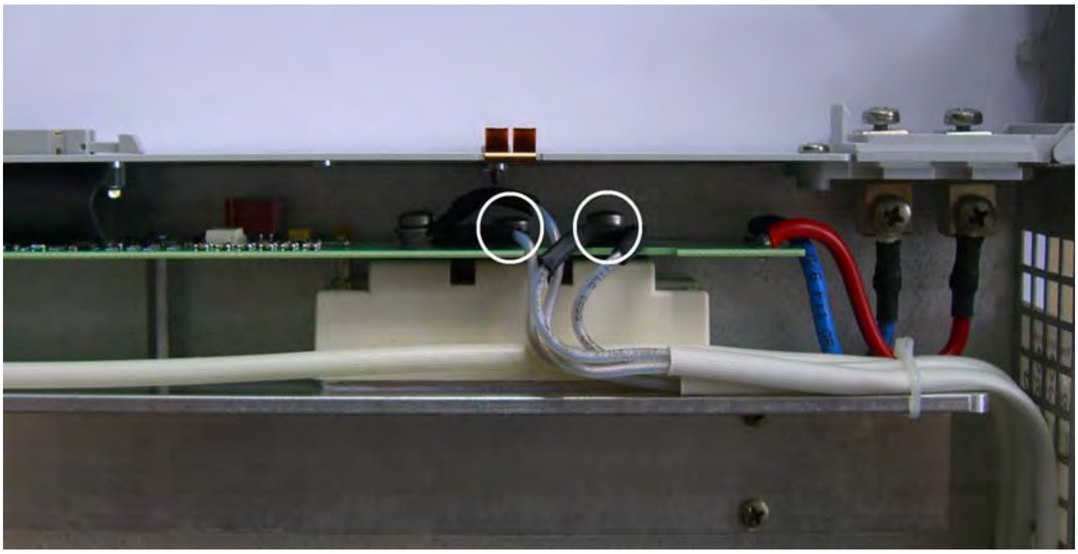
Flowchart: Short circuit or interruption of the braking resistor switch



Note

The measured diffusion voltage depends on the inverter type, the used measuring device and the characteristic of the diode.
Only rough values can be specified here.

Figure: Diode measurement



8.5.5 Checking the temperature switch

The UP 1x0 features a temperature switch.

If the braking resistor is "cold", the switch is closed; if the braking resistor is "hot", the switch opens.

> **Note**
>
> When the temperature switch opens, a temperature error message is output to the control via the unit bus X79.

Procedure

This examination is only possible when the UP 1x0 is open.

Removing and opening the UP 1x0

- Switch off the machine and take precautions against restart.
- Check whether there is zero potential at +/- Uz.

> **Danger**
>
> On the surface of **braking resistors temperatures > 150 °C** are possible!

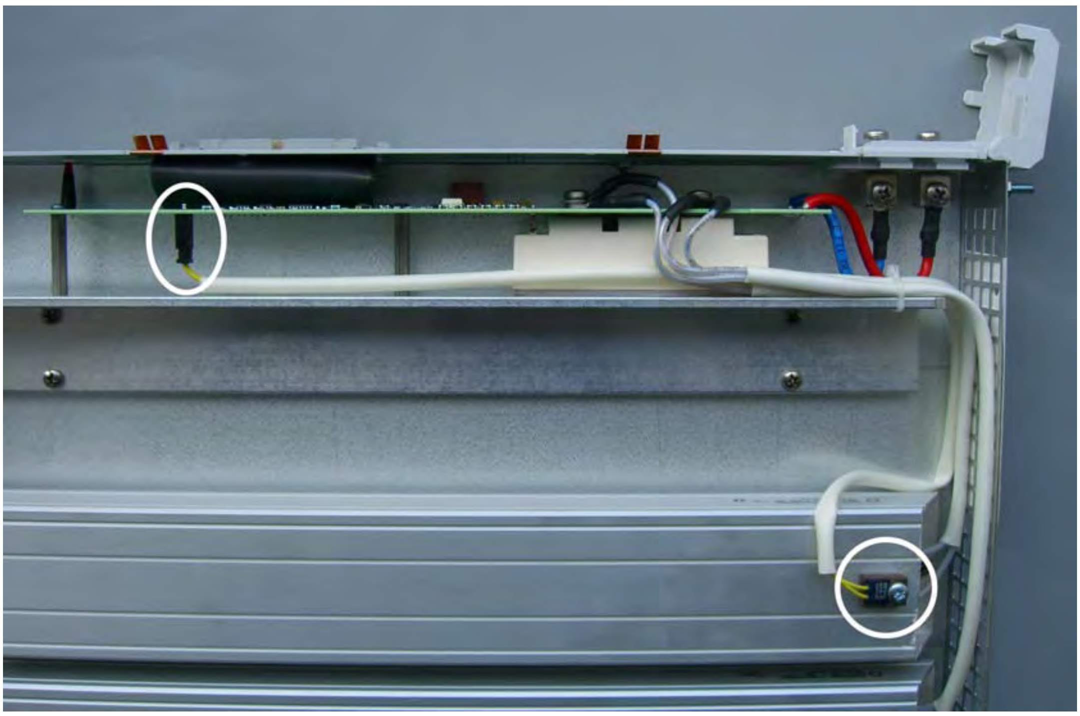
- If necessary, let the braking resistor module cool down.

> **Danger**
>
> Wait at least 5 minutes before you unscrew the conductor bars (there is a corresponding warning on the cover caps of the conductor bars)!
> Use an appropriate voltage tester to check whether the DC-link voltage is zero!

- Open the protective covers and unscrew the conductor bars.
- Unscrew the grounding bars or ground lead on the top of the UP 1x0.
- Unscrew the cover plate and disconnect the bus cable X79.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift UP 1x0 slightly and remove it towards you.
- Remove the side plate.
  Caution: One screw is located under the cover of the connector of the conductor bar!

Checking the temperature switch

- Use an ohmmeter to measure on the lines for the temperature switch whether it is closed when the UP 1x0 is "cold".



8.6 Error diagnosis on the SM voltage-protection module

8.6.1 Inspection for short circuit

The voltage on the power connections of the motor (e.g., synchronous spindle, torque motor) is rectified by means of rectifier diodes inside the voltage protection module.
In the event of overvoltage, an integrated thyristor ignites and short-circuits the motor phases. Electrical energy is thus converted into heat.

When the drive with the integrated voltage protection module is switched on and, for example, an overcurrent message is displayed, **a short circuit in the SM can be suspected**.

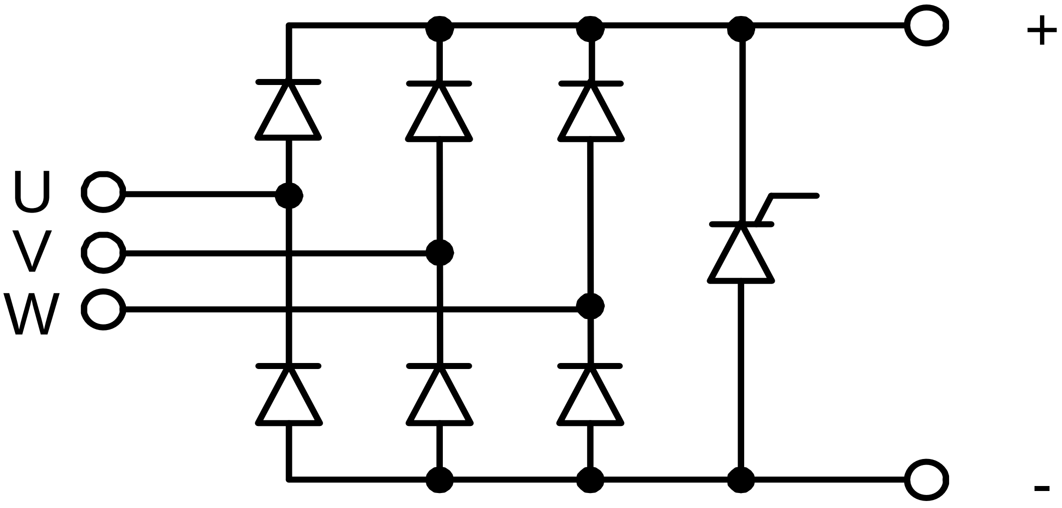
Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential --> See “Voltage tester” on page 14 – 412
- Standard commercial multimeter that can be set to "diode test".

Diode measurement

In the following instruction the diffusion voltages (forward voltages) of the rectifier diodes in the SM are measured.

Block diagram: Rectified motor phases and thyristor



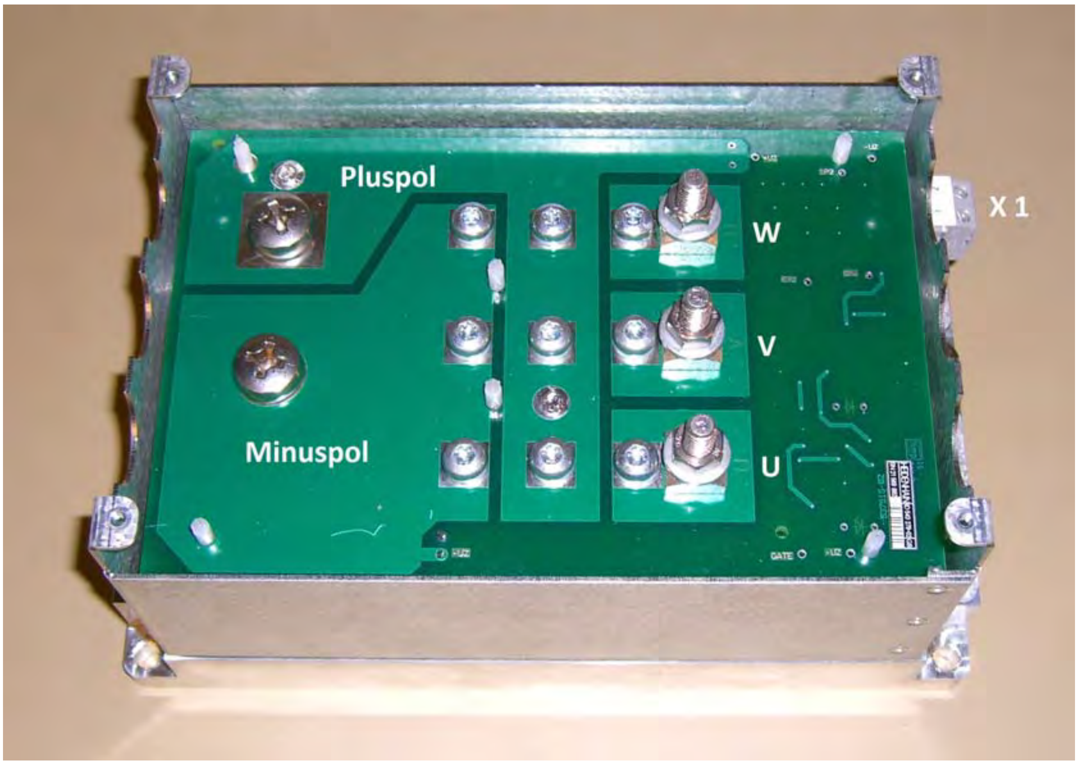
Procedure

Proceed as shown in the flow chart!
The figure on the previous page is intended for orientation.

> Danger
>
> **Danger of electrical shock!**
> The units must be free of potential for the following measurements.
> Ensure that the machine is switched off and is not under voltage!

> Danger
>
> **High temperatures** on the surface of voltage protection modules are possible!

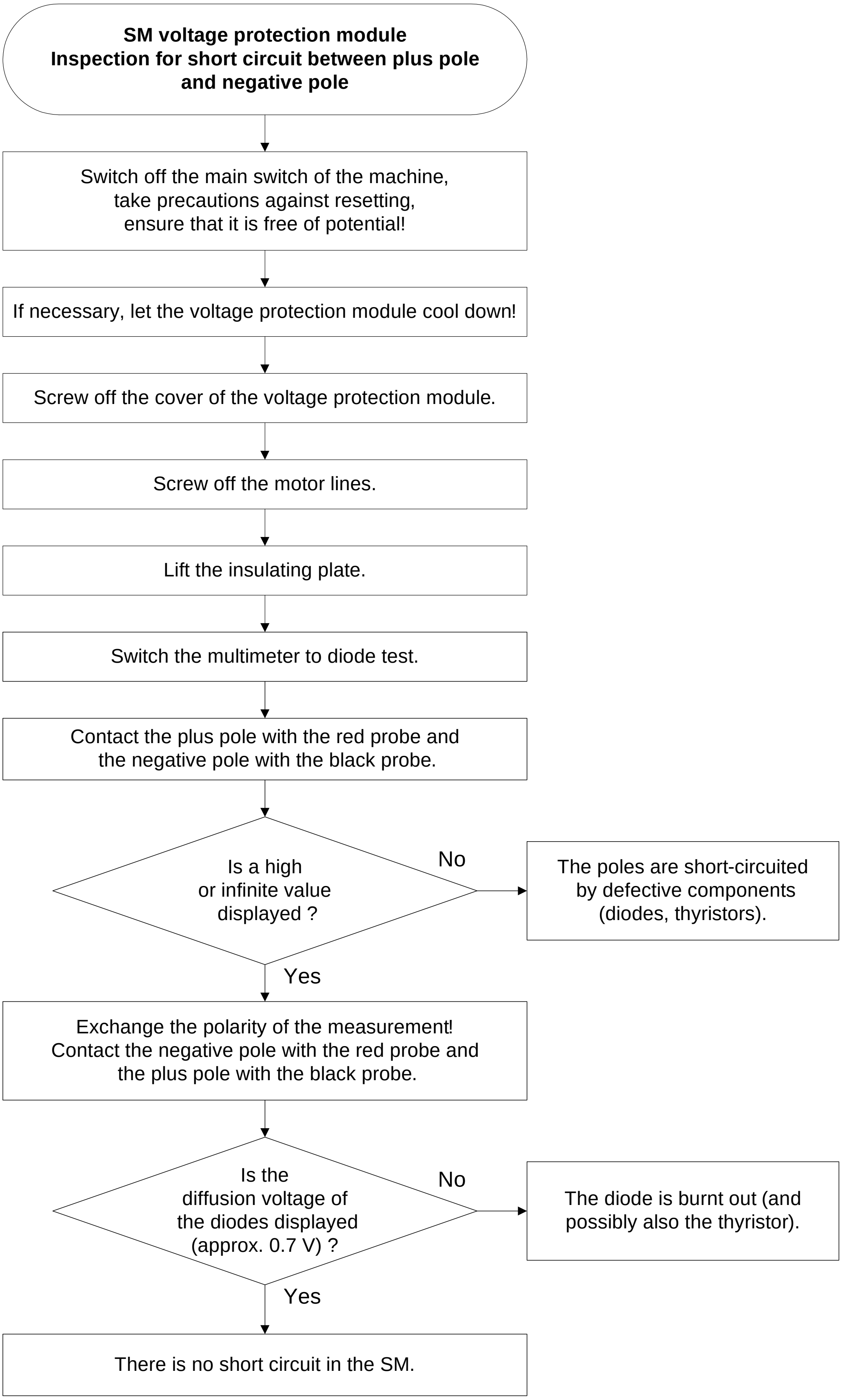
Figure:
Open SM



Note

On the board of the SM, the plus pole of the rectified motor phases is designated as +Uz and the negative pole as -Uz.

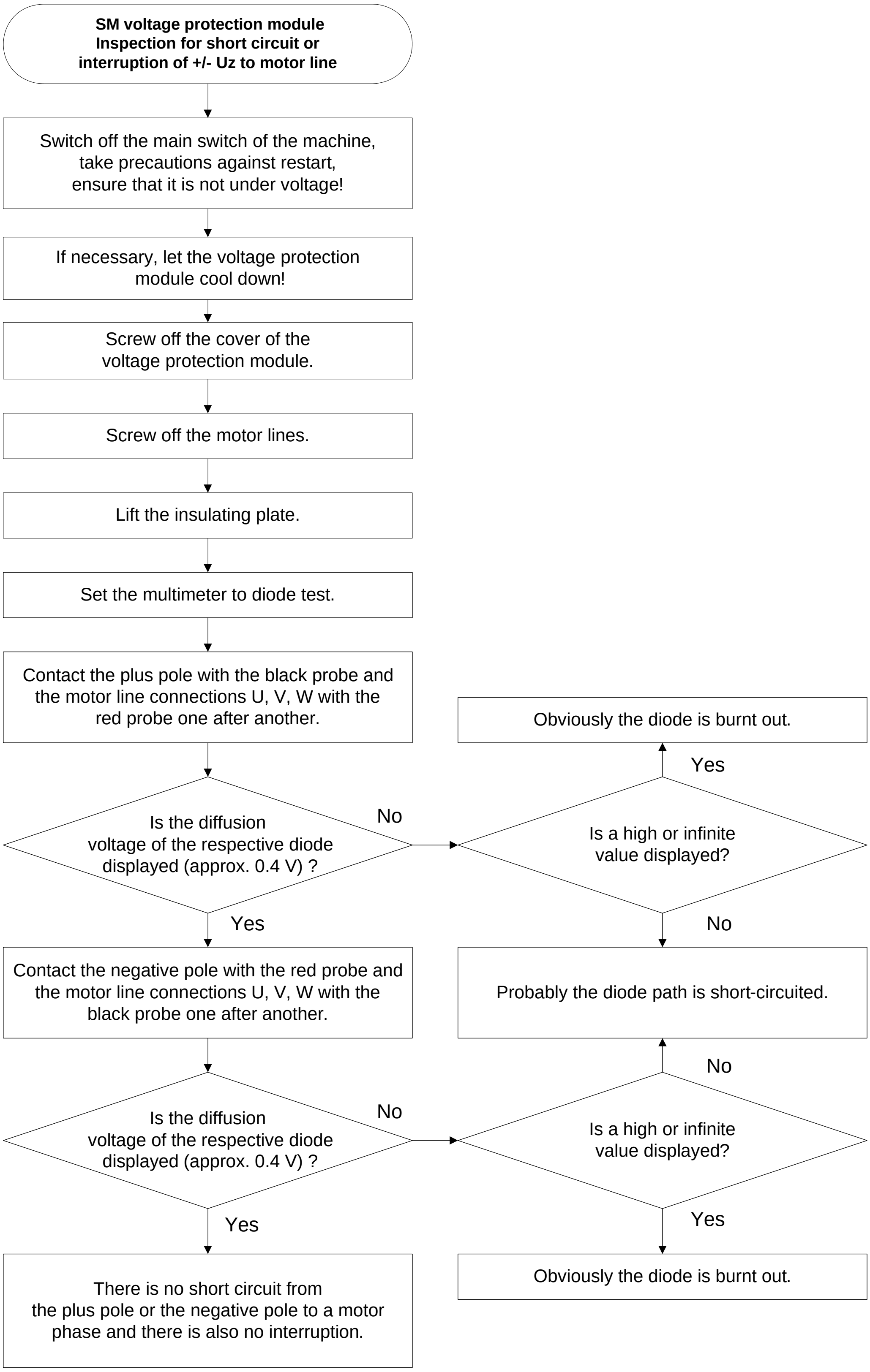
Flowchart:
Short circuit between plus pole and negative pole



Note

The measured diffusion voltage depends on the measuring device used and the characteristic of the diode.
Only rough values can be specified here.

Flowchart: Short circuit of ± pole to motor line



Note

The measured diffusion voltage depends on the measuring device used and the characteristic of the diode.
Only rough values can be specified here.

Note

After inspection or replacement of an SM 130, the motor lines must be screwed on with 9 Nm!

8.6.2 Checking the temperature switch

The SM 130 features a temperature switch.

The switch is closed under 60 °C and opens at higher temperatures.

Note

The temperature switch of the voltage protection module is normally included in the EMERGENCY STOP chain of the machine.
If the SM 130 is hot after an error has occured (e.g., power failure), the machine cannot be put into operation immediately afterwards. See circuit diagram of the machine.

Danger

High temperatures on the surface of voltage protection modules are possible!

- Switch off the machine.
- Remove the original wires on the X1 of the SM 130.
- Use an ohmmeter to measure whether the switch is closed when the voltage protection module is "cold".

9 Error diagnosis on UV power supply units

9.1 Safety

Power supply units operate at **high voltages and currents!**

Before you perform work on the power supply units, note the safety precautions in this service manual! See “Safety precautions” on page 2 - 13

Please also note the **safety precautions of the machine manufacturer!**

9.2 Possible causes of error

No claim for completeness; contact your machine manufacturer!
If possible, write your own experience!

- Supply voltage 400 Vac to U and V missing
- DC-link voltage missing
- Fuses on protective PCB released (connected to conductor bar of a SIMODRIVE system)
- Ribbon cable defective
- Defective fan
- Fuse on board of the UV 105 (B), UV 106 (B) released
- UV 105 (B), 106 (B) defective
- Contamination
- Humidity
- Overload

9.3 Error diagnosis on UV 101 B

When checking the UV 101 B power supply unit, proceed as follows:

Checking the supply voltages

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

> **Danger**
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See “Voltage tester” on page 14 - 412.
> Proceed carefully and concentratedly!

- Measure on connector X31 on the bottom of the UV 101 B phase U1 to U2.
  The voltage should be 400 Vac +/– 10 %.

> **Attention**
>
> Check whether the AC voltage input is connected via an isolating transformer. Do not ground this isolating transformer on the secondary side.

If 400 Vac are not available:

- Trace the phases to the main switch of the machine and to the fuses.

If connected:

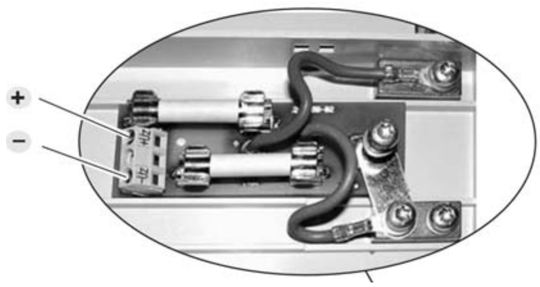
- Measure carefully whether the DC-link voltage on connector X31 on the bottom of the UV 101 B is available (the voltage depends on the inverter system).

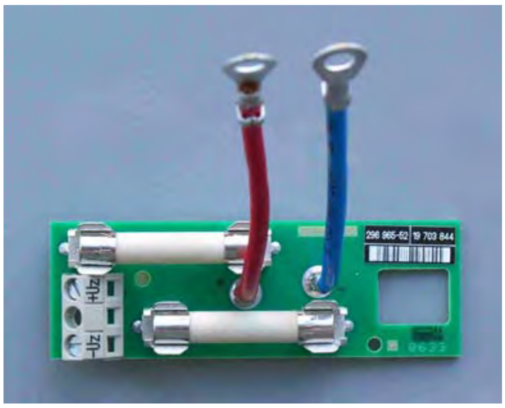
If the DC-link voltage is not available:

- Check the function of the power supply unit. See “Checking the voltages” on page 7 - 171.
- Check the protective PCB on the conductor bars of the SIMODRIVE system.

Protective PCB

When using a non-HEIDENHAIN inverter system (e.g., SIMODRIVE 611), the power supply from the DC-link is mostly lead via a protective PCB. This is secured to the conductor bar on the non-HEIDENHAIN inverter.





Figures: Protective PCB

Danger

Danger to life due to high voltages and currents!
The units must be free of potential for the following inspection.
Ensure that the machine is switched off and is not under voltage!

- Check the fuses on the protective PCB and exchange them, if necessary.

Checking the low voltages

If you have the HEIDENHAIN test adapter with the corresponding ribbon cable, you can connect it parallel to the 50-line ribbon cable of the UV 101 B and measure the corresponding low voltages.
See “Test adapter” on page 14 - 414.
See “X69, X169: NC supply voltage and control signals” on page 12 - 394.

Fuses in the UV 101 B

Danger

Danger of electrical shock!
The units must be free of potential for the following inspection.
Ensure that the machine is switched off and is not under voltage!

- Disconnect X31.
- Dismantle the UV 101 B power supply unit completely.
- Remove the side plate.
- Check the fuses on the power supply board.

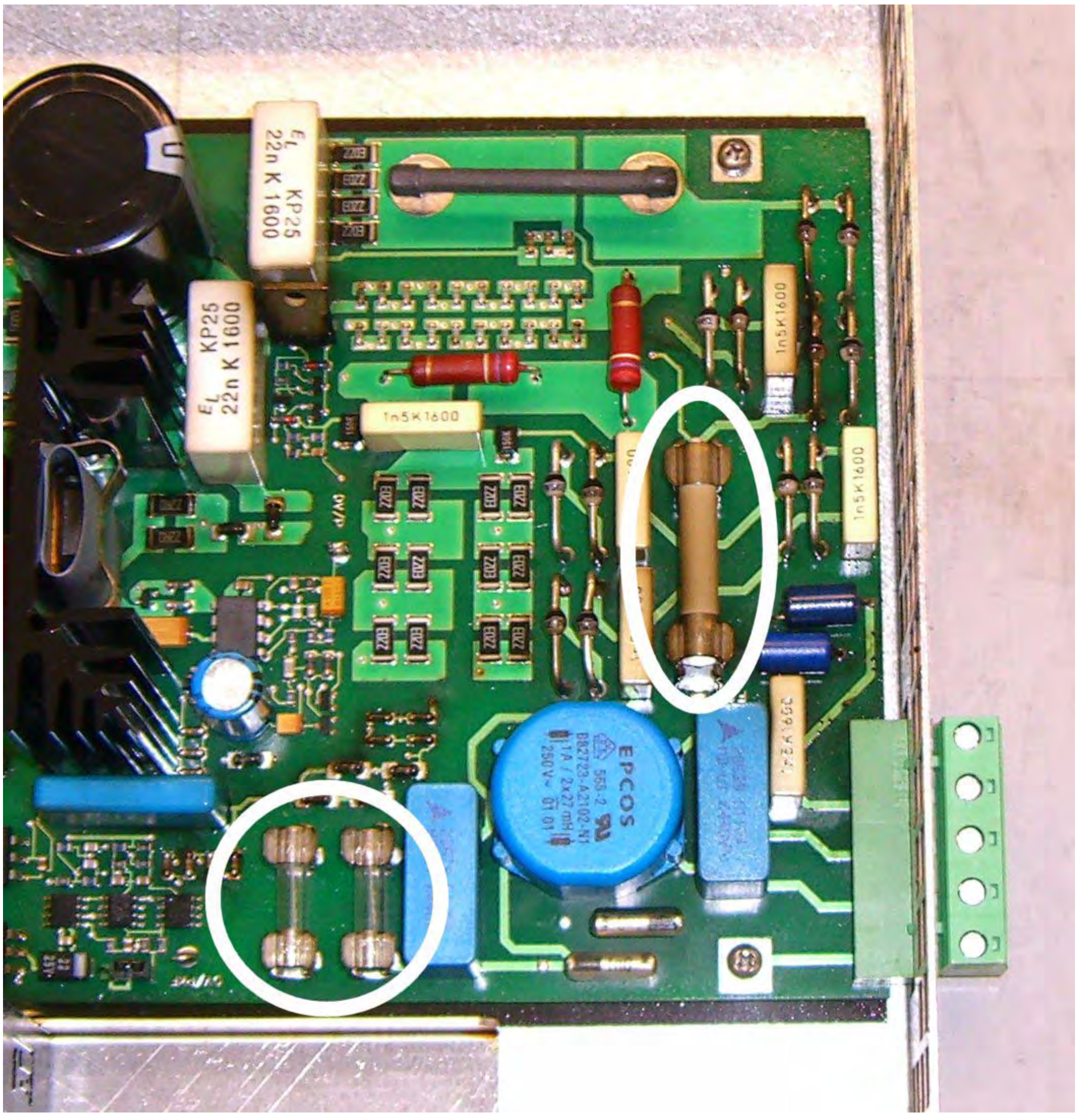
Danger

Danger of electrical shock!
A switching power supply is located in the UV 101 B. This switching power supply may still be under voltage although it is separated from the power source (without current consumer, the voltage on the board reduces only slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Attention

Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

Position of the fuses in the UV 101 B:



Note

If any of the fuses is defective, the UV 101 B power supply unit must be replaced. Replacing the fuses is not advised.

Corrective action

Defective power supply units are replaced!
See “Exchanging power supply units” on page 10 - 263.

9.4 Error diagnosis on the UV 102

When checking the UV 102 power supply unit, proceed as follows:

Checking the supply voltages

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

> **Danger**
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See "Voltage tester" on page 14 - 412.
> Proceed carefully and concentratedly!

- Measure on connector X31 on the bottom of the UV 102 phase U1 to U2.
  The voltage should be 400 Vac +/– 10 %.

If 400 Vac are not available:

- Trace the phases to the main switch of the machine and to the fuses.

If connected:

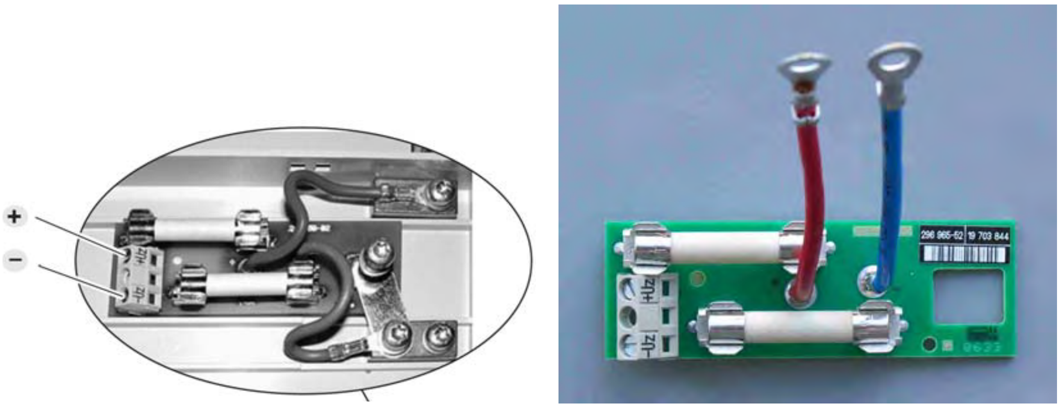
- Measure carefully whether the DC-link voltage on connector X31 on the bottom of the UV 102 is available (the voltage depends on the inverter system).

If the DC-link voltage is not available:

- Check the function of the power supply unit. See "Checking the voltages" on page 7 - 171.
- Check the protective PCB on the conductor bars of the SIMODRIVE system.

Protective PCB

When using a non-HEIDENHAIN inverter system (e.g., SIMODRIVE 611), the power supply from the DC-link is mostly lead via a protective PCB. This is secured to the conductor bar on the non-HEIDENHAIN inverter.



Figures: Protective PCB

> **Danger**
>
> **Danger to life due to high voltages and currents!**
> The units must be free of potential for the following inspection.
> Ensure that the machine is switched off and is not under voltage!

- Check the fuses on the protective PCB and exchange them, if necessary.

Checking the low voltages

If you have the HEIDENHAIN test adapter with the corresponding ribbon cable, you can connect it parallel to the 50-line ribbon cable of the UV 102 and measure the corresponding low voltages.
See “Test adapter” on page 14 - 414.
See “X69, X169: NC supply voltage and control signals” on page 12 - 394.

Fuses in UV 102

Danger

Danger of electrical shock!
The units must be free of potential for the following inspection.
Ensure that the machine is switched off and is not under voltage!

- Disconnect X31.
- Dismantle the UV 102 power supply unit.
- Remove the side plate.
- Check the fuses on the power supply board.

Danger

Danger of electrical shock!
A switching power supply is located in the UV 102. This switching power supply may still be under voltage although it is separated from the power source (without current consumer, the voltage on the board reduces only very slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Attention

Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

Note

If any of the fuses is defective, the UV 102 power supply unit must be replaced.
Replacing the fuses is not advised.

Corrective action

Defective power supply units are replaced.
See “Exchanging power supply units” on page 10 - 263.

9.5 Error diagnosis on the UV 105, UV 105 B

When checking the UV 105 (B) power supply unit, proceed as follows:

Checking the LED READY UV

The green LED READY UV on the front panel of the UV 105 B indicates that the unit is ready:

- Is this LED lit when the machine is switched on?

5 V on auxiliary terminal

- Measure whether the 5 V voltage on the auxiliary terminal on the front panel of the UV 105 (B) is available.

Function of the fan

- Check, whether the fan of the UV 105 (B) is running.

If it does not, this might indicate that ...

- No supply voltage for the UV 105 (B) is available.
- Fuses in the UV 105 (B) have blown
- The UV 105 (B) is defective.

The fan itself might be defective.

Checking the supply voltages

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

Danger

Danger to life due to high voltages and currents!
Use a suitable voltage test unit for the following measurement.
See “Voltage tester” on page 14 - 412.
Proceed carefully and concentratedly!

- Measure phase U to phase V on the connector on the bottom of the UV 105 or on the connector on the front panel of the UV 105 B.
  The voltage should be 400 Vac +/– 10 %.

Attention

If the UV 105 (B) is used in connection with regenerative HEIDENHAIN inverter systems or with non-HEIDENHAIN inverters:
Check whether the AC voltage input is connected correctly via an isolating transformer.
In this connection it is also important that the isolating transformer is not grounded on the secondary side.
Background: The isolating transformer decouples the line voltage from ground. Grounding the isolating transformer on the secondary side leads to an addition of the DC-link voltage and the supply voltage. This causes an overload that may destroy the UV 105 (B)!

If 400 Vac are not available:

- Trace the phases to the main switch of the machine and to the fuses.

If connected:

- Measure carefully whether a DC-link voltage on the conductor bars of the UV 105 or on the connector on the front panel of the UV 105 B is available (the voltage depends on the inverter system).

Note

When using the UV 105 in addition to a single-row HEIDENHAIN inverter system:
If the needle tip probes are thin and long, you do not have to open the protective covers over the conductor bars for measuring. You can contact the conductor bars between the gaps of the cover caps!

When using the UV 105 in addition to a multiple-row HEIDENHAIN invertery system or in connection with a SIMODRIVE system, you must lift the protective covers.

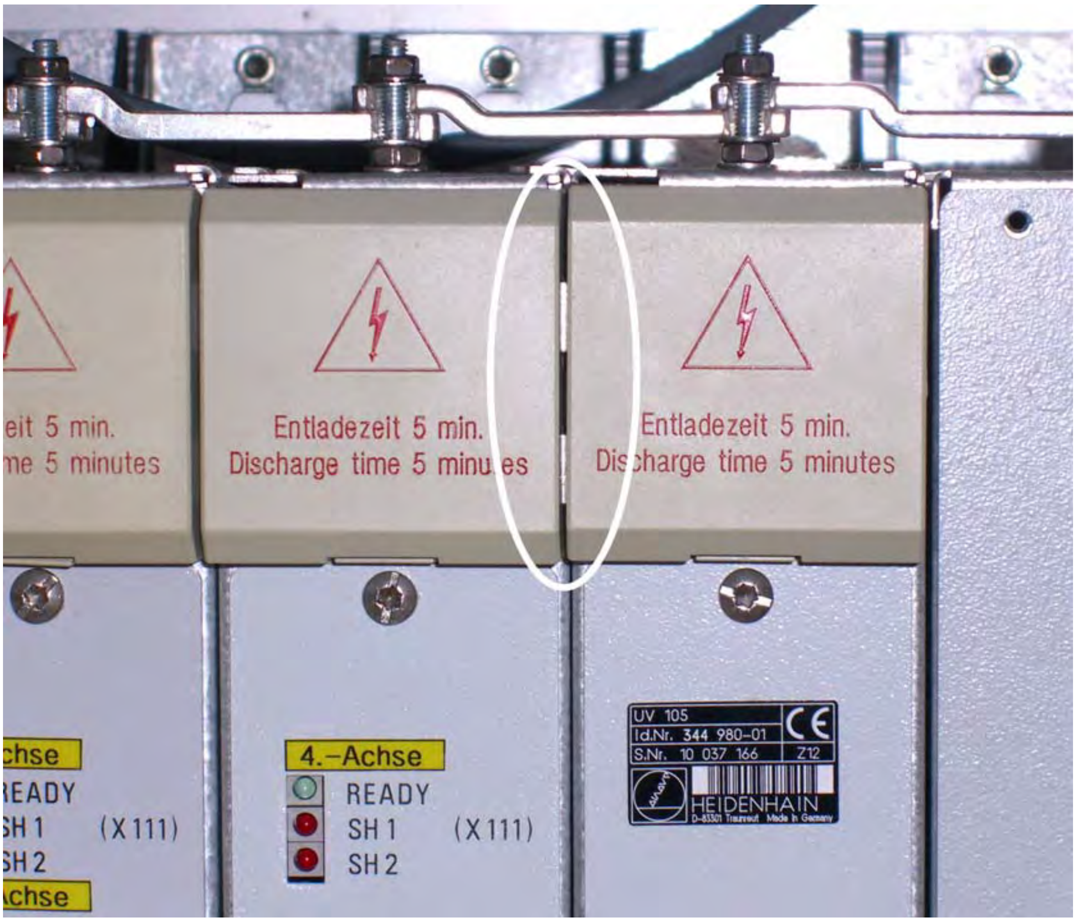


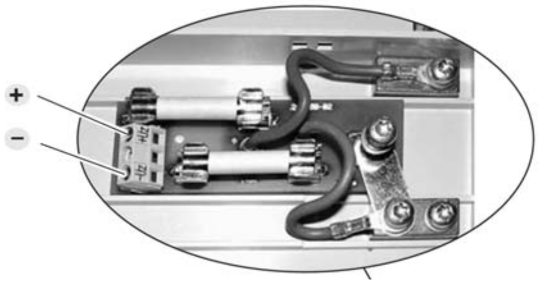
Photo: UV 105 in a single-row HEIDENHAIN inverter system

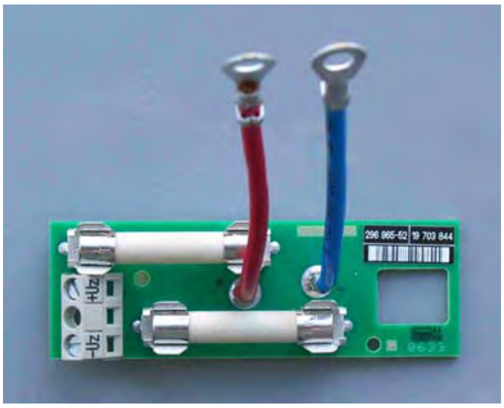
If the DC-link voltage is not available:

- Check the function of the power supply unit. See "Checking the voltages" on page 7 - 89, See "Checking the voltages" on page 7 – 171.
- Check the protective PCB on the conductor bars of the SIMODRIVE system.

Protective PCB

When using a non-HEIDENHAIN inverter system (e.g., SIMODRIVE 611), the power supply from the DC-link is mostly lead via a protective PCB. This is secured to the conductor bar on the non-HEIDENHAIN inverter.





Figures: Protective PCB

Danger

Danger to life due to high voltages and currents!
The units must be free of potential for the following inspection.
Ensure that the machine is switched off and is not under voltage!

▶ Check the fuses on the protective PCB and exchange them, if necessary.

Checking the low voltages

If you have the HEIDENHAIN test adapter with the corresponding ribbon cable, you can connect it in parallel to the 50-line ribbon cable of the UV 105 (B) and measure the corresponding low voltages.
See “Test adapter” on page 14 - 414.
See “X69, X169: NC supply voltage and control signals” on page 12 - 394.

Photo: Connection of the test adapter to the power supply bus

Fuses in the UV 105 (B)

Danger

Danger of electrical shock!
The units must be free of potential for the following inspection.
Ensure that the machine is switched off and is not under voltage!

- Switch off the machine and take precautions against restart.
- Check whether there is zero potential at U, V and +/- Uz.
- Wait at least 5 minutes, ensure again that there is zero potential at +/- Uz (there must be no residual voltage or current available) and remove the conductor bars or disconnect the connector on the front panel.
- Dismantle the UV 105 (B) power supply unit completely.
- Remove the side plate.
  Caution: On the UV 105, one screw is located under the cover cap for the connection of the conductor bar!
- Check the fuses on the power supply board.

Danger

Danger of electrical shock!
A switching power supply is located in the UV 105 (B). This switching power supply may still be under voltage although it is separated from the power source (without current consumer, the voltage on the board reduces only very slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Attention

Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

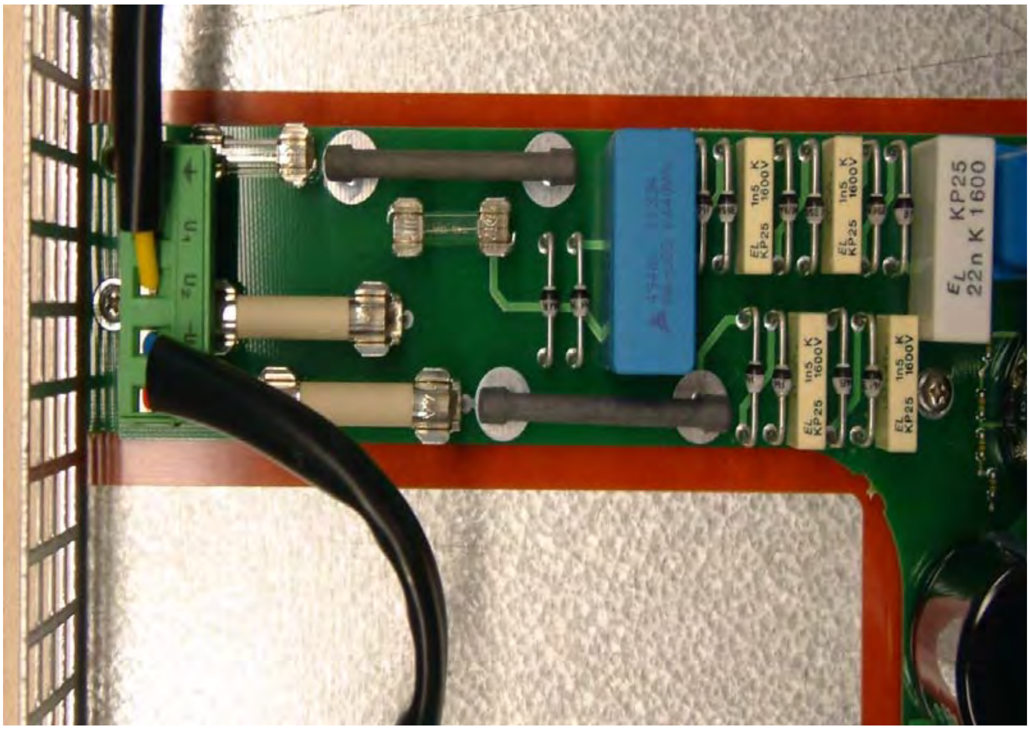


Photo: Position of the fuses in the UV 105

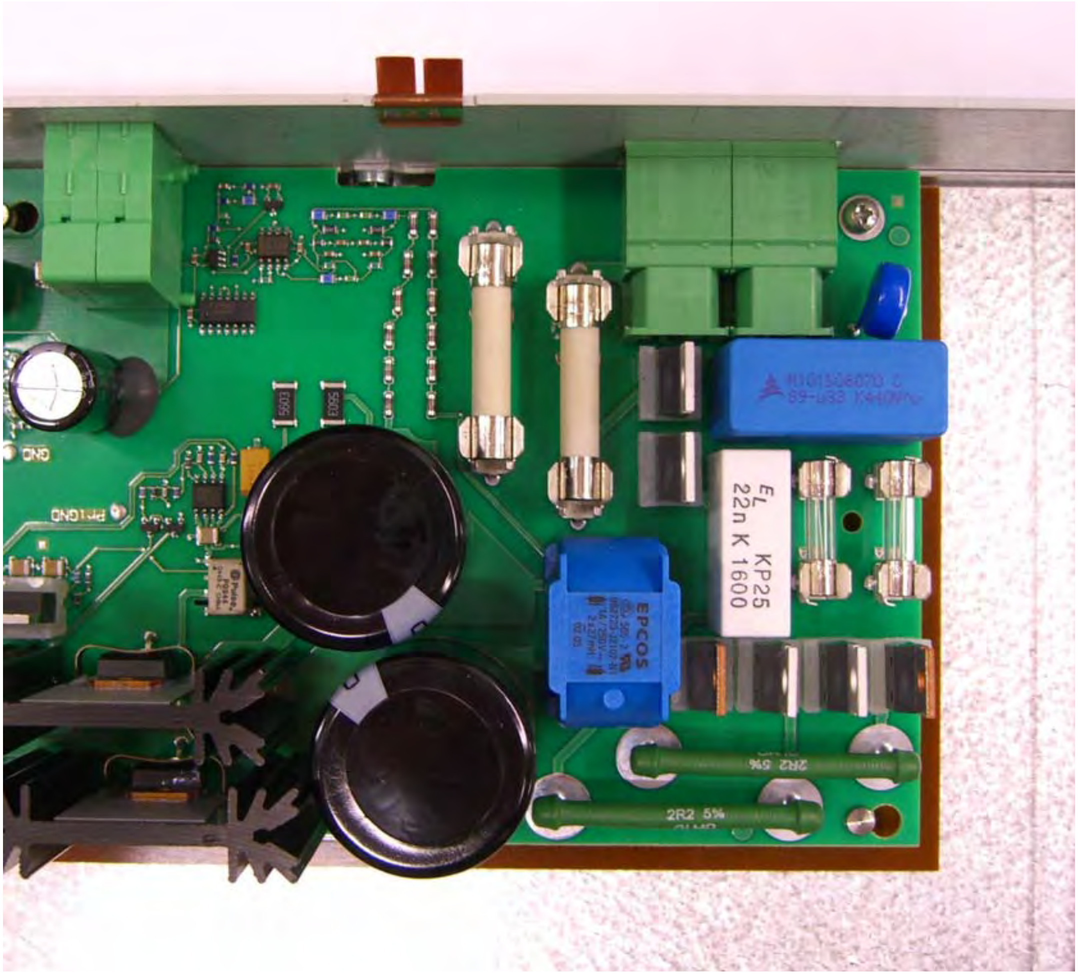


Photo: Position of the fuses in the UV 105 B

Note

If any of the fuses is defective, the UV 105 (B) power supply unit must be replaced.
Replacing the fuses is not advised.

Corrective action

Defective power supply units are replaced!
See "Exchanging power supply units" on page 10 - 263.

9.6 Error diagnosis on the UV 106 B

When checking the UV 106 B power supply unit, proceed as follows:

Checking the LED READY UV

The LED READY UV on the front panel of the UV 106 B indicates that the unit is ready:

- Is this LED lit when the machine is switched on?

Function of the fan

- Check, whether the fan of the UV 106 B is running.

If it does not, this might indicate that ...

- No supply voltage for the UV 106 B is available.
- Fuses in the UV 106 B have blown
- The UV 106 B is defective.

The fan itself might be defective.

Checking the supply voltages

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

> **Danger**
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See "Voltage tester" on page 14 - 412.
> Proceed carefully and concentratedly!

- Measure phase U to phase V on connector X31 on the front panel of the UV 106 B.
  The voltage should be 400 Vac +/– 10 %.

If 400 Vac are not available:

- Trace the phases to the main switch of the machine and to the fuses.

Checking the low voltages

Measuring the low voltages on the 50-pin ribbon cable of the UV 106 B (e.g. with the HEIDENHAIN test adapter) **does not make sense**.
The MC could not be connected and the UV 106 B would operate without current consuming unit.

Fuses in the UV 106 (B)

- Switch off the machine and take precautions against restart.
- Check whether there is zero potential at U and V.
- Dismantle the UV 106 B power supply unit completely.
- Remove the side plate.
- Check the fuses on the power supply board.

> **Danger**
>
> Danger of electrical shock!
> A switching power supply is located in the UV 106 B. This switching power supply may still be under voltage although it is separated from the power source (without current consumer, the voltage on the board reduces only very slowly).
> Do not touch the board or the fuses with bare hands!
> Use insulated pincers when removing the fuses!

> **Attention**
>
> Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

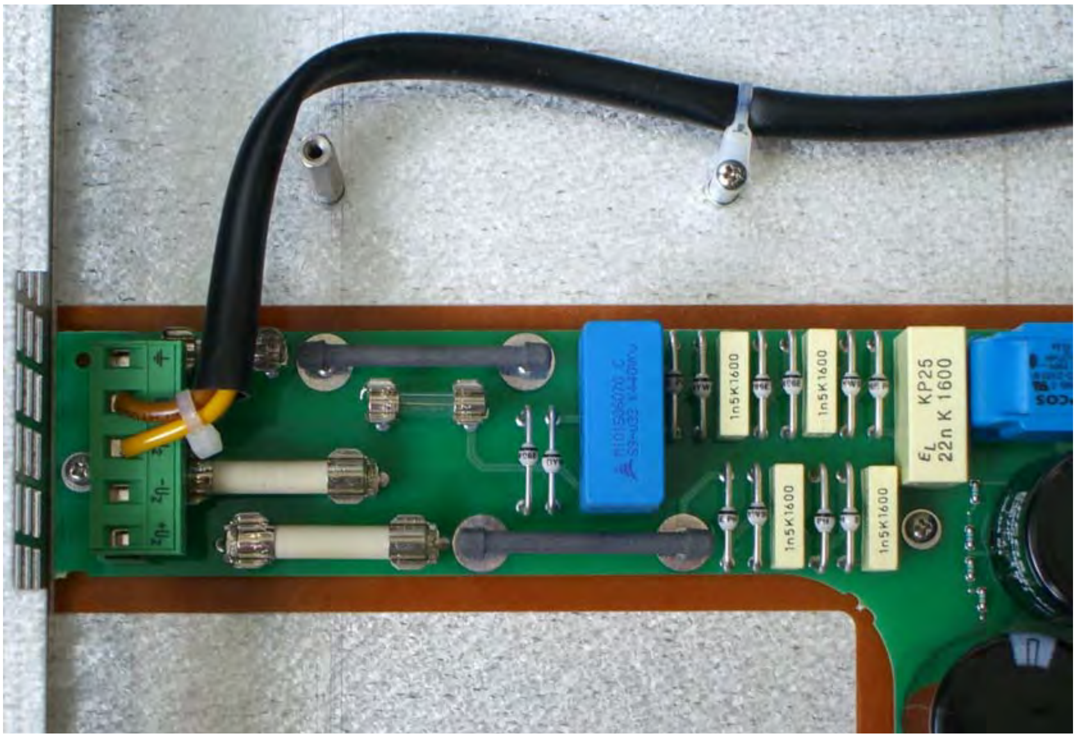


Photo: Position of the fuses in the UV 106 B

Note

If any of the fuses is defective, the UV 106 B power supply unit must be replaced.
Replacing the fuses is not advised.

Corrective action

Defective power supply units are replaced!
See “Exchanging power supply units” on page 10 - 263.

9.7 Error diagnosis on the UV 111A, UV 111B

When checking the UV 111x power supply unit, proceed as follows:

Checking the supply voltages

The following measurements must be performed while the machine is switched on.

- Always comply with the safety precautions!

> Danger
>
> Danger to life due to high voltages and currents!
> Use a suitable voltage test unit for the following measurement.
> See "Voltage tester" on page 14 - 412.
> Proceed carefully and concentratedly!

- Measure on connector X31 on the bottom of the UV 111x phase U1 to U2.
  The voltage should be 400 Vac +/– 10 %.

If 400 Vac are not available:

- Trace the phases to the main switch of the machine and to the fuses.

If connected:

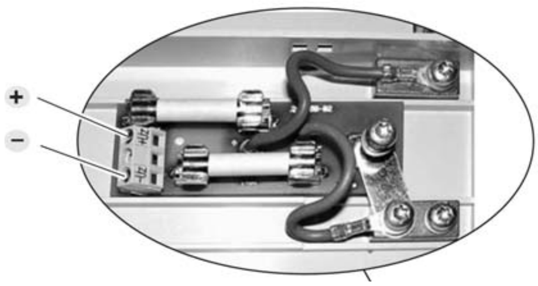
- Measure carefully whether the DC-link voltage on connector X31 on the bottom of the UV 111 is available (the voltage depends on the inverter system).

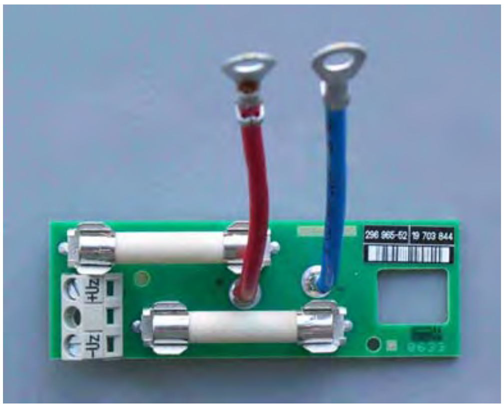
If the DC-link voltage is not available:

- Check the function of the power supply unit. See "Checking the voltages" on page 7 - 171.
- Check the protective PCB on the conductor bars of the SIMODRIVE system.

Protective PCB

When using a non-HEIDENHAIN inverter system (e.g., SIMODRIVE 611), the power supply from the DC-link is mostly lead via a protective PCB. This is secured to the conductor bar on the non-HEIDENHAIN inverter.





Figures: Protective PCB

> Danger
>
> **Danger to life due to high voltages and currents!**
> The units must be free of potential for the following inspection.
> Ensure that the machine is switched off and is not under voltage!

- Check the fuses on the protective PCB and exchange them, if necessary.

Checking the low voltages

If you have the HEIDENHAIN test adapter with the corresponding ribbon cable, you can connect it in parallel to the 50-line ribbon cable of the UV 111x and measure the corresponding low voltages.
See “Test adapter” on page 14 - 414.
See “X69, X169: NC supply voltage and control signals” on page 12 - 394.

Fuses in the UV 111x

- Switch off the machine and take precautions against restart.
- Disconnect X31.
- Dismantle the UV 111x power supply unit.
- Remove the side plate.
- Check the fuses on the power supply board.

Danger

Danger of electrical shock!
A switching power supply is located in the UV 111x. This switching power supply may still be under voltage although it is separated from the power source (without current consumer, the voltage on the board reduces only very slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Attention

Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

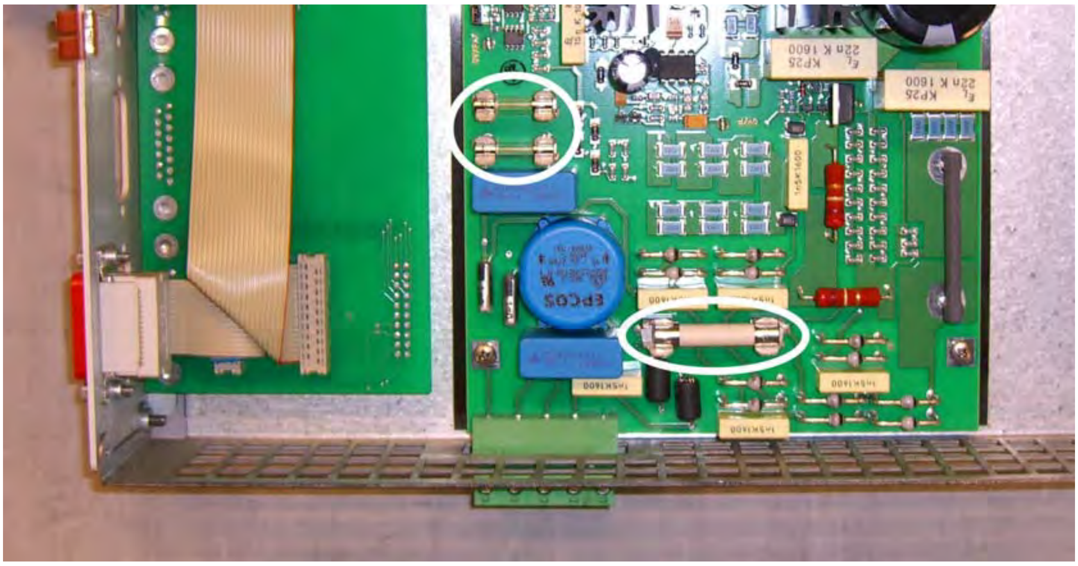


Photo: Position of the fuses in the UV 111x

Note

If any of the fuses is defective, the UV 111x power supply unit must be replaced.
Replacing the fuses is not advised.

Corrective action

Defective power supply units are replaced!
See “Exchanging power supply units” on page 10 - 263.

10 Exchange of HEIDENHAIN components

10.1 Important notes

Danger

Observe the safety precautions to avoid injury or damage to persons or machines!
See “Safety precautions” on page 2 – 13!

Attention

Always use original HEIDENHAIN components as replacements!

Which components can be exchanged in the field?

- **Complete inverter**
- **Controller unit with integrated UEC / UMC inverter**
- **Inverter accessories (UP, SM, ...) complete**
- **Complete motor**
- **Motor encoder of the QAN asynchronous motor**
- **Signal socket of the motor**
- **Fan of the spindle motor**
- **Fan guard of the spindle motor**
- **Temperature sensors in the spindle motor**
- **Cables, various connectors and accessories**
- **HEIDENHAIN interface cards for the SIMODRIVE system**

What cannot be replaced?

- **Boards of the inverter**
  (HEIDENHAIN inverters must not be disassembled!)
- **Motor bearing**
  (The motor is balanced at HEIDENHAIN.)
- **Motor brake**
  (After replacing the motor brake, normally the motor must be balanced again. This will be effected at HEIDENHAIN.)
- **Motor encoder of the QSY synchronous motor**
  (The mounting, adjusting and the programming of the electronic ID label is performed by HEIDENHAIN.)
- **Contacts in power sockets**
  (Special crimp pliers are required.)

Electronic ID label

Following HEIDENHAIN units feature an electronic ID label:

- **Controller units with integrated inverter**, e.g., UEC 112, UMC 111
- **Inverter components**, that contain a **"D"** in the designation, e.g., UM 112D
- **Synchronous motors** with **EnDat motor encoders**, e.g., QSY 96A EnDat

The product name, the ID number and the serial number are saved in this ID label.

These units are automatically recognized when the current HEIDENHAIN control (e.g., iTNC 530) is booted.

Units with electronic ID label are logged on automatically to the HEIDENHAIN control. They effect an automatic entry in the machine parameter list of the control ("Plug and Play").

Photo: The electronic ID label of a HEIDENHAIN power module is reported to the monitor of the control

During every control restart, the control checks whether the connected units with electronic ID label match the entries in the machine parameter list.

ESD protection ESD = Electrostatic discharge

Attention

When you exchange HEIDENHAIN components, you might come into direct or indirect contact with electronic components.

Always assume that **all electronic components and assemblies are endangered by electrostatic discharge (ESD)** and may be **damaged by incorrect handling**.

These ESD-sensitive components could also come into contact with a statically charged object (tool, workbench, packaging, etc.)

Therefore, observe the ESD protective measures, when you exchange HEIDENHAIN components with directly accessible electronic components!

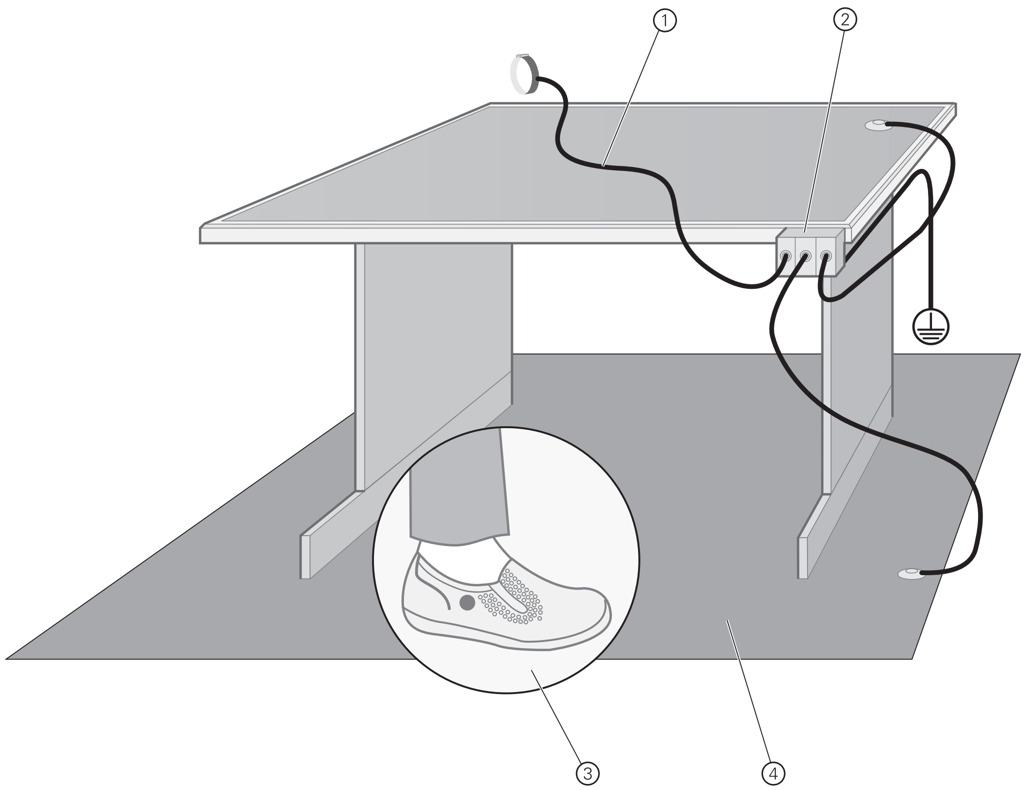
Keep in mind that you can damage components that are not accessible simply by touching the pins in connectors!

To ensure protection from ESD, follow the precautionary measures described in **IEC 61340-5-1**, **IEC 61340-5-2** and **IEC 61340-4-1**.

The following are some points covered in the above mentioned standards:

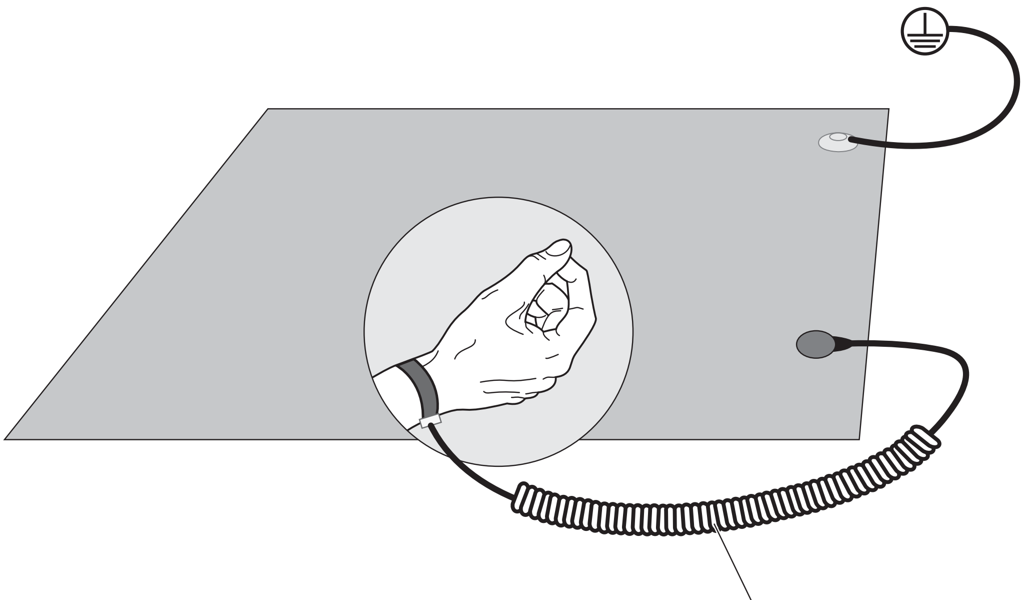
- When handling electrostatically endangered components or assemblies (e.g. exchange, installation, shipping), **always comply with** the **precautionary measures in these standards**.
- Store and transport ESD-sensitive components in **ESD protective containers** (use the original packaging).
- Ensure during handling the **proper grounding of the working area** (e.g. tool, workbench, packaging) **and the person**.
- **Inspect the ESD protection system regularly.**

The following figure shows how a suitable working area could look in accordance with IEC 61340.



1	Wristband with 1 Mohm grounding cable for grounding the person
2	Grounded connection for wristbands, floor mats, table mats etc. for equipotential bonding
3	Dissipative shoes
4	Dissipative flooring or floor mat

An important part of the working area is a suitable working surface with a wristband with 1 Mohm grounding resistance for grounding the person:



Information about possible errors

Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.

ID number for service order

When placing a service order, always indicate the ID number of the HEIDENHAIN device concerned.

Serial number for traceability

For reasons of **traceability** also indicate the serial number of the HEIDENHAIN device. The serial number as well as the ID number can be found on the ID label of the device.

Replacement units and spare parts

For replacement units and spare parts, ask your **machine manufacturer**!

Please observe:

- **Always use original HEIDENHAIN components as replacements!**
- Please send the defective unit in its **original packaging** to your machine manufacturer or your HEIDENHAIN agency.

Repair

Many HEIDENHAIN units are not repaired on site but are exchanged or replaced.
These devices are exclusively repaired by the specialists of the HEIDENHAIN workshops. The devices are also updated to the latest state-of-the-art and subjected to tests.

Packaging

- If possible, use the original packaging from HEIDENHAIN.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- ▶ Check whether the electrical equipment corresponds to the technical documentation.
- ▶ Check whether the protective ground system is continuous.
- ▶ Perform a functional check.

10.2 Replacement of the complete controller unit with integrated inverter

Removing the defective controller unit

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential!

> Note
>
> If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

- Unscrew the grounding lead on the top of the UEC/UMC.
- Label and disconnect or unscrew all plug and clamp connections on the UEC/UMC.
- Unscrew the ground leads for the motors.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the defective UEC/UMC slightly and remove it towards you.

Integrating the new controller unit

- Hook the new UEC/UMC into the mounting screws.
- Tighten the mounting screws.
- Screw the grounding lead to the top of the UEC/UMC.
- Re-establish and screw into place all of the connections.
- Screw on the ground leads for the motors.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective UEC/UMC in the original packaging of the new UEC/UMC.
- Return the defective inverter to the machine manufacturer or to your HEIDENHAIN agency.

10.3 Exchanging the complete inverter

10.3.1 Inverter without water cooling

Removing the defective inverter

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential!

Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Danger

Wait at least 5 minutes before you unscrew the conductor bars (there is a corresponding warning on the cover caps of the conductor bars)!
Use an appropriate voltage tester to check whether the **DC-link voltage is zero**!

- Open the protective covers and unscrew the conductor bars.
- Unscrew the grounding bars or ground lead on the top of the inverter.
- Screw off the cover plate.
- Label and disconnect or unscrew all of the connections on the inverter.
- Unscrew the ground leads for the motors.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the defective inverter slightly and remove it towards you.

Integrating the new inverter

- Hook the new inverter into the mounting screws.
- Tighten the mounting screws.
- Screw the grounding bars or ground lead on the top of the inverter.
- Screw the conductor bars (3.5 Nm tightening torque) and close the protective caps!
- Re-establish and screw into place all of the connections.

Danger

If the inverter features a connection possibility for additional 5V lines:
The additional 5 V lines must be polarized and connected correctly!
Otherwise there will be a short circuit of these lines on the 5V ribbon wires.

- Screw the ground leads for the motors.
- Screw on the cover plate.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective inverter in the original packaging of the new inverter.
- Return the defective inverter to the machine manufacturer or to your HEIDENHAIN agency.

10.3.2 Inverter with water cooling

Removing the defective inverter

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential!

> Note
>
> If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

> Attention
>
> The replacement of water-cooled components must only be performed after consultation with a person responsible for the coolant system of the machine or trained specialists.
> Follow the **instructions of the machine manufacturer** regarding the coolant system of the machine!

- You need to empty the coolant circuit completely outside the electrical cabinet before screwing off the pressure tubing from the inverter.

> Danger
>
> Wait at least 5 minutes before you unscrew the conductor bars (there is a corresponding warning on the cover caps of the conductor bars)!
> Use an appropriate voltage tester to check whether the **DC-link voltage is zero**!

- Open the protective covers and unscrew the conductor bars.
- Unscrew the grounding bars or ground lead on the top of the inverter.
- Screw off the cover plate.
- Label and disconnect or unscrew all of the connections on the inverter.
- Unscrew the ground leads for the motors.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the defective inverter slightly and remove it towards you.

Integrating the new inverter

- Hook the new inverter into the mounting screws.
- Tighten the mounting screws.
- Screw the grounding bars or ground lead on the top of the inverter.
- Screw the conductor bars (3.5 Nm tightening torque) and close the protective caps!
- Re-establish and screw into place all of the connections.

> Danger
>
> If the inverter features a connection possibility for additional 5V lines:
> The additional 5 V lines must be polarized and connected correctly!
> Otherwise there will be a short circuit of these lines on the 5V ribbon wires.

- Screw on the ground leads for the motors.
- Screw on the cover plate.
- Check the sealings at the end of the pressure hoses:
  They must not be damaged and have to be in the correct position!

- After correct connection, the coolant circuit must be ventilated.

> Danger
>
> Check the complete cooling circuit for tightness before putting the components into service (max. pressure of coolant = 5 bar)!
> **Water may not penetrate into electrical units or into the electrical cabinet!**

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective inverter in the original packaging of the new inverter.
- Return the defective inverter to the machine manufacturer or to your HEIDENHAIN agency.

10.4 Exchanging the complete motor

10.4.1 Motor without hollow shaft

Removing the defective motor

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential!

> Danger
>
> Secure vertical axes to prevent them from falling down before you remove motors on these axes!

> Note
>
> If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

- Label and disconnect or unscrew all plug and clamp connections on the motor.
- Screw out the mounting screws for the motor.
- Remove the defective motor.

Integrating the new motor

- Insert the new motor.
- Tighten the mounting screws for the motor.
- Re-establish and screw into place all of the connections.

> Attention
>
> When exchanging a spindle motor with terminal box:
> Do not switch any phases in the terminal box and observe the correct rotational direction when connecting the fan!

> Note
>
> After exchanging the spindle motor:
> If the reference mark of the motor encoder is used for spindle orientation, the "spindle preset" (offset between nominal and actual position of the reference mark) must be set again after replacement of the spindle motor.
>
> After exchanging the axis motor:
> If the motor encoder of the axis motor is used for referencing this axis, the machine datum must be set again for this axis.
>
> Consult the service manual for the respective HEIDENHAIN control or ask the machine manufacturer or a HEIDENHAIN service agency.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Testing the functions

- Ramp the motor slowly up to maximum speed.
- Check the rotational direction of the fan on the spindle motor.
- Check the function of the brake on the axis motor.

Return shipment

- Write the assumed error or circumstances that caused the failure of the motor on a slip of paper and apply it to the outside of the unit.
- Pack the defective motor in the original packaging of the new motor.
- Return the defective motor to the machine manufacturer or to your HEIDENHAIN agency.

10.4.2 Motor with hollow shaft

Removing the defective motor

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential!

> **Note**
>
> If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

> **Attention**
>
> The replacement of hollow shaft motors with coolant feed for tools with inner cooling must only be performed after consultation with a person responsible for the coolant system of the machine or trained specialists.
> Follow the **instructions of the machine manufacturer** regarding the coolant system of the machine!

- You need to empty the coolant circuit completely before screwing off the pressure tubing from the hollow-shaft motor.
- Label and disconnect or unscrew all plug and clamp connections on the motor.
- Screw out the mounting screws for the motor.
- Remove the defective motor.

Integrating the new motor

- Insert the new motor.
- Tighten the mounting screws for the motor.
- Re-establish and screw into place all of the connections.

> **Attention**
>
> When exchanging a spindle motor with terminal box:
> Do not switch any phases in the terminal box and observe the correct rotational direction when connecting the fan!

- Check the sealings at the end of the pressure hoses:
  They must not be damaged and have to be in the correct position!
- After correct connection, the coolant circuit must be ventilated.

> **Danger**
>
> Check the complete cooling circuit for tightness before putting the components into service!
> **Coolant must not penetrate into electrical units or into the electrical cabinet!**

> **Note**
>
> If the reference mark of the motor encoder is used for spindle orientation, the "spindle preset" (offset between nominal and actual position of the reference mark) must be set again after replacement of the spindle motor.
>
> Consult the service manual for the respective HEIDENHAIN control or ask the machine manufacturer or a HEIDENHAIN service agency.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Testing the functions

- Ramp the motor slowly up to maximum speed.
- Check the rotational direction of the fan.

Return shipment

- Write the assumed error or circumstances that caused the failure of the motor on a slip of paper and apply it to the outside of the unit.
- Pack the defective motor in the original packaging of the new motor.
- Return the defective motor to the machine manufacturer or to your HEIDENHAIN agency.

10.5 Exchanging the motor encoder of the QAN asynchronous motor

Introduction

Motor encoders in asynchronous motors (usually ERN 1381) do not have to be adjusted to the field angle!
To date they do not feature electronic ID labels with information on the spindle motor and other information of the machine manufacturer.
Thus you do not need any special instructions and devices (e.g., PWM 9, PWM 20, IK 215) for the exchange.

The motor encoder of the asynchronous motor can be exchanged in the field.

Mounting instructions

All motor encoders are supplied with mounting instructions. It describes the dismounting and mounting of the encoder shown by figures.

Tools

The following screws are helpful for dismounting the various motor encoders:

- Setscrew M4 x 45
- Forcing screw M5 x 50
- Setscrew M5 x 10
- Setscrew M5 x 45
- Forcing screw M6 x 70
- Forcing screw M10 x 70 (for "redesign encoder“)

> **Attention**
>
> Sometimes self-made "forcing screws" are used for dismounting motor encoders. The front section of these "special screws“ is twisted off. It can penetrate into the hole of the motor shaft. The metric thread that engages in the internal thread of the motor encoder begins in the back section.
> **But:**
> It is possible that the blind hole in the motor shafts varies.
> When the hole depth varies, a self-made "forcing screw" is not effective or may even damage the internal thread of the motor shaft!

> **Attention**
>
> Do not use striking tools for dismounting the motor encoder!
> The bearings of the motor shaft could be damaged.
> Furthermore, massive strokes would have a negative effect on the magnetism of the permanent magnets of synchronous motors.

A **torque screwdriver** is also required.
HEIDENHAIN recommends the following adjustable torque screwdrivers:

Torque	**ID number**
0,2 ... 1.2 Nm	350379-04
1,0 ... 5.0 Nm	350379-05

You can also find the current torque screwdrivers in the HEIDENHAIN brochures "Rotary Encoders" and "Measuring Systems for Servo Drives".

Removing the defective motor encoders

Ideally you have dismounted the motor and you can replace the motor encoder on a workbench.

If larger spindle motors are affected it makes sense to replace the encoder while the motor is still incorporated.

Danger

If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
Check whether the machine is under voltage.
Observe the safety precautions to avoid injury or damage to persons or machines!
See “Safety precautions” on page 2 – 13.

Note

Due to design reasons the exchange of motor encoders can be **very complex**!

This especially applies to **motors with complete chassis**.
Individual metal sheet parts cannot be removed to gain fast and easy access to the fan assembly and the motor encoder.

Nearly all mounting parts of the motor must be removed, cables unclamped in the terminal box and the signal socket dismounted with a special tool in order to dismantel the chassis.

HEIDENHAIN recommends to send these motor to HEIDENHAIN for repair.

Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Example with QAN 3M with ERN 1381 rotary encoder:

- Screw off the fan guard and cover plate.
- Screw off the signal socket from the cover plate.
- Screw off the cap to which the fan is attached. The motor encoder is now accessible.
- Screw off and remove the cover cap of the encoder cable.
- Disconnect the encoder cable.
- **Loosen the expanding coupling of the motor encoder** (do not screw out the screw completely). The housing of the motor encoder must be free to rotate!
- Screw out the hexagon socket screw connecting the encoder with the motor shaft.
- Screw the setscrew four to five revolutions into the thread of the motor shaft.

> Attention
>
> Do not screw in too deep! The forcing screw is to hit the setscrew and not the internal thread of the motor shaft (mounting instructions).

- Turn the forcing screw into the internal thread of the conical encoder shaft until the encoder is loosened in the precision guide.

Integrating the new motor encoder

Example with QAN 3M with ERN 1381 rotary encoder:

- Screw out the setscrew again.
- Push the new encoder into the precision guide of the motor shaft.
- Screw in the hexagon socket screw connecting the rotary encoder with the motor shaft and tighten it with a torque wrench (the torque setting is specified in the mounting instructions for the corresponding rotary encoder).
- Connect the encoder cable.

> Attention
>
> If there is no reverse-polarity protection, pay attention to the **TOP** label!

- Put the metal sleeve at the end of the motor encoder cable in the prepared depression of the cover cap.
- Insert and screw on the cover cap.
- Turn the encoder housing in a position that is favorable for the cable route.
- Mount the encoder coupling with a torque screwdriver (you can find the torque setting in the respective mounting instructions).
- Screw on the cap to which the fan is attached.
- Screw the plate with the right-angle coupling to the cover plate.
- Screw on the fan guard and cover plate.

> Note
>
> Motor encoders in asynchronous motors do not have to be adjusted to the rotor position!
> If the reference mark of the encoder is used for spindle orientation, the "spindle preset" (offset between nominal and actual position of the reference mark) must be set again after the rotary encoder has been replaced.
> Consult the service manual for the respective HEIDENHAIN control or ask the machine manufacturer or a HEIDENHAIN service agency.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the motor encoder on a slip of paper and apply it to the outside of the unit.
- Pack the defective motor encoder in the original packaging of the new motor encoder.
- Return the defective motor encoder to the machine manufacturer or to your HEIDENHAIN agency.

10.6 Replacement of scanning head and scale drum of the hollow-shaft motor

Introduction

The speed measurement of **hollow shaft motors** with coolant feed for tools with inner cooling (e.g., QAN 200 UH) is made by means of a scale drum and the associated scanning head.

In the event of an error, the scanning head can be replaced on all hollow-shaft motors.
The scale drum cannot be replaced on all hollow-shaft motors in the field.

Possibilities to replace the drum scale in the field	
QAN 200 UH, QAN 260 MH, QAN 260 LH, QAN 260 UH	The drum scale cannot be replaced. It is mounted behind a high-precision balancing ring. When replacing the drum scale, **the spindle motor must thus be balanced again**. This **cannot be done in the field!**
QAN 360 MHW, QAN 360 UHW, QAN 360 LHW	The scale drum can be replaced as it is mounted in front of the balancing ring. When replacing the drum scale, the spindle motor does thus not have to be balanced again.

HEIDENHAIN hollow-shaft motors are asynchronous spindle motors. The field angle does not have to be adjusted.
To date they do not feature electronic ID labels with information on the spindle motor and other information of the machine manufacturer.

Coolant system

Attention

Work on the coolant system of the machine must only be performed after consultation with a person responsible for the coolant system of the machine or trained specialists.
Follow the **instructions of the machine manufacturer** regarding the coolant system of the machine!

- You need to empty the coolant circuit completely before screwing off the pressure tubing from the hollow-shaft motor.

Mounting instructions

All scanning heads and scale drums are supplied with mounting instructions. It describes the mounting shown by figures.

Tools

Attention

Do not use magnetizable tools! The magnetic graduation on the drum could be damaged.

10.6.1 Replacement of the scanning head without signal cable

If only the scanning head is replaced but not the signal cable, the time-consuming pulling through of the cable is not required.

Removing the defective scanning head

Ideally you have dismounted the motor and you can replace the scanning head on a workbench.

Otherwise the scanning head must be replaced on the mounted motor.

Danger

If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
Check whether the machine is under voltage.
Observe the safety precautions to avoid injury or damage to persons or machines!
See "Safety precautions" on page 2 – 13.

Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Example with QAN 200 UH with the scanning head AK ERM 280:

▶ Remove the fan guard and fan on the back side of the motor.

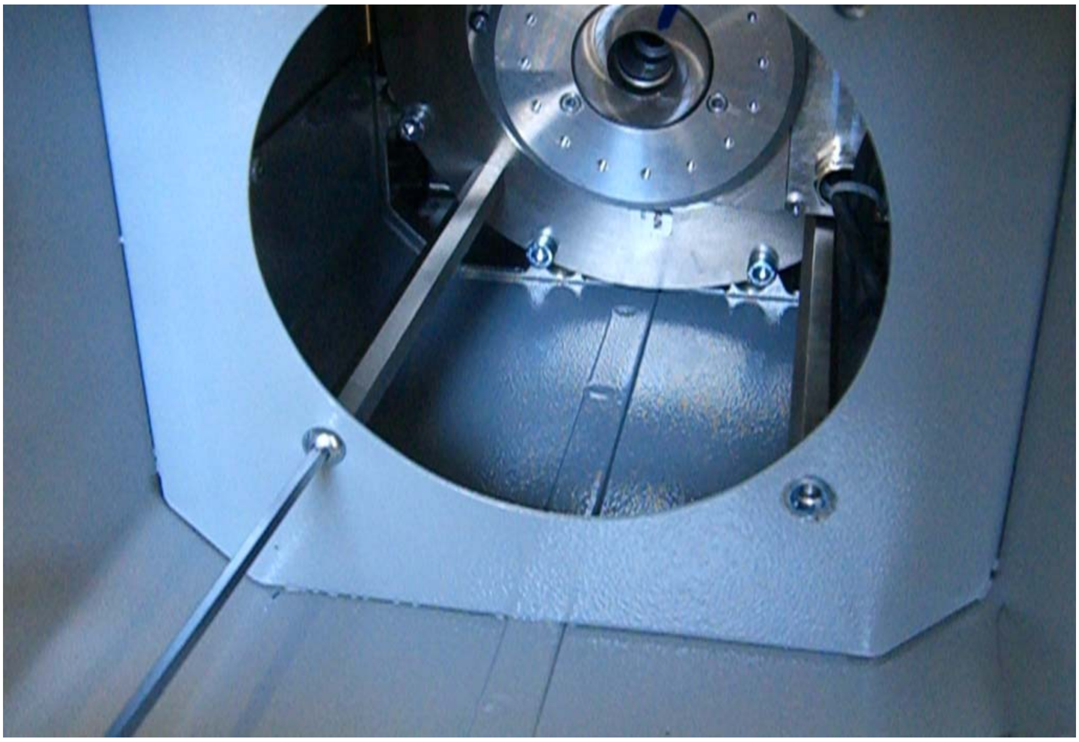
Attention

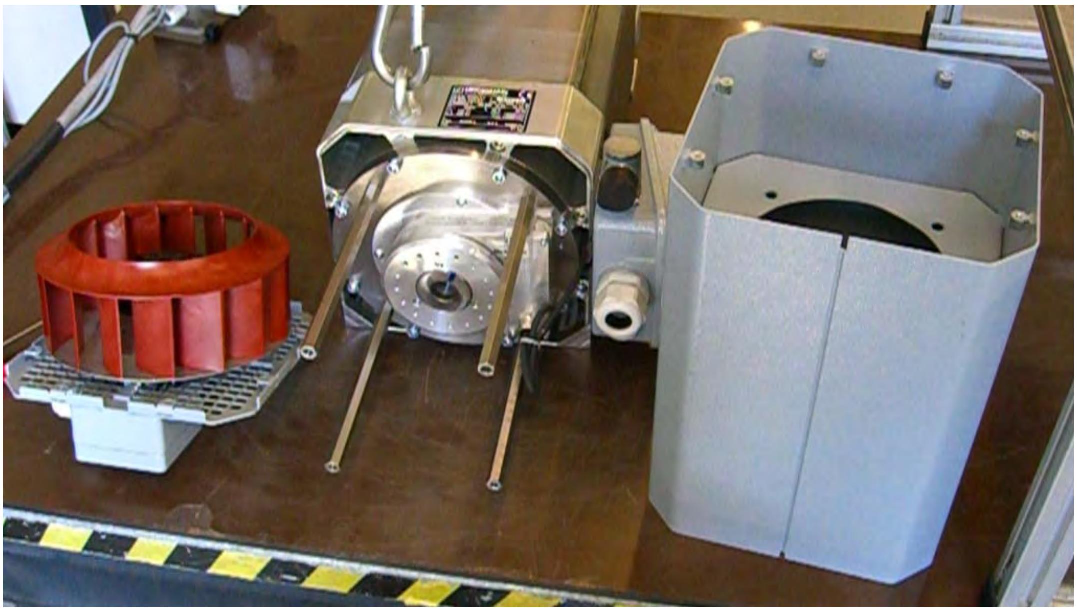
Work on the coolant system of the machine must only be performed after consultation with a person responsible for the coolant system of the machine or trained specialists.
Follow the **instructions of the machine manufacturer** regarding the coolant system of the machine!

▶ You need to empty the coolant circuit completely before screwing off the pressure tubing from the hollow-shaft motor.

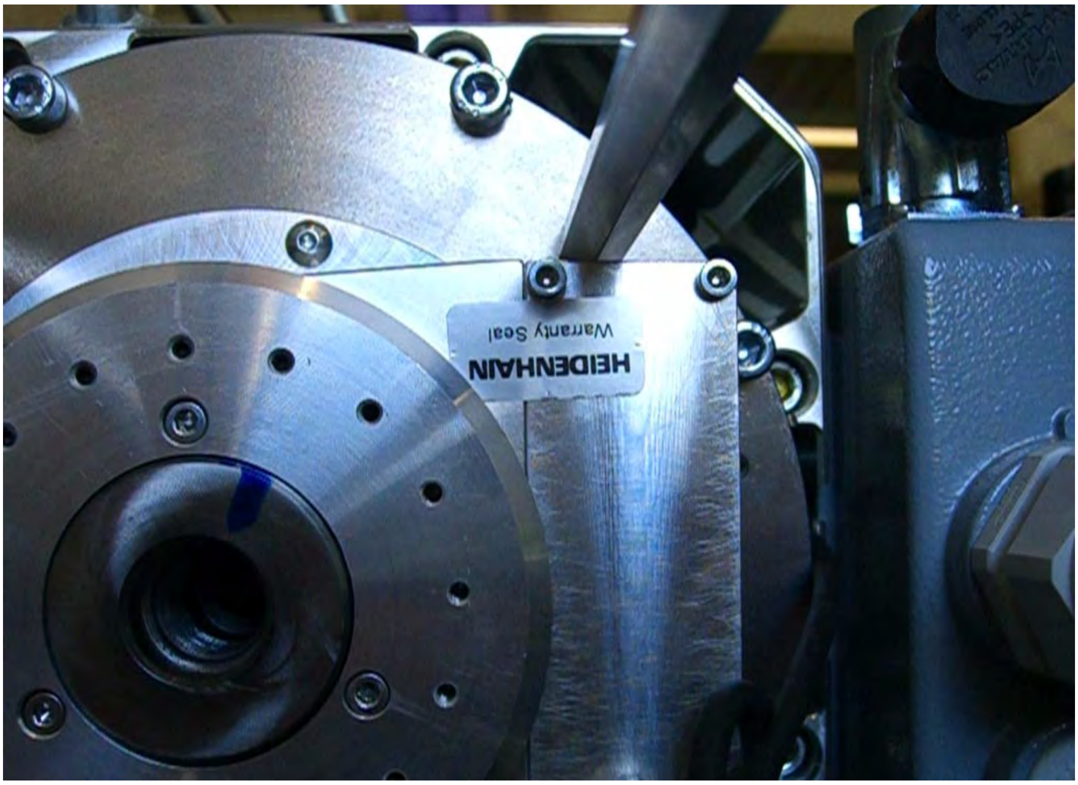
▶ Dismount the coolant connection.

▶ Remove the fan housing.

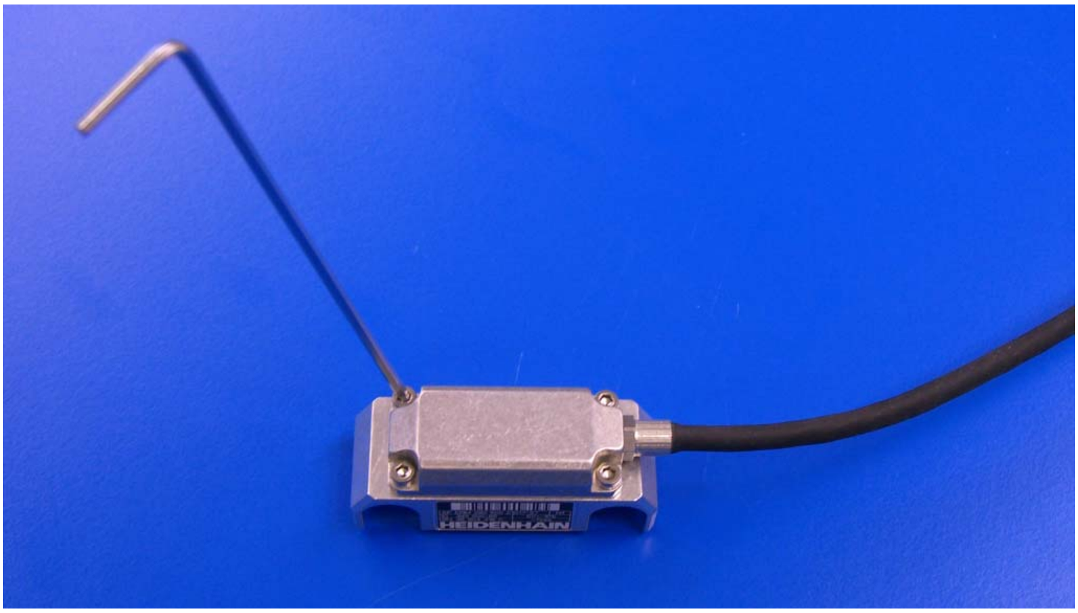


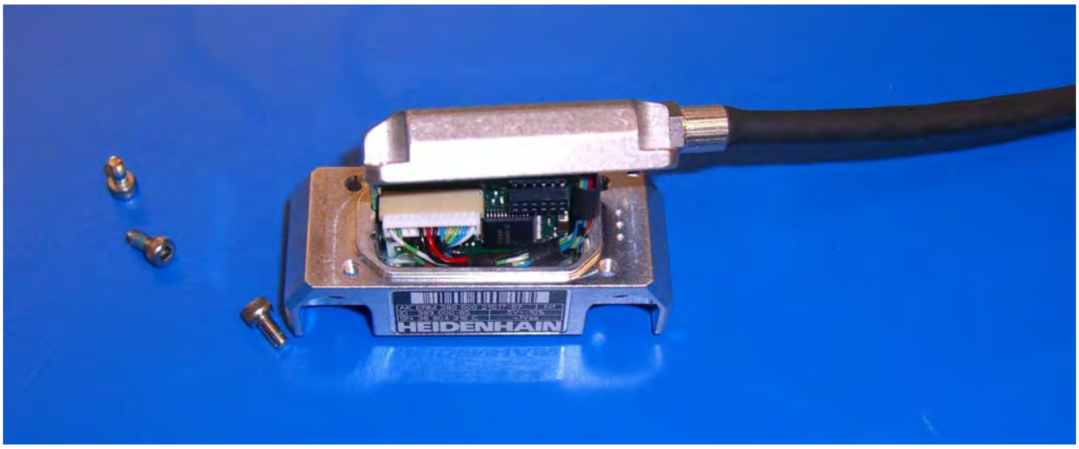


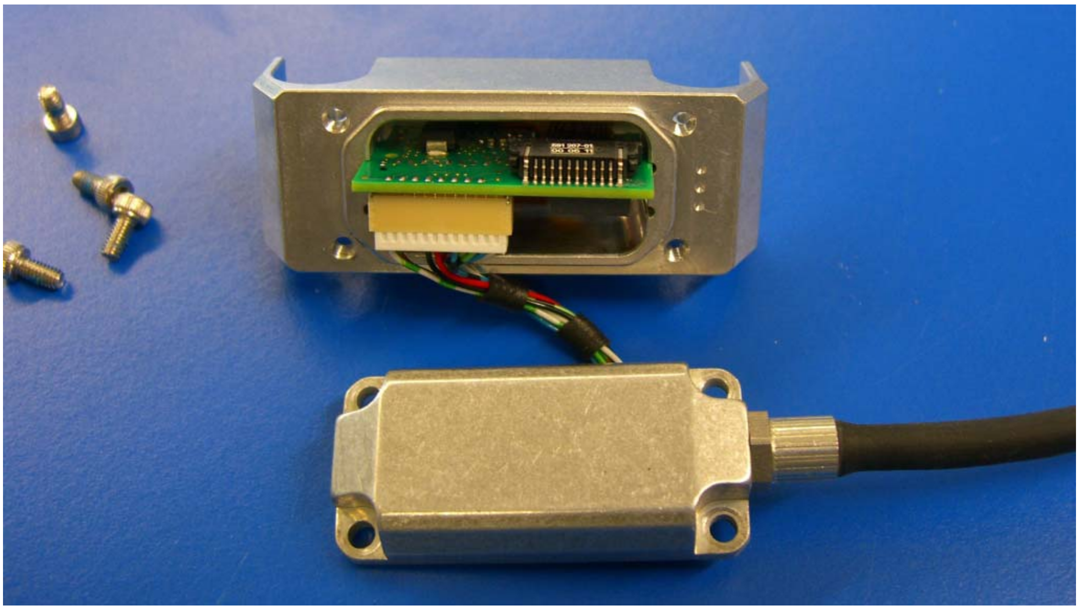
▶ Screw off the covers for the drum scale and the scanning head.



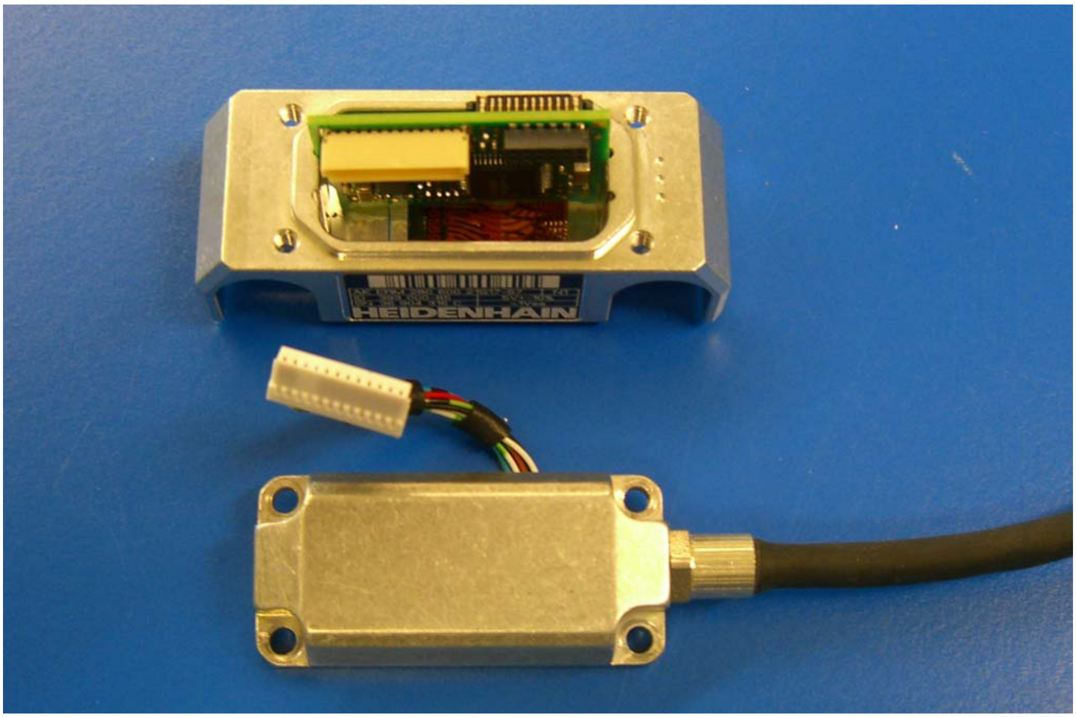
▶ Loosen the screws on the cover of the scanning head and lift it carefully. The flexlink on the scanning PCB must not be damaged.







- Disconnect the signal cable on the scanning PCB carefully.



Mounting the new scanning head

- Loosen the screws on the cover of the scanning head and lift it carefully.
- Disconnect the signal cable on the scanning PCB carefully.
- Connect the original signal cable in the motor carefully to the scanning PCB.
- Screw down the cover of the scanning head.
- Reassemble all parts.

Note

Motor encoders in asynchronous motors do not have to be adjusted to the rotor position!
If the reference mark of the encoder is used for spindle orientation, the "spindle preset" (offset between nominal and actual position of the reference mark) must be set again after the rotary encoder has been replaced.
Consult the service manual for the respective HEIDENHAIN control or ask the machine manufacturer or a HEIDENHAIN service agency.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the motor encoder on a slip of paper and apply it to the outside of the unit.
- Pack the defective motor encoder in the original packaging of the new motor encoder.
- Return the defective motor encoder to the machine manufacturer or to your HEIDENHAIN agency.

10.6.2 Replacement of the scanning head with signal cable

When replacing the scanning head with the signal cable, it must usually be pulled through in a time-consuming manner. Furthermore, special tools are required for removing and inserting the crimp contact in the contact body.

Removing the defective scanning head

Ideally you have dismounted the motor and you can replace the scanning head on a workbench.

Otherwise the scanning head must be replaced on the mounted motor.

> Danger
>
> If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
> Check whether the machine is under voltage.
> Observe the safety precautions to avoid injury or damage to persons or machines!
> See “Safety precautions” on page 2 – 13.

> Note
>
> If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Example with QAN 200 UH with the scanning head AK ERM 280:

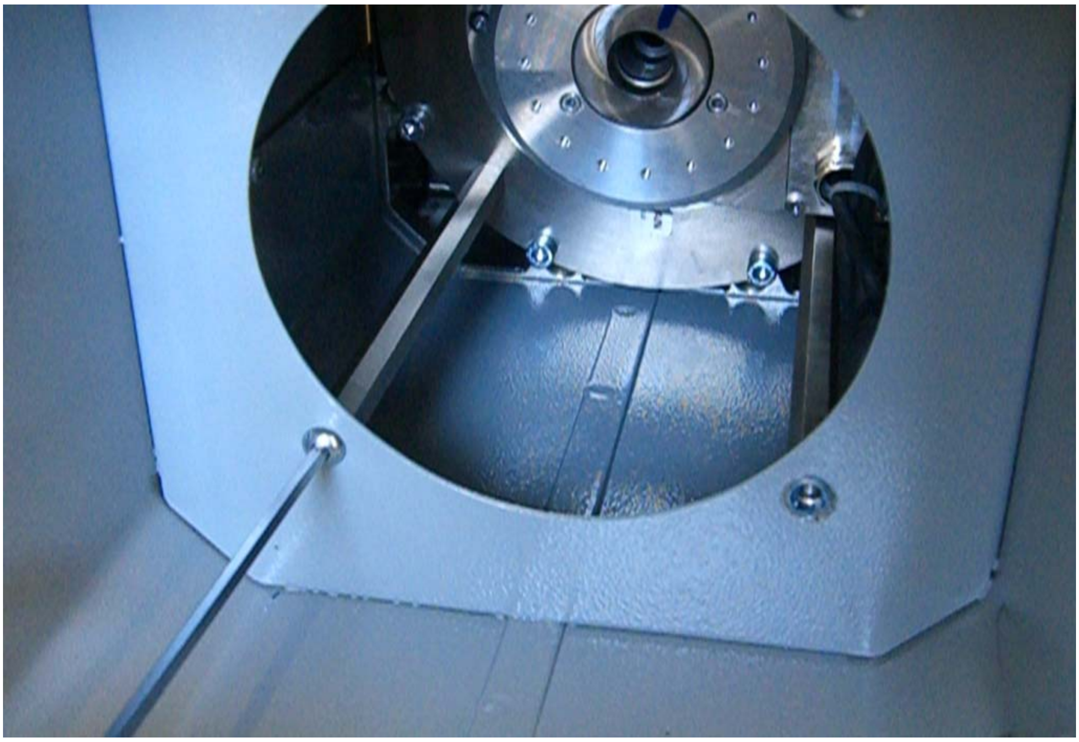
- Remove the fan guard and fan on the back side of the motor.

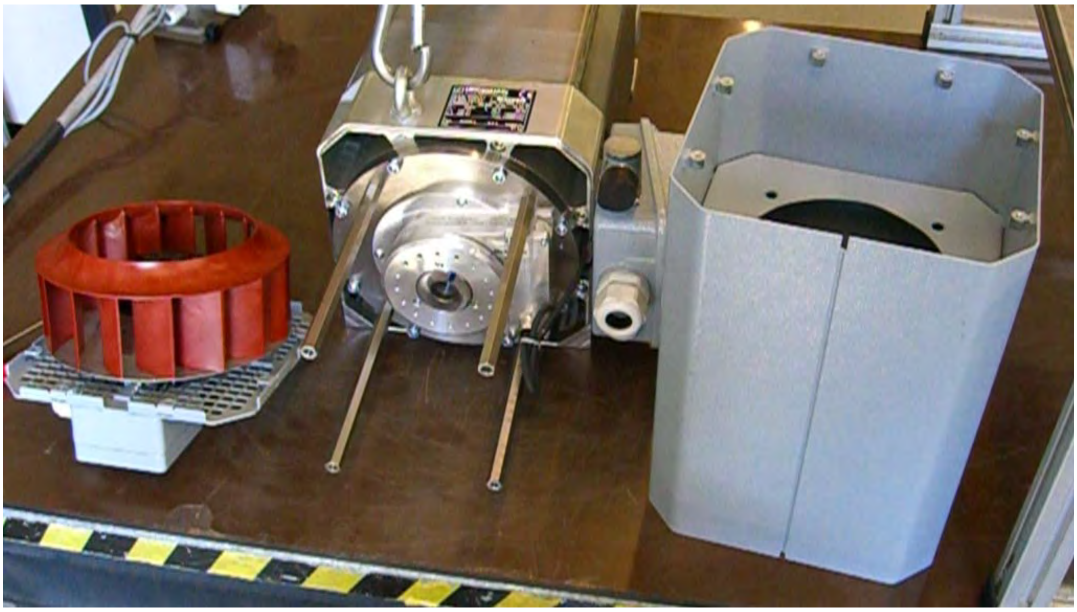
Attention

Work on the coolant system of the machine must only be performed after consultation with a person responsible for the coolant system of the machine or trained specialists.
Follow the **instructions of the machine manufacturer** regarding the coolant system of the machine!

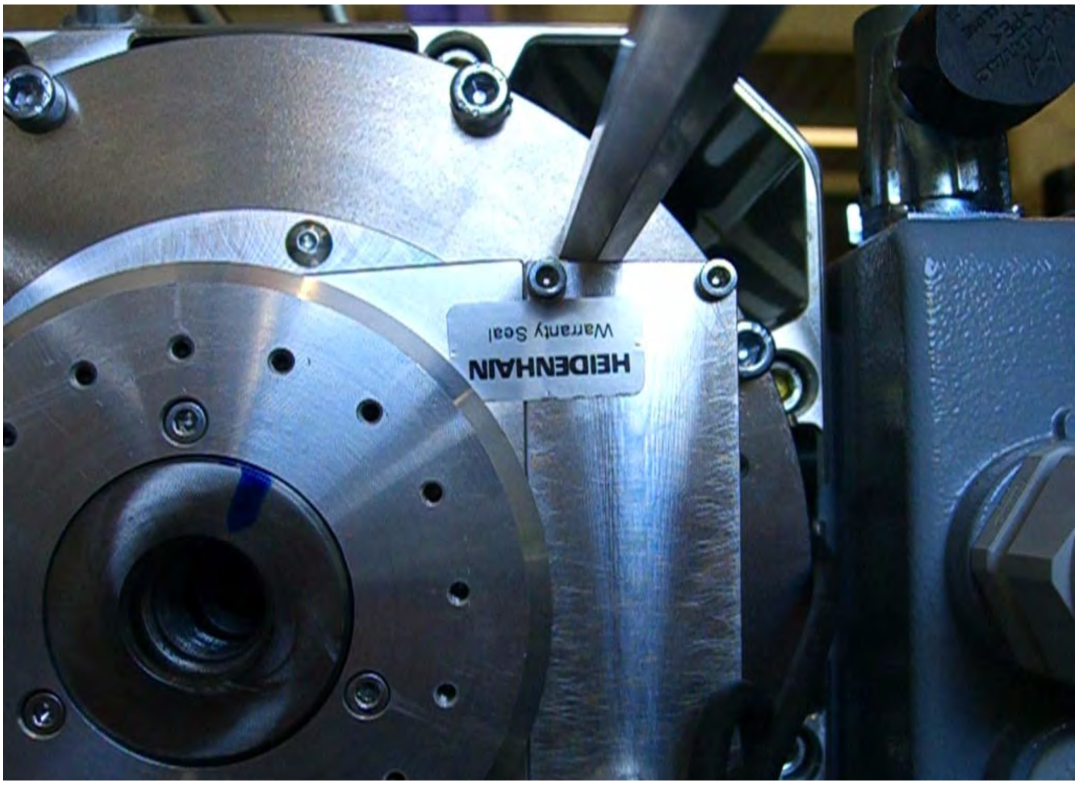
- You need to empty the coolant circuit completely before screwing off the pressure tubing from the hollow-shaft motor.
- Dismount the coolant connection.

▶ Remove the fan housing.

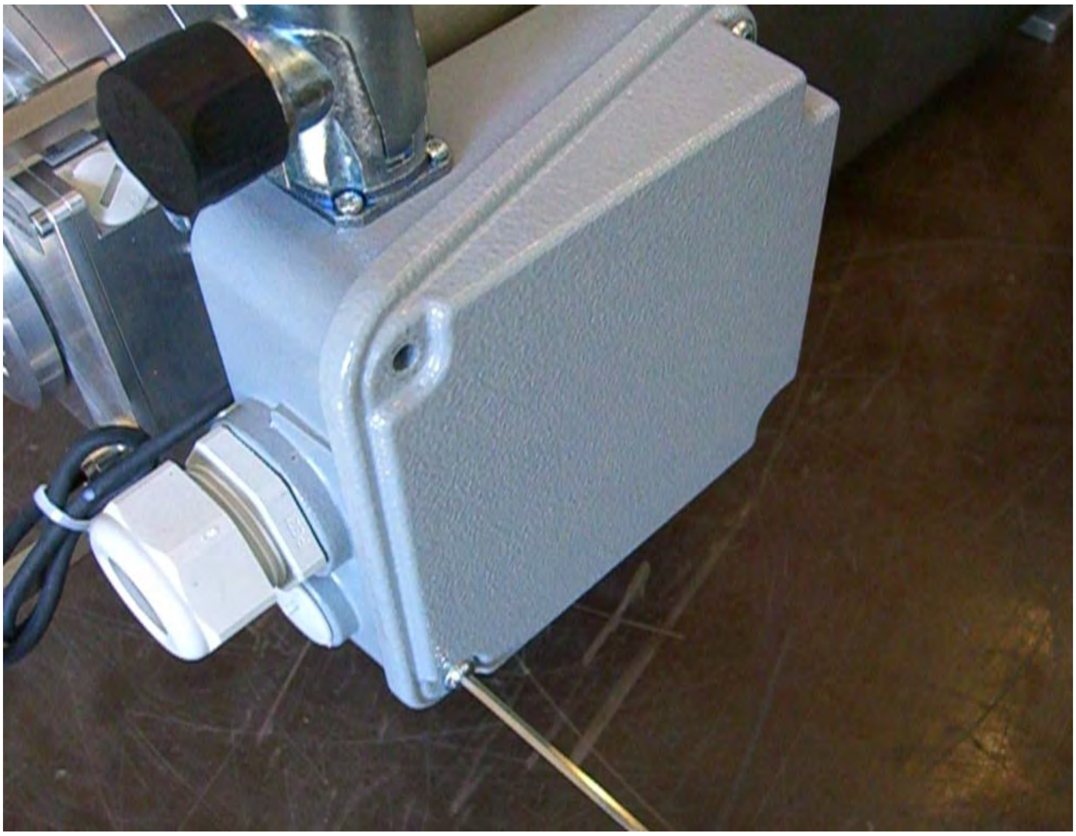




- Screw off the covers for the drum scale and the scanning head.

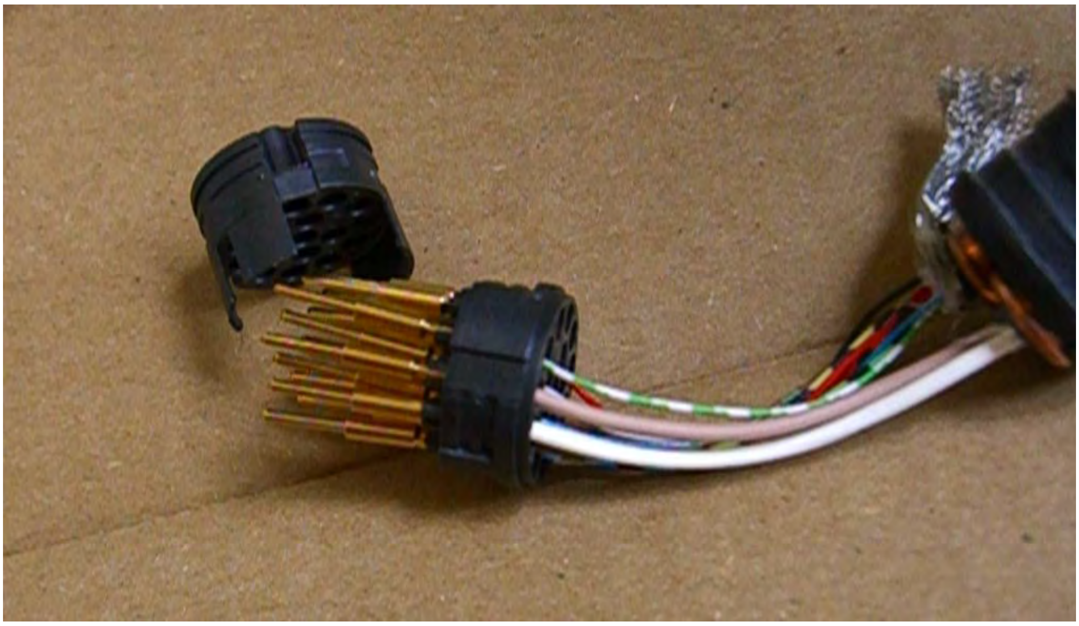


- Screw off the scanning head.
- Open the terminal box.

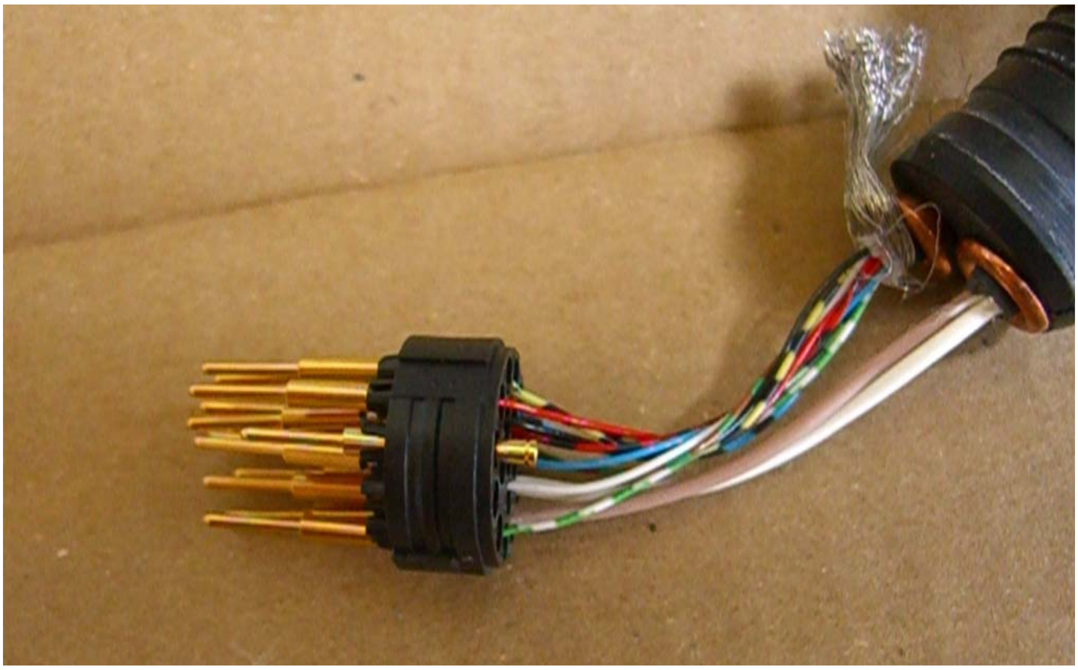


- Screw off the signal socket, dismount the contact insert with special tool and remove the signal cable (or pinch off the old signal cable).

- Disassemble the contact insert.



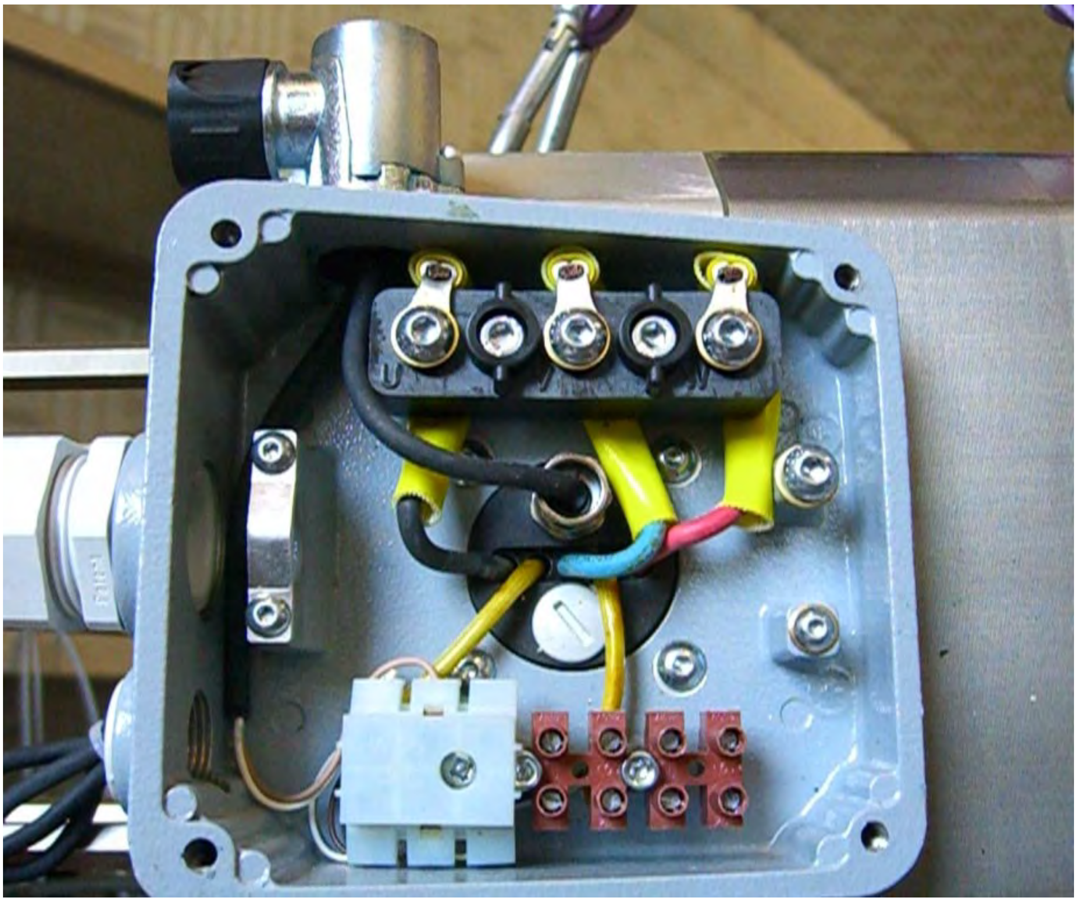
- Press the individual crimp contact out of the contact insert with a special tool so that the signal cable can be pulled out of the narrow cable outlets.



Mounting the new scanning head

- Take the new scanning head AK ERM out of the packaging.
- Take a photo of the pre-assembled cable end (crimp contacts are located in the contact insert) and have the assignment plan ready (can be found in the AK ERM mounting instructions).
- Press the individual crimp contact out of the contact insert with a special tool so that the signal cable can be inserted through the narrow cable outlets.
- Mount the scanning head.
- Insert the signal cable from the scanning head into the terminal box.
- Push the individual crimp contacts into the contact insert and click them into place.
- Mount the delivered signal socket to the terminal box instead of the old one.

▶ Insert the contact insert through the terminal box from below into the signal socket, then push it into the signal socket from the rear side and click it into place.



▶ Reassemble all parts.

> Note
>
> Motor encoders in asynchronous motors do not have to be adjusted to the rotor position!
> If the reference mark of the encoder is used for spindle orientation, the "spindle preset" (offset between nominal and actual position of the reference mark) must be set again after the rotary encoder has been replaced.
> Consult the service manual for the respective HEIDENHAIN control or ask the machine manufacturer or a HEIDENHAIN service agency.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

▶ Check whether the electrical equipment corresponds to the technical documentation.

▶ Check whether the protective ground system is continuous.

▶ Perform a functional check.

Return shipment

▶ Write the assumed error or circumstances that caused the failure of the motor encoder on a slip of paper and apply it to the outside of the unit.

▶ Pack the defective motor encoder in the original packaging of the new motor encoder.

▶ Return the defective motor encoder to the machine manufacturer or to your HEIDENHAIN agency.

10.6.3 Replacing the scale drum

Removing the defective scale drum

Ideally you have dismounted the motor and you can replace the scale drum on a workbench.

Otherwise the scale drum must be replaced on the mounted motor.

Danger

If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
Check whether the machine is under voltage.
Observe the safety precautions to avoid injury or damage to persons or machines!
See "Safety precautions" on page 2 – 13.

Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Example with QAN 360 UHW with ERM 200 scale drum:

Attention

Work on the coolant system of the machine must only be performed after consultation with a person responsible for the coolant system of the machine or trained specialists.
Follow the **instructions of the machine manufacturer** regarding the coolant system of the machine!

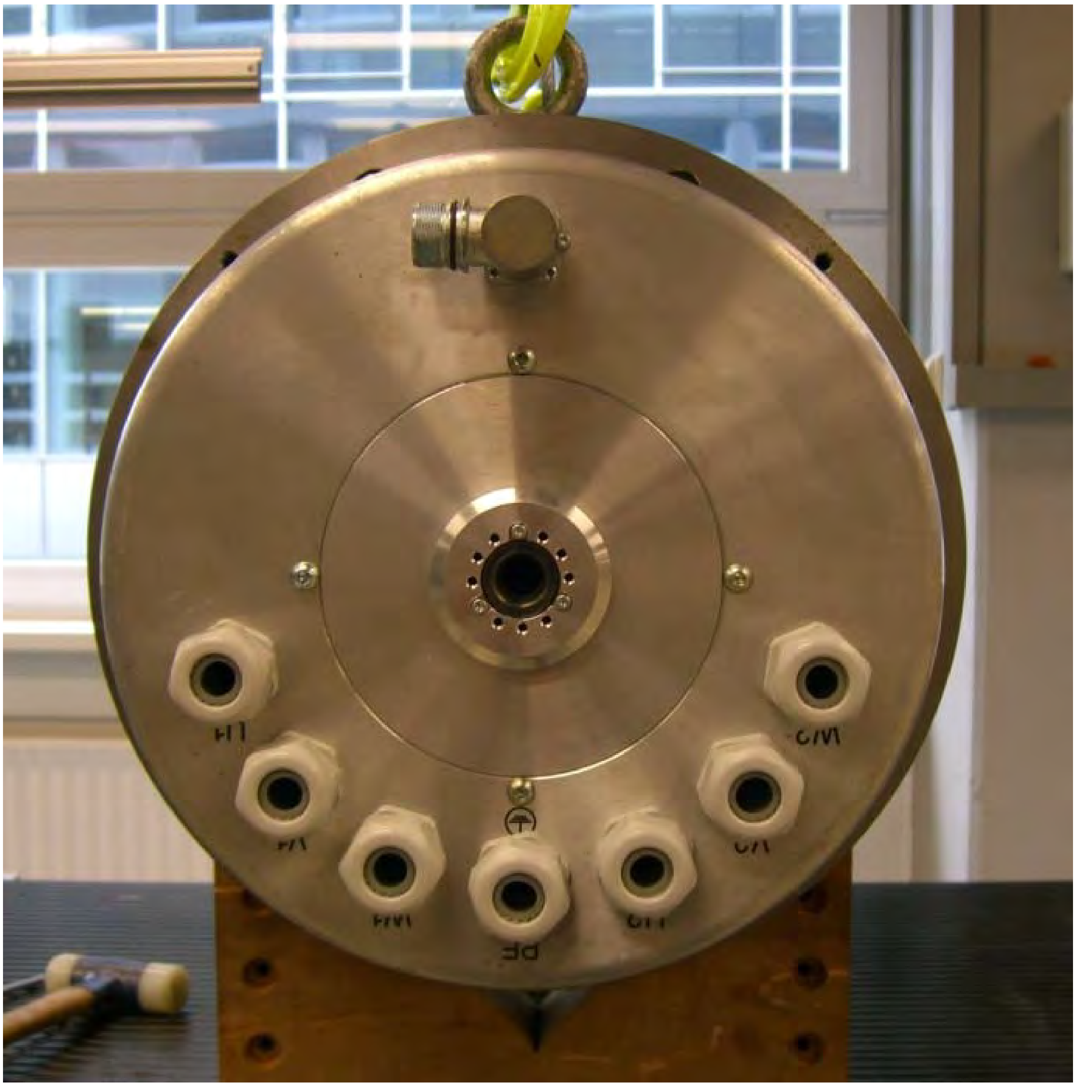
- You need to empty the coolant circuit completely before screwing off the pressure tubing from the hollow-shaft motor.
- Dismount the coolant connection for the hollow shaft.

Note

The connections for the water cooling of the motor do not have to be removed.

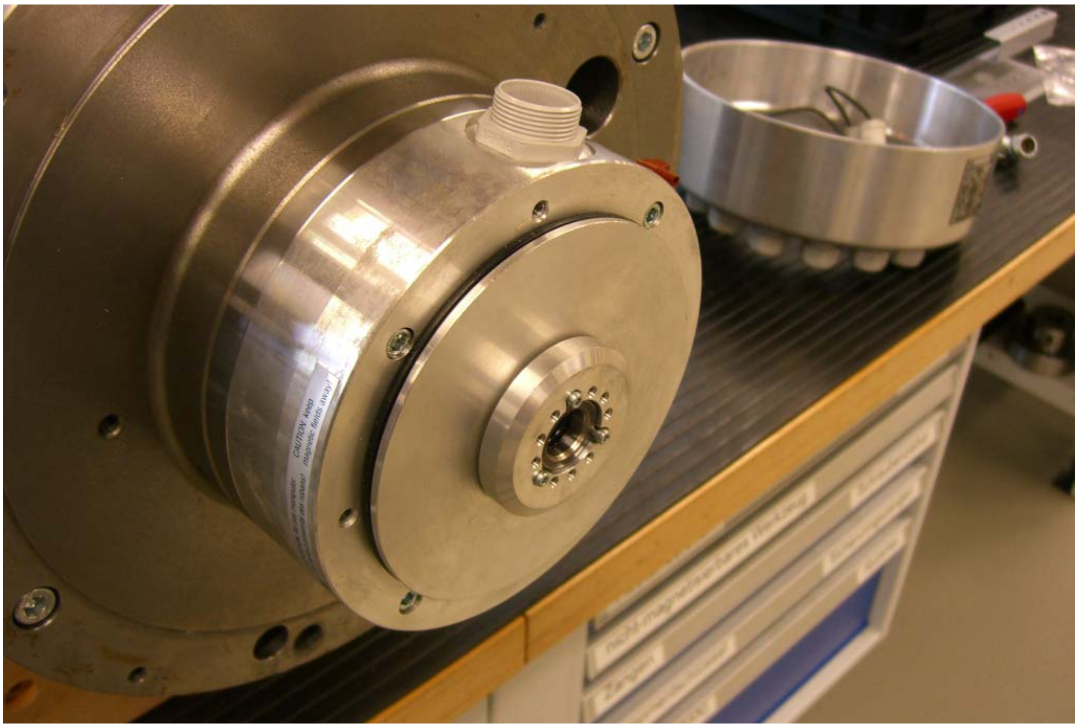
- Loosen the cable glands.
- Press the cable slightly inwards.

▶ Screw off the rear part of the housing.

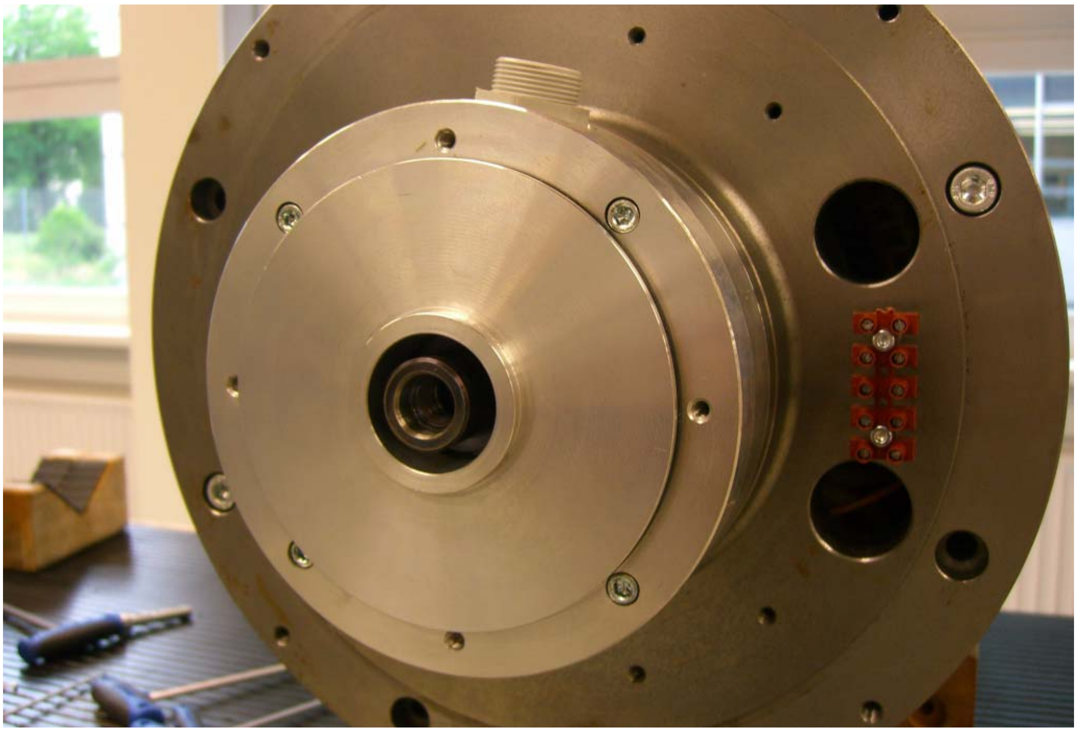


▶ Pinch off the cable tie for the signal cable.

▶ Screw off and remove the rotating manifold.



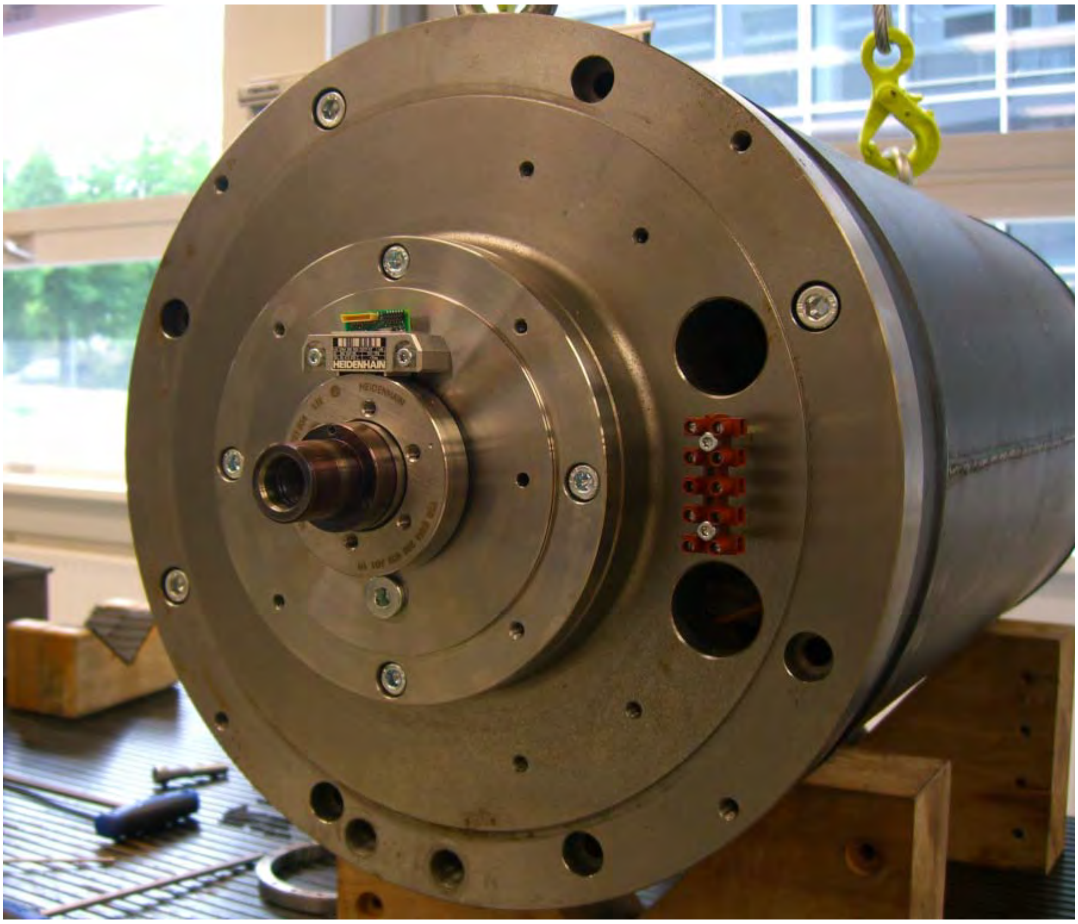
▶ Screw off the cover for the drum scale and the scanning head.



Attention

Do not use magnetizable tools! The magnetic graduation on the drum could be damaged.

▶ Dismount the scale drum (generally, the scanning head does not have to be removed).



Installing the new scale drum

▶ Mount the new scale drum.

▶ Check the distance of scanning head to scale drum and adapt it if necessary.

▶ Reassemble all parts.

▶ Check the sealings at the end of the pressure hoses:
They must not be damaged and have to be in the correct position!

▶ After correct connection, the coolant circuit must be ventilated.

> Danger
>
> Check the complete cooling circuit for tightness before putting the components into service!
> **Water may not penetrate into electrical units or into the electrical cabinet!**

> Note
>
> Motor encoders in asynchronous motors do not have to be adjusted to the rotor position!
> If the reference mark of the encoder is used for spindle orientation, the "spindle preset" (offset between nominal and actual position of the reference mark) must be set again after the rotary encoder has been replaced.
> Consult the service manual for the respective HEIDENHAIN control or ask the machine manufacturer or a HEIDENHAIN service agency.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

▶ Check whether the electrical equipment corresponds to the technical documentation.

▶ Check whether the protective ground system is continuous.

▶ Perform a functional check.

Return shipment

▶ Write the assumed error or circumstances that caused the failure of the motor encoder on a slip of paper and apply it to the outside of the unit.

▶ Pack the defective motor encoder in the original packaging of the new motor encoder.

▶ Return the defective motor encoder to the machine manufacturer or to your HEIDENHAIN agency.

10.7 Exchanging the signal socket of the motor

HEIDENHAIN motors always feature a signal and power connection:

- Signal socket and
- Power socket (on smaller motors) or
- Terminal box (of larger spindle motors)

The signal socket has 17 pins. Besides the signals of the motor encoder (rotary encoder signals) also the signals of the temperature sensors are lead through this flange socket.

> Note
>
> At HEIDENHAIN the **signal socket including signal line and temperature sensor wires** is also designated as **"output cable"**.

Removing the defective signal socket

Ideally you have dismounted the motor and you can replace the signal socket on a workbench.

If larger spindle motors are affected it makes sense to perform the replacement while the motor is still incorporated.

> Danger
>
> If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
> Check whether the machine is under voltage.
> Observe the safety precautions to avoid injury or damage to persons or machines!
> See "Safety precautions" on page 2 – 13.

Note

On some motors the exchange of the signal socket can be **relatively complex**!

This especially affects **spindle motors** with the **signal socket being screwed to the terminal box**.

The terminal box must be dismounted completely to remove and draw in again the signal line.

HEIDENHAIN recommends to send these motor to HEIDENHAIN for repair.

Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Example with QSY 96A:

- Screw off the cover on the back of the motor.
- Disconnect the temperature sensor line.

Note

The temperature sensor lines on some motors are not plugged in, but clamped or soldered. Unscrew the clamping or unsolder the soldered connection with a soldering iron.

- Screw off and remove the cover cap of the encoder cable.
- Disconnect the encoder cable.
- Screw off the defective signal socket including signal line and temperature sensor wires from the cover.

Integrating the new signal socket

Example with QSY 96A:

- Insert the signal socket including signal line and temperature sensor wires into the cover (right-angle socket points backward) and screw it on.
- Connect the encoder cable.

Attention

If there is no reverse-polarity protection, pay attention to the **TOP** label!

- Put the metal sleeve at the end of the motor encoder cable in the prepared depression of the cover cap.
- Insert and screw on the cover cap.
- Connect the temperature sensor line.

Attention

If the temperature sensor lines are not plugged in, but must be clamped or soldered, ensure a correct polarization of the wires, clean soldering points and sufficient insulation!

- Screw on the cover on the back of the motor.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

10.8 Exchanging the fan of a spindle motor

HEIDENHAIN spindle motors are equipped with fans.

Normally, the lifespan of these fans and motors is consistent.

If a fan breaks down prematurely, it can be replaced nevertheless!

Removing the defective fan

Ideally you have dismounted the motor and you can replace the fan on a workbench.

If larger spindle motors are affected it makes sense to perform the replacement while the motor is still incorporated.

Danger

If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
Check whether the machine is under voltage.
Observe the safety precautions to avoid injury or damage to persons or machines!
See "Safety precautions" on page 2 – 13.

Note

On some motors the exchange of the fan is **relatively complex**, as the cable of the fan is lead from inside into the terminal box.

The terminal box of the **spindle motors of the QAN 200, 260, 320 series**, for example, must be dismounted so that the cable of the fan can be removed and pulled in again later on.

HEIDENHAIN recommends to send these motor to HEIDENHAIN for repair.

On the QAN 200 UH and QAN 260 UH spindle motors with hollow shaft, the cable of the fan is connected in a separate small terminal box on the rear side of the motor. This facilitates the replacement of the fan considerably.

Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

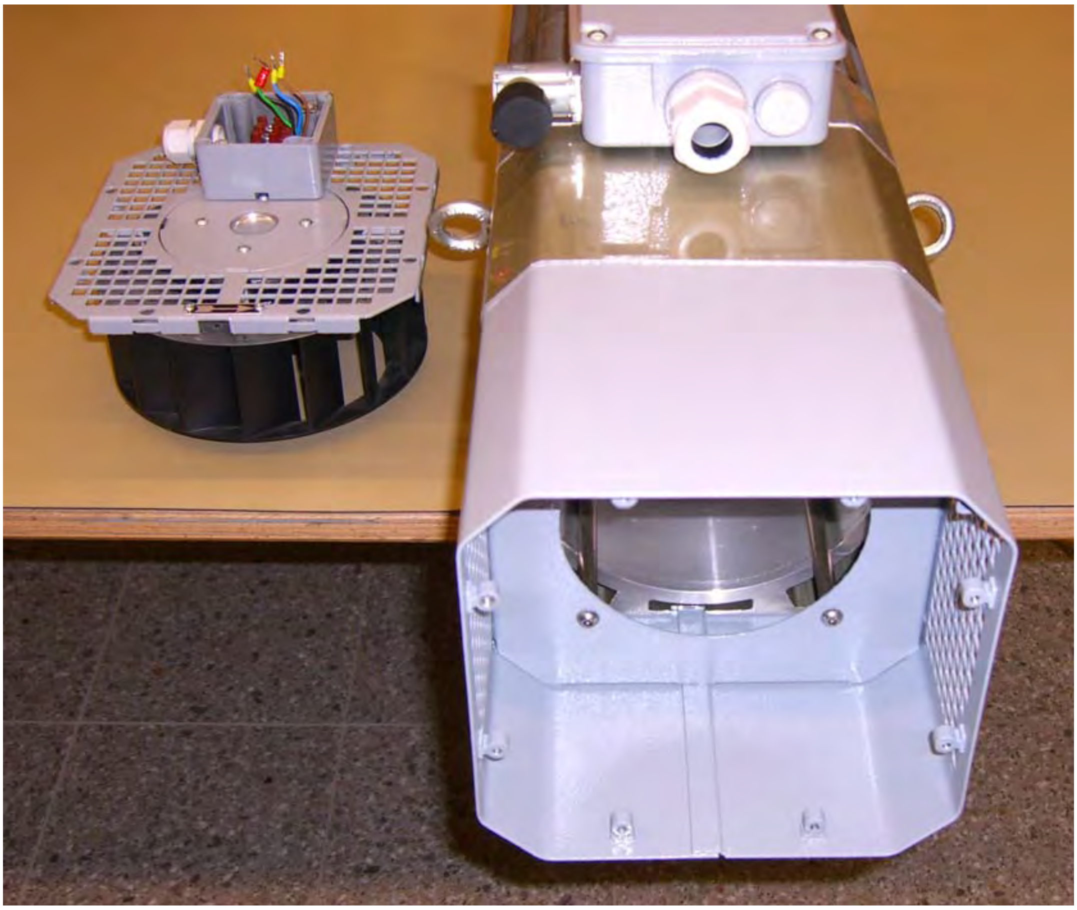
Example with QAN 200 UH series:

▶ Screw off the cover cap of the small terminal box on the back of the motor.

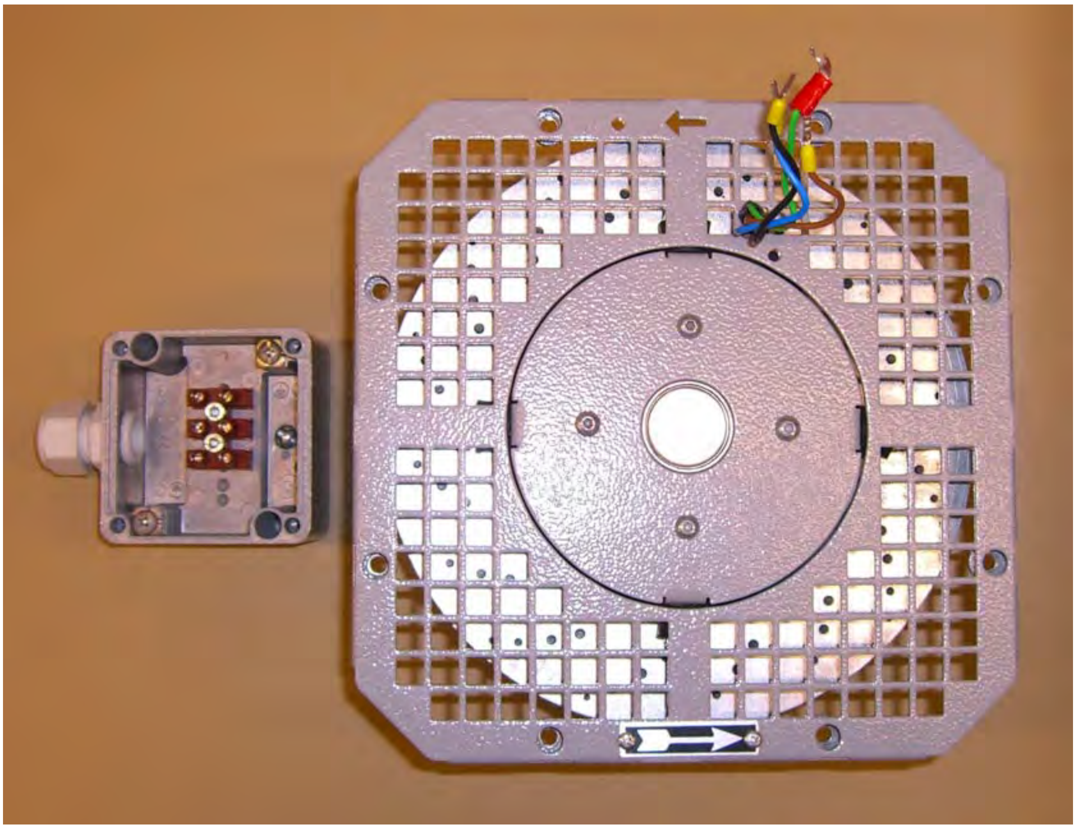
▶ Mark and document the clamped wires (e.g., write down the colors, take photos).

▶ Unclamp the supply and fan cable, screw off the ground leads.

▶ Screw off the fan guard including fan on the rear.



▶ Screw off and remove the small terminal box from the fan guard.

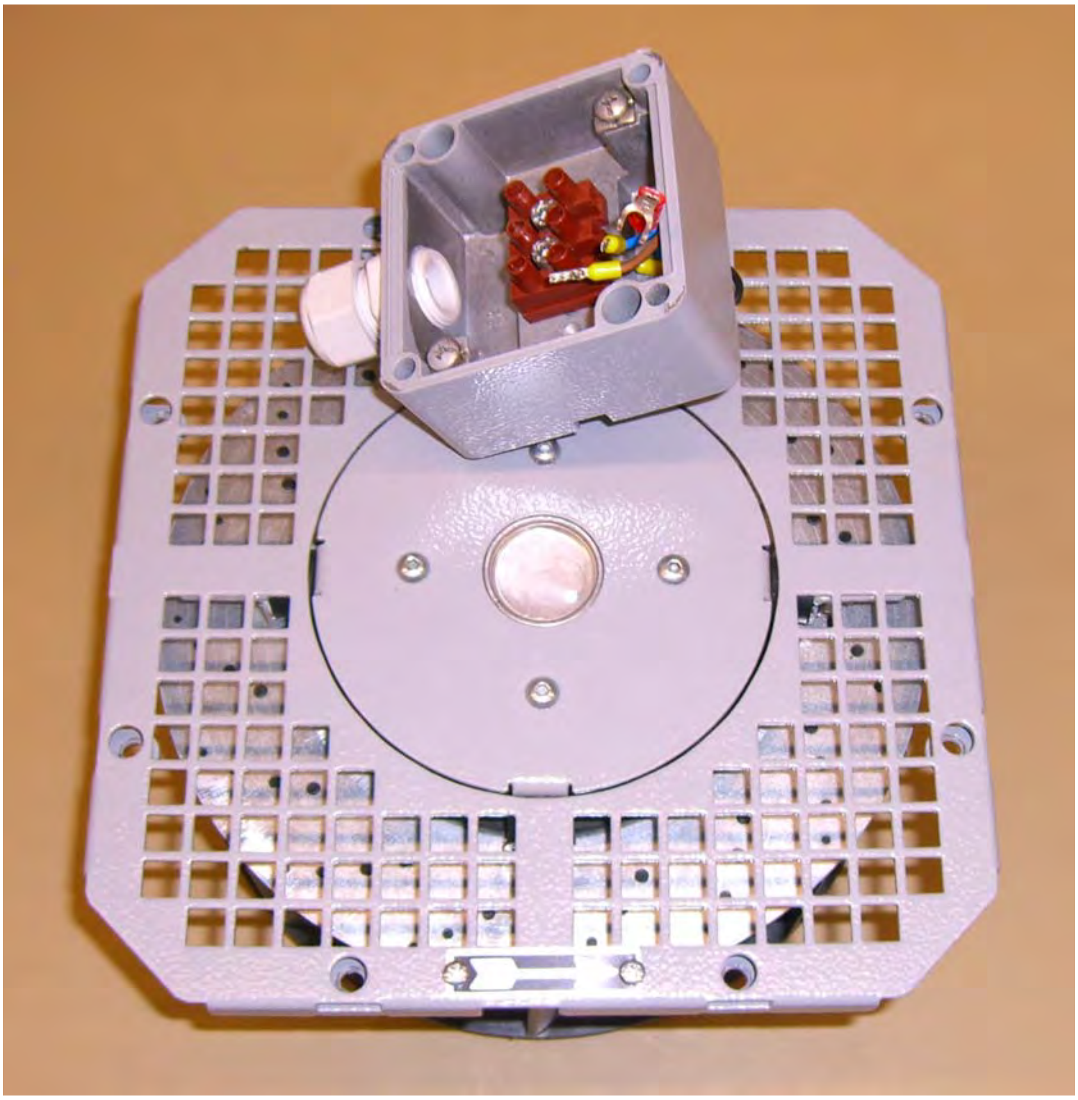


▶ Unscrew 4 screws on the rear. --> Separate the fan from the fan guard.

Mounting the new fan

▶ Place the fan guard on the new fan (the cable points to the upper right) and screw it on.

▶ Insert the wires of the fan cable through the fan guard in the terminal box.



▶ Screw on the terminal box (cable outlet points to the left).

▶ Insert the fan including fan guard with terminal box into the motor housing and screw it on (terminal box is on top).

▶ Insert the lead.

▶ Clamp the wires in the right sequence, screw on the ground leads.

▶ Screw on the cover onto the terminal box.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

▶ Check whether the electrical equipment corresponds to the technical documentation.

▶ Check whether the protective ground system is continuous.

▶ Perform a functional check.

Testing the functions

▶ Check whether the fan is running properly.

Attention

Check the rotational direction of the fan. See arrow on the fan guard!

10.9 Exchanging the fan guard of the spindle motor

The fans of the HEIDENHAIN spindle motors of the QAN 200, 260, 320 series are mounted onto a round plate.
This plate is connected to the fan guard by means of rubber buffers.
The rubber buffers ensure a vibration-damping suspension of the fan during operation.

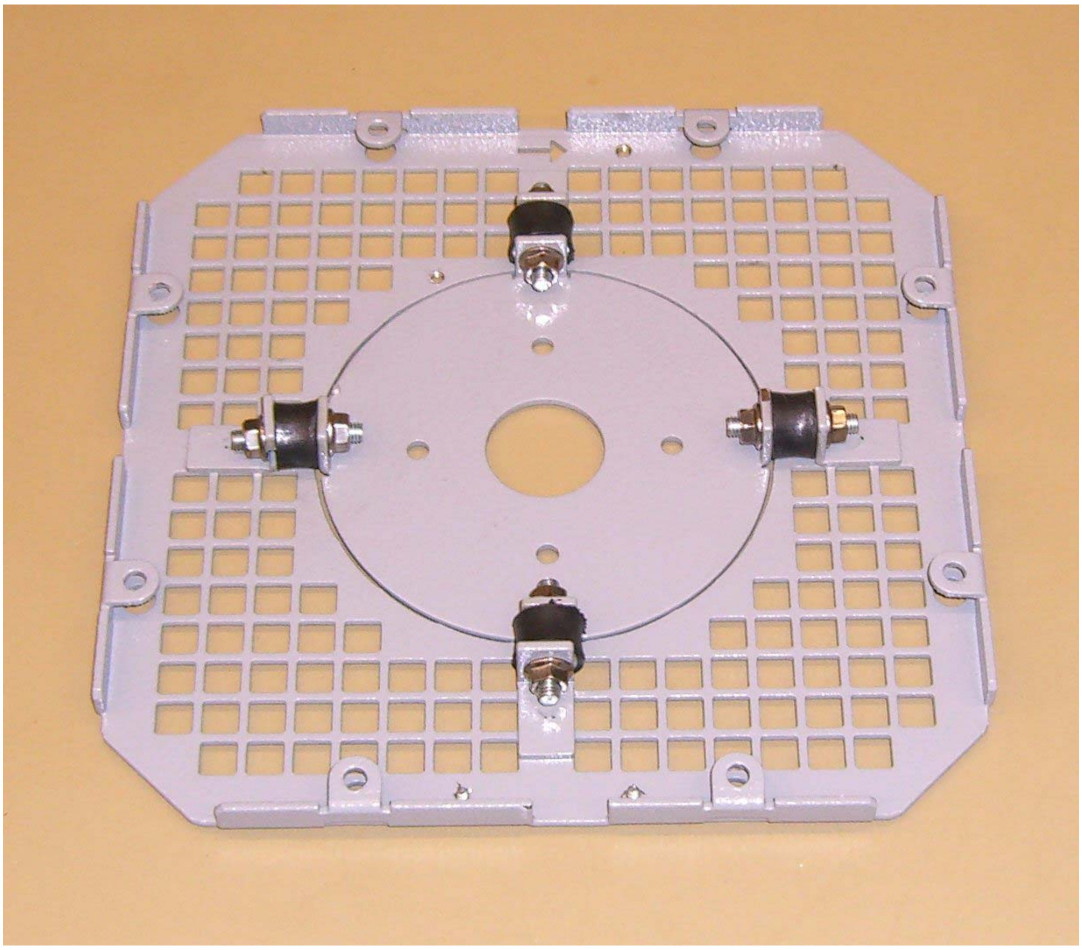


Photo: Fan guard with rubber buffers

If the rubber buffers are defective, the complete fan guard is replaced.

Premounted spare part

The rubber buffers must be mounted evenly at a specified tensile force.
Improper mounting of these rubber buffers might result in an uneven load and could destroy the buffers while the motor is running!

For this reason the fan guard is only supplied with premounted plate.

Removing the defective fan guard

Ideally you have dismounted the motor and you can replace the fan guard on a workbench.

If larger spindle motors are affected it makes sense to perform the replacement while the motor is still incorporated.

Danger

If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
Check whether the machine is under voltage.
Observe the safety precautions to avoid injury or damage to persons or machines!
See “Safety precautions” on page 2 – 13.

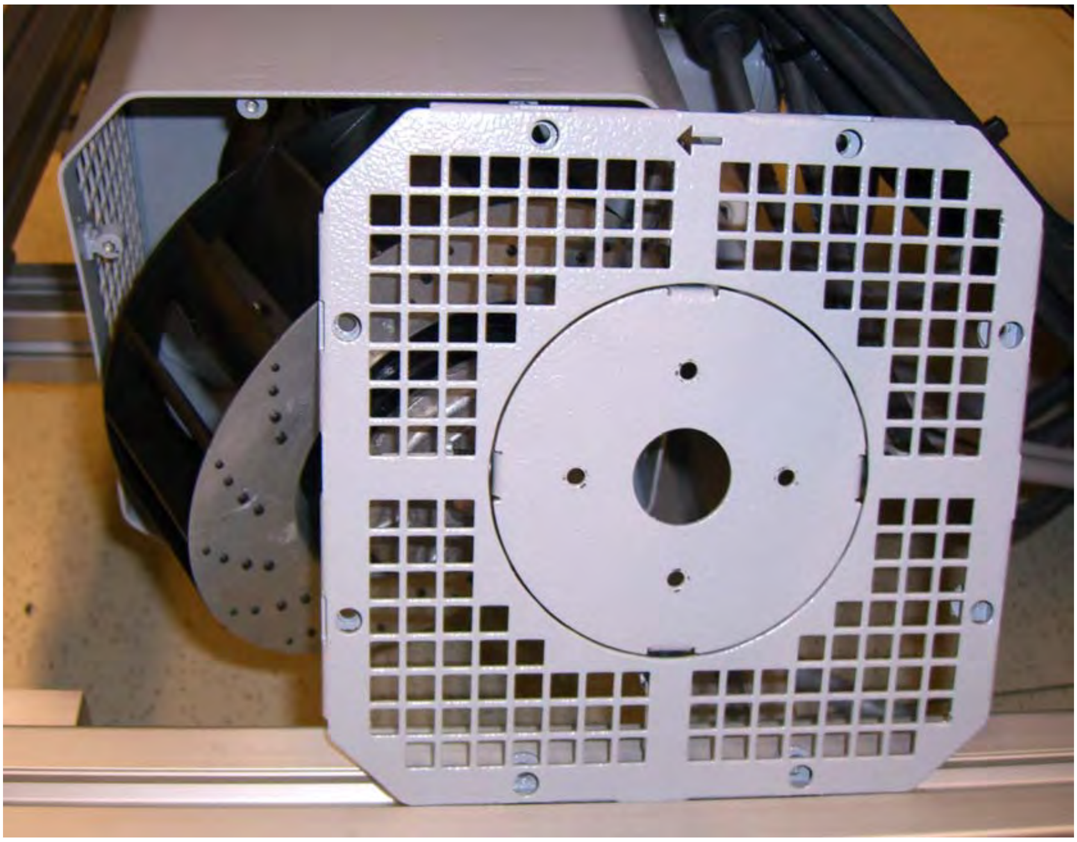
Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Example with QAN 200 M:

▶ Screw off the fan guard from the motor housing.

▶ Unscrew 4 screws on the rear. --> Separate the defective fan guard from the fan.



Mounting the new fan guard

▶ Place the new fan guard onto the fan and screw it on.

▶ Insert the fan guard including fan into the motor housing and screw it on.

10.10 Changing connections to the reserve temperature sensor

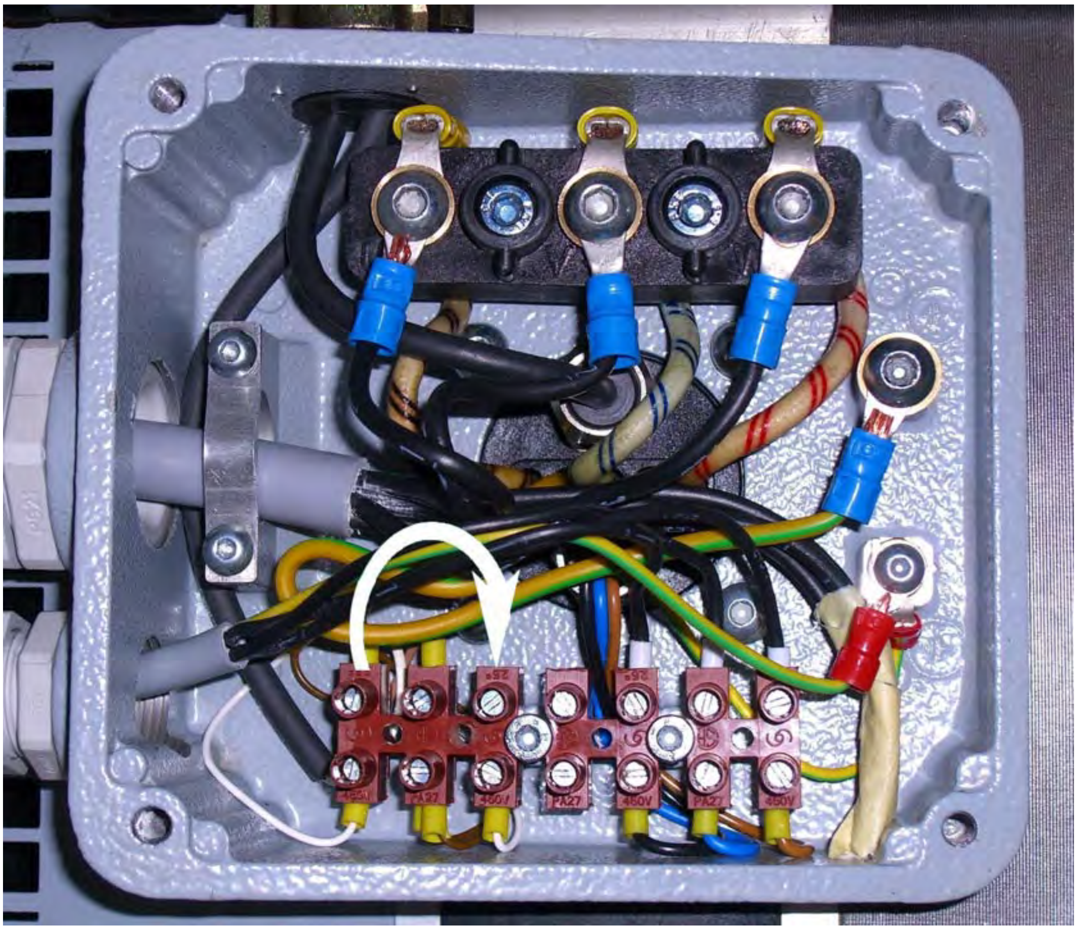
HEIDENHAIN spindle motors are equipped with reserve temperature sensors.

If the original temperatur sensor is defective, connections may be changed to the second sensor.

> **Danger**
>
> Before performing following work, ensure that the devices are free of potential.
> Always comply with the safety precautions. See "Safety precautions" on page 2 – 13!

Example with QAN 200 L:

- Screw off the cover of the terminal box.
- Screw off the cover cap over the terminal strip for the temperature sensors.
- Change connection of the outer wire of the temperature sensor lines to the reserve temperature sensor (the wire in the middle remains unchanged).



- Screw on the cover cap over the terminal strip for the temperature sensors.
- Screw on the cover of the terminal box.

10.11 Exchanging inverter accessories

The exchange of accessories is not described in detail.

Please note the following:

General

- The machine must be switched off before inverter accessories are exchanged! See "Safety precautions" on page 2 – 13.
- Many accessory units are connected directly or indirectly to the DC-link (high voltage and current).

Danger

Danger of electrical shock!
Wait at least 5 minutes before you unscrew the conductor bars or lines connected to Uz (e.g, connecting leads of braking resistor). There is a corresponding warning on the cover caps of the conductor bars!
Use an appropriate voltage tester to check whether the **DC-link voltage is zero**!

- If required, ensure proper shielding and grounding of cables.
- Do not forget to clamp and screw on again the **ground leads for components**.
- Tighten the **conductor bars** with a torque of 3.5 Nm.
- If possible, use the original packaging from HEIDENHAIN.

Note

If you have a camera at hand, we recommend to take photos of the components before they are disassembled. This might be helpful later on!

Note

If you have any questions, contact the machine manufacturer or a HEIDENHAIN service agency.

ZKF

- Ther **ZKF DC-link filter** features an input and an output. Conductor bars must not be connected through!

SM 130

- The **motor lines in the SM 130** must be **tightened with 9 Nm**.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective unit in the original packaging of the new unit.
- Return the defective unit to the machine manufacturer or to your HEIDENHAIN service agency.

10.12 Exchanging cables and connectors

Please note the following:

- The machine must be switched off before cables and connectors are exchanged!
  See "Safety precautions" on page 2 – 13.
- Many cables and connectors are connected directly or indirectly to the DC-link (high voltage and current).

Danger

Danger of electrical shock!
Wait at least 5 minutes before you unscrew the lines connected to Uz (e.g, connecting leads of braking resistor). There is a corresponding warning on the cover caps of the conductor bars!
Use an appropriate voltage tester to check whether the **DC-link voltage is zero**!

- If required, ensure proper shielding and grounding of cables and components.
- The motor lines in the SM 130 must be tightened with 9 Nm.
- Always use original HEIDENHAIN cables as replacements!
- Do not exceed any **maximum lengths**!
- If possible, use the original packaging from HEIDENHAIN.

Note

If you have any questions, contact the machine manufacturer or a HEIDENHAIN service agency.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

10.13 Exchanging power supply units

10.13.1 Exchanging the UV 101 B, UV 102, UV 111A, UV 111 B power supply unit

Removing the defective power supply unit

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential.
- Unscrew the grounding bars or ground lead on the top of the power supply unit.
- Screw off the cover plate.
- Label and disconnect all connecting elements on the power supply unit.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the power supply unit slightly and remove it towards you.

Integrating the new power supply unit

- Hook the power supply unit into the mounting screws.
- Tighten the mounting screws.
- Screw on the grounding bars or ground lead on the top of the power supply unit.
- Re-establish all connections.
- Screw on the cover plate.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective power supply unit in the original packaging of the new power supply unit.
- Return the defective power supply unit to the machine manufacturer or to your HEIDENHAIN service agency.

10.13.2 Exchanging the UV 105 power supply unit

Removing the defective power supply unit

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential.

> Danger
>
> Wait at least 5 minutes before you unscrew the conductor bars (there is a corresponding warning on the cover caps of the conductor bars)!
> Use an appropriate voltage tester to check whether the **DC-link voltage is zero**!

- Screw off the conductor bars.
- Unscrew the grounding bars or ground lead on the top of the power supply unit.
- Screw off the cover plate.
- Disconnect or unscrew all of the connections on the power supply unit.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the power supply unit slightly and remove it towards you.

Integrating the new power supply unit

- Hook the power supply unit into the mounting screws.
- Tighten the mounting screws.
- Screw on the grounding bars or ground lead on the top of the power supply unit.
- Screw the conductor bars (3.5 Nm tightening torque) and close the protective caps!
- Re-establish and screw into place all of the connections.

> Danger
>
> The additional 5 V lines must be polarized and connected correctly!
> Otherwise there will be a short circuit of these lines on the 5V ribbon wires.

- Screw on the cover plate.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective power supply unit in the original packaging of the new power supply unit.
- Return the defective power supply unit to the machine manufacturer or to your HEIDENHAIN service agency.

10.13.3 Exchanging the UV 105 B power supply unit

Removing the defective power supply unit

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential.
- Unscrew the grounding bars or ground lead on the top of the power supply unit.
- Screw off the cover plate.
- Disconnect or unscrew all of the connections on the power supply unit.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the power supply unit slightly and remove it towards you.

Integrating the new power supply unit

- Hook the power supply unit into the mounting screws.
- Tighten the mounting screws.
- Screw on the grounding bars or ground lead on the top of the power supply unit.
- Re-establish and screw into place all of the connections.

Danger

The additional 5 V lines must be polarized and connected correctly!
Otherwise there will be a short circuit of these lines on the 5V ribbon wires.

- Screw on the cover plate.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective power supply unit in the original packaging of the new power supply unit.
- Return the defective power supply unit to the machine manufacturer or to your HEIDENHAIN service agency.

10.13.4 Exchanging the UV 106 B power supply unit

Removing the defective power supply unit

- Switch off the machine, take precautions against resetting, ensure that the equipment is free of potential.
- Label and disconnect all of the connections on the control (MC).
- Loosen two torx screws at the top and two at the bottom of the housing (do not screw off completely).
- Remove the MC by drawing it towards you by the handles until the MC disengages from the UV 106 B.
- Now you can pull out the MC at a slight angle to the right.
- Disconnect connector X31 on the front panel of the power supply unit.
- Screw off the ground lead at the bottom of the UV 106 B.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the power supply unit slightly and remove it towards you.

Integrating the new power supply unit

- Hook the UV 106 B into the mounting screws.
- Tighten the mounting screws.
- Screw on the ground lead at the bottom of the UV 106 B.
- Connect connector X31 on the front panel of the power supply unit.
- Insert the MC in the UV 106 B and screw it into place.
- Re-establish all of the connections.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

Return shipment

- Write the assumed error or circumstances that caused the failure of the unit on a slip of paper and apply it to the outside of the unit.
- Pack the defective power supply unit in the original packaging of the new power supply unit.
- Return the defective power supply unit to the machine manufacturer or to your HEIDENHAIN service agency.

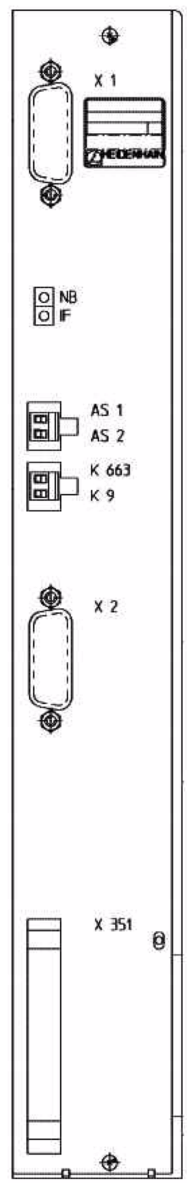
10.14 Exchanging HEIDENHAIN interface boards in the SIMODRIVE system

Version with D-sub connector

HEIDENHAIN interface boards for the SIMODRIVE system in the version with D-Sub connector are available **with or without metallic isolation** of HEIDENHAIN PWM signals to the Siemens interface.

Interface boards **without metallic isolation** are identified as follows:

- On the front panel, there are the LEDs **NB** (not ready) and **IF** (pulse release).
- There is no grounding screw on the front panel.
- There is no transformer on the board.
- These boards have the ID numbers 291070-01, 324952-01, 02, 03 and 10 without index A.

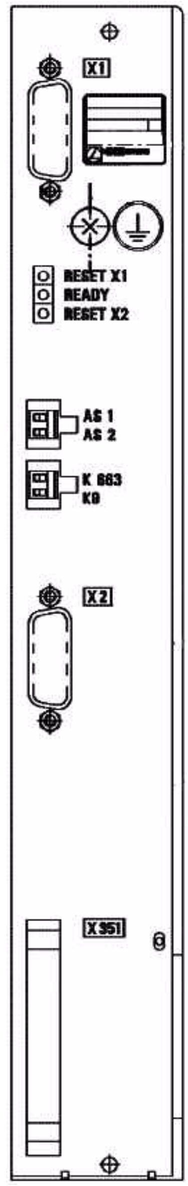


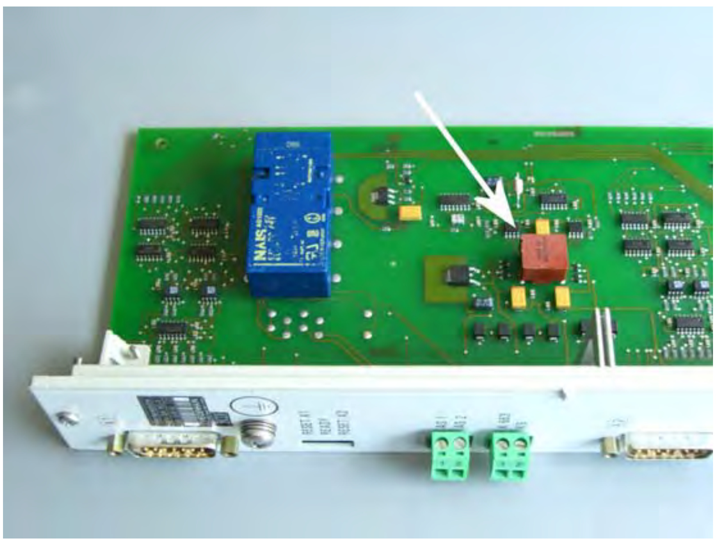
Attention

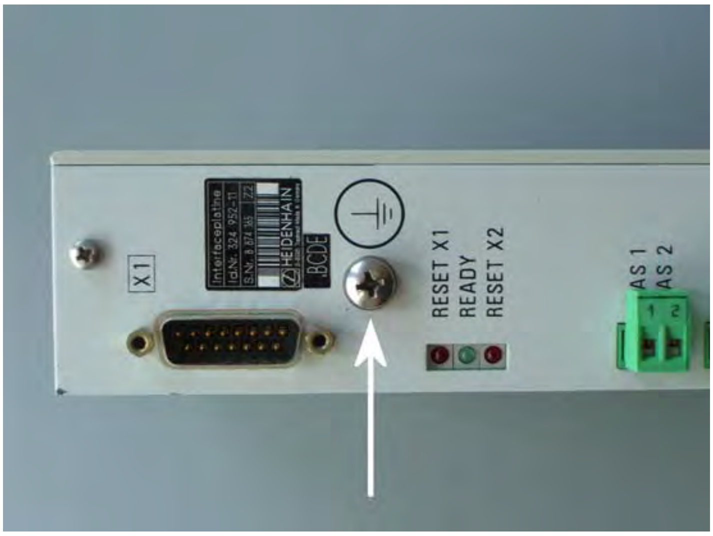
Board without metallic isolation:
The terminal X131 of the Siemens E/R module must not be connected to the central signal ground of the machine!

Note

The HEIDENHAIN interface boards of the first generation were produced without metallic isolation.

Interface boards **with metallic isolation** are recognized as follows: ■ On the front panel, there are the LEDs **RESET X1, READY** and **RESET X2**. ■ There is a grounding screw on the front panel. ■ There is a transformer on the board. ■ These boards have the ID number 324952-10 with index A, 11, 12, ...	

Transformer component on board	

Grounding screw on front panel	

Attention

The terminal X131 of the Siemens E/R module of boards with metallic isolation must be connected to the central signal ground of the machine!
The individual expansion boards must also be connected to the central signal ground of the machine via the grounding screw on the front panel.

Attention

Interface boards **with and without metallic isolation must not be used together!**

Either all boards are metallically isolated and X131 is wired, or all boards are not metallically isolated and X131 is not wired!

Photo: Siemens E/R module with terminal X131

> **Attention**
>
> If a Siemens E/R module is used together with a so-called monitoring module (UEB module), the terminal X131 on this module has to be wired as on the E/R module!

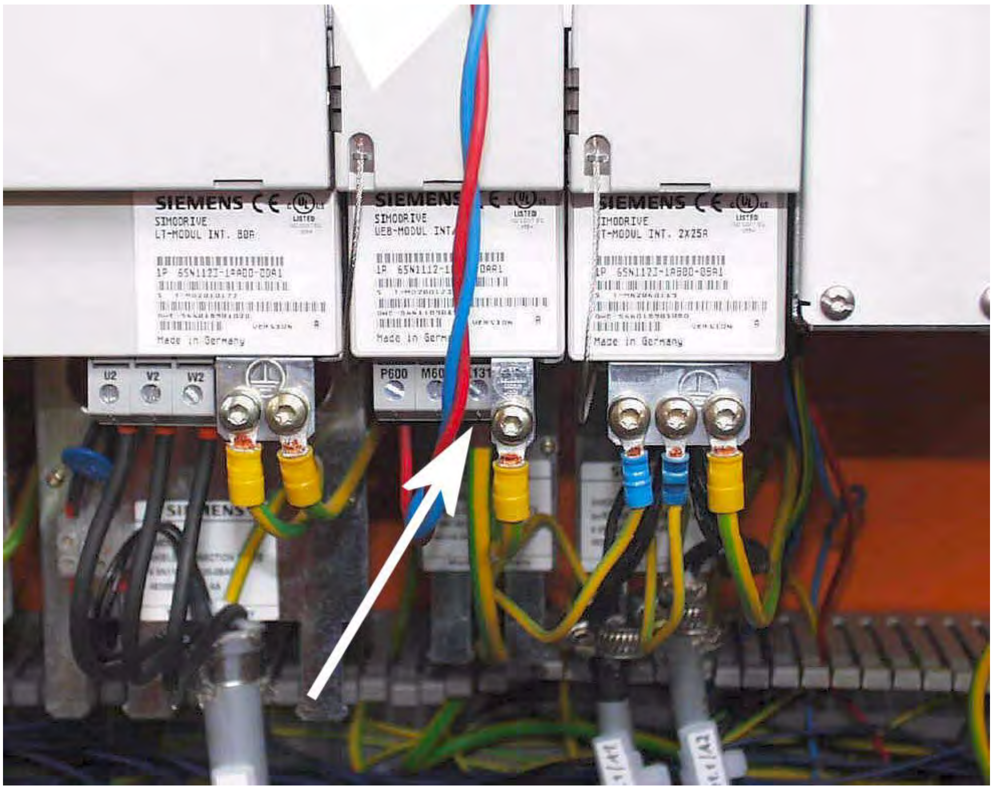


Photo: Siemens UEB module with terminal X131

Version with ribbon cable connector

HEIDENHAIN interface boards for the SIMODRIVE system in the version with ribbon cable feature metallic isolation of the HEIDENHAIN PWM signals to the Siemens interface.

Therefore, the terminal X131 must be available at the SIEMENS drive system!

The individual expansion boards must also be connected to the central signal ground of the machine via the grounding screw on the front panel.

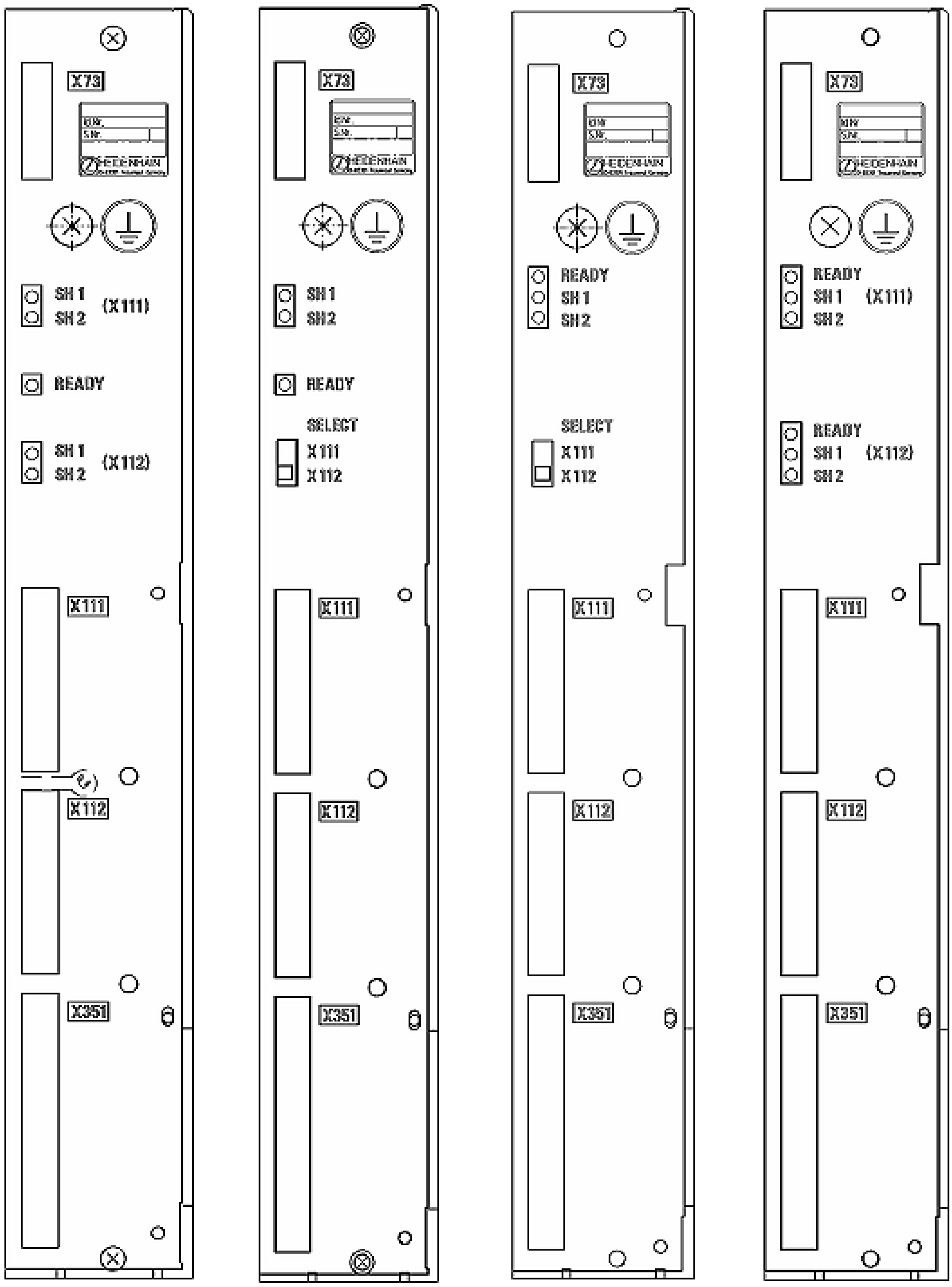


Figure: Various HEIDENHAIN interface boards with ribbon cable connectors

Compatibility of HEIDENHAIN expansion boards to SIMODRIVE power modules

SIEMENS has revised the SIMODRIVE power modules.
Among other things interference suppression circuits have been added.

In 2007, the HEIDENHAIN expansion boards suitable for the modified SIMODRIVE power modules were also improved:

Modified SIMODRIVE power modules	**Matching HEIDENHAIN expansion boards**	**Design**
At the end of the SIEMENS ordering designation of the improved power modules you find the **code A2 or A3**	324952-03, index A	2 axes, D-sub
	324952-12, index D	2 axes, D-sub
	324955-17	1 axis, ribbon cable
	359002-05	2 axes, ribbon-cable
	515012-03	1 axis, ribbon cable

The HEIDENHAIN expansion boards listed in the above table replace the previous variants.
This means that they may also be inserted in "older" SIMODRIVE power modules.

Attention

"Older" HEIDENHAIN expansion boards must not be operated with modified SIMODRIVE power modules.
Possible errors and error messages –> See "Overview of possible errors" on page 3 – 18.

Checking after replacement of electrical components

According to **DIN VDE 0113 part 1 / EN 60204-1**, the following inspections are required after an electrical component has been exchanged:

- Check whether the electrical equipment corresponds to the technical documentation.
- Check whether the protective ground system is continuous.
- Perform a functional check.

11 Overview of components

11.1 Controller units with integrated inverter

Controller units with integrated inverter are available in versions for 3 axes and spindle or 4 axes and spindle.

11.1.1 Compilation

For operation with HEIDENHAIN controller units with integrated **UEC 1xx** inverter, the following components are used:

- UEC 1xx controller units with integrated inverter
- PW 21x (or PW 110(B), PW 120) braking resistor (optional)
- Toroidal cores for interference suppression
- An SM voltage protection module in connection with synchronous spindle motors with a weakened field

Note

UECs are only available as non-regenerative version.

11.1.2 UEC 1xx controller units with integrated inverter

<table>
<tr><th colspan="2">UEC 11x</th></tr>
<tr><td>Controller unit with integrated inverter and PLC for up to 5 control loops for providing line voltage. Compact unit for machines with limited number of axes and low power demands.

It is equipped with:
■ HSCI interface
■ 4 (UEC 111) or 5 (UEC 112) speed encoder inputs
■ 4 (UEC 111) or 5 (UEC 112) position encoder inputs
■ Connection for 3 axes plus spindle (UEC 111) or
Connection for 4 axes plus spindle (UEC 112)
■ Braking resistor
■ 38 PLC inputs, 23 PLC outputs (expandable via PL 61xx)
■ Integrated power supply unit 24 V NC / 3.5 A for supplying the HSCI components
■ Weight: 20 kg

UEC 111 with 4 control loops

UEC 112 with 5 control loops</td><td></td></tr>
</table>

Note

It is not possible to connect an additional UM xxx inverter module to the UE 1xx.

11.1.3 UMC 1xx controller unit with integrated inverter

In preparation!

11.1.4 Toroidal cores

To suppress occurrence of conducted interference, toroidal cores must be mounted in the motor leads (X80 to X84), in the voltage supply lead (X31) and in the lead to the optional, external braking resistor (X89).

Terminal on the UEC	Toroidal core	Units
Power supply (X31)	Diameter 42 mm (ID 309 694-05)	2
Spindle (X80)		2
Axes 1 to 4 (X81 to X84)		ea. 1

Terminal on the UMC	Toroidal core	Units
Spindle (X80)	Diameter 42 mm (ID 309 694-05)	2
Axes 1 to 4 (X81 to X84)		ea. 1

11.2 Compact inverters

Compact inverters are available for up to 4 axes plus spindle or up to five axes.

11.2.1 Compilation

For operation with the non-regenerative HEIDENHAIN **UE 1xx** compact inverters, you need the following components:

- UE 1xx compact inverter
- Toroidal cores for interference suppression
- An SM voltage protection module in connection with synchronous spindle motors with a weakened field

For operation with the non-regenerative HEIDENHAIN **UE 2xx** compact inverters, you need the following components:

- UE 2xx compact inverter
- PW 21x (or PW 110(B), PW 120) braking resistor (optional)
- Toroidal cores for interference suppression
- An SM voltage protection module in connection with synchronous spindle motors with a weakened field
- UV 102 power module (only LE 426 M)

For operation with the non-regenerative HEIDENHAIN **UE 2xxB** compact inverters, the following components are used:

- UE 2xxB compact inverter
- PW 21x (or PW 110(B)) braking resistor (optional)
- Toroidal cores for interference suppression
- One UM 111D power module (optional)
- An SM voltage protection module in connection with synchronous spindle motors with a weakened field
- Ribbon cables for PWM signals and supply voltage (and optional unit bus)
- Covers for the ribbon cables

For operation with the regenerative HEIDENHAIN **UR 2xx(D)** compact inverters, you need the following components:

- UR 2xx (D) compact inverter
- KDR 120 commutating reactor
- EPCOS 35 A line filter
- UP 110 breaking resistor module (optional)
- One UM 111D power module (optional)
- In conjunction with synchronous spindle motors with weakened field: An SM voltage protection module
- In conjunction with direct drives (only via additional power module): One ZKF 1xx DC-link filter
- Ribbon cables for PWM signals and supply voltage (and optional unit bus)
- Covers for the ribbon cables

11.2.2 UE 1xx compact inverter

With UE 1xx compact inverters, the power electronics for all of the axes and the spindle, as well as the power supply for the control are all contained in a single unit. The UE 1xx models are non-regenerative compact inverters with integral braking resistor.
The PWM signals are transferred via **external** 20-line ribbon cables.

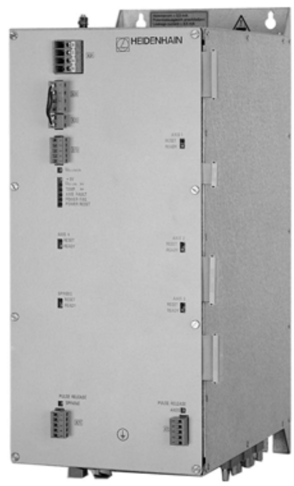
UE 112

Note

It is not possible to connect an external braking resistor or an additional UM xxx inverter module to the UE 1xx compact inverters.

11.2.3 UE 2xx compact inverter

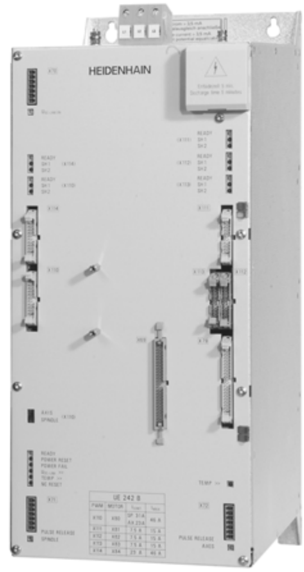
With the non-regenerative UE 2xx compact inverters, the power electronics for all of the axes and the spindle, as well as the power supply for the control are all contained in a single unit.
The PWM signals are transferred via internal 20-line ribbon cables.
If you are using an LE 426 M, you will additionally require UV 102 power supply unit.



UE 212

11.2.4 UE 2xxB compact inverter

With the non-regenerative UE 2xxB compact inverters, the power electronics for all of the axes and the spindle, as well as the power supply for the control are all contained in a single unit.
An additional UM 111D power module of the modular inverter system can be connected via conductor bars.
The PWM signals are transferred via external 20-line ribbon cables.



UE 242B

11.2.5 UR 2xx (D) compact inverter

With the regenerative UR 2xx(D) compact inverters, the power electronics for all of the axes and the spindle, as well as the power supply for the control are all contained in a single unit.
An additional UM 111(D) power module of the modular inverter system can be connected via conductor bars.
The PWM signals are transferred via external 20-line ribbon cables.

UR 242

Attention

Direct drives (linear motors, torque motors) must not be connected directly to regenerative UR 2xx(D) compact inverters→ Danger of destruction!
Direct drives can only be used in connection with an additional power module, e.g. UM 112 D that is connected to the DC-link of the UR 2xx(D) via a ZKF 1xx.

11.2.6 Toroidal cores

To suppress conducted interference, toroidal cores are mounted in the motor leads and in the voltage supply lead of non-regenerative compact inverters.
In the UE 21x also toroidal cores are integrated in the lead to the braking resistor.

Terminal on the compact inverter	Toroidal core
Power supply (X31)	Diameter 87 mm (309 694-02)
Braking resistor (X89)[a]	Diameter 42 mm (309 694-01)
Axes 1 to 3 (X81 to X83)	Diameter 42 mm (309 694-01)
Axis 4 (X84)	Diameter 59 mm (309 694-03)
Spindle (X80)	Diameter 59 mm (309 694-03)

a. only for UE 21x

11.2.7 Ribbon cables and covers (only for UE 2xxB, UR 2xx(D))

20-line ribbon cable

The 20-line ribbon cable connects the PWM outputs of the control with the PWM connections on the compact inverter.
It is responsible for the transmission of **PWM signals** for controlling the digital axes or spindles.
A 20-line ribbon cable is required for each axis or spindle.
If you are using an additional UM 111D power module, you will need an additional 20-line ribbon cable.

40-line ribbon cable

The 40-line ribbon cable serves as the **unit bus**. It is required if an additional UM 111D power module is operated with the compact inverter.

50-line ribbon cable

The 50-line ribbon cable connects the UE 2xxB or UR 2xx to the control.
It is responsible for the **power supply** and the **transmission of status signals**.

Ribbon cable covers

The ribbon cables must be covered **to protect them against interference**.

11.3 Modular inverters

11.3.1 Compilation

For operation with the **non-regenerative** HEIDENHAIN inverters, you need the following components:

- UV 130(D) power supply unit
- PW 21x (or PW 110(B), PW 120) braking resistor
- UM 1xx(B)D power modules, depending on version
- Ribbon cables for PWM signals, unit bus and power supply
- Covers for the ribbon cables

For operation with the **regenerative** HEIDENHAIN inverters, you need the following components:

- UV(R) 1x0(D) power supply unit
- KDR 1x0 commutating reactor
- Line filter
- UP 110, UP 120 braking resistor module (optional)
- UM 1xx(B)D power modules, depending on version
- Ribbon cables for PWM signals, unit bus and power supply bus
- Covers for the ribbon cables

11.3.2 UV 130(D) power supply unit

The UV 130(D) non-regenerative power supply units supply the DC-link voltage, as well as the power supply for the electronics of the control and the power modules.
During braking, the motors feed energy into the DC-link.
This energy is converted into heat by the UV 130(D) through the PW 210 or PW 1x0(B) external braking resistor.

UV 130

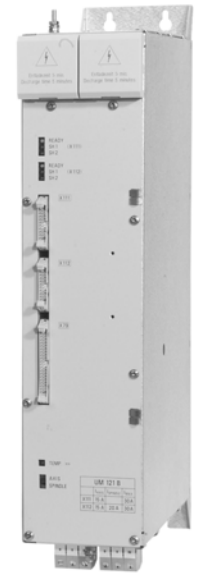
11.3.3 UV(R) 1x0(D) power supply unit

The UV(R) 1x0(D) regenerative power supply units supply the DC-link voltage, as well as the power supply for the electronics of the control and the power modules.
During braking, the motors feed energy into the DC-link.
The UVR 1x0D returns this energy to the power line.
The UVR 1x0(D) can be driven only with commutating reactor and line filter.

UVR 140D

11.3.4 UM 1xx(B)(D) power modules

The power modules differ in the number of axes and the permissible maximum currents.
They can be combined at random.
The PWM signals are transferred via external 20-line ribbon cables.



UM 121BD

11.3.5 Ribbon cables and covers

20-line ribbon cable

The 20-line ribbon cable connects the PWM outputs of the control with the corresponding UM 1xx(D) power modules.
It is responsible for the transmission of **PWM signals** for controlling the digital axes or spindles.
A 20-line ribbon cable is required for each axis or spindle.

40-line ribbon cable

The 40-line ribbon cable connects the UV(R) 1x0(D) with all of the UM 1xx(D) power modules (and the UP 110 braking resistor module, if present), making the **unit bus**.

50-line ribbon cable

The 50-line ribbon cable connects the UV(R) 1x0(D) with the control.
It is responsible for the **power supply** and the **transmission of status signals**.

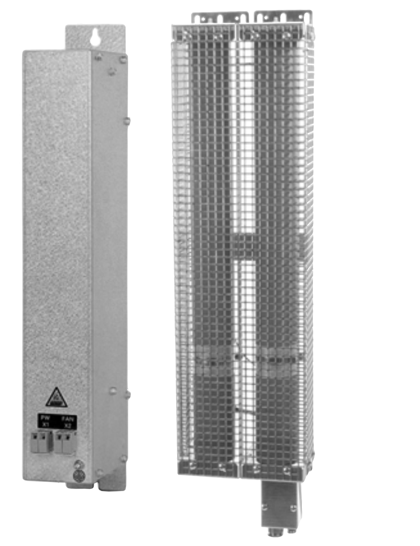
Ribbon cable covers

The ribbon cables must be covered **to protect them against interference**.

11.4 Accessories for compact inverters and modular inverters

11.4.1 PW 21x, PW 110(B), PW 120 braking resistors

The PW braking resistors convert the energy, which is fed back into the DC-link during braking, into heat.
The PW 110(B) and PW 120 braking resistors have a cooling fan, the PW 21x cools only through heat radiation.
Either one PW x10(B) or two PW 120 switched in series can be connected to the UE 2xx compact inverters.
Either one PW 21x, one PW 1x0(B), two PW 210 or two PW 110B in parallel can be connected to the UE 2xxB, UE 2xxD compact inverters and the UV 130, UV 130D power supply unit.


PW 110 and PW 210

Specifications	PW 210	PW 211
Continuous power	2 kW (4 kW)[a]	2 kW
Peak power[b]	27 kW (54 kW)[a]	49 kW
Resistance	18 Ω (9 Ω)	10 Ω
Degree of protection	IP 20	IP 20

a. When two PW 210 are connected in parallel
b. 1.5 % cyclic duration factor for duration of 120 s

Specifications	PW 110B	PW 120
Continuous power	2 kW	4 kW
Peak power[a]	27 kW	49 kW
Power consumption by the fan	2.5 W	2.4 W
Resistance	18 Ω	10 Ω
Degree of protection	IP 20	IP 20

a. PW 110B: 1.5 % cyclic duration factor for duration of 120 s
PW 120: 2 % cyclic duration factor for duration of 120 s

Danger

Mount the PW xxx braking resistors in a way that prevents the ingress of splashing water (coolant). At the same time, a cover must be mounted to make personal contact with the braking resistors impossible.
The surface of the braking resistor can attain temperatures of up to > 150 °C!

Note

The lines between the compact inverter/power supply unit and the braking resistor may have a length of 15 m.

11.4.2 UP 110, UP 120 braking resistor module

In the energy-recovery inverter, the braking energy of the motors is normally returned to the line power.
If in an exceptional case the line power is interrupted, the braking energy cannot be returned.
This can lead to an excessive DC-link voltage that might switch off the inverter and let the motors coast without control.
To prevent damage to the machine and workpiece resulting from uncontrolled machine movement, the energy should be dissipated with the UP 1x0 braking resistor module.

In specific cases, a brake integrated in the motor can be sufficient, or coasting to a stop can be considered as noncritical (e.g. spindle coasting to a stop while the protective doors are closed).
However, it must be considered for each individual application whether this is sufficient.

For the high-performance UVR 160 D(W) power supply unit, either two UP 110 in parallel or one UP 120 can be used.

UP 110

Specifications	UP 110	UP 120
Switching voltage	740 V	740 V
Power	60 kW (for 2 s)	150 kW (for 2 s)
Resistance	9 Ω	3,6 Ω
Degree of protection	IP 20	IP 20

Example for the use of the UP 110. --> See page 11 - 289

11.4.3 Line filter

If you are using regenerative inverter systems, you must use a line filter in addition to the commutating reactor.
Line filters suppress interference and ensure EMC compatible energy recovery.
The line filter must be connected between the power line and the commutating reactor.

The size of the line filter depends on the power supply module used.

EPCOS 35 A line filter

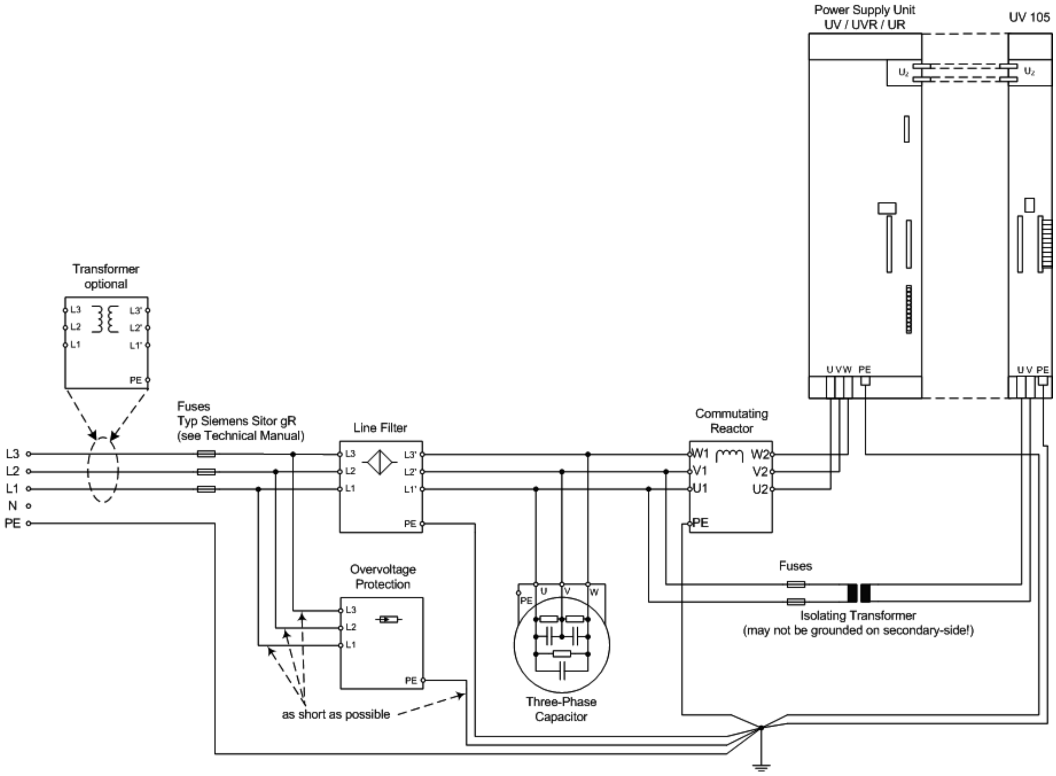
EPCOS 120A line filter

Specifications	EPCOS 35 A line filter	EPCOS 80 A line filter	EPCOS 120 A line filter
suitable for	UR 2xx(D), UV 120, UVR 120D	UV 140, UVR 150, UVR 130D, UVR 140D, UVR 150D	UVR 160D(W)
Rated voltage	3 x 480 V	3 x 480 V	3 x 480 V
Rated frequency	50 Hz/60 Hz	50 Hz/60 Hz	50 Hz/60 Hz
Rated current	3 x 35 A	3 x 80 A	3 x 120 A
Power loss	Approx. 50W	Approx. 75W	Approx. 115W
Degree of protection	IP 20	IP 20	IP 20

Application example for the use of line filter, three-phase current capacitor and commutating reactor

Power connection of regenerative inverter systems with ...

- Line filter
- Three-phase capacitor
- Commutating reactor



A **line filter** and **commutating reactor** are required for connecting **regenerative inverter systems**. The use of a **three-phase capacitor** for additional mains interference suppression is recommended.

> **Note**
>
> A three-phase capacitor has already been integrated in the line filter EPCOS 120 A, and also in the newer line filters EPCOS 35 A and EPCOS 80 A.
> Contact the machine manufacturer or HEIDENHAIN.

If you are using an UV 105 as an additional 5 V power supply, you must connect it through an isolating transformer via separate fuses.

In addition to the above-mentioned components, an overvoltage protector is required for compliance with UL requirements.

If the available supply voltage (L1, L2, L3, N) differs from the supply voltage specified for the modules, an autotransformer is required to adjust the voltages. It must comply at least with the connection specifications of the subsequent compact inverter.

11.4.4 Three-phase capacitor

Three-phase current capacitors are recommended as standard for regenerative inverter systems.
The three-phase capacitor suppresses low-frequency interference (current ripple) during energy infeed to and recovery from the power line.
It must be connected between the line filter and the commutating reactor.

Three-phase capacitor

Specifications	Three-phase capacitor
Phase-to-phase voltage	525 V
Capacitance	3 x 32 µF
Charging and discharging resistors	3 x 620 kΩ (PR03)
Discharge period (5τ)	Approx. 100 s
Degree of protection	IP 00

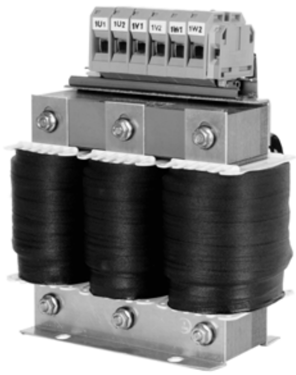
Note

A three-phase capacitor has already been integrated in the line filter EPCOS 120 A, and also in the newer line filters EPCOS 35 A and EPCOS 80 A.
Contact the machine manufacturer or HEIDENHAIN.

Example for the use of the three-phase current capacitor. --> See page 11 - 285

11.4.5 KDR 1x0(B) commutating reactor

Regenerative inverter systems require a commutating reactor.
It serves as energy buffer for the boost converter and suppresses system perturbation.
It is connected between the line filter and the power supply module.
The size of the commutating reactor depends on the power supply module used.



KDR 140

KDR 160

Specifications	KDR 120	KDR 130B	KDR 130C
Rated voltage	3 x 400 V	3 x 400 V	3 x 400 V
Rated frequency	50 Hz/60 Hz	50 Hz/60 Hz	50 Hz/60 Hz
Thermally permissible continuous current	3 x 35 A	3 x 45 A	3 x 45 A
Rated current	3 x 31.5 A	3 x 40.5 A	3 x 40.5 A
Power loss	Approx. 200W	Approx. 250W	Approx. 250W
Degree of protection	IP 00	IP 00	IP 00

Specifications	KDR 140	KDR 150	KDR 160
Rated voltage	3 x 400 V	3 x 400 V	3 x 400 V
Rated frequency	50 Hz/60 Hz	50 Hz/60 Hz	50 Hz/60 Hz
Thermally permissible continuous current	3 x 70 A	3 x 80 A	3 x 130 A
Rated current	3 x 63 A	3 x 72 A	3 x 117 A
Power loss	Approx. 340W	Approx. 350W	Approx. 525W
Degree of protection	IP 00	IP 00	IP 00

Attention

If a machine is required to comply with **UL requirements,** an air current of at least 10 m/s **must** be applied to the commutating reactors. This prevents the temperature on the surface from exceeding the max. permissible value of 105 °C.

Danger

To ensure conformity with IP10 required by the VDE for the installation of the KDR160 in the electrical cabinet, heat shrink tubings must be used.
The heat shrink tubings must be slid onto the connecting terminals!
The shrinking process must prevent the heat shrink tubing from being displaced.

Example for the use of the commutating reactor. –> See page 11 - 285

11.4.6 ZKF 1x0 DC-link filter

Direct drives (linear motors, torque motors) used with regenerative inverter systems result in voltage peaks, which might destroy the drive. If you are using direct drives in conjunction with the regenerative UVR 1xx(D) and UR 2xx(D) inverters, you must therefore use the ZKF 1xx DC-link filter.
The DC-link filter is mounted at left next to the power modules of the direct drives and the DC-link current is conducted through it.

 ZKF 110	 ZKF 130

Specifications	ZKF 110	ZKF 120	ZKF 130	ZKF 140
Rated power output	30 kW	30 kW	55 kW	80 kW
Peak power S6-40 %	47 kW[a]	47 kW[a]	80 kW[a]	110 kW[a]
Peak power S6-20%	67 kW[b]	67 kW[b]	100 kW[b]	140 kW[b]
Peak power	110 kW[c]	110 kW[c]	110 kW[c]	160 kW[c]
Max. leakage current	< 1.3 A	< 6.0 A	< 6.0 A	< 6.0 A
Current consumption 24 V	–	–	440 mA	440 mA
Integral cooling	–	–	Yes	Yes
Degree of protection	IP 20	IP 20	IP 20	IP 20

a. 40 % cyclic duration factor for duty cycle time of 10 minutes (S6-40 %)
b. 20 % cyclic duration factor for duty cycle time of 10 minutes (S6-40 %)
c. Pmax absolute

Attention

The total power of the direct drives must not exceed the power of the filter.

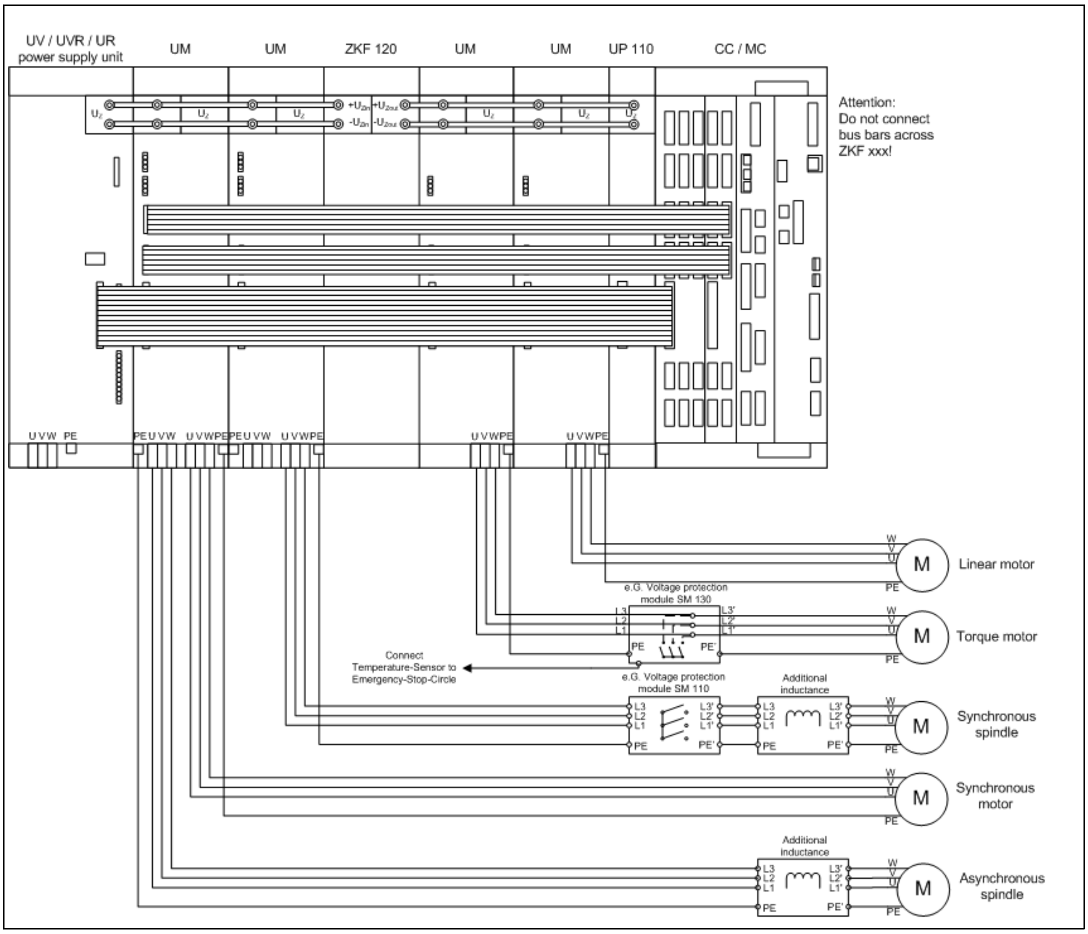
Attention

A ZKF DC-link filter is not permitted for non-HEIDENHAIN inverters!

Application example for the use of DC-link filter, braking resistor module, voltage protection module

Arrangement with .....

- ZKF 120 DC-link filter
- UP 110 breaking resistor module
- Voltage-protection module SM 110 and SM 130



For motors ...

- whose self-inductance is insufficient for operation require **additional inductance** (e.g. series reactors) to ensure proper servo control.
- with cable lengths over 15 m may require **additional inductance** for noise suppression.

11.4.7 SM 1xx voltage protection module

If synchronous motors or direct drives, such as synchronous spindles or torque motors, are operated in the field weakening range (for example, as spindle drives), a power interruption (e.g. power failure) can result in a voltage increase at the power connections of the motor. The voltage increase can damage the inverters and the motor. To prevent this, a voltage protection module must be inserted in the motor lead between the motor and the inverter. If an error occurs, the SM 1xx will short-circuit the motor phases. A thyristor "ignites" and the released braking energy is converted into heat.

Attention

The maximum cable length between the SM 1xx and the inverter is 1.0 m.

The cross section of the grounding conductor (yl/gn) on the voltage protection module must be at least the half of the cross section of the lines to the SM 1xx (e.g. leads = 40 mm^2 , resulting in protective ground = 20 mm^2).
In no case must the cross section of the protective ground be less than 10 mm^2 !

Attention

The **SM 130** is provided with a temperature switch due to its high power consumption.
The switch must be evaluated in the EMERGENCY STOP chain. The switch opens when the temperature is higher than 60 °C.
A restart can thus be prevented temporarily.

Attention

With the **SM 130,** the three motor phases are connected to three screws located in the housing of the **SM 130.** Use only insulated terminals for the connection.
The tightening torque for the screws is approximately 9 Nm.

<table>
<tr><th>Specifications</th><th>SM 110</th><th>SM 130</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Switching voltage</td><td>850 V</td><td>850 V</td></tr>
<tr><td>Maximum phase current</td><td>3 x 63 A</td><td>3 x 300 A</td></tr>
<tr><td>Maximum braking time at maximum phase current</td><td>10 s</td><td rowspan="2">If correctly wired, the integrated temperature switch prevents the drive from being switched on at temperatures above 60 °C. The temperature switch must be integrated in the EMERGENCY-STOP chain!</td></tr>
<tr><td>Minimum duration between braking procedures</td><td>5 min</td></tr>
<tr><td>Degree of protection</td><td>IP 20</td><td>IP 20</td></tr>
</table>

Example for the use of the voltage protection module --> See page 11 - 289.

11.4.8 Adapter module

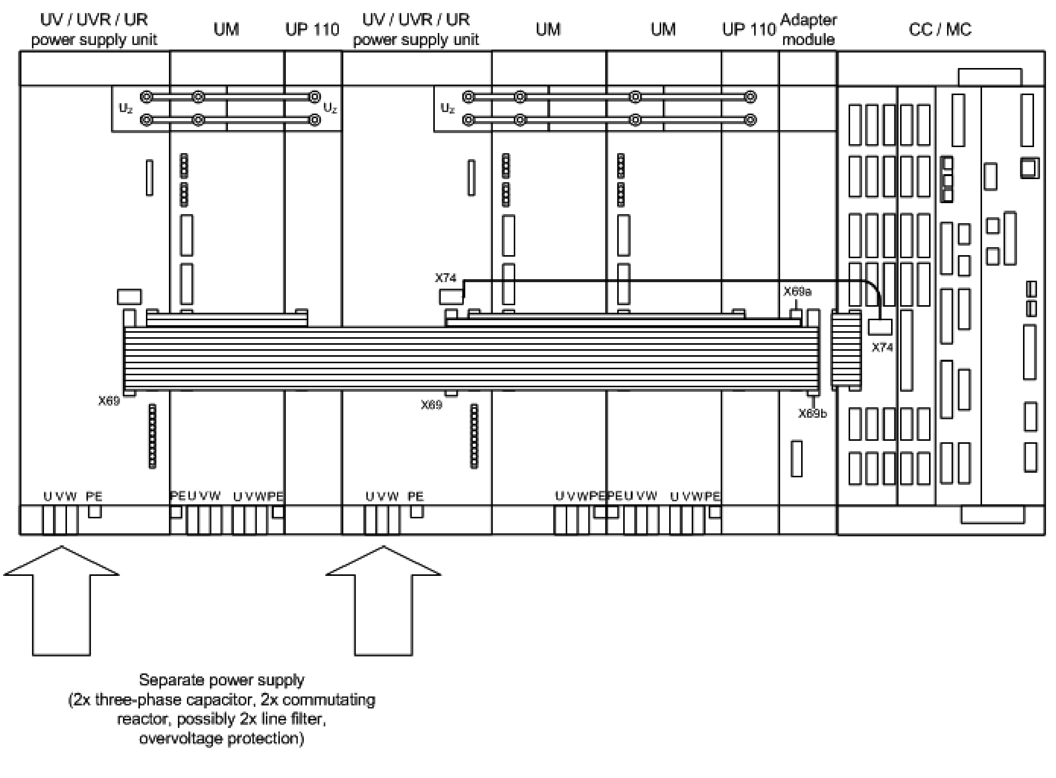
In modular regenerative inverter systems an **additional power supply unit** may become necessary if you are using inverters or motors with a high power demand.
The adapter module makes it possible to connect this power supply unit to the present inverter system.
In this way one power supply unit can, for example, supply the power to a high-performance spindle and the other power supply unit can be used for the axes.

The two power supply units are coupled via the supply bus (X69a/X69b – X69), and are then also monitored by the system.

This results in two **separate** supply systems whose power modules operate independently of each other, but are monitored by the control.

Adapter module

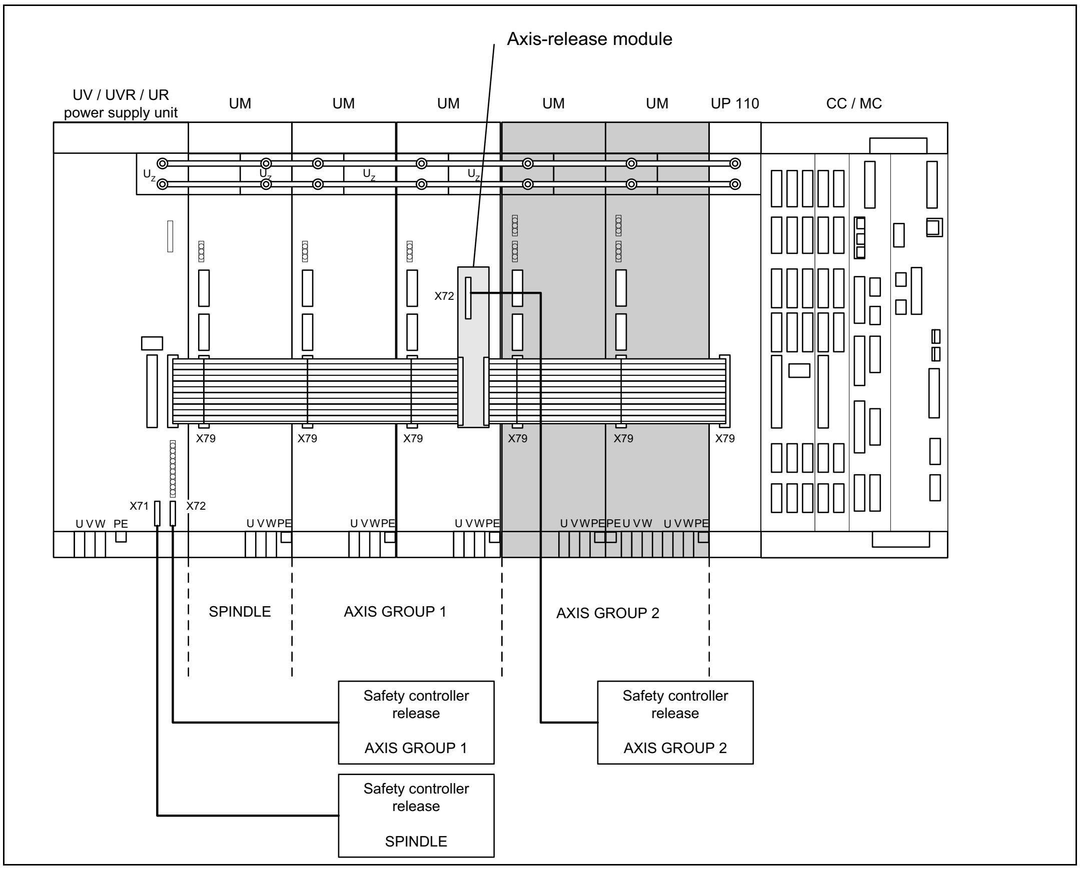
Example for the application of the adapter module



11.4.9 Axis-enabling module

If no axis-enabling module is used, all axis power modules are switched off simultaneously via X72 of the UV(R) 1x0.
The axis-release module makes it possible to switch off power modules group by group.
The module, instead of the mounting pins for the covers, is screwed onto the front panel of a power module.
The axis-enabling signal is transmitted via a line in the unit bus from power module to power module. The axis-enabling module can interrupt this line so that all power modules that are connected to the axis-enabling module are switched off. All other power modules are switched off via X72 of the UV(R) 1x0(D).

Example for the application of the axis release module



The unit bus requires a 40-line ribbon cable which connects the UV(R) 1x0(D) power supply unit with the axis-enabling module and the power modules to be switched off via UV(R) 1x0(D).

Another 40-line ribbon cable connects the axis-enabling module with the power modules to be switched off via the axis-enabling module.

11.4.10 Capacitor module

In case of a power failure, the danger exists that the tool and workpiece can be damaged by uncontrolled motions of the axes.
The LIFTOFF function of the iTNC 530 is able to protect expensive workpieces and tools from being damaged. In case of a power failure, and if the LIFTOFF function is active, the iTNC 530 attempts to retract the tool in a defined manner using the energy remaining in the DC-link.
The capacitor modules provide support for the energy necessary for the LIFTOFF function. They can also be connected in parallel for increased energy demands.

The CML 110 capacitor module serves to maintain the 24-V control voltage in case of a power failure.
In this case the enablings of the control system are maintained even after a power failure.
The CML is attached in the electrical cabinet via a top hat rail.

CML 110

Specifications	CML 110
Power supply	24 V
Capacitance	5.0 F
Charging current	<= 2.4 A

For direct drives, the CMH 120 capacitor module is also necessary in order to maintain the DC-link voltage.
The CMH 120 is mounted directly before the respective inverter module.

CMH 120

Specifications	CMH 120
DC-link voltage	<= 850 V
Capacitance	10.0 mF

11.5 HEIDENHAIN interface boards for the SIMODRIVE system

11.5.1 Compilation

To operate an LE 4xxM or a CC 42x with the SIMODRIVE 611D inverter system in **single-row** configuration you need the following components:

- UV 105B (UV 105) power supply unit
- Protective PCB
- Expansion board depending on the options
- Ribbon cable for the PWM signals
- Covers for the PWM cable

To operate an LE 4xxM or a CC 42x with the SIMODRIVE 611D inverter system in **multi-row** configuration you need the following components:

- UV 105B (UV 105) power supply unit
- Installation kit for double-row configuration
- Protective PCB
- Expansion board depending on the options
- Round cable with ribbon cable connector for the PWM signals
- Covers for the PWM cable

To operate an LE 4xx PA/PB with the SIMODRIVE inverter system you need the following components:

- Protective PCB
- Expansion board depending on the options

11.5.2 Interface boards

The HEIDENHAIN expansion boards are inserted into the power modules of a SIMODRIVE system.
The PWM signals of the HEIDENHAIN control are adapted to the SIMODRIVE system.

The following versions are available:

- 1-axis board or 2-axis board
- Ribbon cable connection or D-sub connection of the PWM cable
- Galvanically isolated or not galvanically isolated

See “Exchanging HEIDENHAIN interface boards in the SIMODRIVE system” on page 10 - 267.

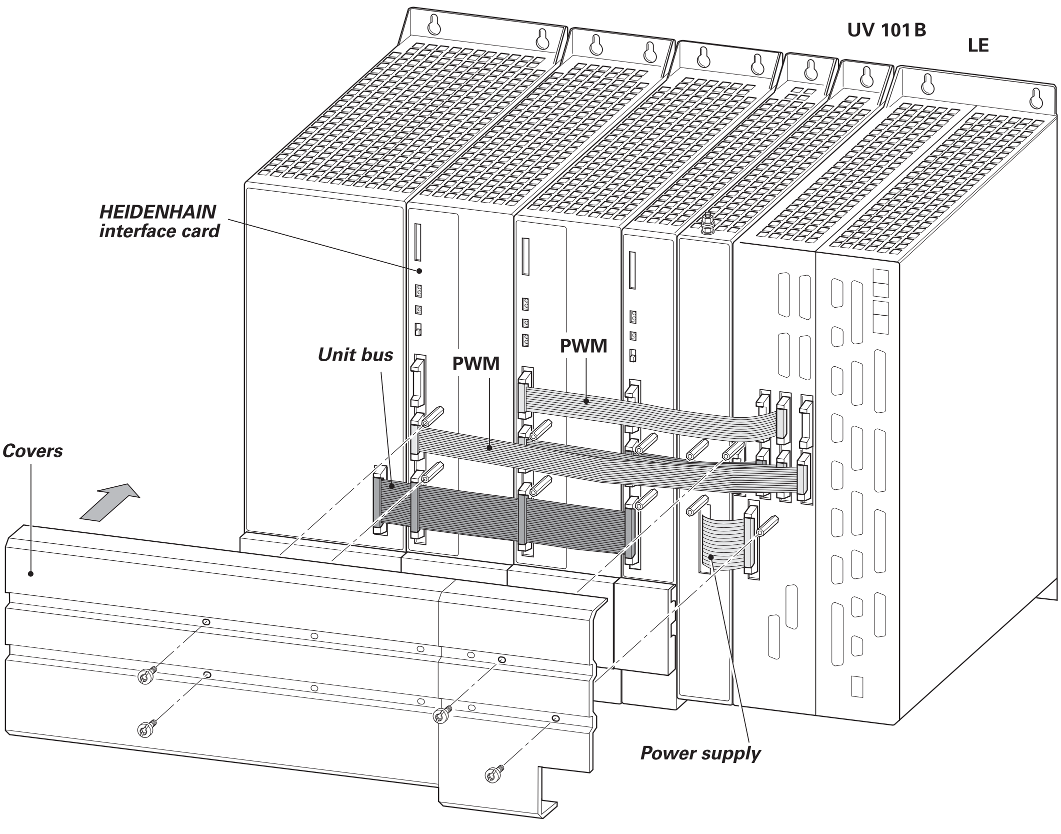
11.6 Power supply units

11.6.1 UV 101 B power supply unit

The UV 101B power supply unit provides the LE 4xx M with power during operation with the SIMODRIVE or POWER DRIVE inverter system.

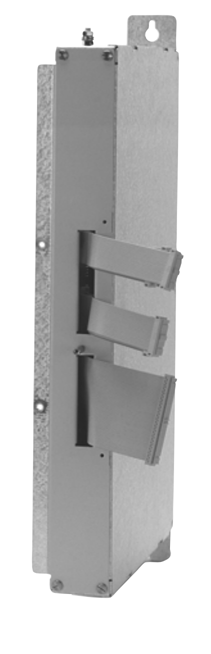
UV 101 B

Example for the application of the UV 101 B



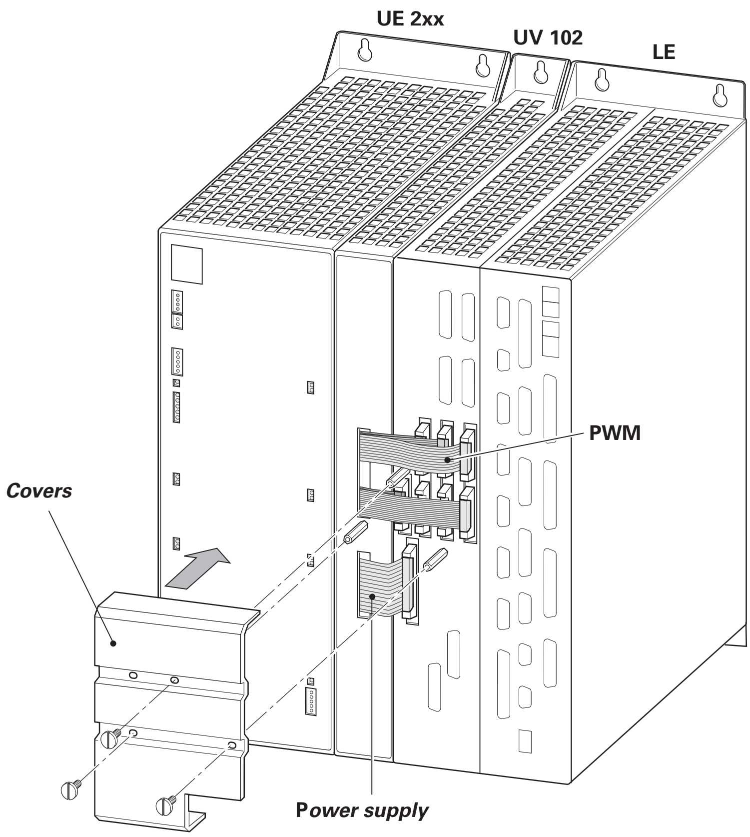
11.6.2 UV 102 power supply unit

The UV 102 power supply unit is necessary if you are using a UE 2xx (**not** UE 2xxB) compact inverter with an LE 426 M.
It supplies the power to the LE 426 M and leads the external PWM connections of the logic unit to the UE 2xx compact inverter.



UV 102

Example for the application of the UV 102



11.6.3 UV 105 power supply unit

The power for the main computer, controller unit and the connected encoders is usually supplied by the compact inverter or the power supply unit of the modular inverter system.
Current HEIDENHAIN inverters feature an additional terminal on the front panel for connecting wires for the 5-V supply (in addition to the ribbon cable).
The earlier generation of inverters does not feature this terminal which means that they are not yet provided with a stronger 5-V power supply unit.

If several encoders with a high current consumption (e.g. encoders with EnDat interface) or a dual-processor control are connected in combination with inverters without 5-V terminal, however, an additional power supply source might become necessary. For this purpose the UV 105 power supply unit is used.

The UV 105 is connected to the control via a ribbon cable and a 5-V terminal.

UV 105

11.6.4 UV 105 B power supply unit

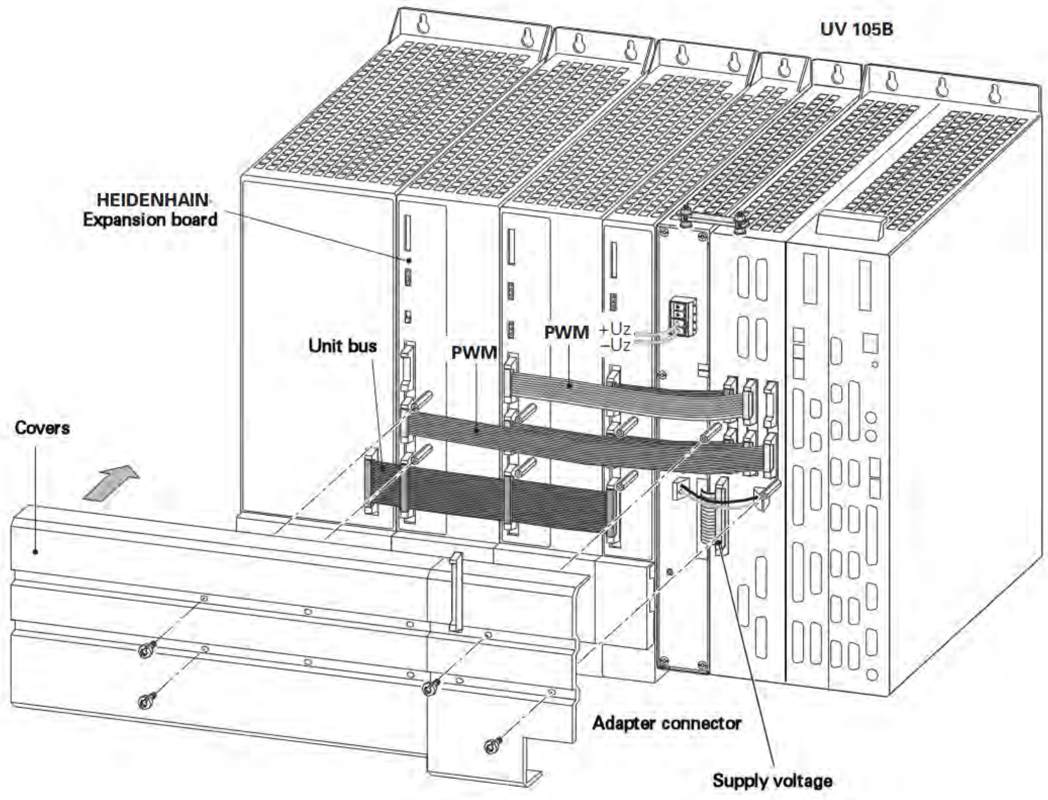
The UV 105 B was designed solely for the use on HEIDENHAIN controls in combination with non-HEIDENHAIN inverter systems.

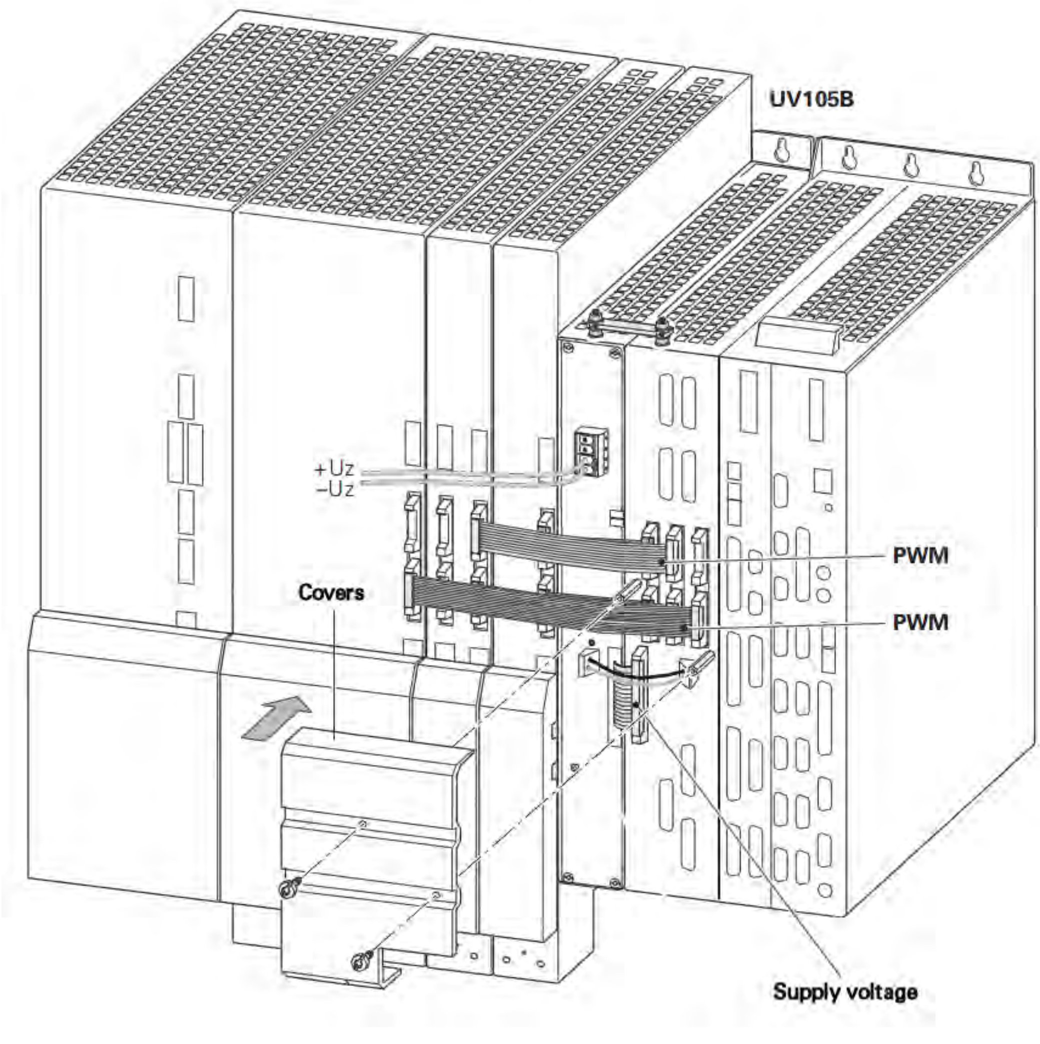
The phases U/V and the DC-link voltage ± Uz (± U_{DC}) are connected via a connector on the front panel. The LED READY UV on the front panel indicates the readiness of the unit.

The HEIDENHAIN control (e.g. iTNC 530) is supplied by means of a 50-line ribbon cable and an additional 5-V terminal on the UV 105 B.

UV 105 B

Examples for the application of the UV 105 B





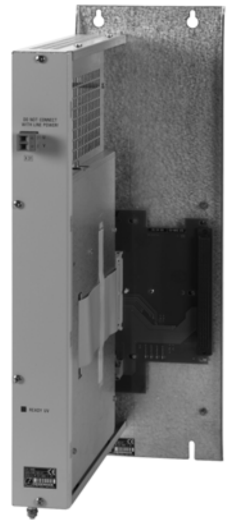
11.6.5 UV 106 B power supply unit

UV 106B power supply unit for analog HEIDENHAIN contouring controls

The **UV 106B** power supply unit was designed so that the iTNC 530 could be used with a compact, coordinated system for analog nominal shaft-speed interfaces (+/– 10 V).

It supplies the iTNC 530 with the supply voltages necessary for operation.

The **UV 106B** is being introduced as a replacement for the **UV 106**.

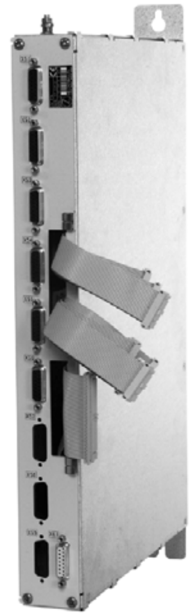


UV 106B

11.6.6 UV 111 A, UV 111 B power supply units

The UV 111 A power supply unit provides the LE 410 M, LE 426 M and the LE 430 M/6 axes with power during operation with the SIMODRIVE 611 D inverter system in multiple-row configuration.

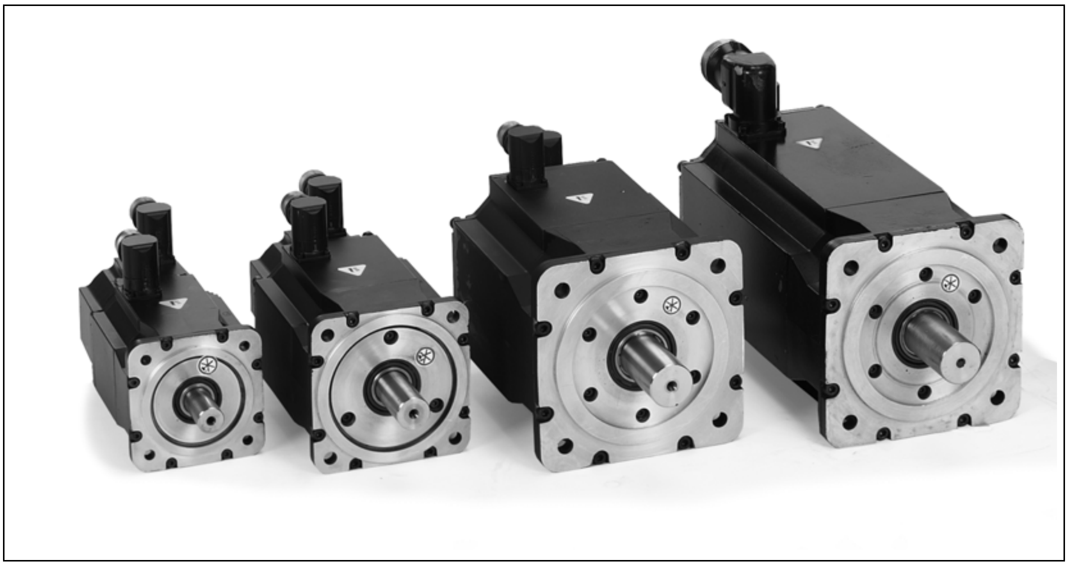
The UV 111 B power supply unit provides the LE 430 M/9 axes with power during operation with the SIMODRIVE 611 D inverter system in multiple-row configuration.



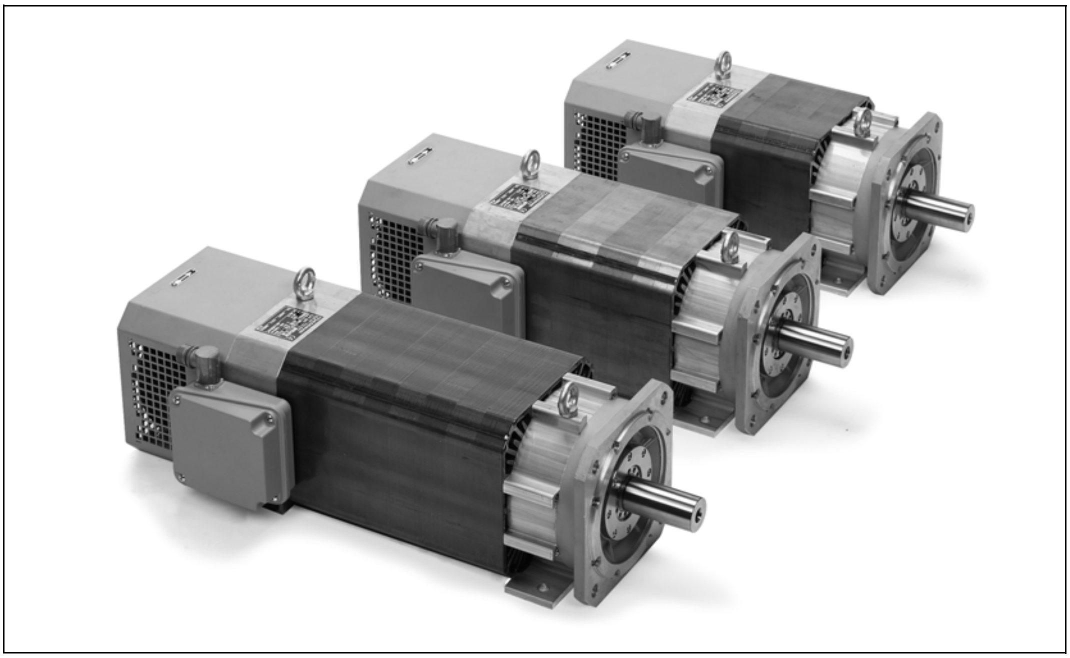
UV 111A

11.7 HEIDENHAIN motors

There exists a wide variety of HEIDENHAIN **synchronous motors**.



There also exists a wide variety of HEIDENHAIN **asynchronous motors**.



The specifications of the motor can be found on the respective ID label.
See “ID label for motors” on page 13 - 406.

You will find a description of the functionality of the HEIDENHAIN motors in the appendix.
See “HEIDENHAIN motors” on page 15 - 429.

12 Connector designations and pin layouts

12.1 Important note

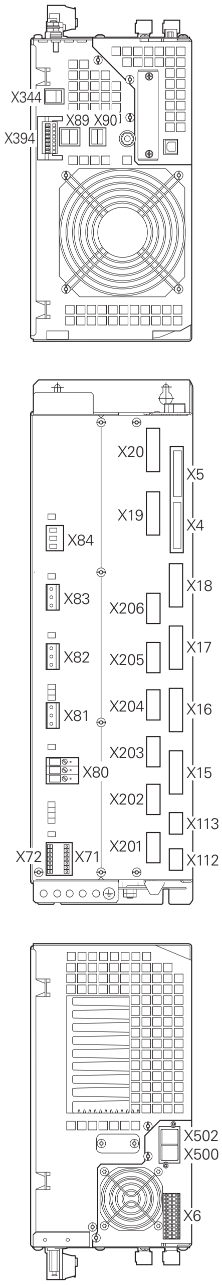
Danger

Do not engage or disengage any connecting elements while the unit is under power!
See "Safety precautions" on page 2 – 13

12.2 Controller units with integrated inverter

12.2.1 Designation and position of connections

UEC 11x Without Functional Safety (FS)

Pin layout	Cnnctr.	Function
	X4, X5	PLC inputs
	X6	PLC outputs
	X15 to X19	Speed encoder
	X31	Supply voltage for UEC 11x (3 x 400 V ± 10 %)
	X71	Safety relay for spindle (pulse inhibitor for spindle)
	X72	Safety relay for axes (pulse inhibitor for axes)
	X80	Motor connection for spindle (24 A rated current at 3.3 kHz)
	X81	Motor connection for axis 1 (6 A rated current at 3.3 kHz)
	X82	Motor connection for axis 2 (6 A rated current at 3.3 kHz)
	X83	Motor connection for axis 3 (9 A rated current at 3.3 kHz)
	X84	Motor connection for axis 4 (6 A rated current at 3.3 kHz)
	X89	Braking resistor
	X90	24 V NC output / 3.5 A
	X112	TS touch trigger probe
	X113	TT touch trigger probe
	X201 to X205	Position encoder
	X344	24 V supply for motor holding brake
	X394	Motor holding brake 1 to 4
	X500	HSCI output
	X502	HSCI input
	⏚	Protective ground M5

12.2.2 Pin layouts on the UEC and UMC

Type of terminals on the UxC 11x (FS)

Socket connectors X4, X5, X6, X104, X106 on the UxC 11x (FS)	
Connection:	Socket connector with tension clamp connection, type: Weidmüller B2L 3.5/24 SN SW 2-row, 24-pin
Connectable conductors:	Usable conductor cross sections without wire-end sleeve: 0.08 mm^2 to 1.0 mm^2 Usable conductor cross sections with wire-end sleeve: 0.14 mm^2 0.34 mm^2 0.5 mm^2 (only with Weidmüller PZ 6/5 crimping pliers)

Note

HEIDENHAIN recommends:

Preferably use a conductor cross section of 0.34 mm^2 if you use stranded wires with wire-end sleeves. This cross section can be clamped appropriately and ensures a reliable terminal connection.

If you use stranded wires with wire-end sleeves and a conductor cross section of 0.5 mm^2, the Weidmüller PZ 6/5 crimping pliers (setting 0.25–0.5 mm^2) must be used for crimping. In this case, orient the crimped wire-end sleeve before inserting it into the socket connector. If crimping pliers from other manufacturers are used for crimping conductors with a cross section of 0.5 mm^2, the crimped wire-end sleeves cannot be inserted into the socket connector and clamped appropriately, and therefore do not result in a reliable terminal connection.

X4: Single-channel PLC inputs

Connections on the front of the UxC 11x (FS):

- 18 single-channel PLC inputs are freely available:
  I0 to I17

Terminal	Signal designation	Assignm. / Function
1a	+24 V PLC.01	24 V supply of the outputs MC.RDY, O16 to O22
2a	+24 V PLC.02	24 V supply of the outputs O8 to O15
3a	+24 V PLC.03	24 V supply of the outputs O0 to O7
4a	0 V PLC	0 V for all I/Os
5a	–REF.SP	Reserved, do not assign
6a	0 V PLC	0 V for all I/Os
7a	I12	24 V inputs
8a	I13	
9a	I14	
10a	I15	
11a	I16	
12a	I17	
1b	I0	24 V inputs
2b	I1	
3b	I2	
4b	I3	
5b	I4	
6b	I5	
7b	I6	
8b	I7	
9b	I8	
10b	I9	
11b	I10	
12b	I11	

X5: Single-channel PLC inputs

Connections on the front of the UxC 11x (FS):

- 20 single-channel PLC inputs are freely available: I18 to I37

Terminal	Signal designation	Assignm. / Function
1a	I30	24 V inputs
2a	I31	
3a	I32	
4a	I33	
5a	I34	
6a	I35	
7a	I36	
8a	I37	
9a	–ES.A	+24 V input for "Control is ready" acknowledgment
10a	–ES.B	24 V input "Drive enable"
11a	Do not assign	
12a	Do not assign	
1b	I18	24 V inputs
2b	I19	
3b	I20	
4b	I21	
5b	I22	
6b	I23	
7b	I24	
8b	I25	
9b	I26	
10b	I27	
11b	I28	
12b	I29	

X104—Safety: Dual-channel PLC inputs

Connections on the front of the UxC 11x FS:

- 8 dual-channel PLC inputs:
  I0.A to I7.A
  I0.B to I7.B

Terminal	Signal designation	Assignm. / Function
1a	+24 V.A	24 V supply of the outputs O0.A to O7.A
2a	+24 V.B	24 V supply of the outputs O0.B to O7.B
3a	+24 V.C	24 V supply of the outputs O8.A to O15.A
4a	Do not assign	
5a	I4.B	24 V inputs
6a	I5.B	
7a	I6.B	
8a	I7.B	
9a	I4.A	
10a	I5.A	
11a	I6.A	
12a	I7.A	
1b	Do not assign	
2b	Do not assign	
3b	Do not assign	
4b	Do not assign	
5b	I0.B	24 V inputs
6b	I1.B	
7b	I2.B	
8b	I3.B	
9b	I0.A	
10b	I1.A	
11b	I2.A	
12b	I3.A	

X6: Single-channel PLC outputs

Connections at the top of the UxC 11x:

- 23 single-channel PLC outputs O0 to O22

Terminal	Signal designation	Assignm. / Function
1a	O4	24 V outputs, can be switched off via terminal X4.3a (+24 V PLC.03)
2a	O5	
3a	O6	
4a	O7	
5a	O12	24 V outputs, can be switched off via terminal X4.2a (+24 V PLC.02)
6a	O13	
7a	O14	
8a	O15	
9a	O20	24 V outputs, cannot be switched off
10a	O21	
11a	O22	
12a	MC.RDY	24 V for control-is-ready signal output
1b	O0	24 V outputs, can be switched off via terminal X4.3a (+24 V PLC.03)
2b	O1	
3b	O2	
4b	O3	
5b	O8	24 V outputs, can be switched off via terminal X4.2a (+24 V PLC.02)
6b	O9	
7b	O10	
8b	O11	
9b	O16	24 V outputs, cannot be switched off
10b	O17	
11b	O18	
12b	O19	

Note

Each output of the UxC 11x can be loaded with a maximum current of 150 mA.

X6 – safety: Single-channel PLC outputs

Connections at the top of the UxC 11x FS:

- 20 single-channel PLC outputs

Terminal	Signal designation	Assignm. / Function
1a	O4	24 V outputs, can be switched off via terminal X4.3a (+24 V PLC.03)
2a	O5	
3a	O6	
4a	O7	
5a	O12	24 V outputs, can be switched off via terminal X4.2a (+24 V PLC.02)
6a	O13	
7a	O14	
8a	O15	
9a	–TEST.A	24 V output for emergency stop chain
10a	–TEST.B	24 V output for emergency stop chain
11a	–STOS.A.G	24 V output: (spindle safe torque off)
12a	–STO.A.G	24 V output: (safe torque off) Control-is-ready signal
1b	O0	24 V outputs, can be switched off via terminal X4.3a (+24 V PLC.03)
2b	O1	
3b	O2	
4b	O3	
5b	O8	24 V outputs, can be switched off via terminal X4.2a (+24 V PLC.02)
6b	O9	
7b	O10	
8b	O11	
9b	O16	24 V outputs, cannot be switched off
10b	O17	
11b	O18	
12b	O19	

Note

Each output of the UxC 11x (FS) can be loaded with a maximum current of 150 mA.

X106—Safety: Single/dual-channel PLC outputs

Connections on the front of the UxC 11x FS:

- 8 dual-channel PLC outputs:
  O0.A to O7.A
  O0.B to O7.B
- 8 single-channel PLC outputs:
  O8.A to O15.A

Terminal	Signal designation	Assignm. / Function
1a	O4.B	24 V outputs, can be switched off via terminal X104.2a (+24 V.B)
2a	O5.B	
3a	O6.B	
4a	O7.B	
5a	O4.A	24 V outputs, can be switched off via terminal X104.1a (+24 V.A)
6a	O5.A	
7a	O6.A	
8a	O7.A	
9a	O12.A	24 V outputs, can be switched off via terminal X104.3a (+24 V.C)
10a	O13.A	
11a	O14.A	
12a	O15.A	
1b	O0.B	24 V outputs, can be switched off via terminal X104.2a (+24 V.B)
2b	O1.B	
3b	O2.B	
4b	O3.B	
5b	O0.A	24 V outputs, can be switched off via terminal X104.1a (+24 V.A)
6b	O1.A	
7b	O2.A	
8b	O3.A	
9b	O8.A	24 V outputs, can be switched off via terminal X104.3a (+24 V.C)
10b	O9.A	
11b	O10.A	
12b	O11.A	

Note

Each output of the UxC 11x (FS) can be loaded with a maximum current of 150 mA.

X15 to X20: 1 Vpp speed encoder

Pin layout:

UxC 11x		Adapter cable 289 440-xx				Connecting cable 336 847-xx		
Male	**Assignment**	**Female**	**Color**	**Female**		**Male**	**Color**	**Female**
1	+5 V (U_P)	1	Brown/Green	10	Possibly voltage controller ID 370 226-01	10	Brown/Green	10
2	0 V (U_N)	2	White/Green	7		7	White/Green	7
3	A+	3	Green/Black	1		1	Green/Black	1
4	A–	4	Yellow/Black	2		2	Yellow/Black	2
5	0 V							
6	B+	6	Blue/Black	11		11	Blue/Black	11
7	B–	7	Red/Black	12		12	Red/Black	12
8	0 V	8	Internal shield	17		17	Internal shield	17
9	Do not assign							
10	Do not assign							
11	Do not assign							
12	Do not assign							
13	Temperature +	13	Yellow	8		8	Yellow	8
14	+5 V (sensor)	14	Blue	16		16	Blue	16
15	Do not assign							
16	0 V (sensor)	16	White	15		15	White	15
17	R+	17	Red	3		3	Red	3
18	R–	18	Black	13		13	Black	13
19	C+	19	Green	5		5	Green	5
20	C–	20	Brown	6		6	Brown	6
21	D+	21	Gray	14		14	Gray	14
22	D–	22	Pink	4		4	Pink	4
23	Do not assign							
24	0 V							
25	Temperature –	25	Violet	9		9	Violet	9
Hsg.	Chassis	Hsg.	External shield	Hsg.		Hsg.	External shield	Hsg.

Note

The interface complies with the requirements of EN 61800-5-1 for "protective extra-low voltage" (PELV).

X15 to X20: Speed encoder with EnDat interface

Pin layout:

UxC 11x		Adapter cable 336 376-xx				Connecting cable, ID 340 302-xx		
Male	**Assignment**	**Female**	**Color**	**Female**		**Male**	**Color**	**Female**
1	+5 V (U_P)	1	Brown/Green	10	Possibly voltage controller ID 370 224-01	10	Brown/Green	10
2	0 V (U_N)	2	White/Green	7		7	White/Green	7
3	A+	3	Green/Black	1		1	Green/Black	1
4	A–	4	Yellow/Black	2		2	Yellow/Black	2
5	0 V							
6	B+	6	Blue/Black	11		11	Blue/Black	11
7	B–	7	Red/Black	12		12	Red/Black	12
8	0 V	8	Internal shield	17		17	Internal shield	17
9	Do not assign							
10	Clock	10	Green	5		5	Green	5
11	Do not assign							
12	$\overline{\text{Clock}}$	12	Brown	14		14	Brown	14
13	Temperature +	13	Yellow	8		8	Yellow	8
14	+5 V (sensor)	14	Blue	16		16	Blue	16
15	Data	15	Red	3		3	Red	3
16	0 V (sensor)	16	White	15		15	White	15
17	Do not assign							
18	Do not assign							
19	Do not assign							
20	Do not assign							
21	Do not assign							
22	Do not assign							
23	$\overline{\text{Data}}$	23	Black	13		13	Black	13
24	0 V							
25	Temperature –	25	Violet	9		9	Violet	9
Hsg.	Chassis	Hsg.	External shield	Hsg.		Hsg.	External shield	Hsg.

Note

The interface complies with the requirements of EN 61800-5-1 for "protective extra-low voltage" (PELV).

Danger

Only units that comply with the requirements of EN 61800-5-1 for "protective extra-low voltage (PELV)" may be connected.

Pin layout (for the LC or RCN):

UxC 11x		**Adapter cable 336 376-xx**				**Adapter cable 369 124-xx Adapter cable 369 129-xx**	
Male	**Assignment**	**Female**	**Color**	**Female**		**Male**	**Color**
1	+5 V (U_P)	1	Brown/Green	10	Possibly voltage controller ID 368 210-02	7	Brown/Green
2	0 V (U_N)	2	White/Green	7		10	White/Green
3	A+	3	Green/Black	1		15	Green/Black
4	A–	4	Yellow/Black	2		16	Yellow/Black
5	0 V						
6	B+	6	Blue/Black	11		12	Blue/Black
7	B–	7	Red/Black	12		13	Red/Black
8	0 V	8	Internal shield	17		11	Internal shield
9	Do not assign						
10	Clock	10	Green	5		8	Violet
11	Do not assign						
12	$\overline{\text{Clock}}$	12	Brown	14		9	Yellow
13	Temperature +	13	Yellow	8			
14	+5 V (sensor)	14	Blue	16		1	Blue
15	Data	15	Red	3		14	Gray
16	0 V (sensor)	16	White	15		4	White
17	Do not assign						
18	Do not assign						
19	Do not assign						
20	Do not assign						
21	Do not assign						
22	Do not assign						
23	$\overline{\text{Data}}$	23	Black	13		17	Pink
24	0 V						
25	Temperature –	25	Violet	9			
Hsg.	Chassis	Hsg.	External shield	Hsg.		Hsg.	External shield
					1		
					2 temperature+		
					3 temperature –		
					4		

Note

The interface complies with the requirements of EN 61800-5-1 for "protective extra-low voltage" (PELV).

Pin layout (for the LC or RCN):

UxC 11x		Adapter cable 509 667-xx			Adapter cable 369 124-xx Adapter cable 369 129-xx or RCN	
Male	**Assignment**	**Female**	**Color**	**Female**	**Male**	**Color**
1	+5 V (U_P)	1	Brown/Green	7	7	Brown/Green
2	0 V (U_N)	2	White/Green	10	10	White/Green
3	A+	3	Green/Black	15	15	Green/Black
4	A–	4	Yellow/Black	16	16	Yellow/Black
5	0 V					
6	B+	6	Blue/Black	12	12	Blue/Black
7	B–	7	Red/Black	13	13	Red/Black
8	0 V	8	Internal shield	11	11	Internal shield
9	Do not assign					
10	Clock	10	Green	8	8	Violet
11	Do not assign					
12	$\overline{\text{Clock}}$	12	Brown	9	9	Yellow
13	Temperature +	13	Yellow	5		
14	+5 V (sensor)	14	Blue	1	1	Blue
15	Data	15	Red	14	14	Gray
16	0 V (sensor)	16	White	4	4	White
17	Do not assign					
18	Do not assign					
19	Do not assign					
20	Do not assign					
21	Do not assign					
22	Do not assign					
23	$\overline{\text{Data}}$	23	Black	17	17	Pink
24	0 V					
25	Temperature –	25	Violet	6		
Hsg.	Chassis	Hsg.	External shield	Hsg.	Hsg.	External shield

Note

The interface complies with the requirements of EN 61800-5-1 for "protective extra-low voltage" (PELV).

X31:
UEC power supply

Note

EN 61800-5-1 requires a non-detachable connection to the line power supply.

Note

If the power supply is other than 400 V / 480 V, an autotransformer is required. It must comply at least with the connection specifications of the UEC 11x.

With a power supply of 400 V, the inverter voltage U_Z is 565 Vdc, and with a power supply of 480 V it is 678 Vdc.

<table>
<tr><th>Connecting terminals</th><th>UEC 111, UEC 112</th></tr>
<tr><td colspan="2">Operation on 400 V~</td></tr>
<tr><td>L1</td><td rowspan="3">400 V~ ± 10 %
50 Hz to 60 Hz</td></tr>
<tr><td>L2</td></tr>
<tr><td>L3</td></tr>
<tr><td rowspan="2"></td><td>Cable / single conductor (HT wire):
6 mm² (AWG 10)
Single conductor H07 V2-K:
4 mm² (AWG 10)
Line fuse:
25 A (gR) semiconductor fuse, Siemens Sitor type
Grounding terminal:
≥ 10 mm² (AWG 6)</td></tr>
<tr><td>Tightening torque for connecting terminals:
0.7 Nm (6.5 to 7 pound-inch)</td></tr>
<tr><td colspan="2">Operation on 480 V~</td></tr>
<tr><td>L1</td><td rowspan="3">480 V~ ± 10 %
50 Hz to 60 Hz</td></tr>
<tr><td>L2</td></tr>
<tr><td>L3</td></tr>
<tr><td rowspan="2"></td><td>Cable / single conductor (HT wire):
6 mm² (AWG 10)
Single conductor H07 V2-K:
4 mm² (AWG 10)
Line fuse:
25 A (gR) semiconductor fuse, Siemens Sitor type
Grounding terminal:
≥ 10 mm² (AWG 6)</td></tr>
<tr><td>Tightening torque for connecting terminals:
0.7 Nm (6.5 to 7 pound-inch)</td></tr>
</table>

X71: Safety relay for spindle
X72: Safety relay for axes

For information on the wiring and function, see the circuit diagram for your machine.

Connecting terminals X71 to X72	Assignment
1	+24 V pulse release output (max. 250 mA) for control of the relays at X71.3 and X72.3 for drive enabling (Axis ON, Spindle ON).
2	0 V for pulse release output
3	+24 V pulse release input for Axis ON, Spindle ON
4	Do not assign
5	Do not assign
6[a]	Normally closed contact (OE1, OE1A or OE1S)
7[a]	Normally closed contact (OE2, OE2A or OE2S)

a. maximum 125 V

Note

The +24 V pulse release voltage at terminals X71.1 and X72.1 is generated internally by a separate power supply unit of the UEC 11x. This voltage may only be used for drive enabling (for supplying the relay coils that are internally connected to X71.3 and X72.3).

Attention

The +24 V pulse release voltage must not be linked with other voltages (e.g. +24 V NC or +24 V PLC) of the HEIDENHAIN control system.

Attention

A recovery diode is required in the proximity of inductive loads, e.g. relay or contactor coils.

X80: Spindle motor
X81: Axis motor 1
X82: Axis motor 2
X83: Axis motor 3
X84: Axis motor 4

Connecting terminals	Assignment
U	Motor connection U
V	Motor connection V
W	Motor connection W

X89: Braking resistor

Connecting terminal X89 UEC 11x	Assignment	PW 21x	PW 1x0(B); Connecting terminal X1
1	$+U_Z$	RB1	1
2	Switch to $-U_Z$	RB2	2

X90: 24 V output

Connecting terminal X90		Assignment
1	+	+24 V (maximum 3.5 A)
2	–	0 V

X112, X113: Triggering touch probes

> Note
>
> The touch probes are connected to the PLB 62xx PLC system module or UEC 11x controller unit at X112 (TS) and X113 (TT).

Pin layout X112 / X113 on UEC 11x:

(15-pin D-sub, triple-row)

Female	Assignment of X112 (TS)	Assignment of X113 (TT)
1	Trigger signal	Trigger signal
2	$\overline{\text{Trigger signal}}$[a]	$\overline{\text{Trigger signal}}$[a]
3	TS ready	Do not assign
4	$\overline{\text{Battery warning}}$	$\overline{\text{Battery warning}}$
5	+ 5 V-NC (+/- 5%)	+ 5 V-NC (+/- 5%)
6	TS start	Do not assign
7	Do not assign	TT start
8	0 V-NC	0 V-NC
9	0 V-NC	0 V-NC
10	+ 24 V-NC	+ 24 V-NC
11	Do not assign	TT ready
12	Do not assign	Do not assign
13	Do not assign	Do not assign
14	Do not assign	Do not assign
15	Do not assign	Do not assign

a. Stylus at rest means logic level HIGH.

> Note
>
> The interface complies with the requirements of EN 60204-1:2006 for protective extra-low voltage (PELV).

X201 to X206: Position encoder 1 Vpp

Pin layout:

UxC 11x		**Adapter cable 309 783-xx Adapter cable 310 199-xx**			**Measuring system**	
Male	**Assignment**	**Female**	**Color**	**Female**	**Male**	**Color**
1	+5 V (U_P)	1	Brown/Green	12	12	Brown/Green
2	0 V (U_N)	2	White/Green	10	10	White/Green
3	A+	3	Brown	5	5	Brown
4	A–	4	Green	6	6	Green
5	Do not assign	5				
6	B+	6	Gray	8	8	Gray
7	B–	7	Pink	1	1	Pink
8	Do not assign	8				
9	+5 V (sensor)	9	Blue	2	2	Blue
10	R+	10	Red	3	3	Red
11	0 V (sensor)	11	White	11	11	White
12	R–	12	Black	4	4	Black
13	0 V	13				
14	Do not assign	14	Violet	7	7	Violet
15	Do not assign	15				
Hsg.	External shield	Hsg.	External shield	Hsg.	Hsg.	External shield

Note

The interface complies with the requirements of EN 50 178 for "low voltage electrical separation."

X201 to X206: Position encoder with EnDat interface

Pin layout:

UxC 11x		**Adapter cable 332 115-xx**			**Connecting cable 323 897-xx**				**Adapter cable 313 791-xx**		
Male	**Assignm.**	**Female**	**Color**	**Female**	**Male**	**Color**	**Fem.**		**Male**	**Color**	**Fem.**
1	+5 V (U_P)	1	Brown/ Green	7	7	Brown/ Green	7	Evtl. Spannungsregler ID 336 697-02	7	Brown/ Green	5b
2	0 V (U_N)	2	White/ Green	10	10	White/ Green	10		10	White/ Green	6a
3	A+	3	Green/ Black	15	15	Green/ Black	15		15	Green/ Black	2a
4	A–	4	Yellow/ Black	16	16	Yellow/ Black	16		16	Yellow/ Black	2b
5	Data	5	Gray	14	14	Gray	14		14	Gray	3b
6	B+	6	Blue/ Black	12	12	Blue/ Black	12		12	Blue/ Black	1a
7	B–	7	Red/ Black	13	13	Red/ Black	13		13	Red/ Black	1b
8	$\overline{\text{Data}}$	8	Pink	17	17	Pink	17		17	Pink	3a
9	+5 V (sensor)	9	Blue	1	1	Blue	1		1	Blue	5a
10	Vacant	10		3	3	Red	3		3		
11	0 V (sensor)	11	White	4	4	White	4		4	White	6b
12	Free	12		2	2	Black	2		2		
13	Internal shield	13	Internal shield	11	11	Internal shield	11		11	Internal shield	
14	Clock	14	Violet	8	8	Violet	8		8	Violet	4a
15	$\overline{\text{Clock}}$	15	Yellow	9	9	Yellow	9		9	Yellow	4b
Hsg.	Chassis	Hsg.	Ext. shield	Hsg.		Ext. shield			Hsg.	Ext. shield	

Note

The interface complies with the requirements of EN 50 178 for "low voltage electrical separation."

**X344:
24 V power supply for motor holding brakes**

Connecting terminals	Assignment
1	+24 V PLC
2	0 V PLC

**X394:
Motor holding brakes**

Connecting terminals	Assignment
1	Holding brake X80
2	0 V PLC
3	Holding brake X81
4	0 V PLC
5	Holding brake X82
6	0 V PLC
7	Holding brake X83
8	0 V PLC
9	Holding brake X84
10	0 V PLC

**X500, X502:
HSCI interfaces**

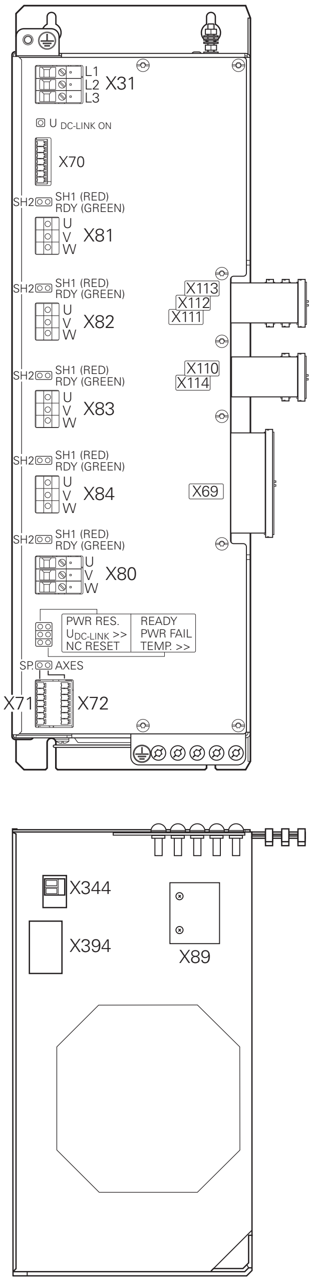
HSCI connection X500, output	
RJ45 connection (female) 8-pin	**Assignment**
1	TD0+
2	TD0–
3	RD0+
4	Do not assign
5	Do not assign
6	RD0–
7	Do not assign
8	Do not assign

HSCI connection X502, input	
RJ45 connection (female) 8-pin	**Assignment**
1	RD0+
2	RD0–
3	TD0+
4	Do not assign
5	Do not assign
6	TD0–
7	Do not assign
8	Do not assign

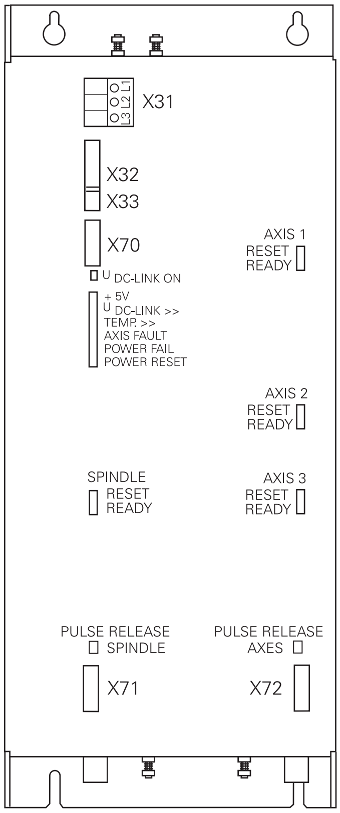
12.3 Compact inverters

12.3.1 Designation and position of connections

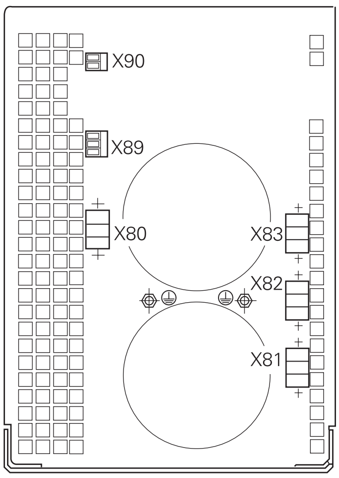
UE 110 / UE 112



X31	Power supply for inverter (L1, L2, L3)
X70	Main contactor
X81	Motor connection for axis 1 (to X111) (6 A at 3.3 kHz PWM frequency)
X82	Motor connection for axis 2 (to X112) (6 A at 3.3 kHz PWM frequency)
X83	Motor connection for axis 3 (to X113) (6 A at 3.3 kHz PWM frequency)
X84	Motor connection for axis 4 (to X114) (9 A at 3.3 kHz PWM frequency) (only UE 112)
X69	Supply bus
X80	Motor connection for spindle (to X110) (24 A at 3.3 kHz PWM frequency)
X71	Safety relay for spindle
X72	Safety relay for axes
X344	24 V supply for motor brake output
X394	24 V brake outputs
⏚	Equipment ground

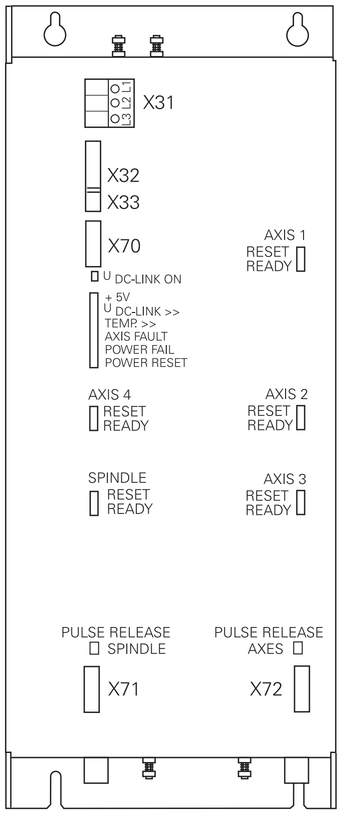


X31	Power supply for inverter
X32	Output for power supply (L1, L2, $+U_Z$, $-U_Z$)
X33	Power supply for supply unit (L1, L2)
X70	Main contactor
X71	Safety relay for spindle
X72	Safety relay for axes



X90	24-V output
X89	Braking resistor
X80	Motor connection for spindle (19 A)
X83	Motor connection for axis 3 (7.5 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground

UE 212

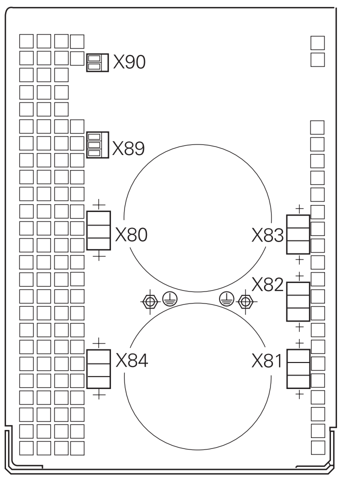


X31 Power supply for inverter

X32 Output for power supply (L1, L2, $+U_Z$, $-U_Z$)
X33 Power supply for supply unit (L1, L2)

X70 Main contactor

X71 Safety relay for spindle
X72 Safety relay for axes



X90 24-V output

X89 Braking resistor

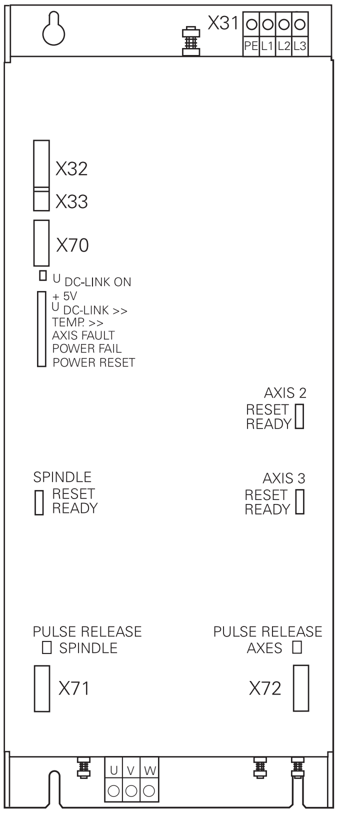
X80 Motor connection for spindle (19 A)
X83 Motor connection for axis 3 (7.5 A)

X82 Motor connection for axis 2 (7.5 A)

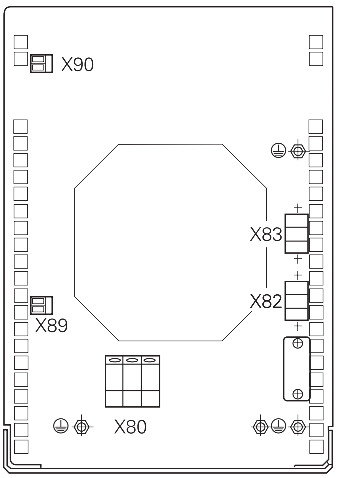
X84 Motor connection for axis 4 (14 A)
X81 Motor connection for axis 1 (7.5 A)

⏚ Equipment ground

UE 230

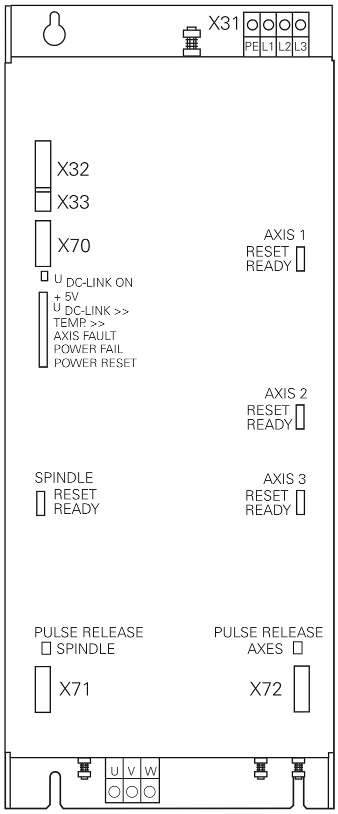


X31	Power supply for inverter
X32	Output for power supply (L1, L2, $+U_Z$, $-U_Z$)
X33	Power supply for supply unit (L1, L2)
X70	Main contactor
X71	Safety relay for spindle
X72	Safety relay for axes

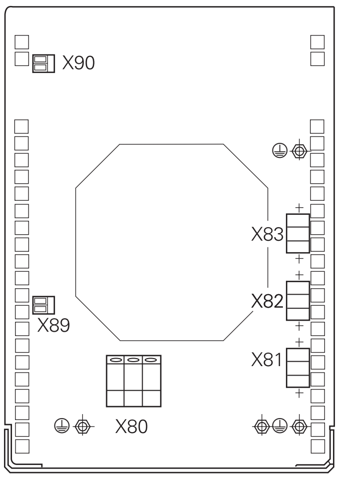


X90	24-V output
X83	Motor connection for axis 3 (7.5 A)
X82	Motor connection for axis 2 (7.5 A)
X89	Braking resistor
X80	Motor connection for spindle (31 A)
⏚	Equipment ground

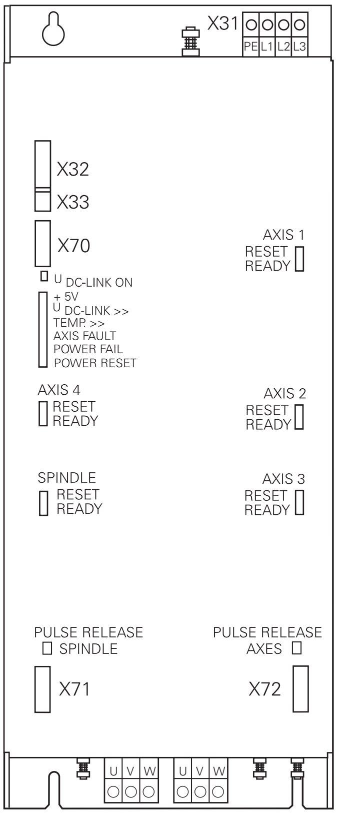
UE 240



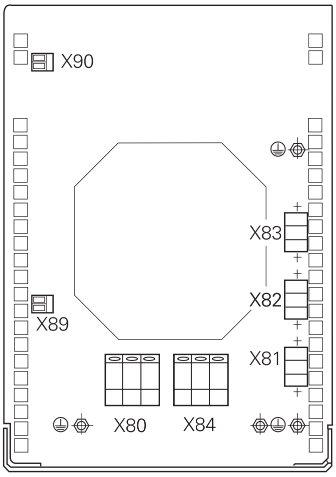
X31	Power supply for inverter
X32	Output for power supply (L1, L2, +U_Z, –U_Z)
X33	Power supply for supply unit (L1, L2)
X70	Main contactor
X71	Safety relay for spindle
X72	Safety relay for axes



X90	24-V output
X83	Motor connection for axis 3 (7.5 A)
X82	Motor connection for axis 2 (7.5 A)
X89	Braking resistor
X81	Motor connection for axis 1 (7.5 A)
X80	Motor connection for spindle (31 A)
⏚	Equipment ground

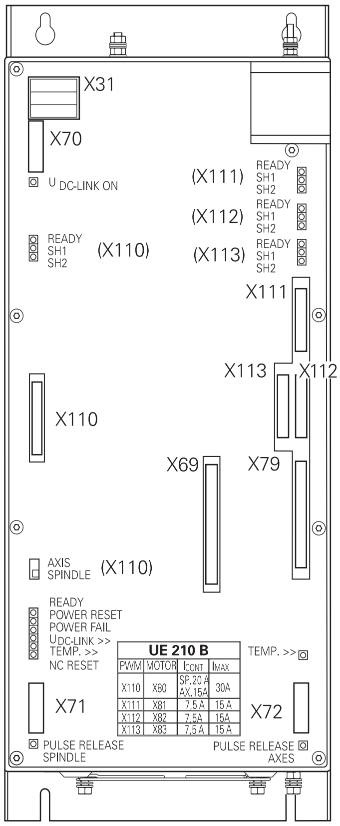


X31	Power supply for inverter
X32	Output for power supply (L1, L2, $+U_Z$, $-U_Z$)
X33	Power supply for supply unit (L1, L2)
X70	Main contactor
X71	Safety relay for spindle
X72	Safety relay for axes



X90	24-V output
X83	Motor connection for axis 3 (7.5 A)
X82	Motor connection for axis 2 (7.5 A)
X89	Braking resistor
X81	Motor connection for axis 1 (7.5 A)
X80	Motor connection for spindle (31 A)
X84	Motor connection for axis 4 (23 A)
⏚	Equipment ground

UE 210 B

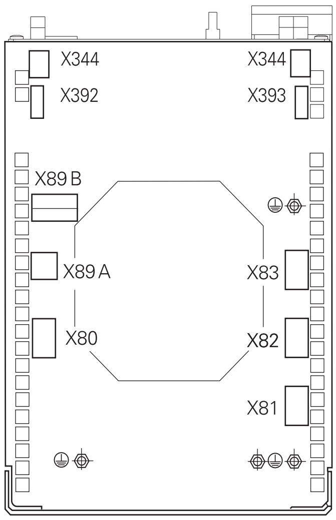


X31	Power supply for inverter
X70	Main contactor
X110 to X113	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

Sliding switch:

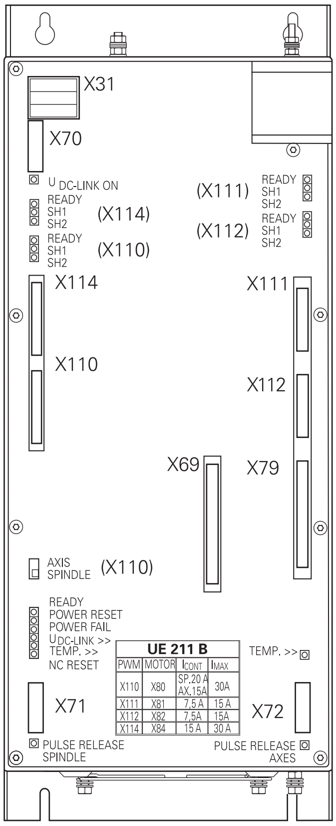
AXIS: X110 is used as axis
SPINDLE: X110 is used as spindle

X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110)
X393	Motor holding brake (X111 to X113)
X89B	Internal braking resistor
X89A	External braking resistor PW 21x or PW 1x0(B)
X83	Motor connection for axis 3 (7.5 A)
X80	Motor connection for spindle (20 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground

UE 211 B

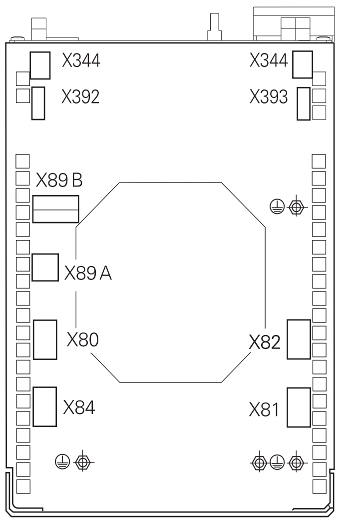


X31	Power supply for inverter
X70	Main contactor
X110 to X114	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

Sliding switch:

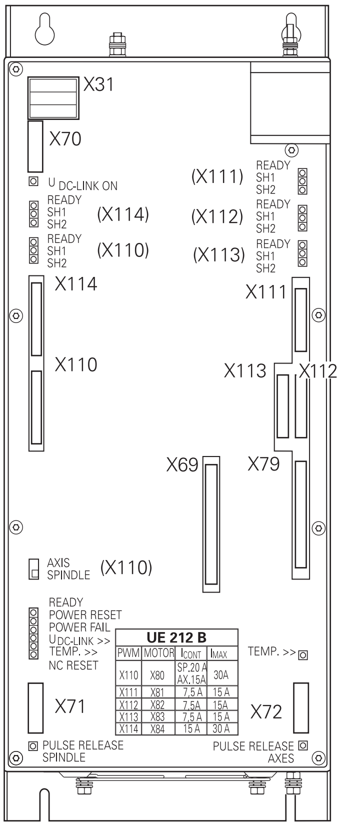
AXIS:	X110 is used as axis
SPINDLE:	X110 is used as spindle

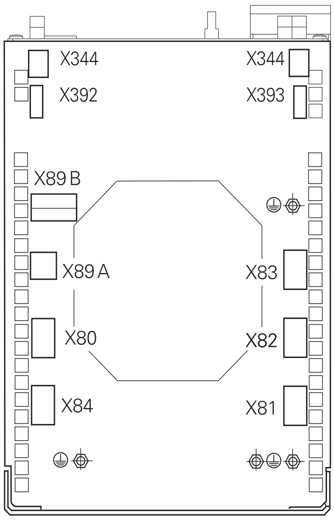
X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110, X114)
X393	Motor holding brake (X111, X113)
X89B	Internal braking resistor
X89A	External braking resistor PW 21x or PW 1x0(B)
X80	Motor connection for spindle (20 A)
X82	Motor connection for axis 2 (7.5 A)
X84	Motor connection for axis 3 (15 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground

UE 212 B



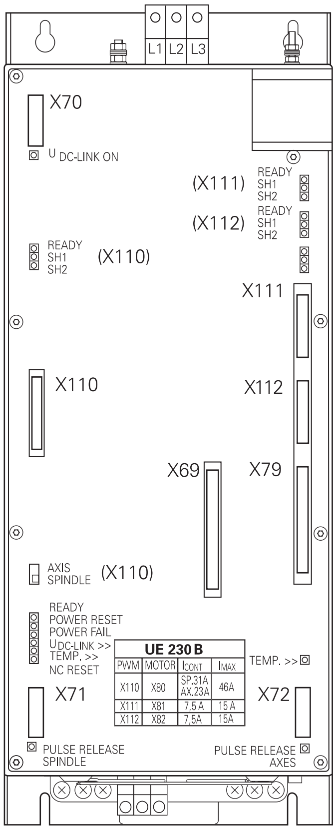


X31	Power supply for inverter
X70	Main contactor
X110 to X114	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

Sliding switch:

AXIS:	X110 is used as axis
SPINDLE:	X110 is used as spindle
X71	Safety relay for spindle
X72	Safety relay for axes
X344	24 V supply for motor holding brake
X392	Motor holding brake (X110, X114)
X393	Motor holding brake (X111 to X113)
X89B	Internal braking resistor
X89A	External braking resistor PW 21x or PW 1x0(B)
X83	Motor connection for axis 3 (7.5 A)
X80	Motor connection for spindle (20 A)
X82	Motor connection for axis 2 (7.5 A)
X84	Motor connection for axis 4 (15 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground

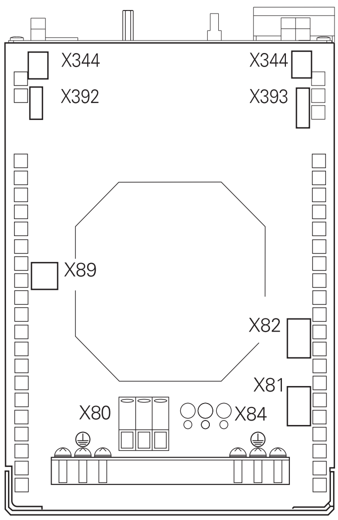
UE 230 B



X31	Power supply for inverter
X70	Main contactor
X110 to X112	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

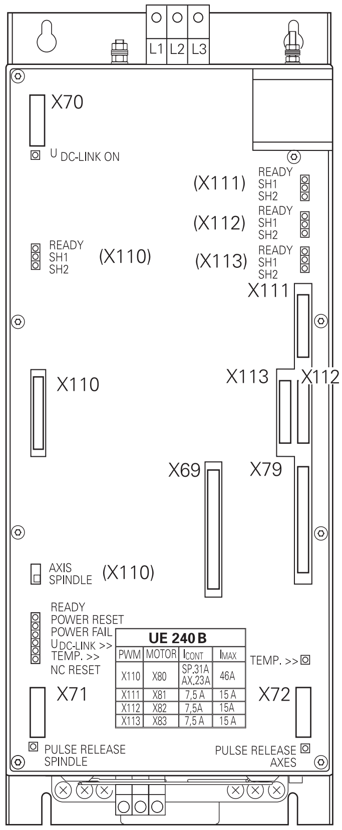
Sliding switch:

AXIS:	X110 is used as axis
SPINDLE:	X110 is used as spindle
X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110)
X393	Motor holding brake (X111, X112)
X89	Braking resistor
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
X80	Motor connection for spindle (31 A)
⏚	Equipment ground

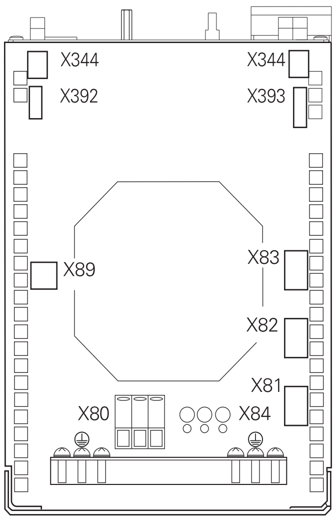
UE 240 B



X31	Power supply for inverter
X70	Main contactor
X110 to X113	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

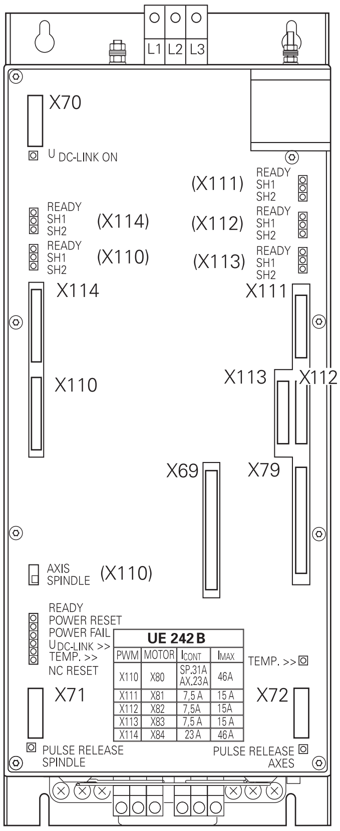
Sliding switch:

AXIS:	X110 is used as axis
SPINDLE:	X110 is used as spindle
X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110)
X393	Motor holding brake (X111 to X113)
X89	Braking resistor
X83	Motor connection for axis 3 (7.5 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
X80	Motor connection for spindle (31 A)
⏚	Equipment ground

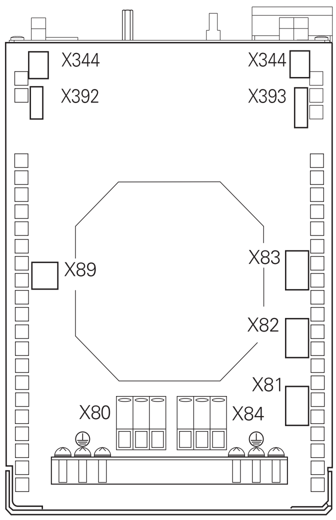
UE 242 B



X31	Power supply for inverter
X70	Main contactor
X110 to X114	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

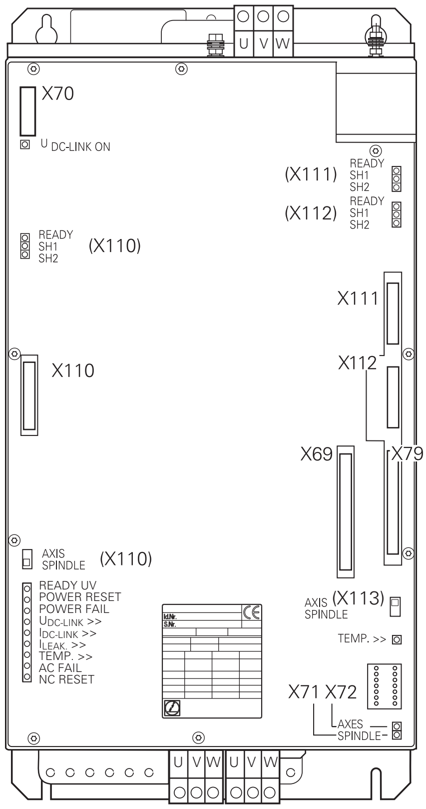
Sliding switch:
AXIS: X110 is used as axis
SPINDLE: X110 is used as spindle

X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110, X114)
X393	Motor holding brake (X111 to X113)
X89	Braking resistor
X83	Motor connection for axis 3 (7.5 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
X80	Motor connection for spindle (31 A)
X84	Motor connection for axis 4 (23 A)
⏚	Equipment ground

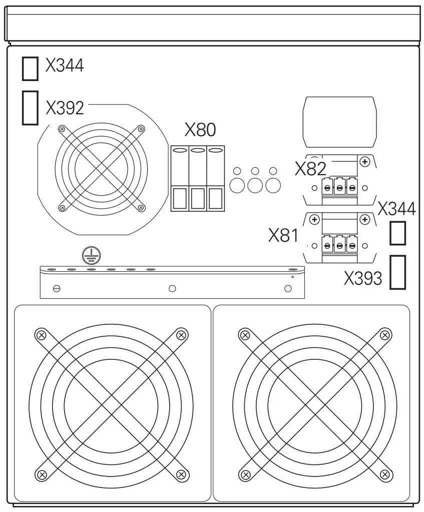
UR 230



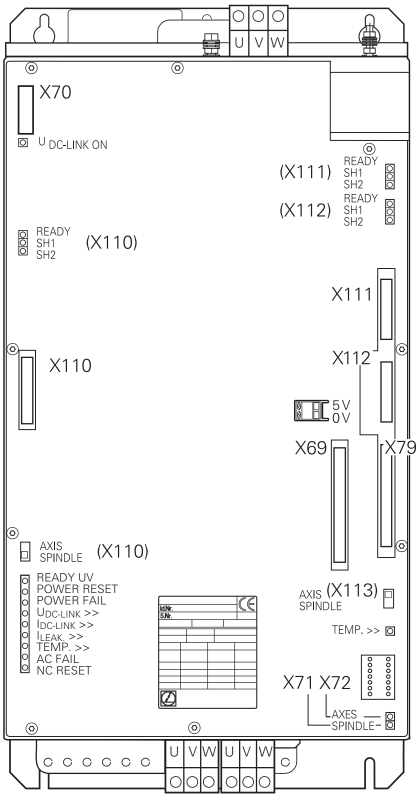
X31	Power supply for inverter
X70	Main contactor
X110 to X112	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

Sliding switch:

AXIS:	X110 or X113 is used as axis
SPINDLE:	X110 or X113 is used as spindle
X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110)
X80	Motor connection for spindle (35 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground
X393	Motor holding brake (X111, X112)



X31 Power supply for inverter

X70 Main contactor

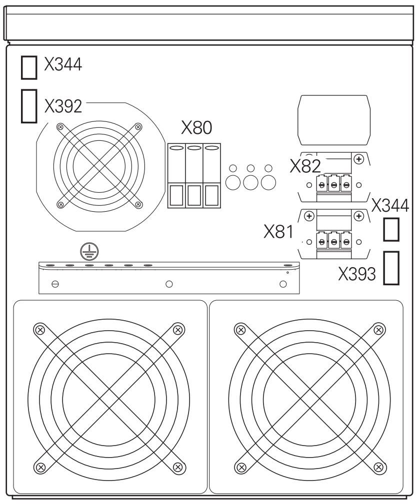
X110 to
X112 PWM connection for axes/spindle

X74 5-V power supply

X69 Power supply for control
X79 Unit bus

Sliding switch:
AXIS: X110 or X113 is used as axis
SPINDLE: X110 or X113 is used as spindle

X71 Safety relay for spindle
X72 Safety relay for axes



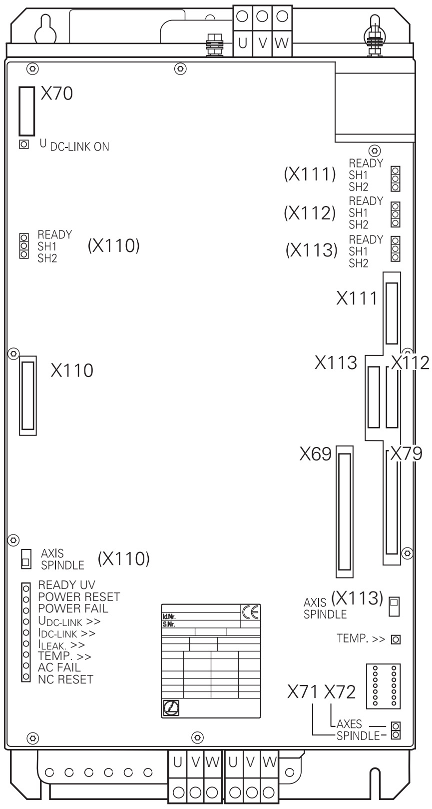
X344 24 V supply for motor holding brake
X392 Motor holding brake (X110)

X80 Motor connection for spindle (35 A)
X82 Motor connection for axis 2 (7.5 A)
X81 Motor connection for axis 1 (7.5 A)

⏚ Equipment ground

X393 Motor holding brake (X111, X112)

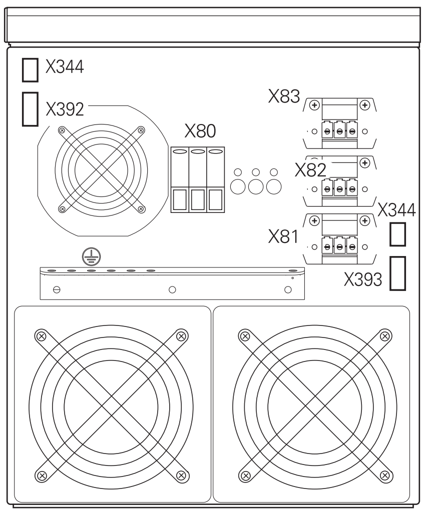
UR 240



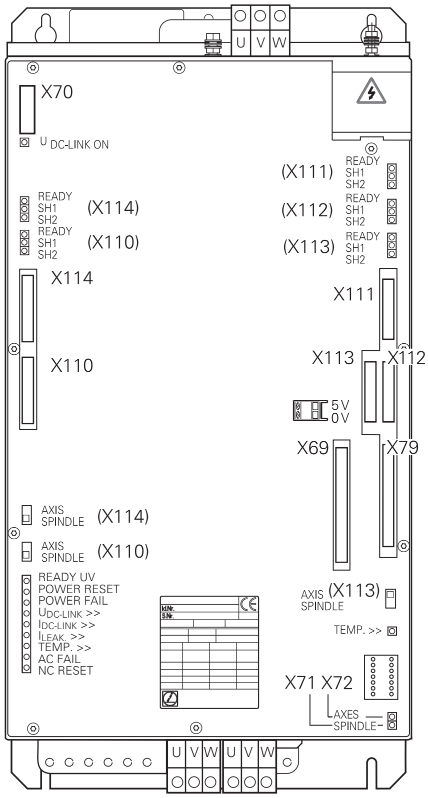
X31	Power supply for inverter
X70	Main contactor
X110 to X113	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

Sliding switch:

AXIS:	X110 or X113 is used as axis
SPINDLE:	X110 or X113 is used as spindle
X71	Safety relay for spindle
X72	Safety relay for axes



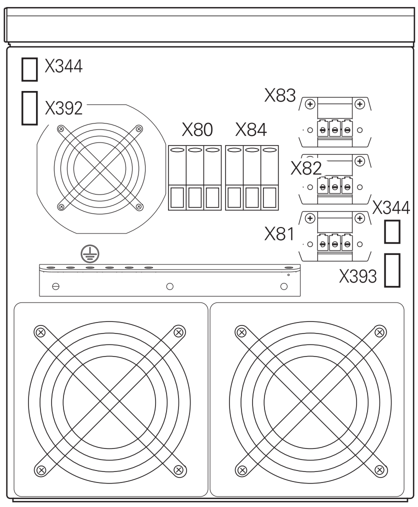
X344	24 V supply for motor holding brake
X392	Motor holding brake (X110)
X83	Motor connection for axis 3 (7.5 A)
X80	Motor connection for spindle (35 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground
X393	Motor holding brake (X111 to X113)



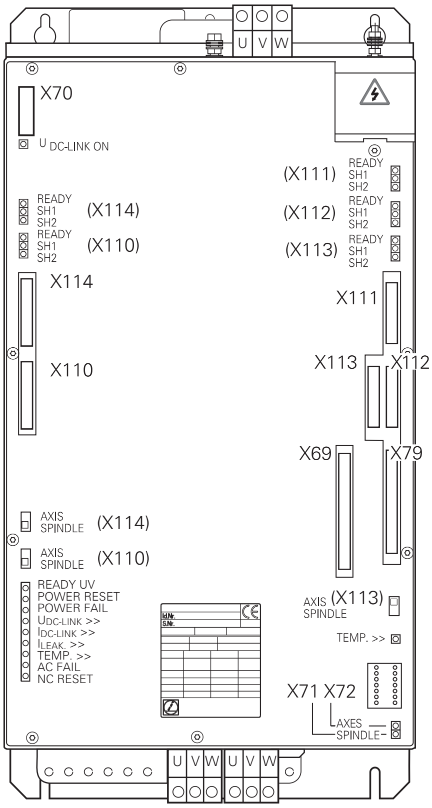
X31	Power supply for inverter
X70	Main contactor
X110 to X113	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

Sliding switch:

AXIS:	X110 or X113 is used as axis
SPINDLE:	X110 or X113 is used as spindle
X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110)
X83	Motor connection for axis 3 (7.5 A)
X80	Motor connection for spindle (35 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground
X393	Motor holding brake (X111 to X113)



X31 Power supply for inverter

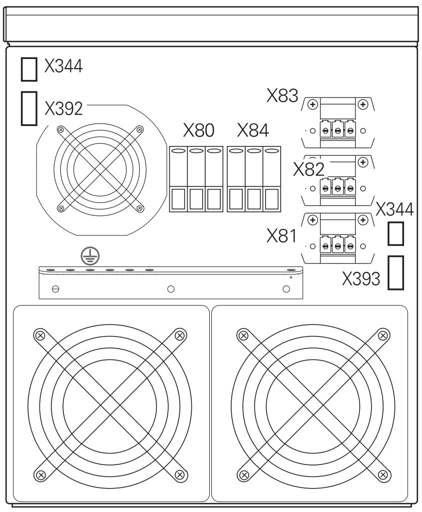
X70 Main contactor

X110 to
X114 PWM connection for axes/spindle

X69 Power supply for control
X79 Unit bus

Sliding switch:
AXIS: X110, X113 or X114 is used as axis
SPINDLE: X110, X113 or X114 is used as spindle

X71 Safety relay for spindle
X72 Safety relay for axes

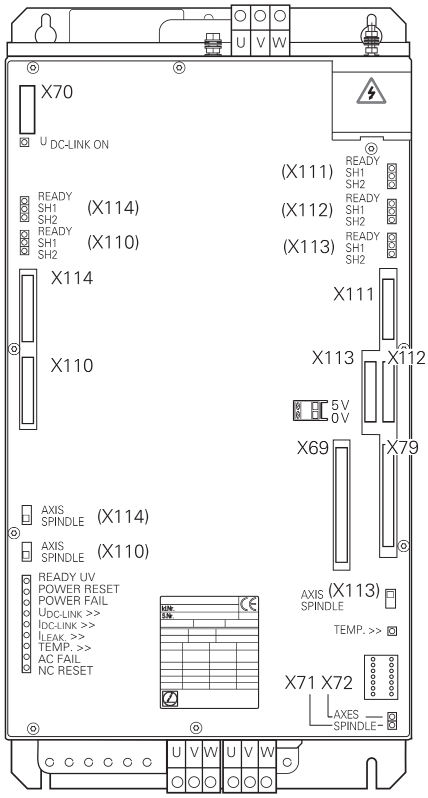


X344 24 V supply for motor holding brake
X392 Motor holding brake (X110, X114)

X83 Motor connection for axis 3 (7.5 A)
X80 Motor connection for spindle (35 A)
X84 Motor connection for axis 4 (25 A)
X82 Motor connection for axis 2 (7.5 A)
X81 Motor connection for axis 1 (7.5 A)

⏚ Equipment ground

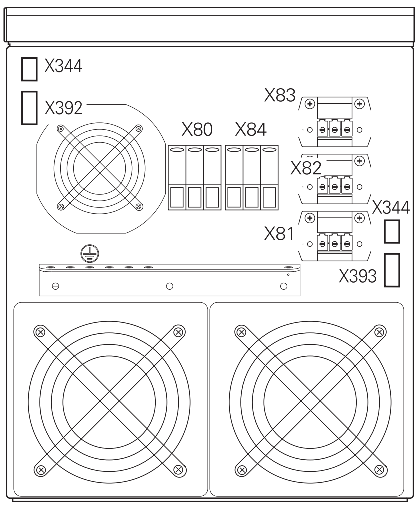
X393 Motor holding brake (X111 to X113)



X31	Power supply for inverter
X70	Main contactor
X110 to X114	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

Sliding switch:

AXIS:	X110, X113 or X114 is used as axis
SPINDLE:	X110, X113 or X114 is used as spindle
X71	Safety relay for spindle
X72	Safety relay for axes



X344	24 V supply for motor holding brake
X392	Motor holding brake (X110, X114)
X83	Motor connection for axis 3 (7.5 A)
X80	Motor connection for spindle (35 A)
X84	Motor connection for axis 4 (25 A)
X82	Motor connection for axis 2 (7.5 A)
X81	Motor connection for axis 1 (7.5 A)
⏚	Equipment ground
X393	Motor holding brake (X111 to X113)

12.3.2 Pin layout on the compact inverter

X31:
Supply voltage

> Note
>
> EN 61800-5-1 requires a non-detachable connection to the line power supply.

> Note
>
> If the power supply is other than 400 V, an autotransformer is required. It must comply at least with the connection specifications of the subsequent compact inverter.

Connecting terminals	UE 110, UE 112
Operation with 400 V~	
L1	400 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
	Cable / single conductor (HT wire): 6 mm^2 (AWG 10) Single conductor H07 V2-K: 4 mm^2 (AWG 10) Line fuse: 25 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 to 7 pound-inch)
Operation with 480V~	
L1	480 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
	Cable / single conductor (HT wire): 6 mm^2 (AWG 10) Single conductor H07 V2-K: 4 mm^2 (AWG 10) Line fuse: 25 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 to 7 pound-inch)

Connecting terminals	UE 210, UE 212	UE 230, UE 240, UE 242
L1	400 V~ ± 10 % 50 Hz to 60 Hz	400 V~ ± 10 % 50 Hz to 60 Hz
L2		
L3		
	Cable / single conductor (HT wire): Wire cross section: 6 mm^2 (AWG 10) Line fuse: 35 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)	Cable / single conductor (HT wire): Wire cross section: 10 mm^2 (AWG 6) Line fuse: 50 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)
Tightening torque for connecting terminals	0.7 Nm (6.5 – 7 pound-inch)	2.0 – 2.3 Nm (18 – 20.5 pound-inch)

Connecting terminals	UE 21xB	UE 230B, UE 24xB
L1	400 V~ ± 10 % 50 Hz to 60 Hz	400 V~ ± 10 % 50 Hz to 60 Hz
L2		
L3		
	Cable / single conductor (HT wire): 6 mm^2 (AWG 10) Single conductor H07 V2-K: 4 mm^2 (AWG 10) Line fuse: 35 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)	Cable / single conductor (HT wire): 10 mm^2 (AWG 6) Single conductor H07 V2-K: 6 mm^2 (AWG 10) Line fuse: 50 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)
Tightening torque for connecting terminals	0.7 Nm (6.5 – 7 pound-inch)	2.0 – 2.3 Nm (18 – 20.5 pound-inch)

Connecting terminals	UR 2xx(D)
L1	400 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
	Cable / single conductor (HT wire): 10 mm^2 (AWG 6) Single conductor H07 V2-K: 6 mm^2 (AWG 10) Line fuse: 35 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)
Tightening torque for connecting terminals	0.7 Nm (6.5 to 7 pound-inch)

Note

The cables between the UR 2xx(D) compact inverter and commutating reactor as well as between the commutating reactor and line filter must be as short as possible (< 0.4 m)!

X32:
Output for supply voltage of power supply unit

Connecting terminals	Assignment
1	Bridge to X33/pin 1 (short-circuit protection with 4 A)
2	Bridge to X33/pin 2 (short-circuit protection with 4 A)
3	$+U_Z$ (short-circuit protection with 4 A)
4	$–U_Z$ (short-circuit protection with 4 A)

X33:
Supply voltage for the inverter supply unit

Connecting terminals	Assignment
1	Bridge to X32/pin 1 (with setup operation L1 from line power 290 V~ to 440 V~, 50 Hz to 60 Hz)
2	Bridge to X32/pin 2 (in setup mode L2 from line)

X69:
NC supply voltage and control signals

50-pin ribbon connector	Assignment
1a to 5b	+5 V
6a to 7b	+ 12 V
8a	+5 V (low-voltage separation)
8b	0 V (low-voltage separation)
9a	+15 V
9b	–15 V
10a	UZAN
10b	0 V
11a	IZAN
11b	0 V
12a	$\overline{\text{RES.PS}}$
12b	0 V
13a	$\overline{\text{PF.PS.ZK}}$
13b	GND
14a	$\overline{\text{ERR.UZ.GR}}$
14b	GND
15a	$\overline{\text{ERR.IZ.GR}}$
15b	GND
16a	$\overline{\text{ERR.TEMP}}$

50-pin ribbon connector	Assignment
16b	GND
17a	RDY.PS
17b	GND
18a	$\overline{\text{ERR.ILEAK}}$
18b	GND
19a	$\overline{\text{PF.PS.AC}}$ (only for regenerative inverters)
19b	GND
20a	Do not assign
20b	GND
21a	0 V
21b	GND
22a	0 V
22b	GND
23a	Reserved (SDA)
23b	GND
24a	Reserved (SCL)
24b	GND
25a	$\overline{\text{RES.LE}}$
25b	GND

Danger

The interface complies with EN 61800-5-1 for "low voltage electrical separation."

X70:
Main contactor
X71:
Safety relay for spindle
X72:
Safety relay for axes

For information on the wiring and function, see the circuit diagram for your machine.

Connecting terminals X70 to X72	Assignment on UE 2xx
1	+24 V output (max. 250 mA)
2	24 V input for U_Z ON, Axis ON, Spindle ON
3	Not assigned
4[a]	Normally closed contact 1
5[a]	Normally closed contact 2

a. Max. 125 V

Connecting terminals X70 to X72	Assignment on UE 1xx, UE 2xxB and UR 2xx(D)
1	+24 V output (max. 250 mA)
2	0 V
3	+24 V input for U_Z ON, axis ON, spindle ON
4	Do not assign
5	Do not assign
6[a]	Normally closed contact (OE1, OE1A or OE1S)
7[a]	Normally closed contact (OE2, OE2A or OE2S)

a. Max. 125 V

Attention

A recovery diode is required in the proximity of inductive loads, e.g. relay or contactor coils.

X74: Additional 5-V supply

Connecting terminal X74	Assignment
+	+5 V (load capacity 20 A)
–	0 V

X79: Unit bus

Ribbon connector, 40-pin	Assignment	
1a to 3b	0 V [*1]	These voltages must not be linked with other voltages (only basic insulation)!
4a	+24 V [*1]	
4b	+24 V [*1]	
5a	+15 V [*1]	
5b	+24 V [*1]	
6a	+15 V [*1]	
6b	+15 V [*1]	
7a to 8b	Do not assign	
9a	Reserved (SDA)	
9b	Do not assign	
10a	Reserved (SCL)	
10b	$\overline{\text{ERR.TEMP}}$	
11a	$\overline{\text{PF.PS}}$	
11b	0 V	
12a	$\overline{\text{RES.PS}}$	
12b	0 V	
13a	$\overline{\text{PWR.OFF}}$	
13b	0 V	
14a	5 V FS (spindle enable)	
14b	0 V	
15a	5 V FA (axis enable)	
15b to 16b	0 V	
17a and 17b	–15 V	
18a and 18b	+15 V	
19a to 20b	+5 V	

Danger

The interface complies with the requirements of IEC 61800-5-1 for low voltage electrical separation (except for 1a to 6b).

X80: Spindle motor
X81: Axis motor 1
X82: Axis motor 2
X83: Axis motor 3
X84: Axis motor 4

Connecting terminals	Assignment
U	Motor connection U
V	Motor connection V
W	Motor connection W

Motor connection	PWM input
X80	X110
X81	X111
X82	X112
X83	X113
X84	X114

X89:
Braking resistor

Pin layout on the UE 21x:

Connecting terminal X89 UE 21x	Assignment	Recommended braking resistance	PW 21x	PW 1x0(B); connecting terminal X1
1	$+U_Z$	Bridge	RB1	1
2	Internal braking resistor		Do not assign	Do not assign
3	Switch to $-U_Z$	Do not assign	CB2	2

Pin layout on UE 230(B) and UE 24x(B):

Connecting terminal X89 UE 230(B) UE 24x(B)	Assignment	PW 21x	PW 1x0(B); Connecting terminal X1
1	$+U_Z$	RB1	1
2	Switch to $-U_Z$	RB2	2

Pin layout on UE 21xB for internal braking resistor:

Connecting terminal X89A UE 21xB	Assignment	Connecting terminal X89B UE 21xB	Assignment
1	Do not assign	1	
2	Do not assign	2	

Pin layout on UE 21xB for external braking resistor:

Connecting terminal X89B UE 21xB	Assignment	Connecting terminal X89A UE 21xB	Assignment	PW 21x	PW 1x0(B); connecting terminal X1
1	Do not assign	1	$+U_Z$	RB 1	1
2	Do not assign	2	Switch to $-U_Z$	RB 2	2

Attention

The internal and an external braking resistor must **not** be operated in parallel!

X90:
24-V output,
e.g. for the fan of an external braking resistor

Connecting terminal X90		Assignment
1	+	+24 V (PLC)
2	–	0 V

X110 to X114: PWM connection to control

Ribbon connector, 20-pin	Assignment
1a	PWM U1
1b	0 V U1
2a	PWM U2
2b	0 V U2
3a	PWM U3
3b	0 V U3
4a	$\overline{\text{SH2}}$
4b	0 V ($\overline{\text{SH2}}$)
5a	$\overline{\text{SH1}}$
5b	0 V ($\overline{\text{SH1}}$)
6a	$+I_{actl\ 1}$
6b	$-I_{actl\ 1}$
7a	0 V (analog)
7b	$+I_{actl\ 2}$
8a	$-I_{actl\ 2}$
8b	0 V (analog)
9a	Do not assign
9b	$\overline{\text{BRK}}$
10a	$\overline{\text{ERR}}$
10b	RDY

Danger

The interface complies with EN 61800-5-1 for "low voltage electrical separation."

X344: 24-V supply for motor holding brake

Connecting terminal X344	Assignment
1	+24 V
2	0 V

X392: Motor holding brake

Connecting the UE 2xxB and UR 2xx(D):

Connecting terminals X392	Assignment
1	Holding brake (X110)
2	0 V (X110)
3	Holding brake (X114)
4	0 V (X114)

X393: Motor holding brake

Connecting the UE 2xxB and UR 2xx(D):

Connecting terminals X393	Assignment
1	Holding brake (X111)
2	0 V (X111)
3	Holding brake (X112)
4	0 V (X112)
5	Holding brake (X113)
6	0 V

Maximum current for X392/X393

Maximum current I_{max} for controlling the holding brakes via X392:

Compact inverters	I_{max} (X392)	I_{max} (X393)
UE 210B, UE 240B, UR 240	3.0 A	1.5 A
UE 211B	2.0 A	2.0 A
UE 212B, UE 242B, UR 242	2.0 A	1.5 A
UE 230B, UR 230	3.0 A	2.0 A

X394: Motor holding brake

Pin layout on the UE 1xx:

Connecting terminals X394	Assignment
1	Holding brake (X111)
2	0 V (X111)
3	Holding brake (X112)
4	0 V (X112)
5	Holding brake (X113)
6	0 V (X113)
7	Holding brake (X114)
8	0 V (X114)

Maximum current for X394

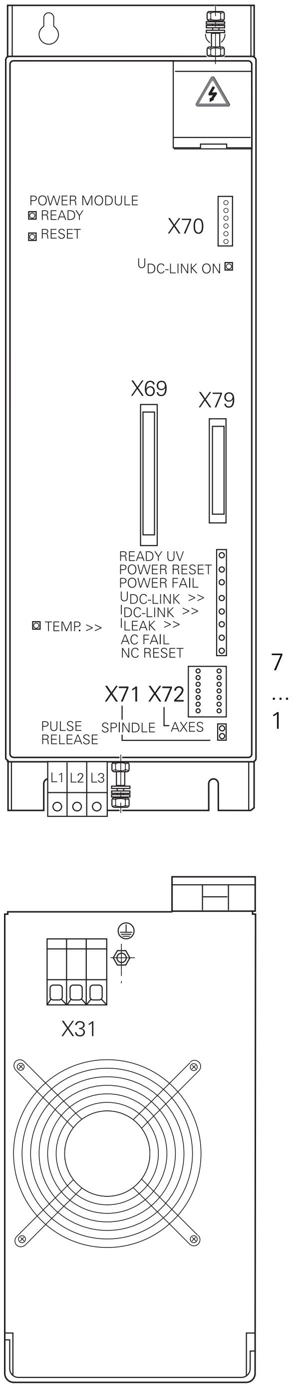
Maximum current I_{max} for controlling the holding brakes via X394:

Compact inverters	I_{max} (X394)
UE 110	1.5 A
UE 112	1.5 A

12.4 Power supply units

12.4.1 Designation and position of connections

UV 120



X70 Main contactor

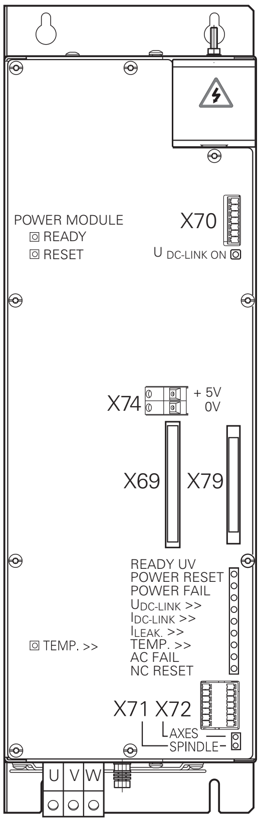
X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for the axes (pulse disable for all axes)

X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 120 D

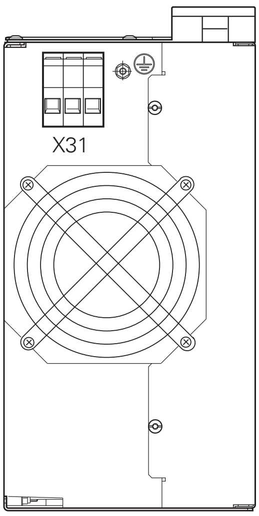


X70 Main contactor

X74 5-V power supply

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

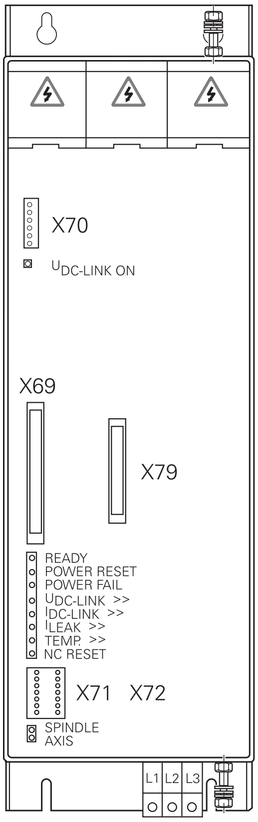
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

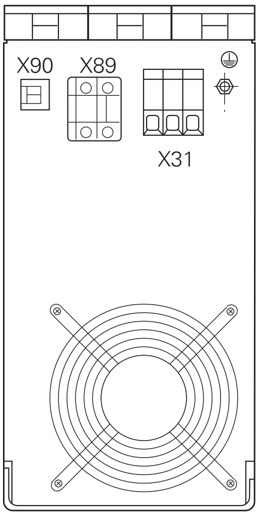
UV 130



X70 Main contactor

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

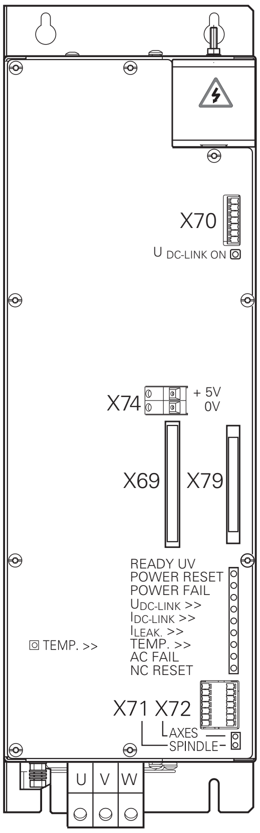
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for axes (pulse disable for all axes)

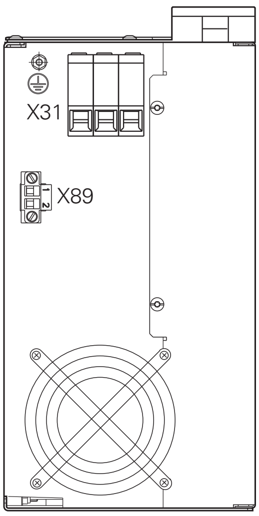


X31 Supply voltage for inverter (3 x 400 V ±10 %)
X89 Braking resistor
X90 24-V output

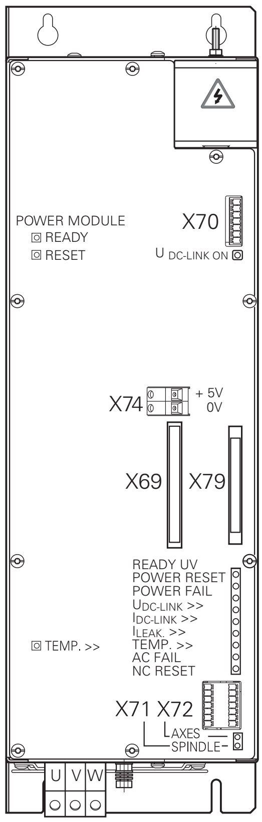
⏚ Equipment ground

UV 130 D





X70	Main contactor
X74	5-V power supply
X69	Power supply for the control (in double for lengths over 0.5 m)
X79	Unit bus
X71	Safety relay for spindle (pulse disable for the spindle)
X72	Safety relay for axes (pulse disable for all axes)
X31	Supply voltage for inverter (3 x 400 V ±10 %)
⏚	Equipment ground
X89	Braking resistor



X70 Main contactor

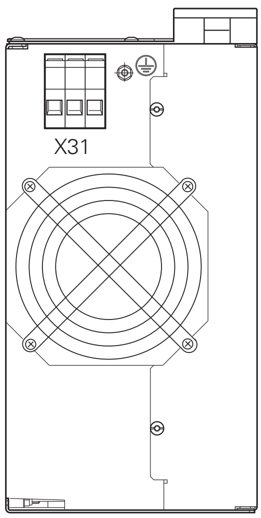
X74 5-V power supply

X69 Power supply for the control
(in double for lengths over 0.5 m)

X79 Unit bus

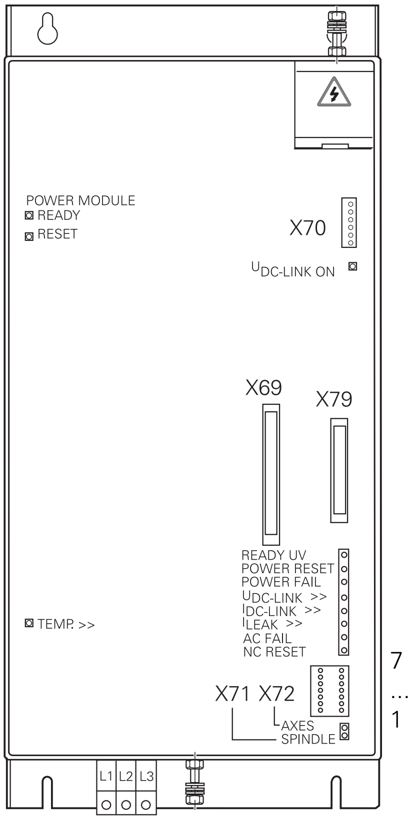
X71 Safety relay for spindle (pulse disable for the spindle)

X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground



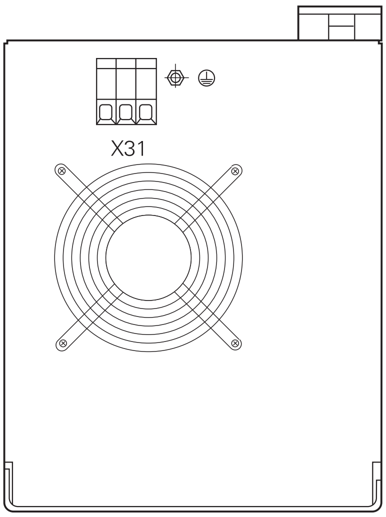
X70 Main contactor

X69 Power supply for the control (in double for lengths over 0.5 m)

X79 Unit bus

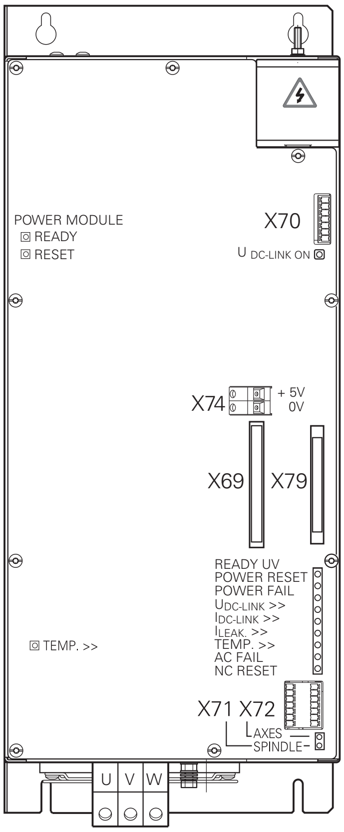
X71 Safety relay for spindle (pulse disable for the spindle)

X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

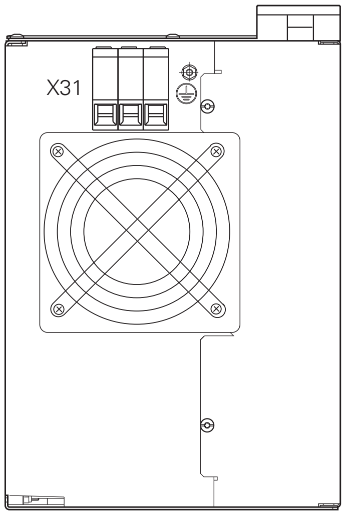


X70 Main contactor

X74 5-V power supply

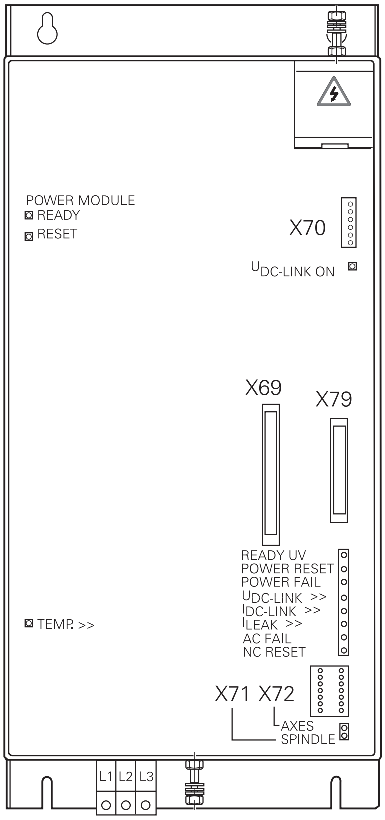
X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

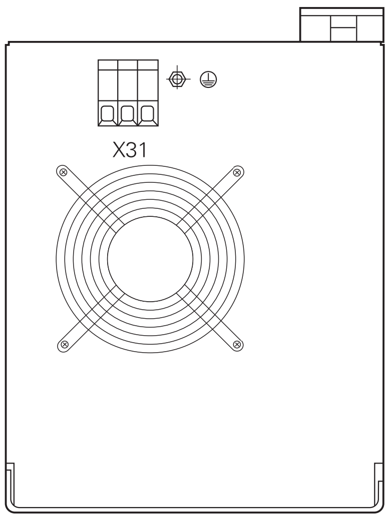
⏚ Equipment ground



X70 Main contactor

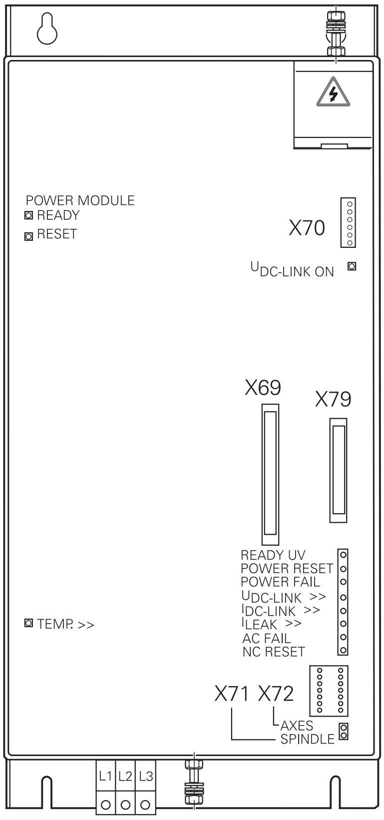
X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

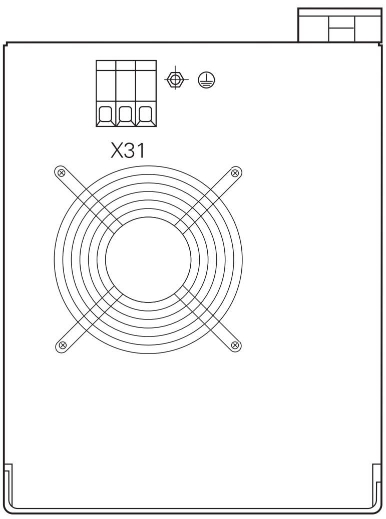


X70 Main contactor

X74 +5 V and 0 V supply

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

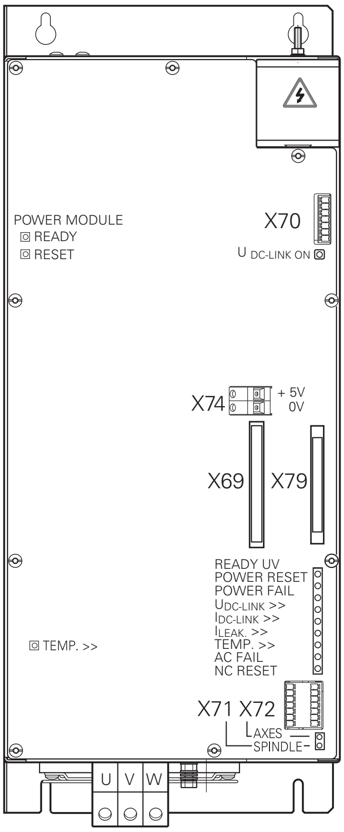
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 150 D

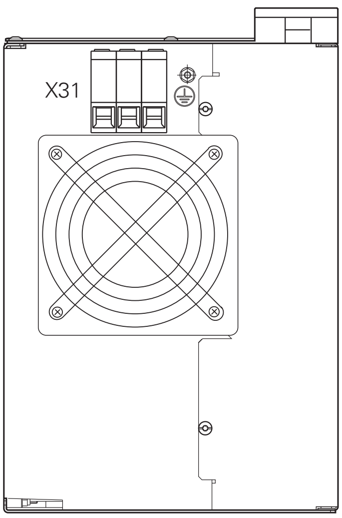


X70 Main contactor

X74 +5 V and 0 V supply

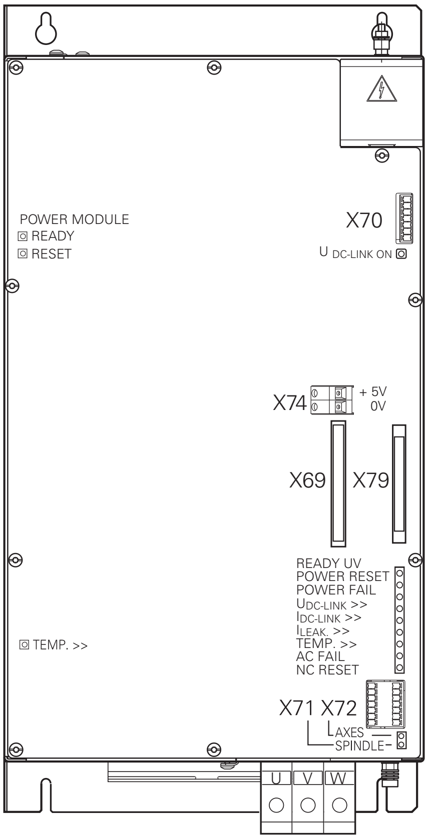
X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

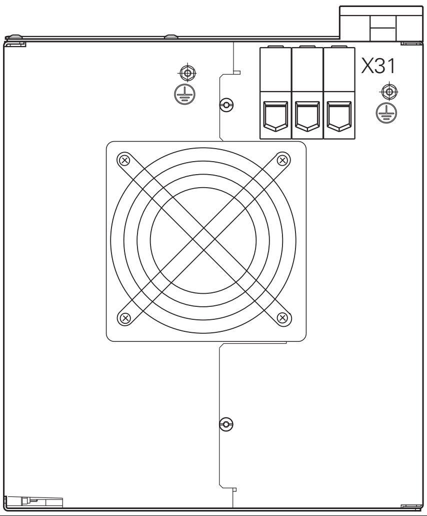


X70 Main contactor

X74 +5 V and 0 V supply

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

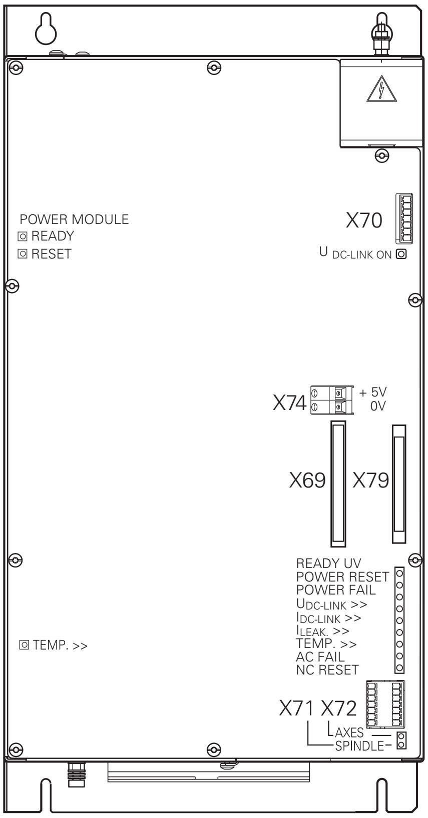
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 160 DW



X70 Main contactor

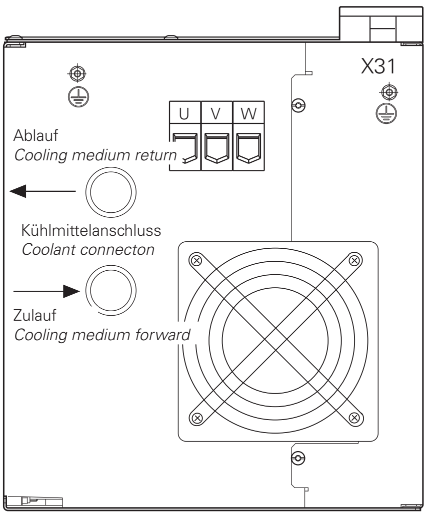
X74 +5 V and 0 V supply

X69 Power supply for the control
(in double for lengths over 0.5 m)

X79 Unit bus

X71 Safety relay for spindle (pulse disable for the spindle)

X72 Safety relay for axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

12.4.2 Pin layout on the power supply units

X31: Supply voltage

Connecting terminals	UV 130(D), UV(R) 1x0(D)
L1	400 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
PE	
	UV 120, UVR 120D: Cable / single conductor (PVC): 10 mm^2 (AWG 8) Single conductor H07 V2-K: 6 mm^2 (AWG 10) Line fuse: 35 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6) Tightening torque for connecting terminals: 2.0 – 2.3 Nm (18 – 20.5 pound-inch) **UV 130, UV 130D:** Cable / single conductor (HT wire): 16 mm^2 (AWG 5) Line fuse: 63 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6) Tightening torque for connecting terminals: 4 – 4.5 Nm (35 to 40 pound-inch) **UVR 130D:** Cable / single conductor (PVC): 16 mm^2 (AWG 6) Single conductor H07 V2-K: 10 mm^2 (AWG 8) Line fuse: 50 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6) Tightening torque for connecting terminals: 2.0 – 2.3 Nm (18 – 20.5 pound-inch) **UV 140, UVR 140D:** Cable / single conductor (PVC): 35 mm^2 (AWG 2) Single conductor H07 V2-K: 25 mm^2 (AWG 4) Line fuse: 80 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 16 mm^2 (AWG 4) Tightening torque for connecting terminals: 4.0 - 4.5 Nm (35 to 40 pound-inch) **UVR 150, UVR 150D:** Cable / single conductor (PVC): 35 mm^2 (AWG 2) Single conductor H07 V2-K: 25 mm^2 (AWG 4) Line fuse: 80 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 16 mm^2 (AWG 4) Tightening torque for connecting terminals: 4.0 - 4.5 Nm (35 to 40 pound-inch) **UVR 160D:** Cable / single conductor (PVC): 50 mm^2 (AWG 1) Single conductor H07 V2-K: 35 mm^2 (AWG 2) Line fuse: 125 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 25 mm^2 (AWG 4) Tightening torque for connecting terminals: 4.0 - 4.5 Nm (35 to 40 pound-inch)

Note

EN 61800-5-1 requires a non-detachable connection to the line power supply.

Note

If the power supply is other than 400 V, an autotransformer is required. It must comply at least with the connection specifications of the subsequent power supply unit.

Note

The cables between the power supply unit and commutating reactor as well as between the commutating reactor and line filter must be as short as possible (< 0.4 m)!

X69:
NC supply voltage and control signals

For lengths of 600 mm and longer, the 50-line ribbon cable for the NC power supply and control signals is led doubled to the control in order to increase the wire cross section.

Connections: See "X69: NC supply voltage and control signals" on page 12 - 338.

X70:
Main contactor

Connecting terminal X70	Assignment
1	+24 V output (max. 250 mA)
2	0 V
3	+24 V input for U_Z ON
4	Do not assign
5	Do not assign
6[a]	Normally closed contact (OE1)
7[a]	Normally closed contact (OE2)

a. Max. 125 V

Attention

A recovery diode is required in the proximity of inductive loads, e.g. relay or contactor coils.

X71:
Safety relay for spindle
X72:
Safety relay for axes

Connecting terminals X71 and X72	Assignment
1	+24 V output (max. 250 mA)
2	0 V
3	+24 V input for Axis ON, Spindle ON
4	Do not assign
5	Do not assign
6[a]	Normally closed contact (OE1A or OE1S)
7[a]	Normally closed contact (OE2A or OE2S)

a. Max. 125 V

Attention

A recovery diode is required in the proximity of inductive loads, e.g. relay or contactor coils.

X74:
Additional 5-V supply

Connecting terminal X74	Assignment
+	+5 V (load capacity 20 A)
–	0 V

X79:
Unit bus

Connections: See “X79: Unit bus” on page 12 - 339.

X89:
Braking resistor

Pin layout on the PW 21x:

Connecting terminal X89	Assignment	PW 21x braking resistor
1	$+U_Z$	RB1
2	Switch to $–U_Z$	RB2

Pin layout on the PW 1x0(B):

Connecting terminal X89	Assignment	PW 1x0(B) braking resistor; Connecting terminal X1
1	$+U_Z$	1
2	Switch to $–U_Z$	2

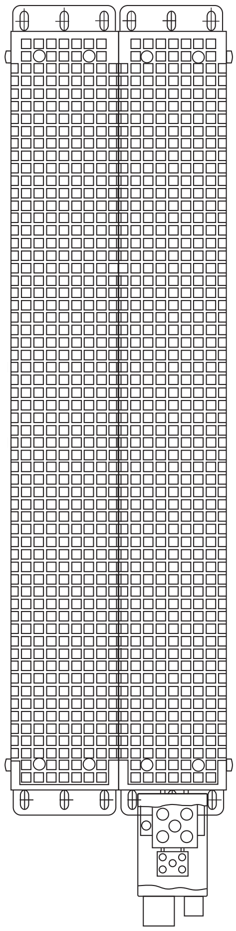
X90:
24-V output, e.g. for the fan of an external braking resistor

Connecting terminal X90		Assignment
1	+	+24 V (PLC)
2	–	0 V

12.5 Braking resistors and braking resistor modules

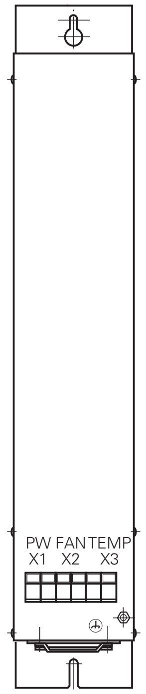
12.5.1 Designation and position of connections

PW 21x



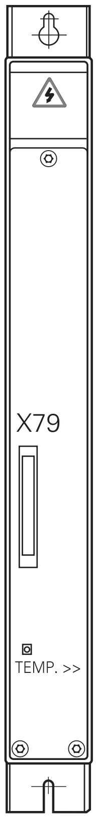
RB1, RB2	Power supply unit
T1, T2	Temperature switch

PW 1x0 (B)



X1 UV 130 power supply module
X2 Supply voltage for the fan of the braking resistor
X3 Temperature switch

UP 1x0



X79 Unit bus

TEMP. >> Warning signal for excessive temperature of braking resistor

12.5.2 Pin layout of braking resistor or braking resistor module

X89: Braking resistor

Pin layout on the UEC 11x

Connecting terminal X89 UEC 11x	Assignment	PW 21x	PW 1x0(B); Connecting terminal X1
1	$+U_Z$	RB1	1
2	Switch to $-U_Z$	RB2	2

Pin layout on the UE 21x:

Connecting terminal X89 UE 21x	Assignment	Recommended braking resistance	PW 21x	PW 1x0(B); connecting terminal X1
1	$+U_Z$	Bridge	RB1	1
2	Internal braking resistor		Not assign	Do not assign
3	Switch to $-U_Z$	Do not assign	RB2	2

Pin layout on UE 21xB for internal braking resistor:

Connecting terminal X89A UE 21xB	Assignment	Connecting terminal X89B UE 21xB	Assignment
1	Do not assign	1	
2	Do not assign	2	

Pin layout on UE 21xB for external braking resistor:

Connecting terminal X89B UE 21xB	Assignment	Connecting terminal X89A UE 21xB	Assignment	PW 21x	PW 1x0(B); connecting terminal X1
1	Do not assign	1	$+U_Z$	RB 1	1
2	Do not assign	2	Switch to $-U_Z$	RB 2	2

Pin layout on UE 230(B) and UE 24x(B):

Connecting terminal X89 UE 230(B) UE 24x(B)	Assignment	PW 21x	PW 1x0(B); connecting terminal X1
1	$+U_Z$	RB1	1
2	Switch to $-U_Z$	CB2	2

Attention

The internal and an external braking resistor must **not** be operated in parallel!

Exception: An optionally connected external braking resistor on the UEC 11x is operated in parallel with the internal braking resistor.

Connection on UV 130(D):

Connecting terminal X89 UV 130(D)	Assignment	PW 21x	PW 1x0(B); Connecting terminal X1
1	$+U_Z$	RB1	1
2	Switch to $-U_Z$	CB2	2

Temperature switch

The temperature switch is a normally closed contact and is set to protect the braking resistor from being damaged. It can have a maximum load of 250 V, 5 A.

Connecting terminal on PW 21x	Assignment
T1	1
T2	2

Connecting terminal X3 on the PW 110B	Assignment
1	1
2	2

X2:
Fan for the external braking resistor PW 1x0(B)

Connecting terminal X2	Assignment
+	+24 V (PLC)
–	0 V

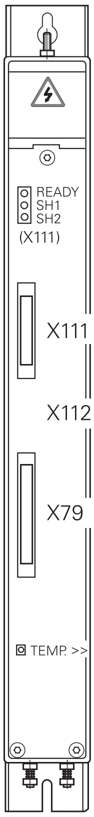
X79:
Unit bus

Connections:See “X79: Unit bus” on page 12 - 339.

12.6 Power modules

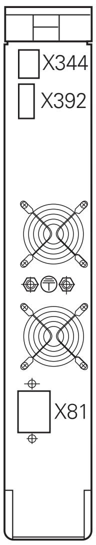
12.6.1 Designation and position of connections

UM 111



X111 PWM, axis

X79 Unit bus

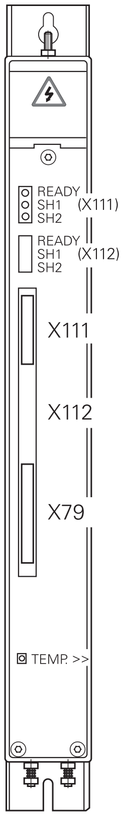


X344 24 V supply for motor holding brake
(available as of version 325000-02)

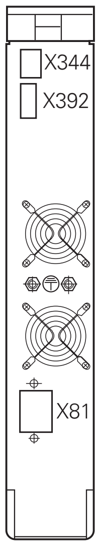
X392 Motor holding brake
(available as of version 325000-02)

⏚ Equipment ground

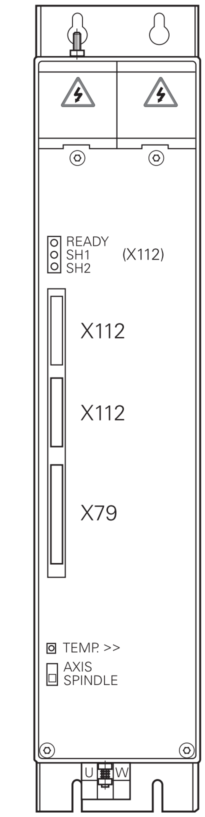
X81 Motor connection for axis



X111	PWM, axis
X79	Unit bus



X344	24 V supply for motor holding brake
X392	Motor holding brake
⏚	Equipment ground
X81	Motor connection for axis

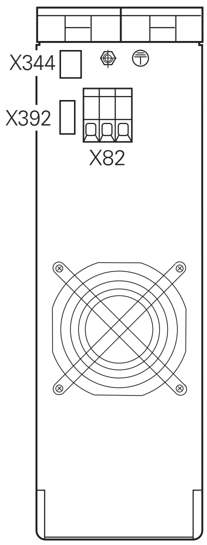


X112 PWM, axis / spindle

X112 PWM, axis/spindle
(The upper or lower X112 may be used;
internally both of these inputs are switched in parallel.)

X79 Unit bus

Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

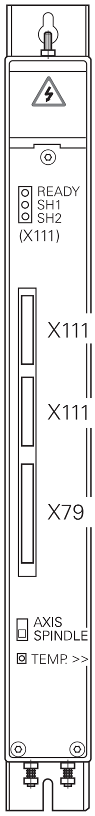


X344 24 V supply for motor holding brake
(available as of version 336 948-03)

X392 Motor holding brake
(available as of version 336 948-03)

X82 Motor connection for axis / spindle

⏚ Equipment ground

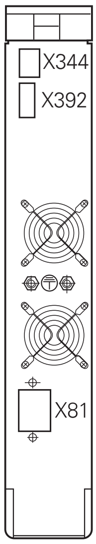


X111 PWM, axis / spindle

X111 PWM, axis / spindle
(The upper or lower X111 may be used;
internally both of these inputs are switched in parallel.)

X79 Unit bus

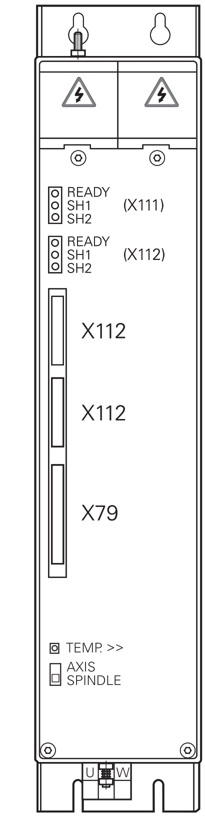
Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit



X344 24 V supply for motor holding brake
X392 Motor holding brake

⏚ Equipment ground

X81 Motor connection for axis / spindle

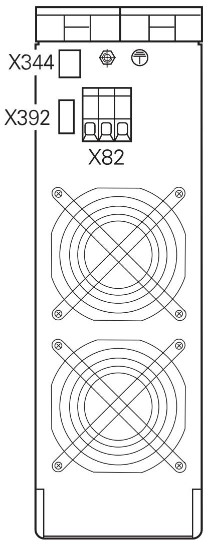


X112 PWM, axis / spindle

X112 PWM, axis / spindle
(The upper or lower X112 may be used;
internally both of these inputs are switched in parallel.)

X79 Unit bus

Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

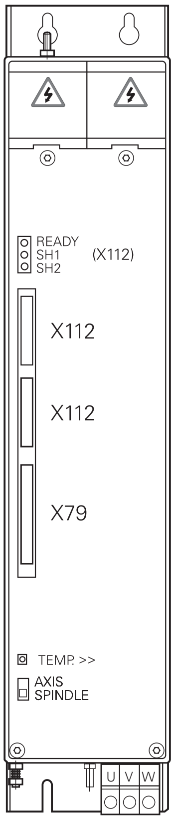


X344 24 V supply for motor holding brake
(available as of version 325 001-02)

X392 Motor holding brake
(available as of version 325 001-02)

X82 Motor connection for axis / spindle

⏚ Equipment ground

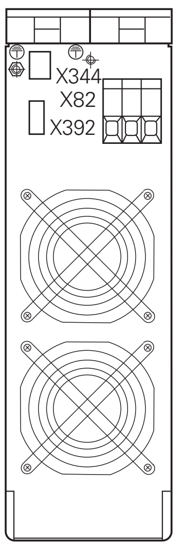


X112 PWM, axis / spindle

X112 PWM, axis/spindle
(The upper or lower X112 may be used;
internally both of these inputs are switched in parallel.)

X79 Unit bus

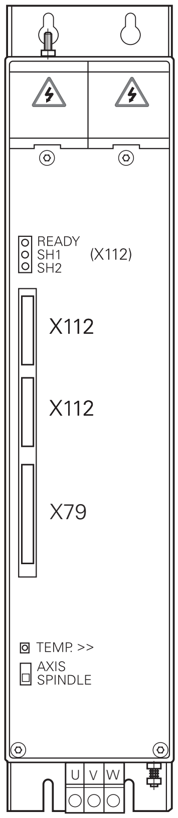
Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit



X344 24 V supply for motor holding brake
X392 Motor holding brake

X81 Motor connection for axis / spindle

⏚ Equipment ground

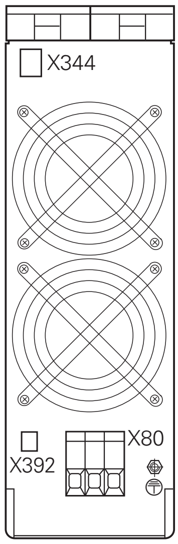


X112 PWM, axis/spindle

X112 PWM, axis / spindle
(The upper or lower X112 may be used;
internally both of these inputs are switched in parallel.)

X79 Unit bus

Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

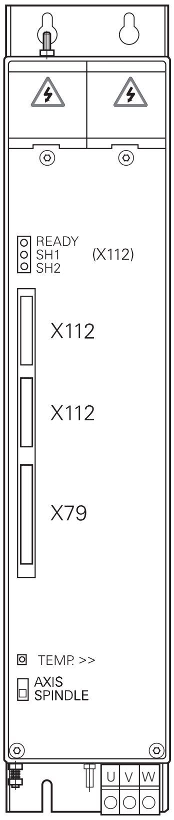


X344 24 V supply for motor holding brake
(available as of version 325002-02)

X392 Motor holding brake
(available as of version 325002-02)

X80 Motor connection for axis / spindle

⏚ Equipment ground

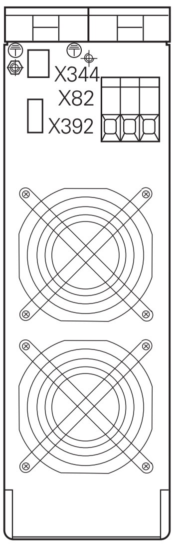


X112 PWM, axis/spindle

X112 PWM, axis / spindle
(The upper or lower X112 may be used;
internally both of these inputs are switched in parallel.)

X79 Unit bus

Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

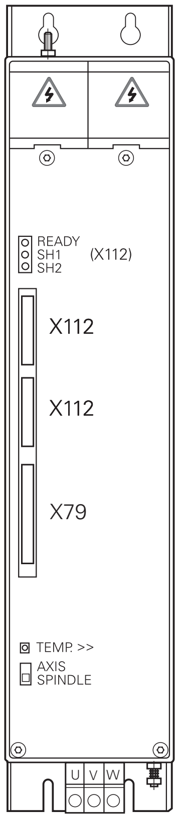


X344 24 V supply for motor holding brake

X392 Motor holding brake

X81 Motor connection for axis / spindle

⏚ Equipment ground

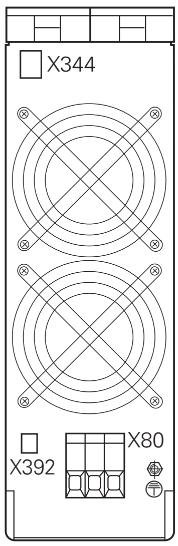


X112 PWM, axis/spindle

X112 PWM, axis / spindle
(The upper or lower X112 may be used;
internally both of these inputs are switched in parallel.)

X79 Unit bus

Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

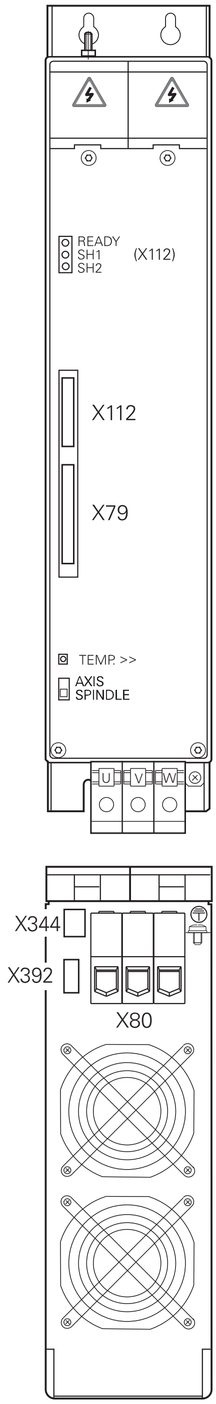


X344 24 V supply for motor holding brake
(available as of version 325005-02)

X392 Motor holding brake
(available as of version 325005-02)

X80 Motor connection for axis / spindle

⏚ Equipment ground



X112 PWM, axis / spindle

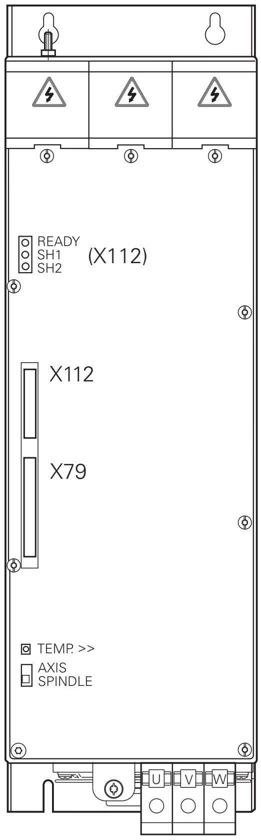
X79 Unit bus

Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

X344 24 V supply for motor holding brake

X80 Motor connection for axis / spindle

⏚ Equipment ground

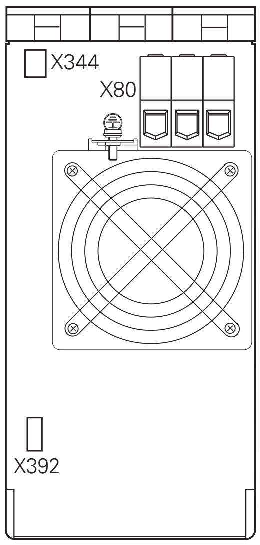


X112 PWM, axis / spindle

X79 Unit bus

Sliding switch:

AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

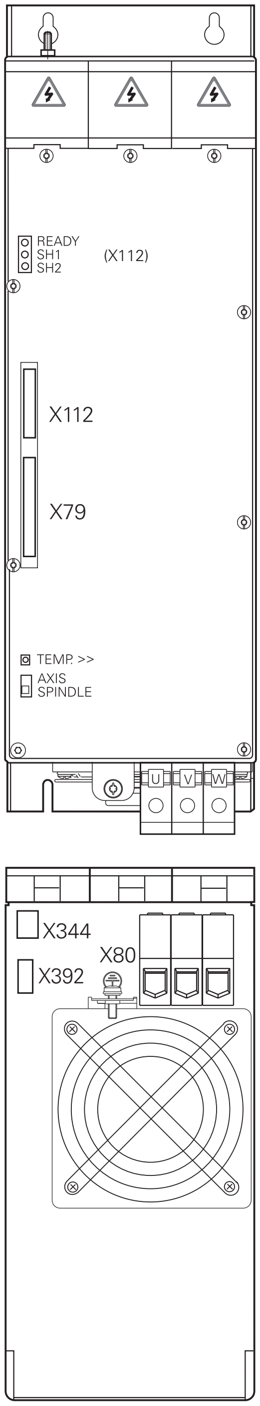


X344 24 V supply for motor holding brake

X80 Motor connection for axis / spindle

⏚ Equipment ground

X392 Motor holding brake



X112 PWM, axis / spindle

X79 Unit bus

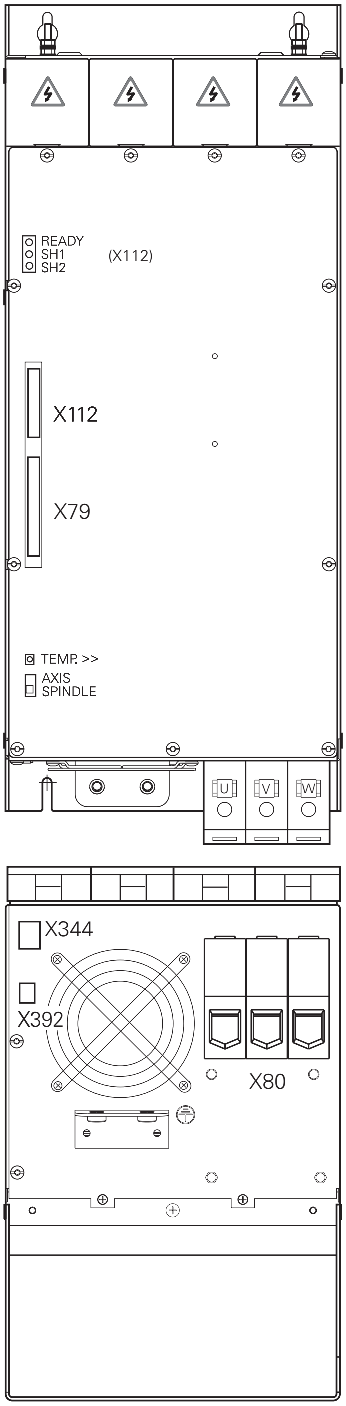
Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

X344 24 V supply for motor holding brake

X392 Motor holding brake

X80 Motor connection for axis / spindle

⏚ Equipment ground



X112 PWM, axis / spindle

X79 Unit bus

Sliding switch:

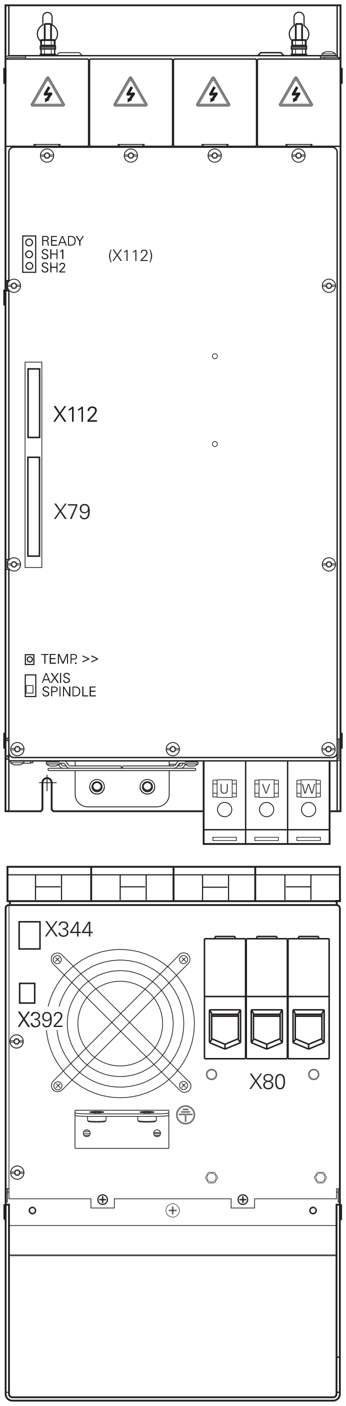
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

X344 24 V supply for motor holding brake

X392 Motor holding brake

X80 Motor connection for axis / spindle

⏚ Equipment ground



X112 PWM, axis / spindle

X79 Unit bus

Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

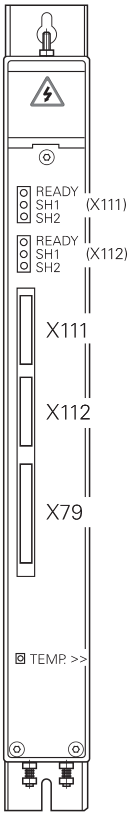
X344 24 V supply for motor holding brake

X392 Motor holding brake

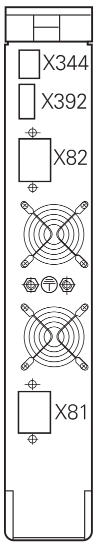
X80 Motor connection for axis / spindle

⏚ Equipment ground

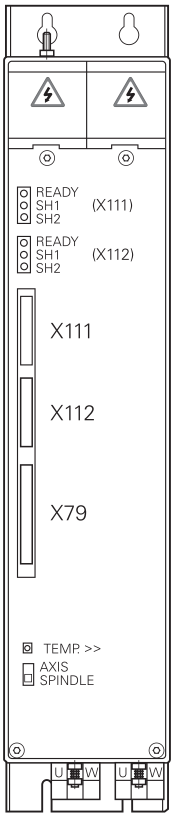
UM 121



X111	PWM, axis 1
X112	PWM, axis 2
X79	Unit bus



X344	24 V supply for motor holding brake (available as of version 325003-02)
X392	Motor holding brake (available as of version 325003-02)
X82	Motor connection for axis 2 (X112)
⏚	Equipment ground
X81	Motor connection for axis 1 (X111)

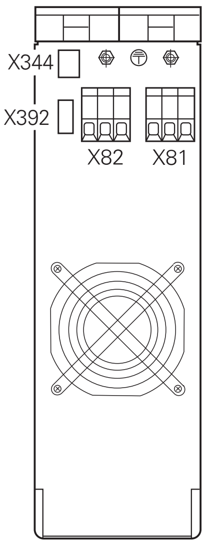


X111 PWM, axis 1

X112 PWM, axis 2 / spindle

X79 Unit bus

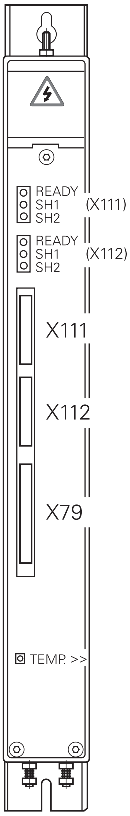
Sliding switch:
AXIS: X112 = axis
Enabling through X72 of the power supply unit
SPINDLE: X112 = spindle
Enabling through X71 of the power supply unit



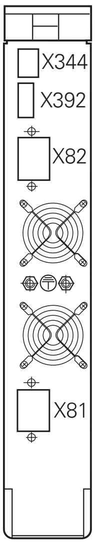
X344 24 V supply for motor holding brake
(available as of version 336948-03)
X392 Motor holding brake
(available as of version 336948-03)

X82 Motor connection for axis 2 / spindle (X112)
X81 Motor connection for axis 1 (X111);

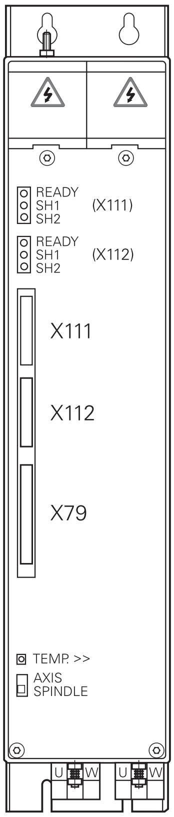
⏚ Equipment ground



X111	PWM, axis 1
X112	PWM, axis 2
X79	Unit bus



X344	24 V supply for motor holding brake
X392	Motor holding brake
X82	Motor connection for axis 2 (X112);
⏚	Equipment ground
X81	Motor connection for axis 1 (X111)

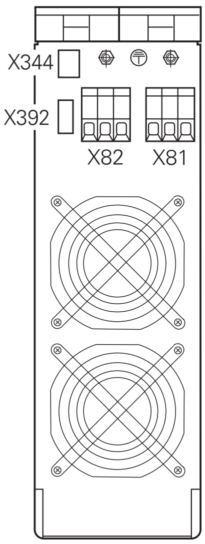


X111 PWM, axis 1

X112 PWM, axis 2 / spindle

X79 Unit bus

Sliding switch:
AXIS: X112 = axis
Enabling through X72 of the power supply unit
SPINDLE: X112 = spindle
Enabling through X71 of the power supply unit

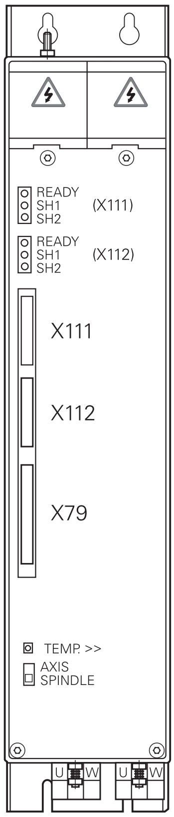


X344 24 V supply for motor holding brake

X392 Motor holding brake

X82 Motor connection for axis 2 / spindle (X112)
X81 Motor connection for axis 1 (X111);

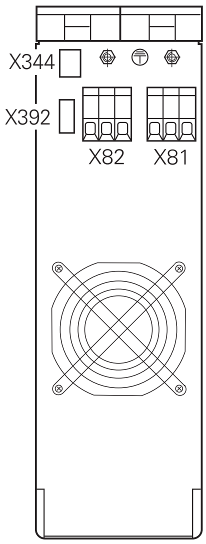
⏚ Equipment ground



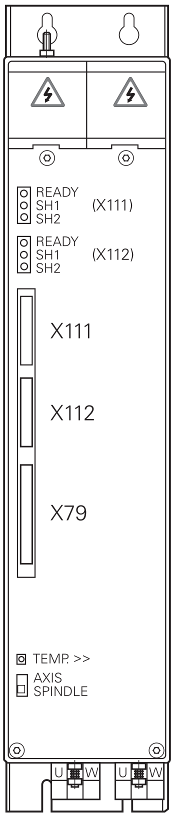
X111	PWM, axis 1
X112	PWM, axis 2 / spindle
X79	Unit bus

Sliding switch:

UM 122:AXIS: X112 = axis
Enabling through X72 of the power supply unit
SPINDLE: X112 = spindle
Enabling through X71 of the power supply unit



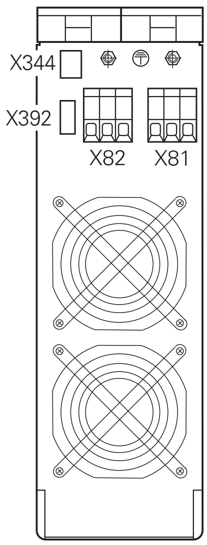
X344	24 V supply for motor holding brake (available as of version 325004-02)
X392	Motor holding brake (available as of version 325004-02)
X82	Motor connection for axis 2 / spindle (X112)
X81	Motor connection for axis 1 (X111)
⏚	Equipment ground



X111	PWM, axis 1
X112	PWM, axis 2 / spindle
X79	Unit bus

Sliding switch:

UM 122:AXIS: X112 = axis
Enabling through X72 of the power supply unit
SPINDLE: X112 = spindle
Enabling through X71 of the power supply unit



X344	24 V supply for motor holding brake
X392	Motor holding brake
X82	Motor connection for axis 2 / spindle (X112)
X81	Motor connection for axis 1 (X111);
⏚	Equipment ground

12.6.2 Pin layout on the power modules

X79: Unit bus

Connections: See “X79: Unit bus” on page 12 - 339.

X81: Axis/spindle motor
X82: Axis/spindle motor

Connecting terminals X81, X82	Assignment
U	Motor connection U
V	Motor connection V
W	Motor connection W

X111, X112: PWM connection to the control

Ribbon connector, 20-pin	Assignment
1a	PWM U1
1b	0 V U1
2a	PWM U2
2b	0 V U2
3a	PWM U3
3b	0 V U3
4a	$\overline{\text{SH2}}$
4b	0 V ($\overline{\text{SH2}}$)
5a	$\overline{\text{SH1}}$
5b	0 V ($\overline{\text{SH1}}$)
6a	+Iactl 1
6b	–Iactl 1
7a	0 V (analog)
7b	+Iactl 2
8a	–Iactl 2
8b	0 V (analog)
9a	Do not assign
9b	$\overline{\text{BRK}}$
10a	$\overline{\text{ERR}}$
10b	RDY

Danger

The interface complies with EN 61800-5-1 for "low voltage electrical separation."

X344: 24-V supply for motor holding brake

Connecting terminal X344	Assignment
1	+24 V
2	0 V

X392: Motor holding brake

2-pin connection:

Connecting terminals X392	Assignment
1	Holding brake
2	0 V

Connection 4-pin:

Connecting terminals X392	Assignment
1	Holding brake (X112)
2	0 V (X112)
3	Holding brake (X111)
4	0 V (X111)

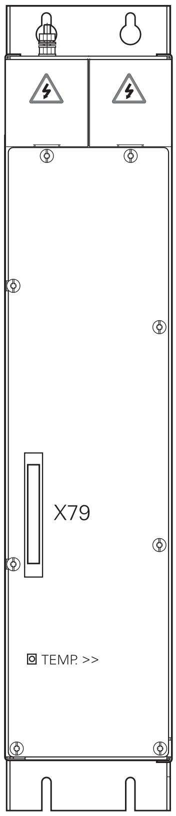
Maximum current I_{max} for controlling the holding brakes via X392:

Power module	I_{max}
UM 11x(B)(D)	3.0 A
UM 12x(B)(D)	2.0 A

12.7 DC-link filter

12.7.1 Designation and position of connections

ZKF 130



Conductor bar	Connection of DC-link voltage Uz
X79	Unit bus
TEMP. >>	Warning signal for excessive temperature of ZKF

12.7.2 Pin layout on the DC-link filter

X79:
Unit bus
(only ZKF 130)

Connections: See “X79: Unit bus” on page 12 - 339.

U_Z:
DC-link
voltage

The inverters for the direct drives are mounted to the right of the ZKF in order to separate the DC-link of the direct drives from the DC-link of the conventional drives through the filter.

Connecting terminals	Assignment
$-U_Z$in	DC-link voltage –, from power supply unit
$+U_Z$in	DC-link voltage +, from power supply unit
$-U_Z$out	DC-link voltage –, to direct drives
$+U_Z$out	DC-link voltage +, to direct drives

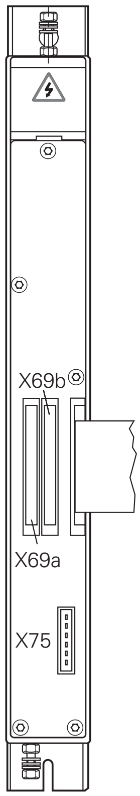
For HEIDENHAIN inverter systems the DC-link is conncected via the conductor bars.

Attention

A DC-link filter is not permitted for non-HEIDENHAIN inverters!

12.8 Adapter module

12.8.1 Designation and position of connections



X69a – X69b	Supply bus from the power supply units Ribbon cable to X69 on the control
X75	Service connector (exclusively for service purposes)

12.8.2 Pin layout on the adapter module

X69a:
From the first power supply unit (diagnosable)

For lengths of 600 mm and longer, the 50-line ribbon cable for the NC power supply and control signals is led doubled to the control in order to increase the wire cross section.

50-line ribbon cable	Assignment
1a to 5b	+5 V
6a to 7b	+ 12 V
8a	+5 V (low-voltage separation)
8b	0 V (low-voltage separation)
9a	+15 V
9b	–15 V
10a	UZAN_U1
10b	0 V
11a	IZAN_U1
11b	0 V
12a	$\overline{\text{RES.PS\_U1}}$
12b	0 V
13a	$\overline{\text{PF.PS\_U1}}$
13b	GND
14a	$\overline{\text{ERR.UZ.GR\_U1}}$
14b	GND
15a	$\overline{\text{ERR.IZ.GR\_U1}}$
15b	GND
16a	$\overline{\text{ERR.TEMP\_U1}}$ (UV, ZKF, UP)

50-line ribbon cable	Assignment
16b	GND
17a	RDY.PS_U1
17b	GND
18a	$\overline{\text{ERR.ILEAK\_U1}}$
18b	GND
19a	Not connected
19b	GND
20a	Not connected
20b	GND
21a	Not connected
21b	GND
22a	Not connected
22b	GND
23a	SDA
23b	GND
24a	SLC
24b	GND
25a	$\overline{\text{RES.LE}}$
25b	GND

Danger

The interface complies with EN 61800-5-1 for "low voltage electrical separation."

X69b:
From the second power supply unit (no diagnosis)

For lengths of 600 mm and longer, the 50-line ribbon cable for the NC power supply and control signals is led doubled to the control in order to increase the wire cross section.

50-line ribbon cable	Assignment
1a to 5b	+5 V
6a to 7b	Not connected
8a	Not connected
8b	Not connected
9a	Not connected
9b	Not connected
10a	UZAN_U2
10b	Not connected
11a	IZAN_U2
11b	Not connected
12a	Not connected
12b	0 V
13a	$\overline{\text{PF.PS\_U2}}$
13b	GND
14a	$\overline{\text{ERR.UZ.GR\_U2}}$
14b	GND
15a	$\overline{\text{ERR.IZ.GR\_U2}}$
15b	GND
16a	$\overline{\text{ERR.TEMP\_U2}}$ (UV, ZKF, UP)

50-line ribbon cable	Assignment
16b	GND
17a	RDY.PS_U2
17b	GND
18a	$\overline{\text{ERR.ILEAK\_U2}}$
18b	GND
19a	Not connected
19b	GND
20a	Not connected
20b	GND
21a	Not connected
21b	GND
22a	Not connected
22b	GND
23a	Not connected
23b	GND
24a	Not connected
24b	GND
25a	$\overline{\text{RES.LE}}$
25b	GND

Danger

The interface complies with EN 61800-5-1 for "low voltage electrical separation."

X69:
Ribbon cable to the control

For lengths of 600 mm and longer, the 50-line ribbon cable for the NC power supply and control signals is led doubled to the control in order to increase the wire cross section.

Connections: See “X69: NC supply voltage and control signals” on page 12 - 338.

X75:
Service connector

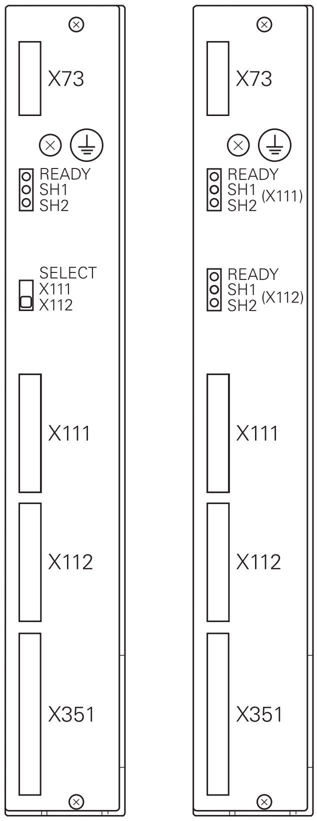
Attention

X75 must not be assigned. This connector is reserved for service purposes.

12.9 HEIDENHAIN interface boards for the SIMODRIVE system

12.9.1 Designation and position of connections

Interface boards
Ribbon cable



1-axis version | 2-axis version

X73 Enabling connector

⏚ Equipment ground (connect with the central grounding point of the machine)

SH1 Pulse release disabled (red)

SH2 Pulse release disabled (red)

READY Ready for operation (green)

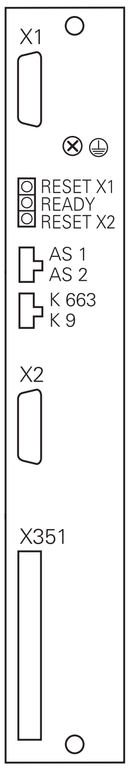
Sliding switch (1-axis version):
Input for PWM signals: X111 or X112

X111 PWM, axis / spindle

X112 PWM, axis/spindle

X351 SIMODRIVE unit bus

Expansion board
2-axis
D-sub connector
(galvanically
isolated)



X1 PWM, axis / spindle

⏚ Grounding conductor (connect with the central grounding point of the machine)

RESET X1/RESET X2
Axes/spindle disabled by LE (red)

READY Ready for operation (green)

AS1 Contact 1 of the normally closed contact

AS2 Contact 2 of the normally closed contact

K663 Safety relay for pulse release

K9 Supply voltage of SIMODRIVE unit bus for safety relay

X2 PWM, axis/spindle

X351 SIMODRIVE unit bus

12.9.2 Pin layout on the expansion boards

X73: Enabling connector

Connect. terminal	Assignment	Old designation	Note
1	+24 V	K9	Power supply from the SIMODRIVE unit bus
2	0 V		
3	ON	K663	Safety relay for pulse enable
4	Do not assign		
5	Do not assign		
6[a]	OE1	AS1	Contact 1 of the normally closed contact
7[a]	OE2	AS2	Contact 2 of the normally closed contact

a. max. 125 V

Attention

A recovery diode is required in the proximity of inductive loads, e.g. relay or contactor coils.

X111, X112: PWM connection to the control

Ribbon connector, 20-pin	Assignment
1a	PWM U1
1b	0 V U1
2a	PWM U2
2b	0 V U2
3a	PWM U3
3b	0 V U3
4a	$\overline{SH2}$
4b	0 V ($\overline{SH2}$)
5a	$\overline{SH1}$
5b	0 V ($\overline{SH1}$)
6a	+Iactl 1
6b	–Iactl 1
7a	0 V (analog)
7b	+Iactl 2
8a	–Iactl 2
8b	0 V (analog)
9a	Do not assign
9b	$\overline{BRK}$
10a	$\overline{ERR}$
10b	Ready

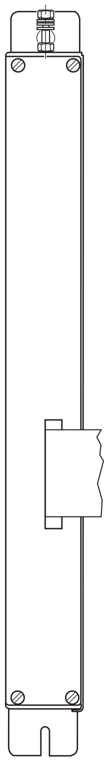
X1, X2: PWM connection to the control

D-sub connection	Assignment
1	Do not assign
2	PWM U1
3	PWM U2
4	PWM U3
5	reset
6	standby
7	–Iactl 2
8	–Iactl 1
9	0 V U1
10	0 V U2
11	0 V U3
12	0 V (analog)
13	ERR
14	+Iactl 2
15	+Iactl 1
Chassis	External shield

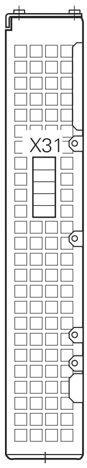
12.10 UV 101 B power supply unit

12.10.1 Designation and position of connections

The UV 101B power supply unit provides the LE 4xx M with power during operation with the SIMODRIVE or POWER DRIVE inverter system.



Power supply for the LE
(connection to X69 on the LE)



X31 Power supply for UV 101B

12.10.2 Error diagnosis on UV 101 B

X31:
Supply voltage

Supply voltage: 400 V ± 10%

Connecting terminal	Assignment
⏚	Equipment ground (YL/GY), ≥ 10 mm^2
U1	Phase 1 / 400 V~ ±10 % / 50 Hz to 60 Hz
U2	Phase 2 / 400 V~ ±10 % / 50 Hz to 60 Hz
$+U_z$	Positive DC-link voltage of the non-HEIDENHAIN inverter system
$–U_z$	Negative or reference potential of the DC-link voltage of the non-HEIDENHAIN inverter system
	Cable: Wire cross section: 1.5 mm^2 (AWG 16) The DC-link connection of the UV 101 B is protected by the additional PCB on the non-HEIDENHAIN inverter system (4 A)
Tightening torque: for the connecting terminals 0.7 Nm (6.5 to 7 pound-inch) **Grounding terminal:** ≥ 10 mm^2 (AWG 6) **Strain relief:** Ensure that the connecting cables are not subject to excessive strain.	

Note

The voltage at the terminals U1 and U2 must be supplied via an isolating transformer (250 VA, basic insulation in accordance with EN 50 178 or VDE 0550).

Attention

Do not ground this isolating transformer on the secondary side!

The isolating transformer decouples the line voltage from ground. Grounding the isolating transformer on the secondary side leads to an addition of the DC-link voltage and the supply voltage. This could destroy the UV 101 B!

Please keep this in mind in your circuit diagrams.

X69:
NC supply voltage and control signals

Note

The 50-line ribbon cable is used to power the control with low voltages.
Status signals of non-HEIDENHAIN inverter systems cannot be transferred to the HEIDENHAIN control via the UV 101 B!

Connections: See “X69: NC supply voltage and control signals” on page 12 - 338.

U_Z:
Power supply of the UV 101 B with U_Z

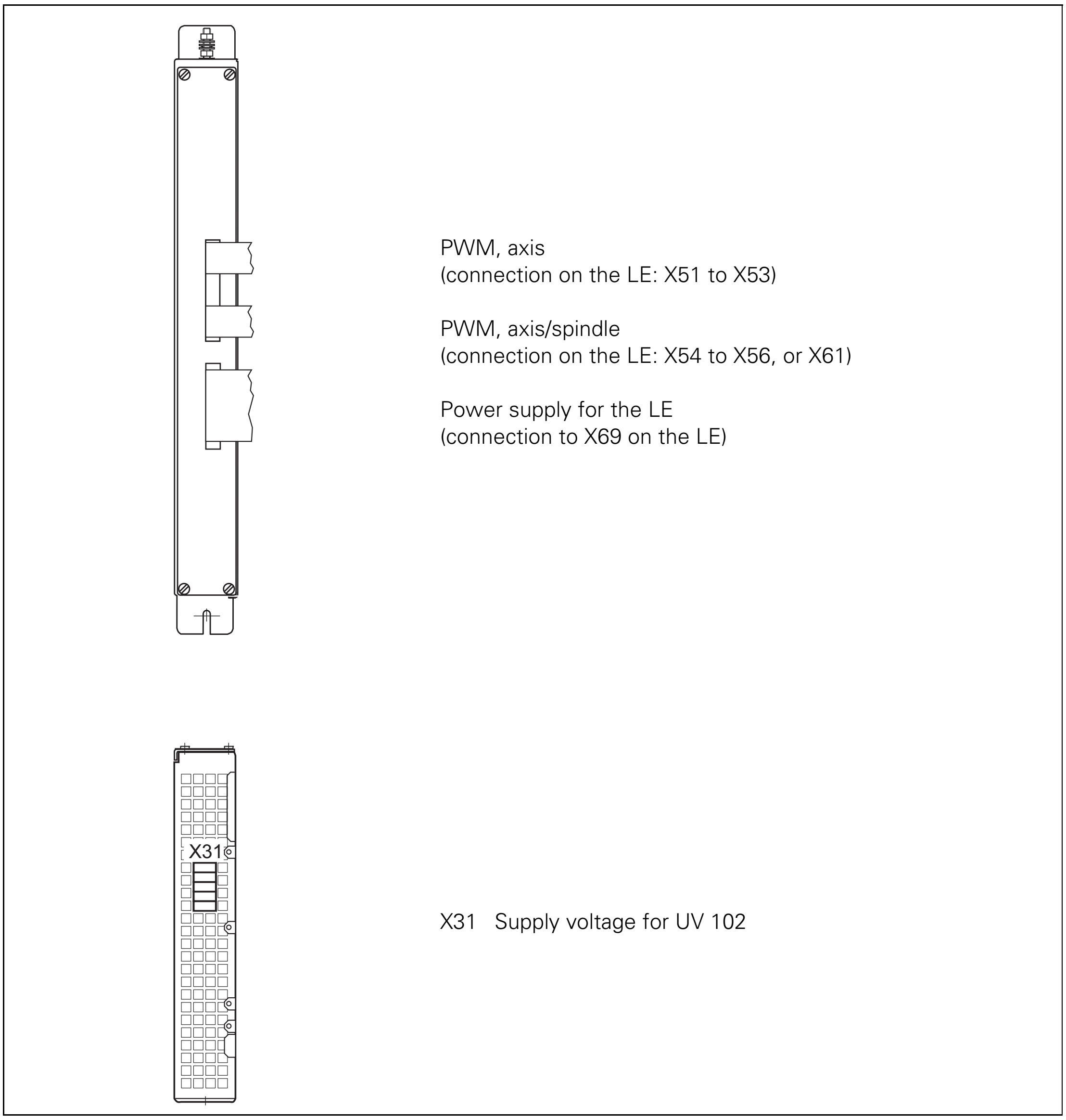
Since the power to the UV 101 B is supplied through the DC-link, the voltage fed into the DC-link by the motors that are still running can be used during line voltage failures. The UV 101 B uses this voltage to maintain the power supply to the control until the non-HEIDENHAIN inverter system has been shut down properly by the control.

Connecting terminals	Assignment
$–U_Z$	DC-link voltage –
$+U_Z$	DC-link voltage +

12.11 UV 102 power supply unit

12.11.1 Designation and position of connections

Only for LE 426 M when used with UE 2xx compact inverter.



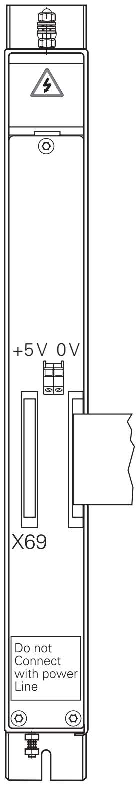
12.11.2 Pin layouts on UV 102

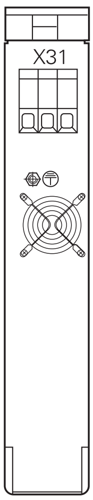
X31:
Supply voltage

Connecting terminals	Assignment
⏚	Equipment ground (YL/GN)
U1	Phase 1 / 400 V~ ±10 % / 50 Hz to 60 Hz
U2	Phase 2 / 400 V~ ±10 % / 50 Hz to 60 Hz
$-U_Z$	DC-link voltage –
$+U_Z$	DC-link voltage +
	Cable / single conductor (HT wire): Wire cross section 1.5 mm^2 (AWG 16) Line fuse: 6.3 A (gR) semiconductor fuse, Siemens Sitor type Ground connection: ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 to 7 pound-inch)

12.12 UV 105 power supply unit

12.12.1 Designation and position of connections





Conductor bar	Power supply via DC-link voltage Uz
X74	5-V power supply for control
Ribbon cable	Transmission of status signal and power supply for the control
X 69	Status signals from UV 1x0 or UE 2xxB
X31	400-V power supply
⏚	Equipment ground

12.12.2 Pin layouts on UV 105

X31: Supply voltage

Supply voltage: 400 V ± 10%

Connecting terminal	Assignment
U	Phase 1 / 400 V~ ±10 % / 50 Hz to 60 Hz
V	Phase 2 / 400 V~ ±10 % / 50 Hz to 60 Hz
⏚	Protective ground (YL/GN), ≥ 10 mm^2
	Cable: Wire cross section 1.5 mm^2 (AWG 16) Line fuse: 6.3 A (gR) semiconductor fuse, Siemens Sitor type The screw terminal between X31 and the grounding terminal must be used for fixing the cable and for ensuring appropriate strain relief of the cable. **Ground connection::** ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 to 7 pound-inch)

Note

If you are using non-HEIDENHAIN inverter systems or regenerative HEIDENHAIN inverter systems, you must connect the supply voltage to the terminals U and V via an isolating transformer (300 VA, basic insulation as per IEC61800-5-1 or protective insulation as per VDE 0550).

Attention

The isolating transformer must not be grounded on the secondary side!

The isolating transformer decouples the line voltage from ground. Grounding the isolating transformer on the secondary side leads to an addition of the DC-link voltage and the supply voltage. This overloads the UV 105, thereby destroying it!

Please keep this in mind in your circuit diagrams.

X69, X169: NC supply voltage and control signals

Connections: See “X69: NC supply voltage and control signals” on page 12 - 338.

Note

For the control to be able to evaluate the status signals of the power supply units, connector X69 of the controller unit must be connected by ribbon cable with X69 of the UV 105. Since status signals from non-HEIDENHAIN inverters are mostly not available on the pins specified by HEIDENHAIN systems, the adapter (ID 349 211-01) must be connected to X69 on the UV 105. This connector is delivered with the UV 105.

X74: 5-V power supply

Wire color of 5 V connection	5-V terminal on CC 42x
Black	0 V
Red	+5 V

U_Z Power supply of the UV 105 with U_Z

Since the power to the UV 105 is supplied through the DC-link, the voltage fed into the DC-link by the motors that are still running can be used during line voltage failures. The UV 105 uses this voltage to maintain the power supply to the control until the system has been shut down properly by the control.

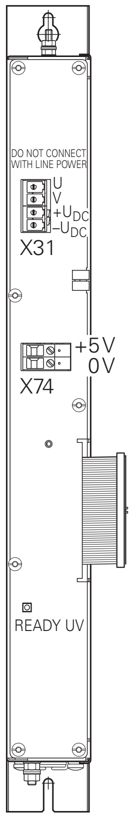
Connecting terminals	Assignment
$–U_Z$	DC-link power –
$+U_Z$	DC-link voltage +

The UV 105 is powered with DC-link voltage U_Z through

- the conductor bars (for HEIDENHAIN inverter systems).
- a cable which is connected instead of the conductor bar (for non-HEIDENHAIN inverter systems).

12.13 UV 105 B power supply unit

12.13.1 Designation and position of connections



X31	U/V	400 V supply voltage
X31	+Uz / -Uz	Supply voltage from DC link
X74		5-V power supply for CC 42x
Free ribbon cable		Further power supply and status signals for CC 42x (to X69 on CC 42x)
LED green		Operating display for UV 105 B
⏚		Equipment ground (YL/GN)

12.13.2 Pin layouts on UV 105 B

X31:
Supply voltage

Supply voltage: 400 V ± 10%

Connecting terminal	Assignment
U	Phase 1 / 400 V~ ±10 % / 50 Hz to 60 Hz
V	Phase 2 / 400 V~ ±10 % / 50 Hz to 60 Hz
⏚	Equipment ground (YL/GY), ≥ 10 mm^2
	Cable: Wire cross section: 1.5 mm^2 (AWG 16) Line fuse: 6.3 A (gRL) semiconductor fuse, Siemens Sitor type
$+U_z$	Positive DC-link voltage of the non-HEIDENHAIN inverter system
$–U_z$	Negative or reference potential of the DC-link voltage of the non-HEIDENHAIN inverter system
	Cable: Wire cross section: 1.5 mm^2 (AWG 16) The DC-link connection of the UV 105B is protected by the additional PCB on the non-HEIDENHAIN inverter system (4 A)
Tightening torque: for the connecting terminals 0.7 Nm (6.5 to 7 pound-inch) **Grounding terminal:** ≥ 10 mm^2 (AWG 6) **Strain relief:** Ensure that the connecting cables are not subject to excessive strain.	

Note

If you are using non-HEIDENHAIN inverter systems, you must connect the supply voltage to the terminals U and V via an isolating transformer (300 VA, basic insulation as per EN 50 178 or VDE 0550).

Attention

Do not ground this isolating transformer on the secondary side!

The isolating transformer decouples the line voltage from ground. Grounding the isolating transformer on the secondary side leads to an addition of the DC-link voltage and the supply voltage. This could destroy the UV 105 B!

Please keep this in mind in your circuit diagrams.

X69: NC supply voltage and control signals

Connections: See "X69: NC supply voltage and control signals" on page 12 - 338.

Note

The 50-line ribbon cable is used to power the control with low voltages.
Status signals of non-HEIDENHAIN inverter systems cannot be transferred to the HEIDENHAIN control via the UV 105 B!

X74: 5-V powersupply

Wire color of 5 V connection	5-V terminal on CC 42x
Black	0 V
Red	+5 V

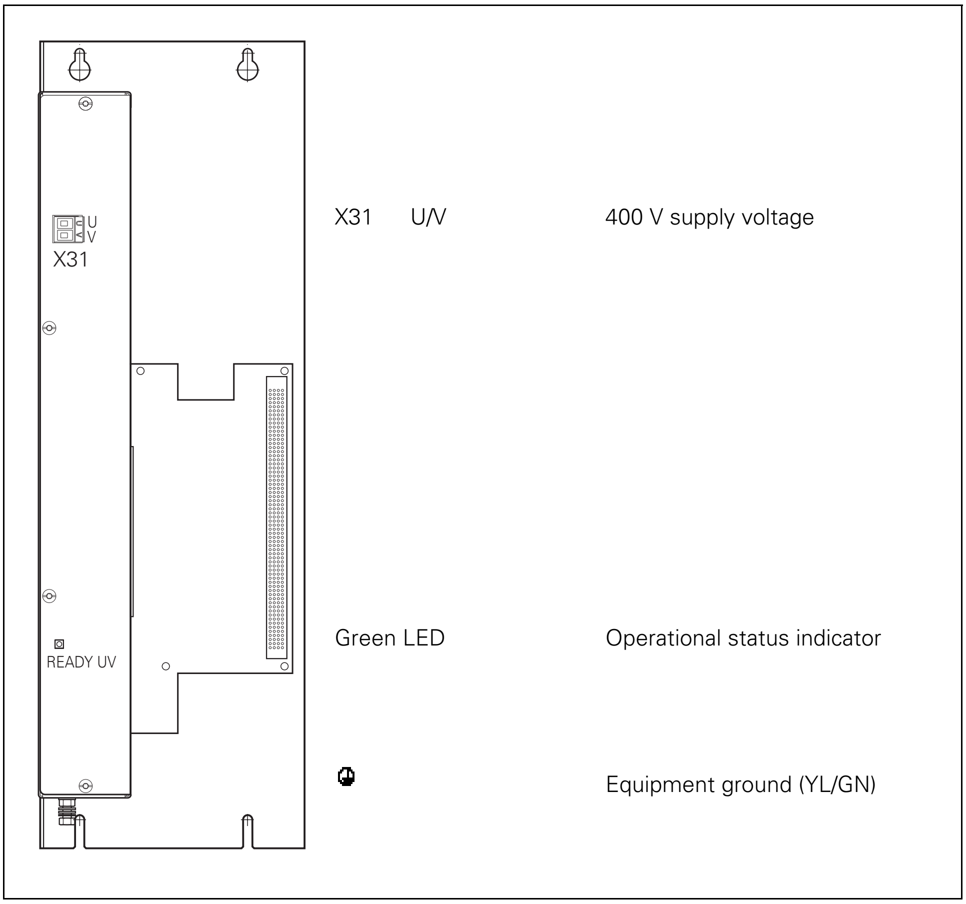
U_Z: Power supply of the UV 105B with U_Z

Since the power to the UV 105 B is supplied through the DC-link, the voltage fed into the DC-link by the motors that are still running can be used during line voltage failures. The UV 105 B uses this voltage to maintain the power supply to the control until the non-HEIDENHAIN inverter system has been shut down properly by the control.

Connecting terminals	Assignment
$-U_Z$	DC-link voltage –
$+U_Z$	DC-link voltage +

12.14 UV 106 B power supply unit

12.14.1 Designation and position of connections



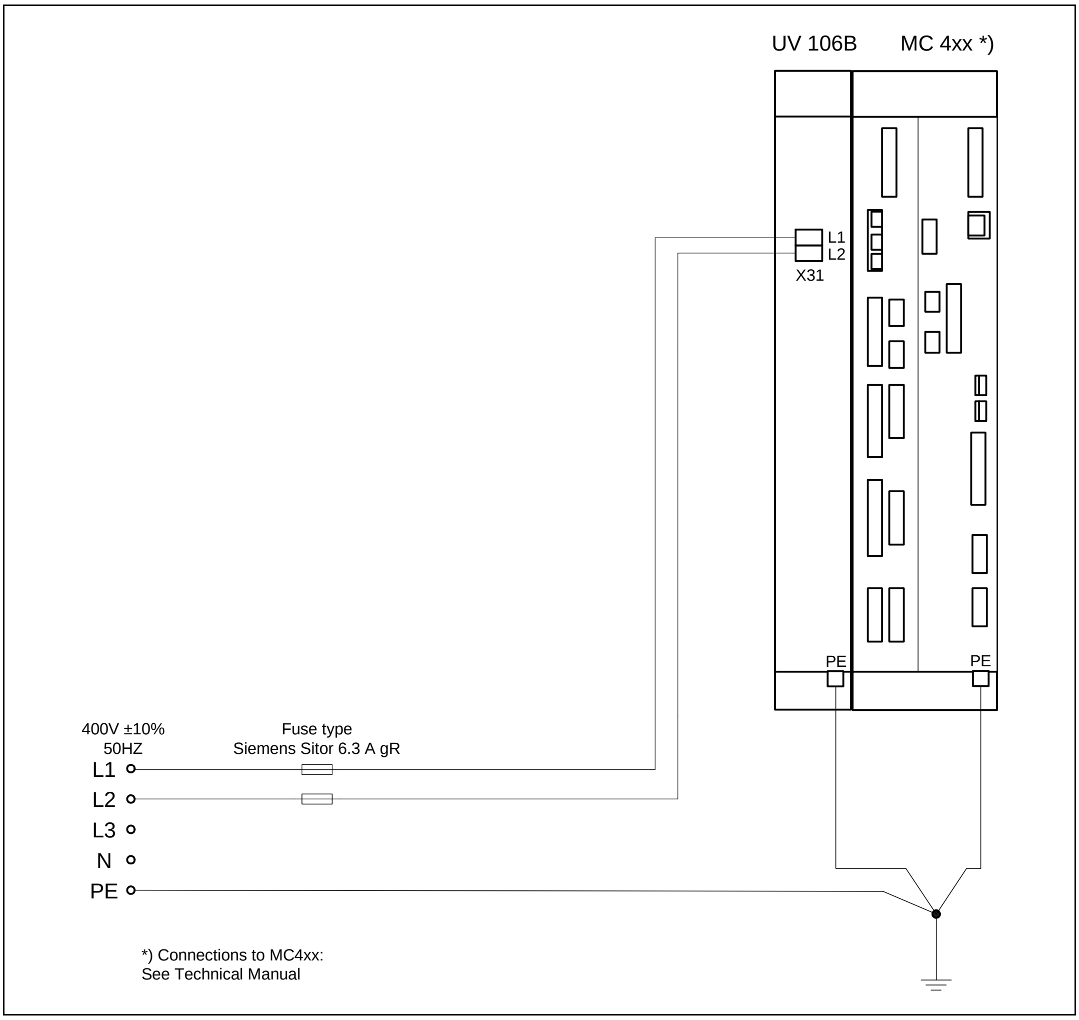
12.14.2 Pin layouts on UV 106 B

X31:
Supply voltage for UV 106B

Supply voltage: 400 V ± 10%

<table>
<tr><th>Connecting terminal</th><th>Assignment</th></tr>
<tr><td>U</td><td>Phase 1 / 400 V~ ±10 % / 50 Hz to 60 Hz</td></tr>
<tr><td>V</td><td>Phase 2 / 400 V~ ±10 % / 50 Hz to 60 Hz</td></tr>
<tr><td>⏚</td><td>Protective ground (YL/GN),
≥ 10 mm^2</td></tr>
<tr><td></td><td>Connecting leads
Wire cross section: 1.5 mm^2 (AWG 16)</td></tr>
<tr><td colspan="2">Tightening torque:
for the connecting terminals
0.7 Nm (6.5 to 7 pound-inch)
Grounding terminal:
≥ 10 mm^2 (AWG 6)
Strain relief:
Ensure that the connecting cables are not subject to excessive strain.</td></tr>
</table>

Power connection

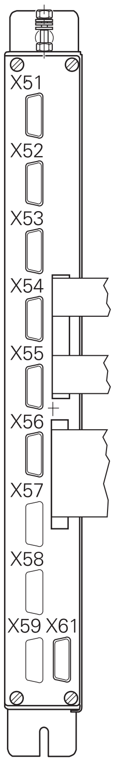


12.15 UV 111A, UV 111B power supply unit

12.15.1 Designation and position of connections

The UV 111A power supply unit provides the LE 410 M, LE 426 M and LE 430 M/6 axes with power during operation with the SIMODRIVE 611 D inverter in multiple-row configuration.

The UV 111B power supply unit provides the LE 430 M/9 axes with power during operation with the SIMODRIVE 611 D inverter in multiple-row configuration.

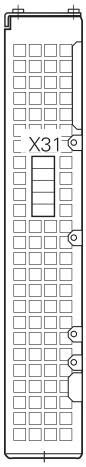


X51 to X56/X59 — PWM connection for axis UV 111A/UV 111B

PWM signals from the LE

Power supply for the LE
(connection to X69 on the LE)

X61 — PWM connection for spindle



X31 — Power supply for UV 111x

12.15.2 Pin layout on the UV 111A, UV 111B

X31:
Supply voltage

Supply voltage: 400 V ± 10%

Connecting terminal	Assignment
⏚	Equipment ground (YL/GY), ≥ 10 mm^2
U1	Phase 1 / 400 V~ ±10 % / 50 Hz to 60 Hz
U2	Phase 2 / 400 V~ ±10 % / 50 Hz to 60 Hz
$+U_z$	Positive DC-link voltage of the non-HEIDENHAIN inverter system
$–U_z$	Negative or reference potential of the DC-link voltage of the non-HEIDENHAIN inverter system
	Cable: Wire cross section: 1.5 mm^2 (AWG 16) The DC-link connection of the UV 111 is protected by the additional PCB on the non-HEIDENHAIN inverter system (4 A)
Tightening torque: for the connecting terminals 0.7 Nm (6.5 to 7 pound-inch) **Grounding terminal:** ≥ 10 mm^2 (AWG 6) **Strain relief:** Ensure that the connecting cables are not subject to excessive strain.	

Note

The voltage at the terminals U1 and U2 must be supplied via an isolating transformer (250 VA, basic insulation in accordance with EN 50 178 or VDE 0550).

Attention

Do not ground this isolating transformer on the secondary side!

The isolating transformer decouples the line voltage from ground. Grounding the isolating transformer on the secondary side leads to an addition of the DC-link voltage and the supply voltage. This could destroy the UV 111 B!

Please keep this in mind in your circuit diagrams.

X69:
NC supply voltage and control signals,

Connections: See “X69: NC supply voltage and control signals” on page 12 - 338.

Note

The 50-line ribbon cable is used to power the control with low voltages.
Status signals of non-HEIDENHAIN inverter systems cannot be transferred to the HEIDENHAIN control via the UV 111!

U_Z:
Power supply of the UV 111 with U_Z

Since the power to the UV 111 is supplied through the DC-link, the voltage fed into the DC-link by the motors that are still running can be used during line voltage failures. The UV 111 uses this voltage to maintain the power supply to the control until the non-HEIDENHAIN inverter system has been shut down properly by the control.

Connecting terminals	Assignment
$–U_Z$	DC-link voltage –
$+U_Z$	DC-link voltage +

X51 to X61:
PWM interface

The service manuals of the HEIDENHAIN controls comprise the assignment of the PWM interface.

13 ID labels

13.1 ID label for inverters

The inverter components are designated according to the system described below:

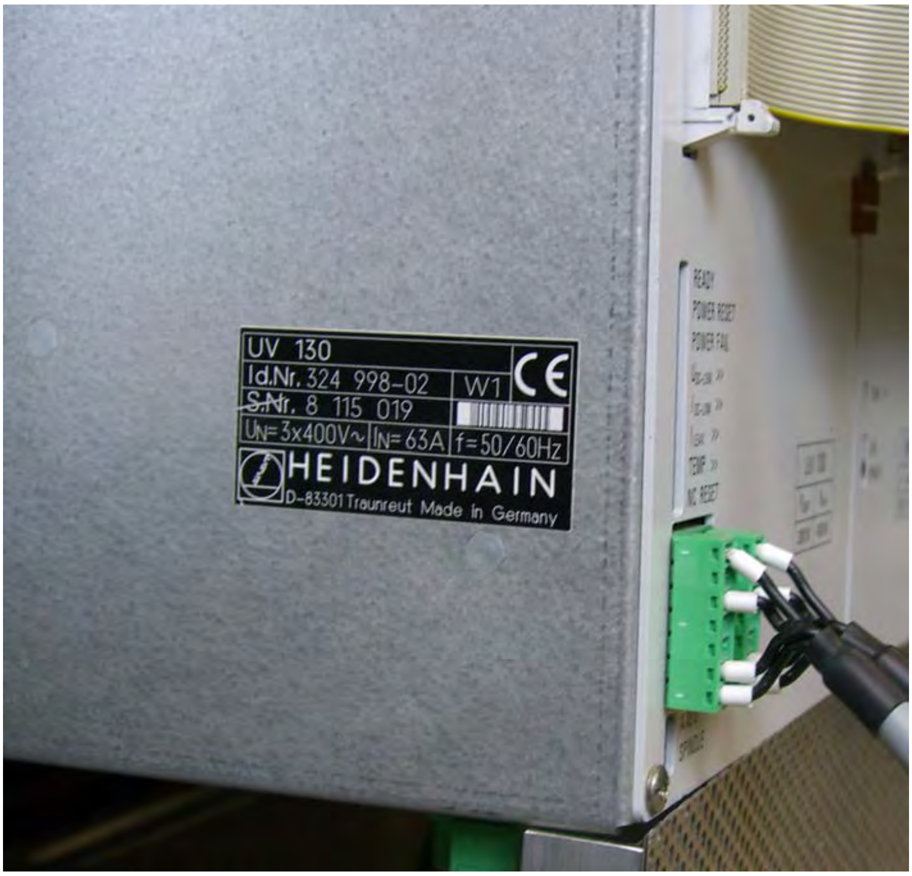
Designation code		
UM 121 B D	Meaning of the designation	
D	Optional: Module with electronic ID label[a]	
121 B	Module name	
UM	Module type	
	- UE	Non-regenerative compact inverter
	- UR	Regenerative compact inverter
	- UV	Non-regenerative power supply unit (except for UV 120 and UV 140)
	- UVR	Regenerative power supply unit
	- UM	Inverter module (power module with IGBTs)

a. See "Electronic ID label for inverters" on page 13 - 404.

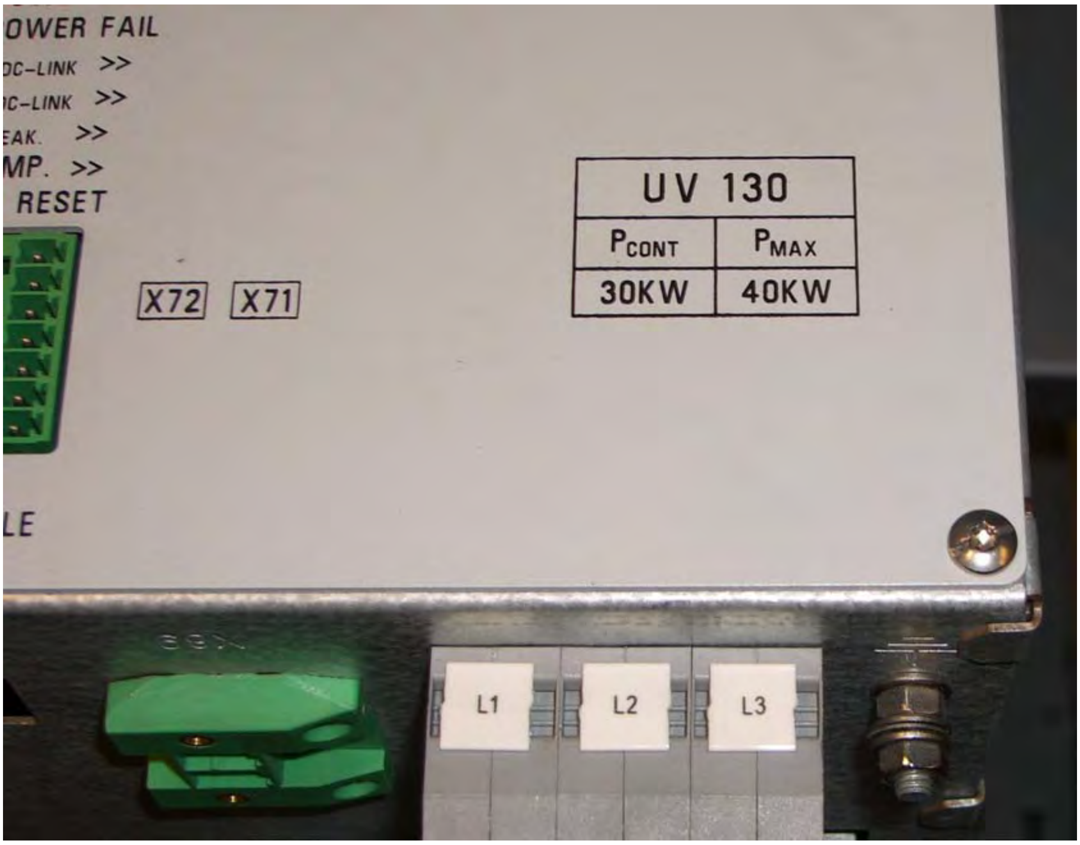
The ID label for inverter components is mostly located at the bottom of the sheet-metal housing:

If the space is not sufficient, the ID label is glued on the bottom of the housing:

You can find the ID label on the side plate of older inverters:



There is often a **label** with the model designation and specifications on the **front panel** of the inverter:



Or an **ID label sticker** with the model designation, ID number, serial number and specifications of the inverter:

13.2 Electronic ID label for inverters

Inverter components with the designation "D" feature an electronic ID label.

Following data is stored in the electronic ID labels for inverters:

- Device
- Model
- Serial number
- ID number

Advantage for commissioning

When commissioning a machine with HEIDENHAIN control, connected power modules and compact inverters are automatically recognized in the system and can be assigned to the respective machine parameters.
This is designated as **"Plug and Play"** function.

The following prerequisites apply for the control:

- It must feature a software that can read the electronic ID labels (e.g. current NC software of the iTNC 530).
- The read-out function for electronic ID labels must be activated in the control (e.g. MP 7690 in the iTNC 530).

Advantage for the field service

Each time the control is rebooted, the connected devices are read out again and compared to the entries in the machine parameters. If the data of the electronic ID labels correspond to the entries in the machine parameter list, messages concerning the ID label are not displayed on the monitor. If the data are not the same, a corresponding ID label message appears on the monitor.

Wrong assignments are detected!

If an ID label message is displayed on the screen when the control is rebooted:

- The connected unit does not correspond to the active MP list (e.g., the mounted replacement unit is not exactly the same).
- The active MP list does not correspond to the connected unit (e.g., if a backup was restored before, that does not fit exactly to the machine).
- You have exchanged the rotary encoder inputs or PWM outputs for troubleshooting, without deactivating the evaluation of the electronic ID lables before.

Attention

Wrong assignments are not detected if ...

- The connected units do not feature an electronic ID label.
- The control cannot read electronic ID labels.
- The control can read electronic ID labels but this function has not been activated.

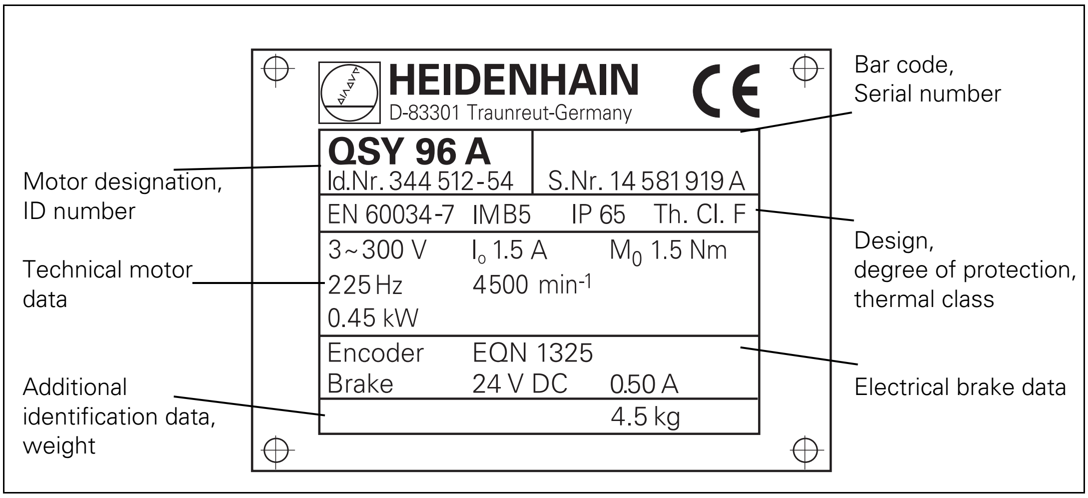
Display of the electronic ID label of the iTNC 530 HEIDENHAIN control:

13.3 ID label for motors

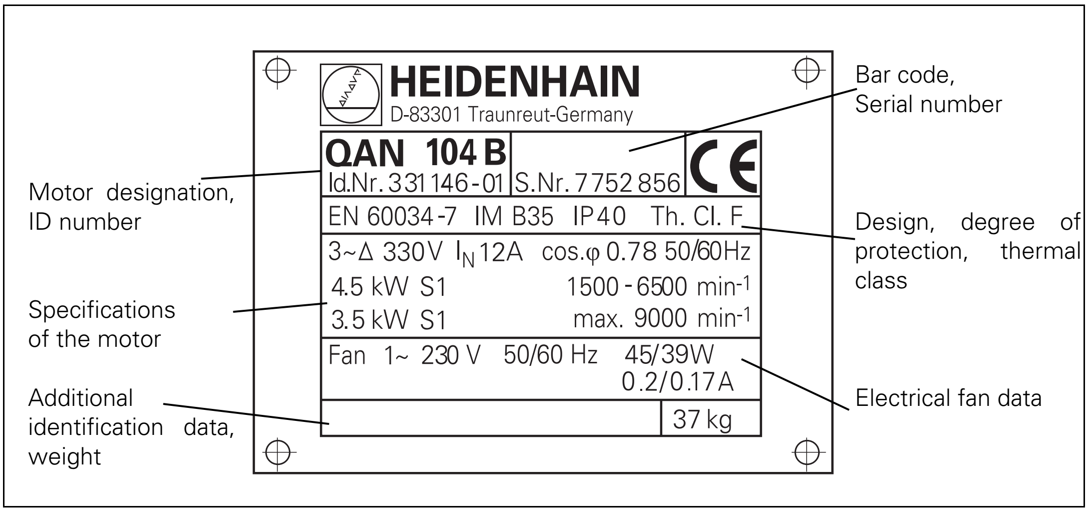
Note

In most cases the ID labels of integral motors cannot be read directly.
HEIDENHAIN motors are thus delivered with additional ID label stickers that are normally applied by the machine manufacturer at an easily visible area of the machine.

QSY synchronous motors



QAN asynchronous motors



Note

The motors of the QAN 30 series and of the QAN 4S are wired for delta connection.
This data is included on the name plate.
The control's motor table includes the data for the wye equivalent circuit.

13.4 Electronic ID label for motors

Current motors with EnDat interface feature electronic ID labels.

Following data is stored in the electronic ID labels for motors:

- Device
- Model
- Serial number
- ID number
- Motor brake available: YES/NO

Advantage for commissioning

When commissioning a machine with HEIDENHAIN control, connected motors are automatically recognized in the system and can be assigned to the respective machine parameters.
This is designated as **"Plug and Play"** function.

The following prerequisites apply for the control:

- It must feature a software that can read the electronic ID labels (e.g. current NC software of the iTNC 530).
- The read-out function for electronic ID labels must be activated in the control (e.g. MP 7690 in the iTNC 530).

Advantage for the field service

Each time the control is rebooted, the connected devices are read out again and compared to the entries in the machine parameters. If the data of the electronic ID labels correspond to the entries in the machine parameter list, messages concerning the ID label are not displayed on the monitor. If the data are not the same, a corresponding ID label message appears on the monitor.

Wrong assignments are detected!

If an ID label message is displayed on the screen when the control is rebooted:

- The connected unit does not correspond to the active MP list (e.g., the mounted replacement unit is not exactly the same).
- The active MP list does not correspond to the connected unit (e.g., if a backup was restored before, that does not fit exactly to the machine).
- You have exchanged the rotary encoder inputs or PWM outputs for troubleshooting, without deactivating the evaluation of the electronic ID lables before.

> Attention
>
> Wrong assignments are not detected if ...
>
> - The connected units do not feature an electronic ID label.
> - The control cannot read electronic ID labels.
> - The control can read electronic ID labels but this function has not been activated.

Display of the electronic ID label of the iTNC 530 HEIDENHAIN control:

13.5 ID label for HEIDENHAIN expansion boards

The label for the HEIDENHAIN expansion board for the SIMODRIVE system is located on the top of the front panel:

13.6 ID label for accessories

Other inverter components, such as braking resistor, braking resistor module, line filter, three-phase capacitor, commutating reactor, DC-link filter, voltage protection module, adapter module, axis release module **do not feature electronic ID labels** at present.

In most cases the respective **ID label sticker** is located highly readable **on the housing** of the units.

Original HEIDENHAIN cables are provided with the **inscription of the respective ID number**.

14 Measuring, testing and inspection equipment

14.1 Important notes

Danger

Observe the safety precautions in chapter 2 of this manual!
See “Safety precautions” on page 2 – 13.

Attention

The following inspection, measuring and testing equipment is **only** intended **for testing** machines!

Attention

Encoder cables, etc., are no longer continuously shielded when the test adapter is connected.

Attention

When using grounded measuring equipment (e.g., oscilloscope with power connection), always use the socket of the machine's electrical cabinet for power supply.
Compensating currents caused by different earth potentials can thus be avoided.

Attention

For measuring voltages, first connect to 0 V and only then to the voltage to be measured!

Attention

Always observe the **User's Manual** of PWM 9 as well as the **Operating Instructions** of PWT 10/17/18 and PWM 20 / IK 215!

14.2 Voltage tester

Ensure that the unit is switched off before performing work on the drive system for which the system must be free of potential.

Use a **voltage tester** that corresponds to the **IEC / EN 61243-3** or **DIN VDE 0682-401** standards (e.g., moving coil measuring device which draws a test charge from the circuit and thus eliminates capacitive and inductive reactance voltages).

It must be possible to perform reliable measurements of the **alternating current** as well as **direct current** up to **at least 1000 V**!

Danger

The voltage tester used (including the measuring lines used) must at least conform to the safety category Cat III / 1000 V or Cat IV / 600 V!

Danger

You should prefer an especially designed voltage tester (e.g., Duspol) to a common multimeter to determine if the equipment is free of potential.

Danger

Electrical drives on machine tools operate at high voltages!
Read the operating instructions of the voltage tester, convince yourself of the operating safety and handle this test equipment with care!

14.3 Insulation tester

Use a mobile insulation tester to recognize, e.g., ground faults on motors and inverters.

Use a topical unit that charges up to the selected isolation voltage and discharges after the measurement.

It should also be possible to select the test voltage (500 V, 1000 V).

Danger

The units to be checked (e.g., motors, inverters) must be free of potential!
The insulation tester operates at high voltages.
Read the operating instructions of the insulation tester, convince yourself of the operating safety and handle this measuring equipment with care!

14.4 Multimeter

With a commercial battery-operated multimeter it is possible to perform simple measurements and inspections on inverters (e.g., in connection with the test adapter) and motors.

Multimeters are mainly used for measuring voltages.

Danger

The multimeter used (including the measuring lines used) must at least conform to the safety category Cat III / 1000 V or Cat IV / 600 V!

Most multimeters can be set to "Diode measuring". This is used, e.g., to inspect inverters for short circuits (See “Inspection for short circuit or interruption” on page 7 – 99).

Some multimeters feature the possibility to connect a current probe.

Danger

Electrical drives on machine tools operate at high voltages and currents.
Read the operating instructions of the multimeter, convince yourself of the operating safety and handle this measuring device with care!

14.5 Current probe

Use a current probe to measure currents (e.g. in the motor power cables) without contact.

Current probes are available as accessories for multimeters or as independent units.

Danger

Electrical drives on machine tools operate at high currents.
Read the operating instructions of the current probe, convince yourself of the operating safety and handle this measuring device with care!

14.6 Test adapter

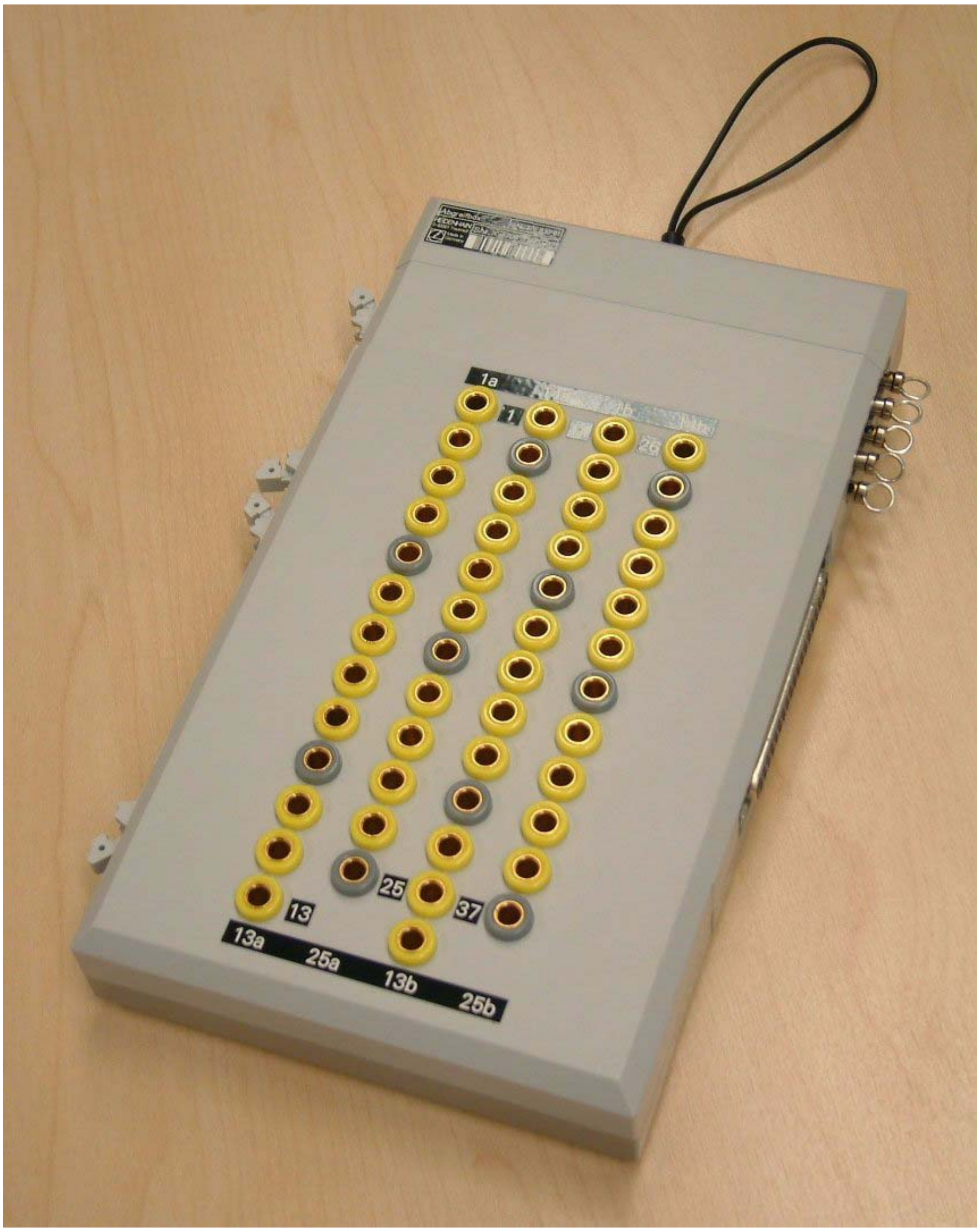
Brief description

The test adapter ...

- Currently has the ID 375830-01.
- Can be connected to all D-Sub and ribbon-cable connectors of HEIDENHAIN devices.
- Requires adapter cables.
- Has numbered banana jacks to which, e.g., a multimeter can be connected.
- Permits signal and voltage measurement during the operation of HEIDENHAIN devices.
- Has 5 prepared banana plugs with eyes to be clipped on the measuring lines.
  These banana plugs are located at the upper right; if required, they can be plugged into the numbered banana jacks.

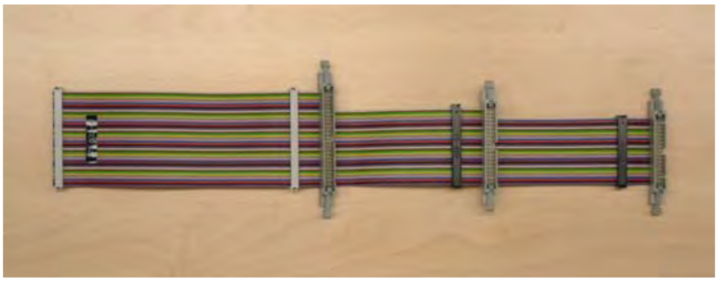
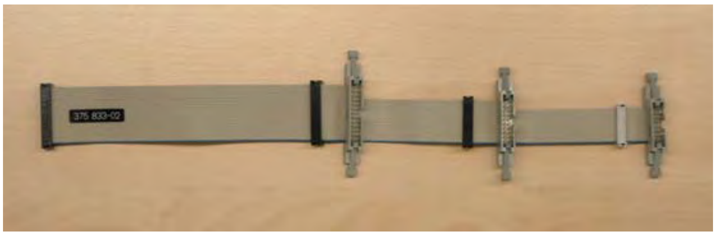
Danger

Only **one** interface may be inspected on the test adapter!



Adapter cable to the test adapter

Each ribbon cable and D-sub connector requires its own adapter cable.

	Connecting cable, ribbon type 50, 40, 34-pin ID 375833-01
	Connecting cable, ribbon type 26, 20, 16-pin ID 375833-02

A new and an old version of the D-sub adapter cables are available.
The older version has some disadvantages:

- The oval-head screws on the D-sub connector reduce the insertion depth. An adapter connector can/must be used.
- More space is required as the adapter connector has a lateral cable outlet and the original connector must be connected directly to the adapter connector.

	D-sub adapter cable 9-pin ID 255481-01 New version
	D-sub adapter cable 9-pin ID 255481-01 Older version

	D-sub adapter cable 15-pin ID 255482-01 New version
	D-sub adapter cable 15-pin ID 255482-01 Older version
	D-sub adapter cable 25-pin ID 255483-01 New version
	D-sub adapter cable 25-pin ID 255483-01 Older version

	D-sub adapter cable 37-pin ID 255484-01 New version
	D-sub adapter cable 37-pin ID 255484-01 Older version

14.7 PWM 9 encoder diagnostic kit

Brief description

- The PWM 9 set currently has the ID 512134-01.
- With the PWM 9 phase angle measuring unit it is also possible to **inspect and analyse motor encoders with incremental tracks**.
  For HEIDENHAIN motor encoders an **expansion board for 1 Vpp** is used.
- The PWM 9 can be connected **between motor encoder and control in series**.
  The motor encoder can be checked at "Operating speed".

> **Danger**
>
> If the PWM 9 is connected in the signal path between the encoder and the control:
> Do not change the settings of the PWM 9 (e.g., parameters, encoder voltages) and do not switch it off while the machine tool is operating.
> Ignoring this may cause machine damage or personal injury!
> Read the **PWM 9 User's Manual**, before you use the device.

- The motor encoder can also be inspected without being connected to the control. It is exclusively connected to the PWM 9 and is powered by this unit. The encoder or the motor must be rotated externally (e.g., manually).
- The signal amplitude is also measured when the encoder has stopped.
- Three BNC sockets (A/B/C) are available for checking the motor encoder output signals on an oscilloscope (recommended by HEIDENHAIN!)

.

Available functions

The PWM 9 functions consist of the PWT MODE and the PWM MODE.

The most important functions of the PWM MODE:

- Display of phase angle and on-to-off ratio
- Display of scanning frequency
- Measurement of signal amplitude, current consumption and supply voltage of the encoder
- Display of internal universal counter and of encoder signal periods (pulse count)
- Display of reference signal, fault-detection signal and counting direction
- Output of amplified output signals (interface boards: 11 µApp, 1 Vpp) or of original output signals (expansion boards: TTL, HTL) via 3 BNC sockets (e.g. on an oscilloscope).

The most important functions of the PWT MODE:

Graphic bar display of ...

- Signal amplitude
- Signal quality
- Width of reference signal
- Position of reference signal

Note

Every **PWM 9** is delivered with a detailed **User's Manual**.
It also describes the cables and adapters that are required for the wiring.
This User's Manual is available on the Internet in German and other languages and can be downloaded from www.heidenhain.de/...
During our **training courses on measuring systems** or special **PWM 9 trainings** the PWM 9 is explained in detail.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the PWM 9 correctly and efficiently.
Contact HEIDENHAIN Traunreut or your regional agency.

14.8 Testing unit PWT 18

Brief description

- The **PWT** phase angle test unit is a mounting and adjusting aid for the **scanning heads of exposed incremental encoders**.
  However, it is also possible to check **signals** (A track, B track, reference mark) of **motor encoders**.
- For HEIDENHAIN motor encoders, the PWT 18 is used for 1 Vpp signals (ID 325413-xx).
- The PWT 18 **cannot** be connected between motor encoder and control in series.
  The motor encoder can hardly be checked at "Operating speed".
- It is connected to the PWT 18 and is powered by this unit. The encoder or the motor must be rotated externally (e.g., manually).
- The signal amplitude is also measured when the encoder has stopped.
- For a detailed assessment of the signal quality, an inspection of the motor encoder with the PWM 9 is recommended.

Available functions

With the PWT the …

- Signal amplitude
- Signal quality
- Width of reference mark
- Position of reference mark ... can be shown in a display.

> Note
>
> Every **PWT** is delivered with **operating instructions**.
> These instructions are available on the Internet in German and other languages. They can be downloaded from www.heidenhain.de/...
> A detailed explanation of the PWT is part of our **training courses on measuring systems**.
> We recommend that you participate in a HEIDENHAIN service training course so that you can use the PWT correctly and effectively.
> Contact HEIDENHAIN Traunreut or your regional agency.

14.9 IK 215 adjusting and testing package

- The IK 215 is a **hardware platform for the HEIDENHAIN ATS Software** (Adjusting and Testing Software).
- The above package currently has the ID 547858-01.
- The IK 215 is an adapter card for PCs (PCI bus) for inspecting and testing absolute HEIDENHAIN encoders with EnDat or SSI interface.
- The incremental signals of encoders are also displayed.
- With the SA 100 service adapter, the IK 215 can be connected **in series between encoder and control**.
  Inspections at "operating speed" are possible.
- Parameters (e.g. datum shift), the electronic ID label and OEM information can be read and written via the EnDat interface.

Note

The **IK 215 Adjusting and Testing Package** is delivered with detailed **operating instructions**.
These instructions are also available on the Internet in German and English at www.heidenhain.de/...
A detailed explanation of the **IK 215 Adjusting and Testing Package** is part of our **training courses on measuring systems**.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the IK 215 Adjusting and Testing Package correctly and efficiently.
Contact HEIDENHAIN Traunreut or your regional agency.

14.10 PWM 20 encoder diagnostic kit

- Like the IK 215, the **PWM 20** phase angle measuring unit is a **hardware platform for the HEIDENHAIN ATS software** (adjusting and testing software).
- The above kit currently has the ID 759251-01.
- The PWM 20 can directly be connected to a PC or laptop via the **USB interface**.
- It serves to inspect and test HEIDENHAIN absolute encoders with EnDat or SSI interface.
- The incremental signals of encoders are also displayed.
- With the SA 100 service adapter, the PWM 20 can be connected **in series between encoder and control**.
  Inspections at "operating speed" are possible.
- Parameters (e.g. datum shift), the electronic ID label and OEM information can be read and written via the EnDat interface.

Note

The **PWM 20 encoder diagnostic kit** is delivered with detailed **operating instructions**.
These instructions are also available on the Internet in German and English at www.heidenhain.de/...
A detailed explanation of the **PWM 20 Encoder Diagnostic Kit** is part of our **training courses on measuring systems**.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the PWM 20 correctly and efficiently.
Contact HEIDENHAIN Traunreut or your regional agency.

15 Annex: Functional principles

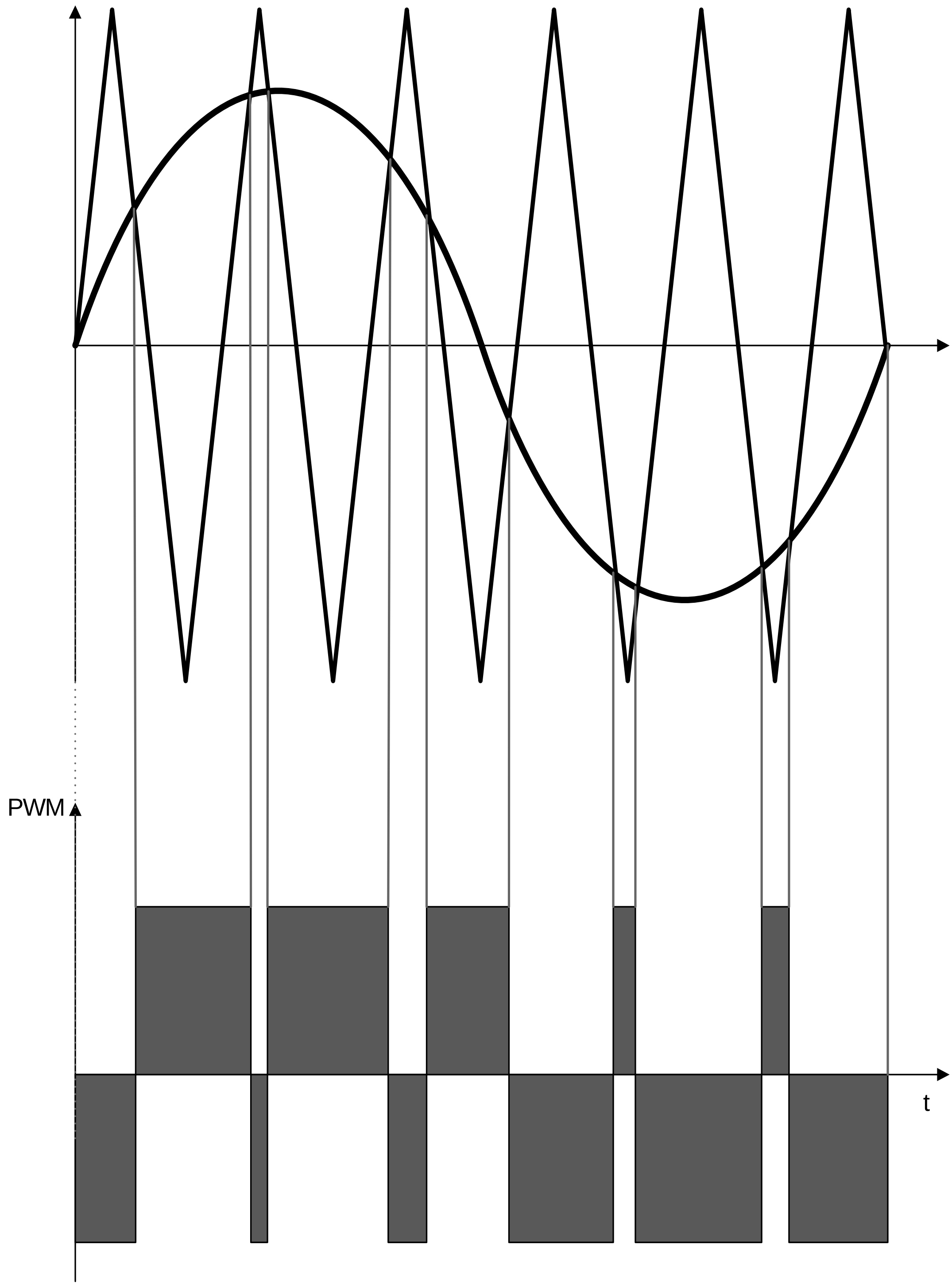
15.1 PWM signals

Digital axes and spindles are driven with PWM signals.

PWM is the abbreviation of **"Pulse Width Modulation"**. The information (speed, torque) for the output stages is converted into a pulse and pause ratio.

The PWM signal is generated in the HEIDENHAIN control and is transferred to the inverter via PWM interfaces.

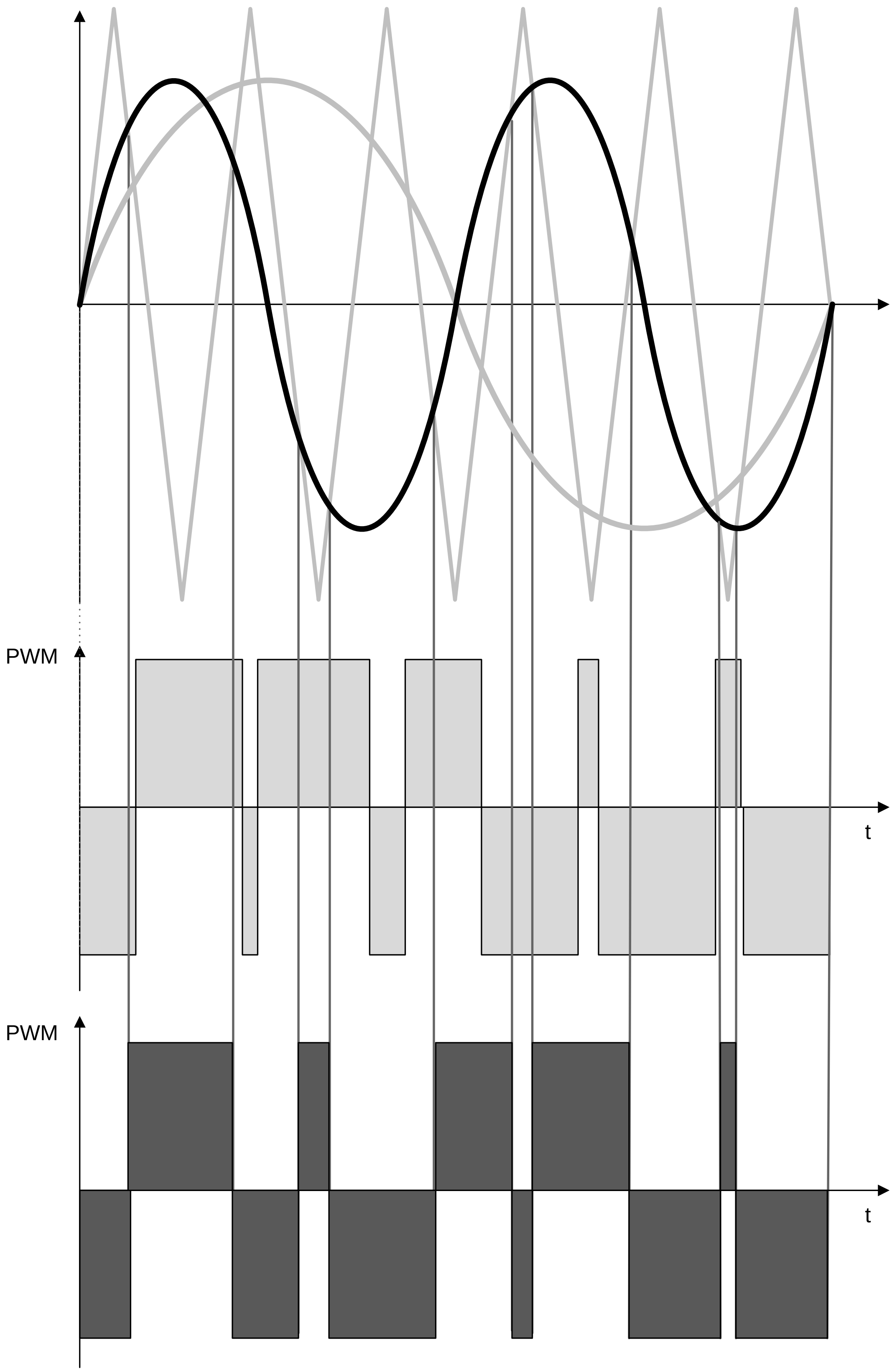
Schematic display of the PWM creation



The output signal of the current controller is compared to a delta voltage (e.g., 5 kHz fixed frequency) to create the PWM signal. At each touch point of the current controller signal and the delta voltage there is a switchover from pulse to pause.

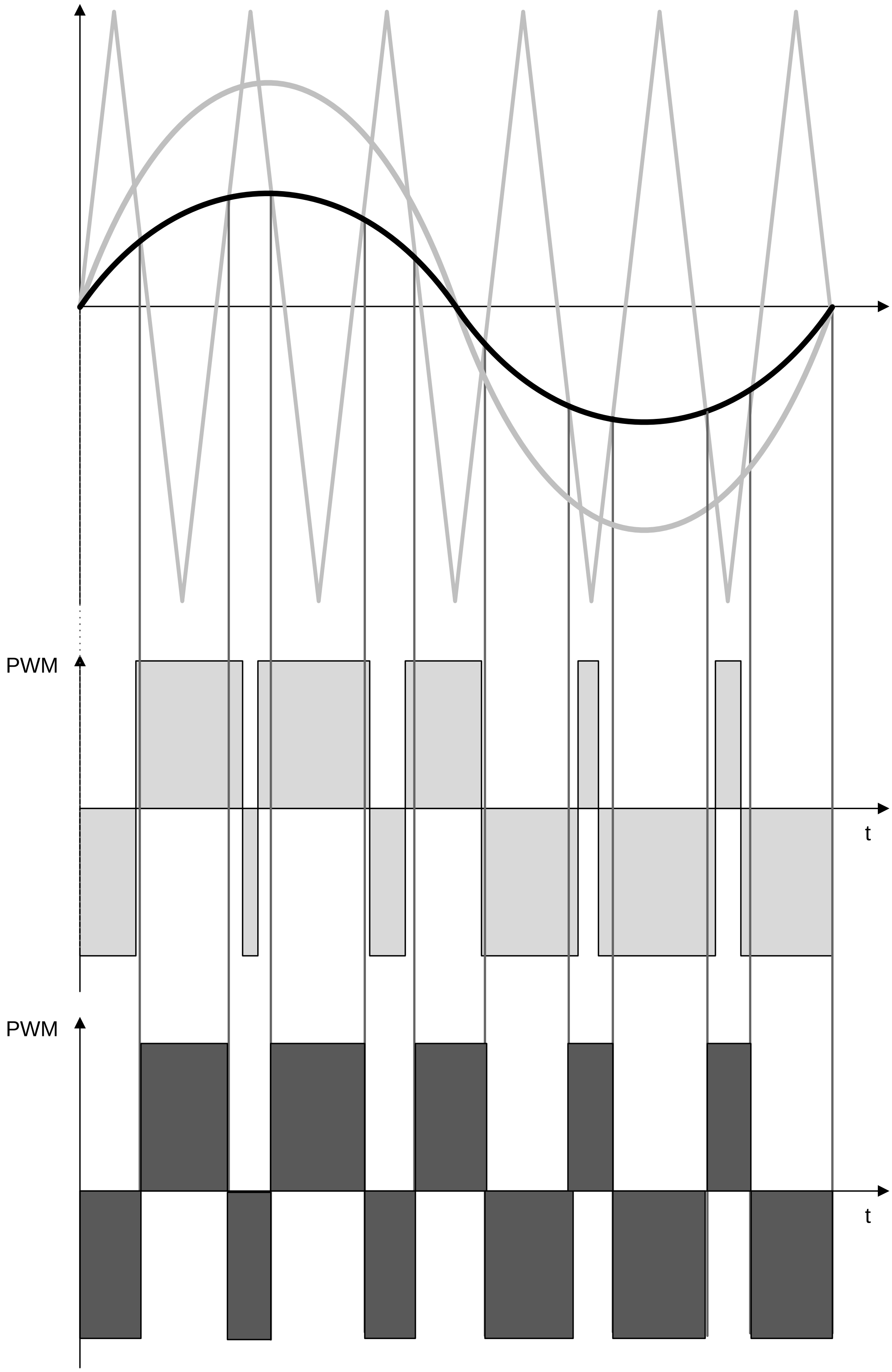
Change of the motor speed

"Scanning" a signal with higher frequency (higher motor speed) effects a more frequent change of pulses and pauses.



Change of the motor torque

"Scanning" a signal with a lower amplitude (lower motor torque) results in a smaller difference between pulses and pauses.



An infinitely small or a missing signal "intersects" the scanning triangular signal in the zero line.
This effects a ratio of pulse to pause of 50:50.
The torque on the motor is zero.

15.2 HEIDENHAIN inverter systems

The inverter systems from HEIDENHAIN are suitable for the HEIDENHAIN controls with digital speed control.
They are designed for operating the synchronous and asynchronous motors from HEIDENHAIN.

HEIDENHAIN offers:

- **Modular inverter systems**
- **Compact inverter systems**
- **Controller units with integrated inverter**

A modular inverter system consists of a power supply unit (UV, UVR) and mostly of several power modules (UM).

A compact inverter (UE, UR) combines the power supply unit and the axes or spindle output stages in one unit.

A controller unit with integrated inverter (UEC, UMC) combines the drive-control board and the axes or spindle output stages in one unit.

HEIDENHAIN also distinguishes between:

- **Regenerative inverter systems**
- **Non-regenerative inverter systems**

The regenerative inverters include all URs, the UV 120, the UV 140 and all UVRs.
The braking energy of motors is fed back into the line power.
Regenerative inverter systems are always operated together with a **commutating reactor** and a **line filter**.
The DC-link voltage is **650 Vdc**.

The non-regenerative inverters include all UEs, the UV 130 and the UV 130 D and the UECs / UMCs.
The braking energy of motors is converted into heat.
Non-regenerative inverter systems are always operated with one or several **braking resistors**.
The DC-link voltage is **565 Vdc**.

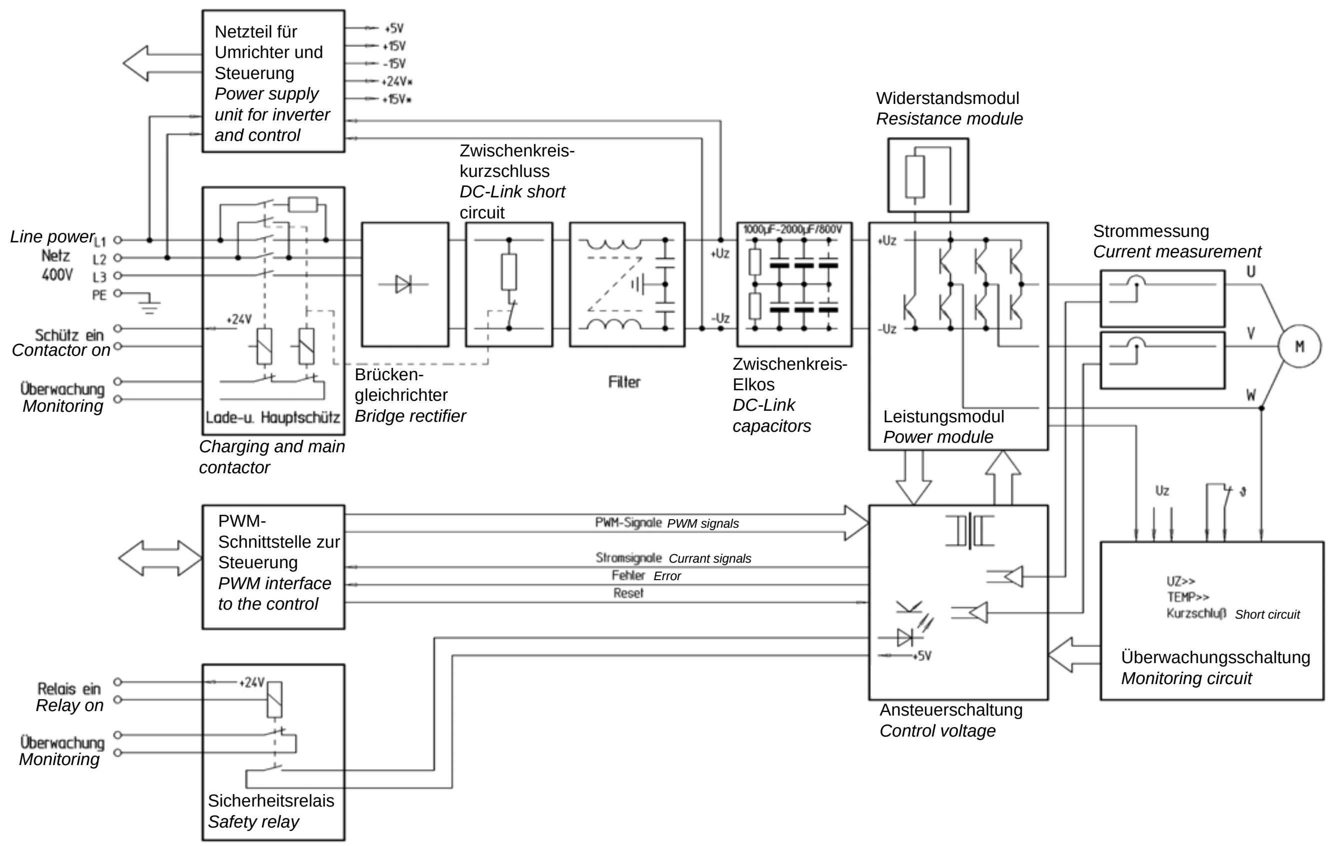
The current or speed controller has not to be set on HEIDENHAIN inverters (this is made in the HEIDENHAIN control).
Their function is **to power the motors** and thus the machine.

An inverter system first generates a **DC-link voltage** from a **line voltage** and from this DC link voltage a **three-phase motor voltage** with variable frequency and voltage/current.

The **speed** and the **torque of three-phase ac motors** is controlled by means of an inverter.

Current inverters with the designation "D" feature an **electronic ID label**. See “Electronic ID label for inverters” on page 13 - 404.

Block diagram



The inverter is connected to a 400 V three-phase line power. The fuses are located outside of the inverter.

Charging and main contactor

The line voltage is switched via two contactors. The charging contactor charges the DC-link capacitors via a dropping resistor.
The time-delayed main contactor transmits the entire line power after the loading process. The perfect condition of the contactors is monitored by normally closed contacts lead to the outside.

Bridge rectifier

By rectifying the line voltage (alternating voltage), direct current (DC-link voltage Uz) is generated in non-regenerative inverters. The rectifier operates in the B6 bridge circuit. The result is a direct voltage of 565 Vdc at a line voltage Ueff = 400 Vac.

Infeed regenerative module

In regenerative inverters from HEIDENHAIN, the DC-link voltage Uz is controlled with an infeed/ regenerative module (650 Vdc). Regenerative inverters must be connected to the line power via a **commutating reactor**. The commutating reactor serves as a power storage device for the infeed/ regenerative module. Only thus the DC-link voltage can be adjusted up to 650 Vac. The electromagnetic compatibility (EMC) requires a special **line filter**.

Power supply unit

A power supply unit integrated in the inverter supplies the electronics of the inverter system and the control. The power supply unit is powered by the DC-link voltage and from the line power.

The DC-link voltage is buffered with capacitors. Motors that are braked, feed the energy to the DC-link as generators.

Therefore, the DC-link voltage still supplies sufficient energy to brake all axes and the spindle, even in the event of a sudden power failure.

The power supply unit is additionally powered by the line power as there is no DC-link voltage available when it is switched on.

Power modules

The DC-link voltage supplies all power modules. IGBT modules are used as power modules that include a braking transistor in addition to the bridge transistors. Furthermore, the transistor drivers and a short-circuit and excessive temperature monitoring are included.

Braking resistor (resistance module)

When braking three-phase ac motors, the kinematic energy is converted into electrical energy. Thus the DC-link voltage increases. To convert dangerous excessive voltage into heat, a braking resistor is connected to the DC-link via an IGBT if a certain voltage is exceeded. The DC-link voltage is measured with a potential devider and an isolating amplifier.

Current measurement

The currents of the motor phases U and V are measured with two current sensors and are supplied to the control as inverted signals. The third phase current can be determined arithmetically.

Potential divider

The integral potential deviders measure the following:

- DC-link voltage
- Phase voltage

Uz monitoring

The DC-link voltage is "observed" in a monitoring circuit. If it exceeds the limit value, all inverter axes are switched off so that another voltage rise is prevented. A defective braking resistor or an excessive braking power can be the reason for an excessive DC-link voltage. The heat sink temperature is also monitored and if it is too high, this is reported to the control. There is an additional monitoring that recognizes the short circuit of an IGBT and switches off the inverter.

Triggering

The controlling and metallic isolation of the gate drivers is realized via optocouplers.

Safety relay

The supply voltage of the optocouplers is lead via a safety relay so that an unintended triggering of the power switch can be prevented. The safety relay is triggered from outside. The proper condition of the relay is checked via a normally closed contact that is lead to the outside.

EMC

The following measures serve to meet the EMC regulations:

- Capacitors between the power input and housing
- Capacitors between the individual mains phases
- Current compensated toroidal core reactor. This reactor features two windings that are wired such that the go-and-return current compensates the magnetic field of the coil. Thus the coil is not saturated. Current-compensated reactors are used to suppress the common-mode interference.
- Two capacitors between DC-link and housing
- Toroidal cores in the motor lines. They influence common-mode interferences, especially in the upper frequency range (approx. as of 1 MHz).

Accessories

You can find short explanations on other inverter components, such as ...

- Three-phase capacitor
- DC-link filter
- Voltage-protection module
- Adapter module
- Axis-enabling module
- Braking resistor module
- Capacitor module

... in chapter “Overview of components” on page 11 – 273

15.3 HEIDENHAIN motors

15.3.1 Introduction

HEIDENHAIN offers **three-phase ac motors** for the control of digital axes and spindles (PWM signals).

These include ...

- Synchronous motors (QSY)
- Asychronous motors (QAN)
- Linear motors
- Torque motors

For driving three-phase ac motors energy must be supplied.
When braking three-phase ac motors during operation, they supply energy.

HEIDENHAIN motors are equipped with **HEIDENHAIN motor encoders**.
Synchronous motors either feature a conventional **motor encoder with 1 Vpp signal and Zn/Z1 track** or an **EnDat encoder with absolute value output**.
Asynchronours motors normally feature a conventional encoder with **1 Vpp signal and Zn track**.
The **speed measurement** and, if required, the position measurement is performed with motor encoders.

Current **motors with EnDat encoder** feature an **electronic ID label**.
See “Electronic ID label for motors” on page 13 - 407.

At least one **temperature sensor** is integrated in each motor.
The **temperature signal** is normally transmitted **to the control via the motor encoder cable**.

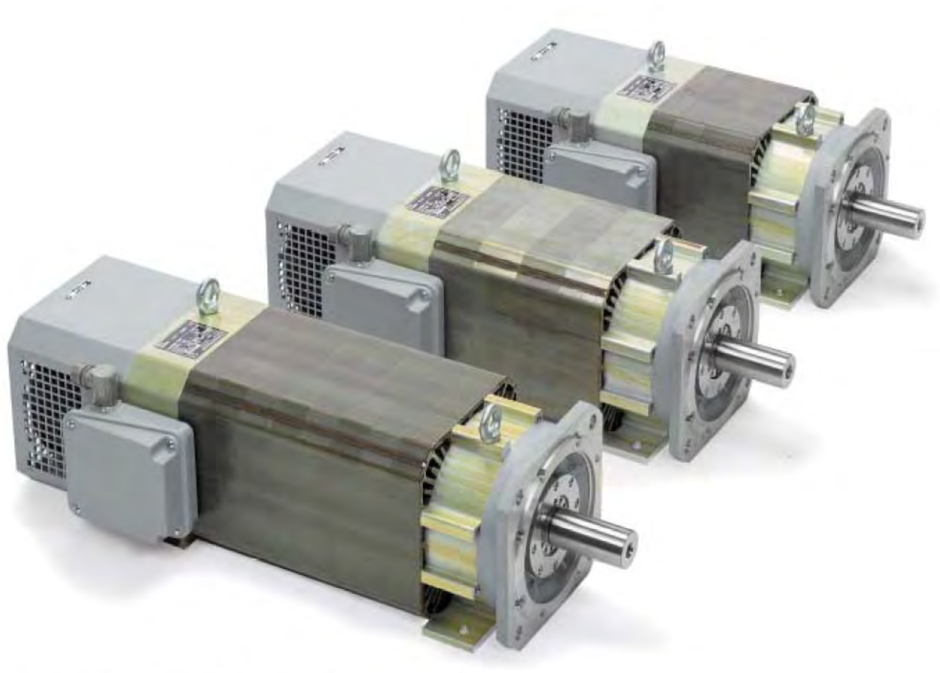
Many axis motors are equipped with a **brake**.
The control lines for the brake are normally lead **via the power cable**.

15.3.2 Asynchronous motors

In contrast to dc motors, asynchronous motors do not include a collector (circuit changer or commutator) and carbon brushes. Asynchronous motors are very durable since the rotating part consists of a single piece of metal. In most conventional asynchronous motors, the rotating part is made of a steel core with slots.

The generation of induced current in an asynchronous motor requires a relative motion between the rotating field and the secondary conductor. This means that the rotor does not reach the same speed as the field (slip).

For asynchronous motors the terms **"cage motor"** and (depending on the design) **"squirrel cage motor"** have also formed.



Asynchronous motors for spindles

Advantage of **asynchronous motors**:

- Very durable motors, long service life
- Can be overstrained heavily for a short time
- High speed can be reached quickly.

HEIDENHAIN uses asynchronous motors **for spindles**.

HEIDENHAIN spindle motors are equipped with fans.

These motors are also available in hollow-shaft design for the internal cooling of tools.

15.3.3 Synchronous motors

In synchronous motors, the moving part (rotor) consists of a configuration of permanent magnets or of electromagnets which are supplied with direct current. The magnetized rotor ensures that the rotor speed does not change even under fluctuations of load. There is no slip in a synchronous motor.

Synchronous motors for feed drives

Advantage of **synchronous motors**:

- Very good speed stability
- Smaller mass moment of inertia
- Better dynamics
- Better efficiency
- Slimmer structural shape

HEIDENHAIN uses synchronous motors **for machine axes**.

Rotational speed

The speed of a synchronous motor depends on the alternating frequency of the three-phase line power (50 Hz) and on the number of pole pairs. If the rotor consists of one pole pair and the rotating field rotates by 360° during one period, a motor speed of 50 revolutions per second (3000 rpm) is achieved. If the number of pole pairs is doubled, the rpm is halved. When connected to the three-phase line power, the possible synchronous motor speeds are thus 3000 rpm, 1500 rpm (3000:2), 1000 rpm (3000:3), 750 rpm (3000:4), 600 rpm (3000:5), etc.

When using these motors in machine tools, a stepless control of the motor speed is required (from 0 to partly more than 3000 U/min). This can be accomplished by changing the speed (frequency) of the rotating field. Controlled inverter circuits serve as the frequency converters.

Motor control

HEIDENHAIN synchronous motors are controlled according to the following principle:

The field strength of the rotating field is the controlled variable. The flux lines hit the rotor at a 90° angle. The position of the rotor is known through the rotary encoder. The strength of the field determines the speed of rotor rotation (as in a dc motor). The rotating field is adjusted (by an actuating circuit) in such a way that the flux lines always hit the rotor at a 90° angle. In this way, the frequency of the stator field windings equals the rotor frequency.

15.3.4 Linear motors

Linear motors do not effect a rotating but a linear movement. The exciter windings of the stator are located in a plane; the rotor is "pulled" by the magnetic field that is moving longitudinally.

The term **"direct drive"** is also commonly used for linear motors.

Advantage of linear motors:

- Very high dynamics (high accelerations and traversing speeds)
- High accuracy

Linear motors are used for linear machine axes.

15.3.5 Torque motors

Torque motors are directly driven rotating motors.
They consist of a stator and rotor with magnet (permanent or separate-excited), i.e., they operate on the principle of synchronous motors.

Torque motors reach torques of several thousand Nm. This is normally achieved with an immobile stator that transmits the torque directly to the rotor via the clearance in the same way as with linear motors. Therefore, mechanical transfer elements (such as gears) are not required and the inaccuracies they cause are avoided.

Furthermore, the torque motor permits a nearly maintenance-free and wear-free operation. It ensures a high accuracy and dynamics when it is used for positioning and also on the contouring control.

Advantage of torque motors:

- Very high torque
- High dynamics
- High accuracy

Torque motors are mainly used for rotary axes (e.g. rotary tables).

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D

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V

W

HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Germany
☏ +49 (8669) 31-0
FAX +49 (8669) 5061
E-mail: info@heidenhain.de

www.heidenhain.com

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E-mail: service.nc-support@heidenhain.de

PLC programming TNC
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E-mail: service.plc@heidenhain.de

TNC programming
☏ +49 (8669) 31-3103
E-mail: service.nc-pgm@heidenhain.de

Measuring systems / machine measurement
☏ +49 (8669) 31-3104
E-mail: service.ms-support@heidenhain.de

Lathe controls
☏ +49 (86) 31-3105
E-mail: service.hsf@heidenhain.de

Service order processing
Domestic team
☏ +49 (8669) 31-3121
Foreign team
☏ +49 (8669) 31-3123
E-mail: service.order@heidenhain.de

Service coordination
Complaints and returned goods team
☏ +49 (8669) 31-3135
E-mail: service.order@heidenhain.de

Documentation
E-mail: service.docu@heidenhain.de

Technical training
☏ +49 (8669) 31-2293, 31-1695
FAX +49 (8669) 31-1999
E-mail: mtt@heidenhain.de