HEIDENHAIN

Service Manual

Inverter Systems and Motors

June 2008

1 Safety Precautions

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 knowledge and competence!

1.2 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.

Caution

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.

1.3 Please Observe:

DANGER

Ensure that the equipment grounding conductor is continuous!
Interruptions in the equipment grounding conductor may cause damage to persons or property.

DANGER

Ensure that the main switch of the machine is switched off and that connected devices are not under power when you engage or disengage any connecting elements or connection clamps.
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!

DANGER

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

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.

Caution

HEIDENHAIN assumes no liability for indirect or direct damage caused to persons or property through incorrect use or operation of the machine.

Caution

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

DANGER

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

DANGER

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

1.4 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!

1.5 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 (open of terminal box, make or break connections) while it is under power.

Caution

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.

Caution

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 functioning of your motor in the operating instructions that accompany each unit.

2 How to Use this Service Manual

2.1 About this Manual

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

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 of June 2006).

Note

If you need information on linear and torque motors, please 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
- Lathe controls: MANUALplus 4110, MANUALplus M, CNC PILOT 4290

Among other things, the Service Manual contains:

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

The "Overview of Possible Errors" on page 14 includes many references to troubleshooting descriptions. You will find these descriptions in the chapters of the Service Manual sorted by topics.

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

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

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

Udpate service

This Service Manual is updated at irregular intervals.
You find the current printable version on our website –>
www.heidenhain.de
A zip file can be downloaded. This zip file can be unzipped with a password. Your receive this password during a HEIDENHAIN service training course or upon request by telephone!

Printed copies of the manual (ring binders) are only distributed to the participants of our service training courses.

2.2 Further Service Manuals

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

2.3 Other Documentation

In the following documents you find further important information:

- Machine documentation by the manufacturer
  (circuit diagrams, wiring diagrams, machine operation manual, etc.)
- User's Manuals for HEIDENHAIN controls
- TNCguide (DVD)
- HEIDENHAIN mounting instructions
- Brochures of the respective HEIDENHAIN products
- PWM 9 Operating Instructions

Note

Current HEIDENHAIN documentation can be obtained fast from our website. -->
www.heidenhain.de

2.4 Support

Caution

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

Support will, however, also be provided by the HEIDENHAIN service department and agencies.

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

2.5 Service Training Seminars

HEIDENHAIN Traunreut offers service training seminars in German. We recommend the HEIDENHAIN Service Training Seminars for iTNC 530 for the technician who works with this Service Manual.
Please inquire at HEIDENHAIN Traunreut or go to our website at www.heidenhain.de/Services/Training.

Note

If required, please inquire at the HEIDENHAIN subsidiary in your country whether Service Training Seminars are offered in your language.

2.6 Safety

Danger

It is extremely important that you read the safety precautions in chapter 1!
See “Safety Precautions” on page 7.

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.

Static and nonstatic errors

Errors can also be defined in the categories of static errors (e.g., interruption in the electrical cabinet, defective unit) and nonstatic errors (e.g., loose connection, shielding problems, interferences).
Naturally, static errors can be found more easily.

Sporadic and nonsporadic errors

Check whether you can reproduce a certain error on the machine at any time (nonsporadic error).
This assists you in troubleshooting.
Integrated diagnosis tools in the control (e.g.,. an integrated log, a PLC logic diagram or an integrated oscilloscope) can be used for the investigation of sporadic errors.

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	**Error causes**	**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, damages cable, etc.) ■ Is there a smell of burning? ■ Measure ground faults and short circuits, see respective descriptions in this manual ■ Replace inverters, motors, cables, accessories that are obviously defective
When hooking up axes, an "overcurrent" error message is generated	■ Motor coil fault ■ Short circuit in the motor 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 – 50 ■ Check the motor for a short circuit ■ Check the voltage protection module for a short circuit--> See “Inspection for Short Circuit” on page 8 – 155 ■ Check power modules and end stages for short circuits --> See respective descriptions in this manual ■ Replace inverters, motors, cables, accessories that are obviously defective
The control generates error messages regarding the motor current (e.g., No motor current, Motor current too high)	■ Motor defective ■ Motor cable defective ■ Inverter defective ■ Conductor bars for the dc-link not tightened sufficiently	■ Check the motor --> See “Troubleshooting on Motors” on page 6 – 45 ■ Check the motor for a short circuit ■ Check power modules and end stages --> See respective descriptions in this manual ■ Check the voltage protection module for a short circuit--> See “Inspection for Short Circuit” on page 8 – 155 ■ Tighten conductor bars with 3.5 Nm ■ Replace inverters, motors, cables, accessories that are obviously defective

Error	Error causes	Measures for error diagnosis and/or corrective action
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 ■ 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 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
The dc-link voltage U_z 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 power supply for outputs 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 HEIDENHAIN control
Axes cannot be traversed.	■ Drive release missing ■ Inverter system is not ready for operation	■ See service manual of the respective HEIDENHAIN control ■ Check whether the inverter system is ready
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 has locked up. The main switch has to be switched off and on again. After reset of the control **"Power fail Interrupt!"** is entered in the log of new software versions.	■ Power failure ■ Failure of one or several phases in the supply line ■ The power supply voltage has fallen below the minimum value ■ 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
"Vibrating" axes, sometimes connected with loud noises. and/or Various error messages are generated which, however, are not substantive.	■ Poor shielding or grounding ■ Connection (short circuit) of shielding potential (chassis, cable shielding) with 0V voltage potential of the NC power supply ■ Connectors on grounding terminal X131 of infeed/regenerative module (Simodrive 611D) not properly wired	■ Check the grounding of the machine --> Consult the machine manufacturer! ■ Ensure that all grounding clamps are secure ■ Check the cables for damage. ■ Check the shieldings, covers, etc. ■ Check the groundIng in connection with the used HEIDENHAIN expansion boards, See "Error Diagnosis on the Inverter System" on page 7 – 67

Error	Error causes	Measures for error diagnosis and/or corrective action
When braking axes and spindles, the motors suddenly coast out of loop to a stop.	■ Defective braking resistor (conversion of electrical energy to 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 – 140 ■ 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.	■ 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.
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 3 – 22
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 3 – 22
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 3 – 22

3.3 Important Notes on the Use of HEIDENHAIN Expansion Boards in the SIMODRIVE System

Version with D-sub connector

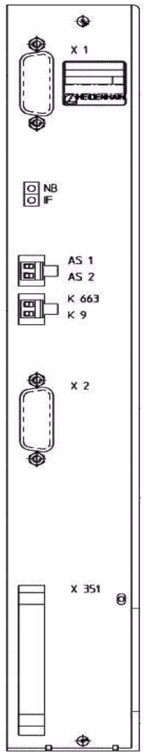
HEIDENHAIN expansion boards for the SIMODRIVE system in the version with D-Sub connector are available **with or without metallic insulation** of HEIDENHAIN PWM signals to the Siemens interface.

<table>
<tr>
<td>
Expansion boards without metallic insulation are recognized 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 front panel.

■ These board have the Id.Nr. 291070-01, 324952-01, -02, -03 and -10 without index A.
</td>
<td>


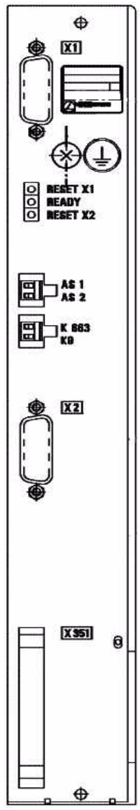
</td>
</tr>
</table>

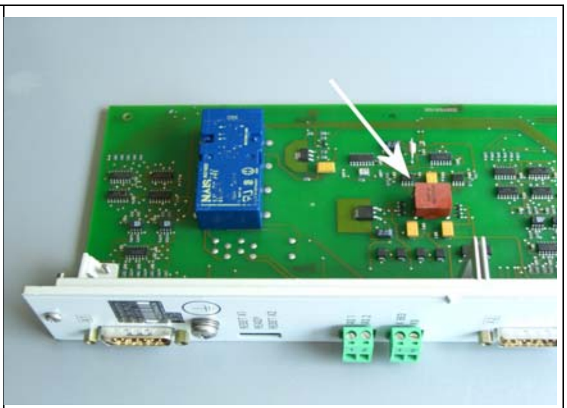
Caution

The terminal X131 of the Siemens E/R module of boards without metallic insulation may not be connected to the central signal ground of the machine!

Note

The HEIDENHAIN expansion boards of the first generation were built without metallic insulation.

Expansion boards **with metallic insulation** 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 front panel. ■ These boards have the Id.Nr. 324952-10 with index A, -11, -12, ...	

Transformer component on the board	
Grounding screw on the front panel	

Caution

The terminal X131 of the Siemens E/R module of boards with metallic insulation must be connected to the central signal ground of the machine!

Caution

Expansion boards **with and without metallic insulation** may **not be used together**! Either all boards have a metallic insulation and X131 is wired or all boards do not have a metallic insulation and X131 is not wired!

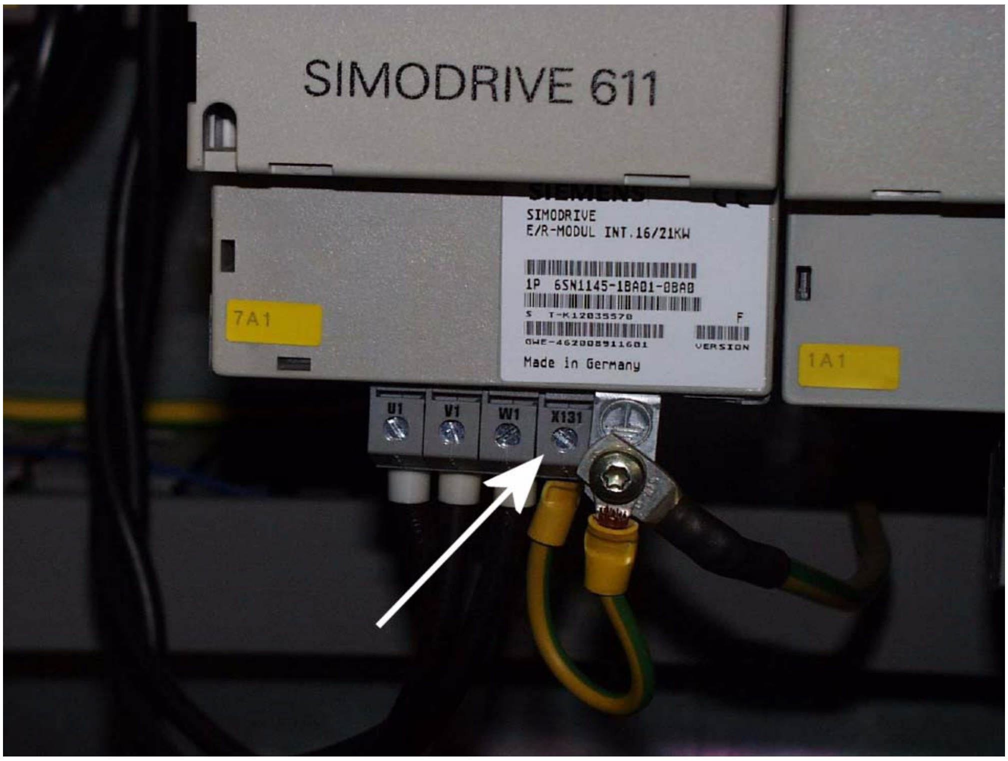


Photo: Siemens E/R module with X131

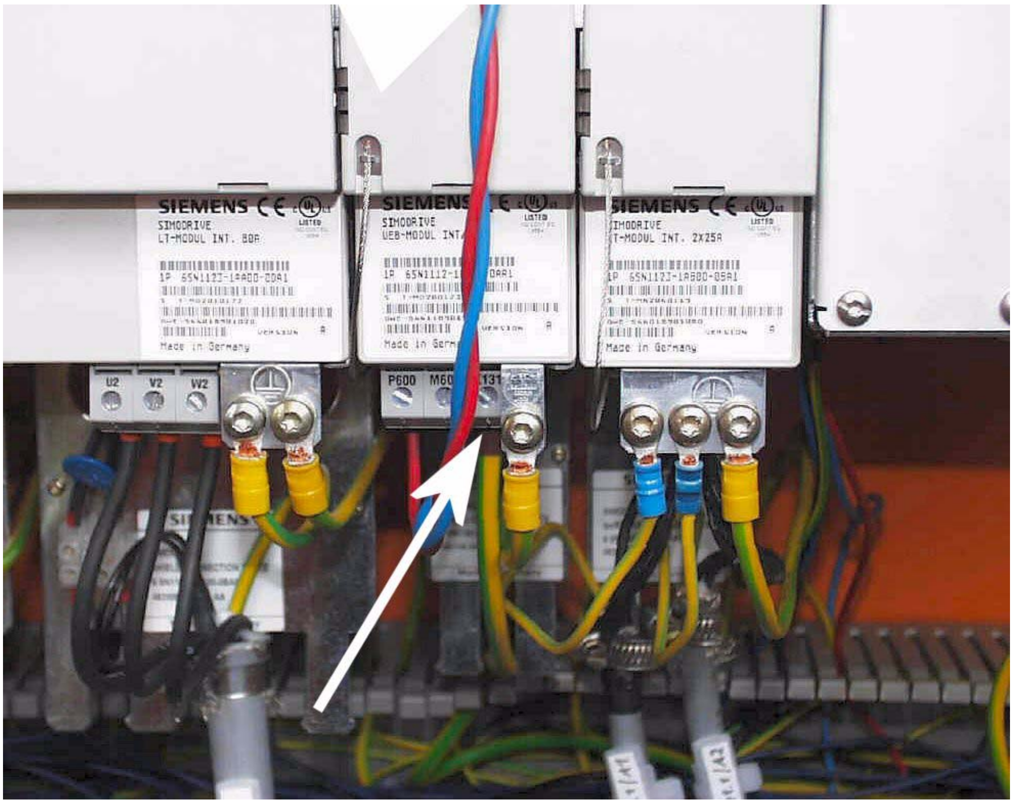


Photo: Siemens UEB module with X131

Caution

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!

Version with ribbon cable connector

HEIDENHAIN expansion boards for the SIMODRIVE system in the version with ribbon cable have a metallic insulation of the HEIDENHAIN PWM signals to the Siemens interface.

Thus X131 of the Siemens drive system must be wired!

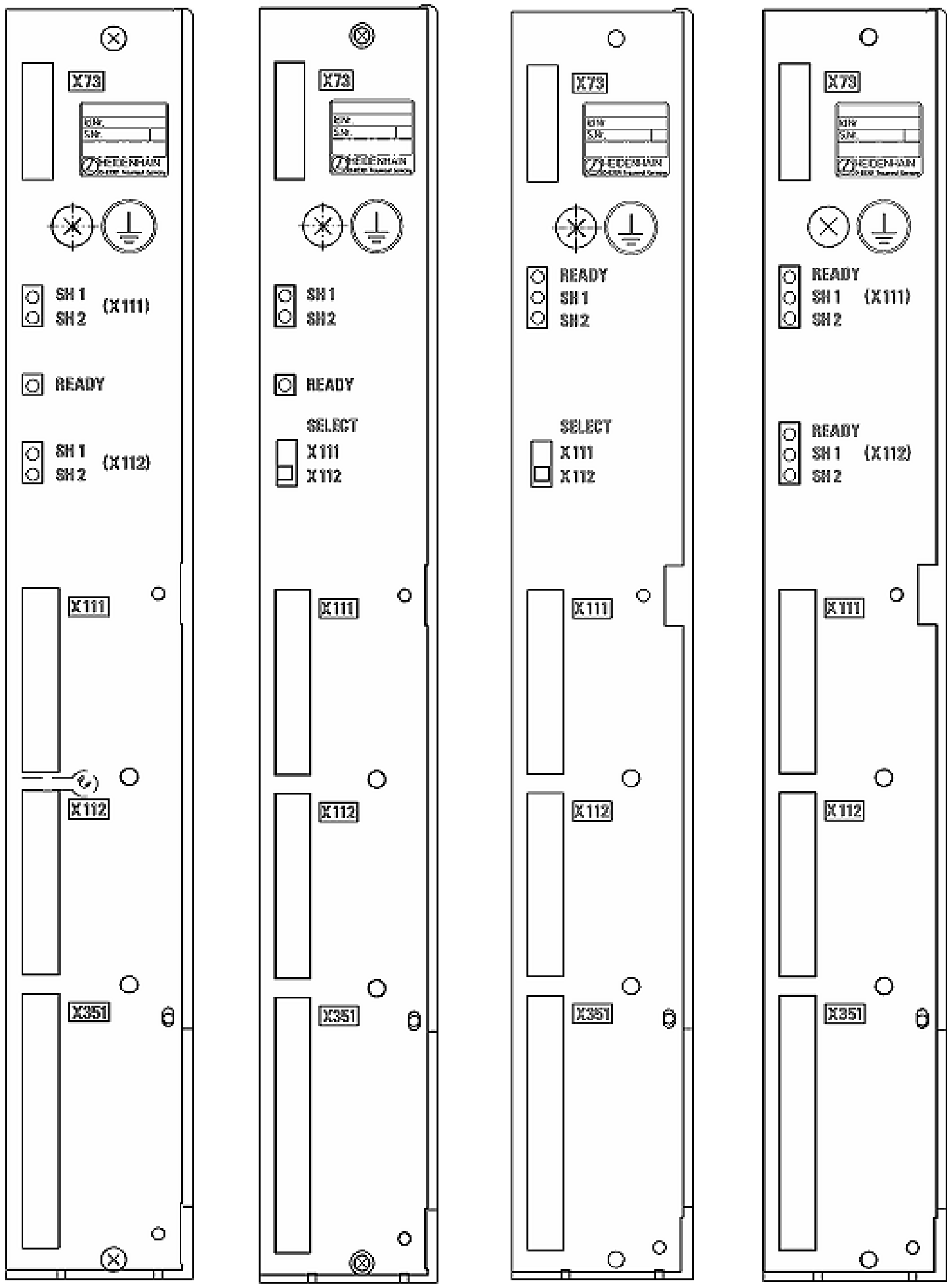


Figure: Various HEIDENHAIN expansion boards with ribbon cable connectors

Compatibility of HEIDENHAIN expansion boards to SIMODRIVE power modules

SIEMENS has already improved the SIMODRIVE power modules.
Among other things the interference suppression circuits have been supplemented.
The HEIDENHAIN expansion boards suitable for the modified SIMODRIVE power modules have also been improved:

Modified SIMODRIVE power modules	**Suitable 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-axis version, D-sub connector
	324952-12, index D	2-axis version, D-sub connector
	324955-17	1-axis version, ribbon-cable connector
	359002-05	2-axis version, ribbon-cable connector
	515012-03	1-axis version, ribbon-cable connector

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.

Caution

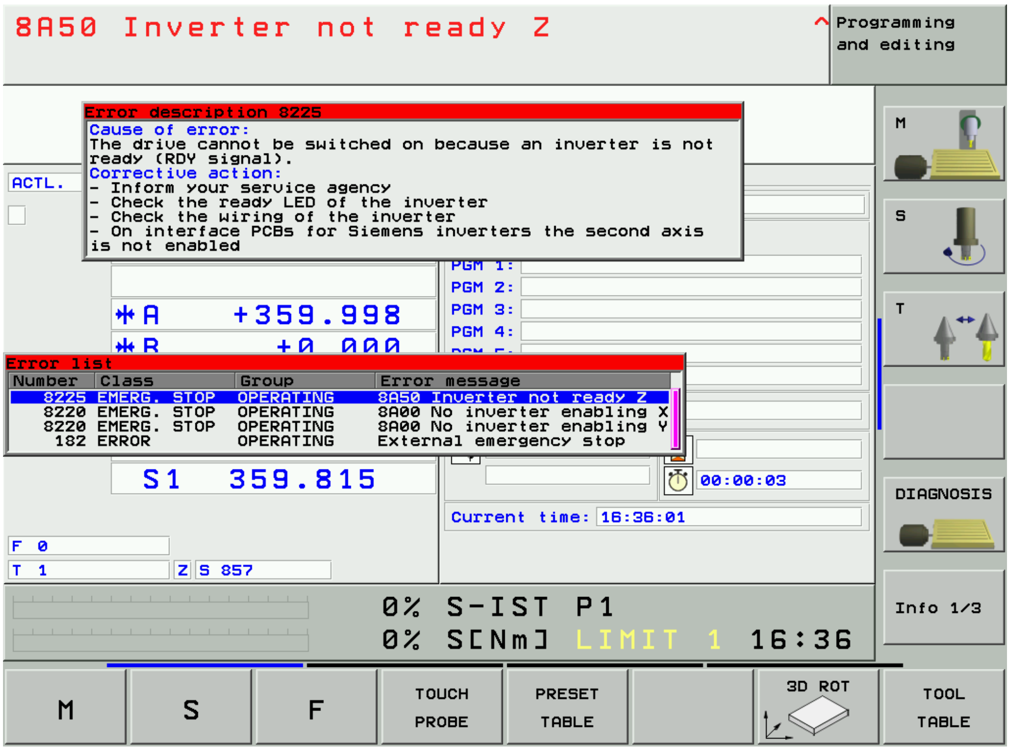
"Older" HEIDENHAIN expansion boards may not be operated with modified SIMODRIVE power modules.
Possible errors and error messages --> See “Overview of Possible Errors” on page 3 – 14

3.4 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 motor 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

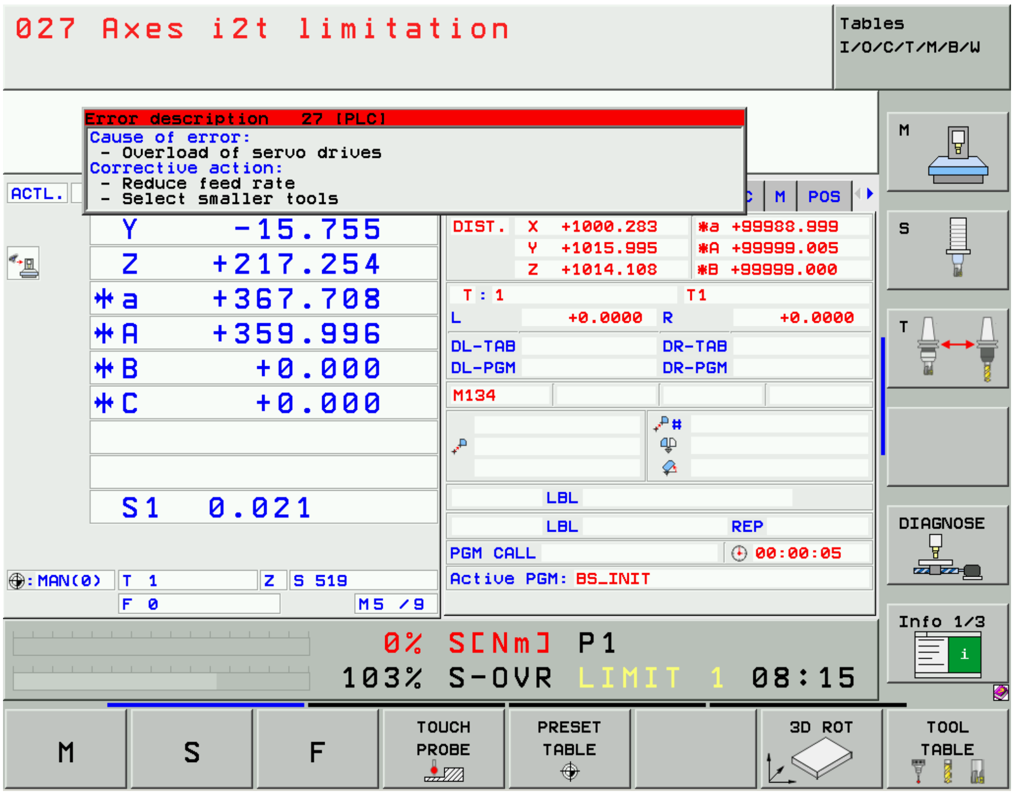
HEIDENHAIN has defined NC error messages. You can find the complete list of all NC error messages for TNC controls on the **TNCguide DVD** in several languages and sorted by error numbers. You find this TNCguide information on our website **www.heidenhain.de.**

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:

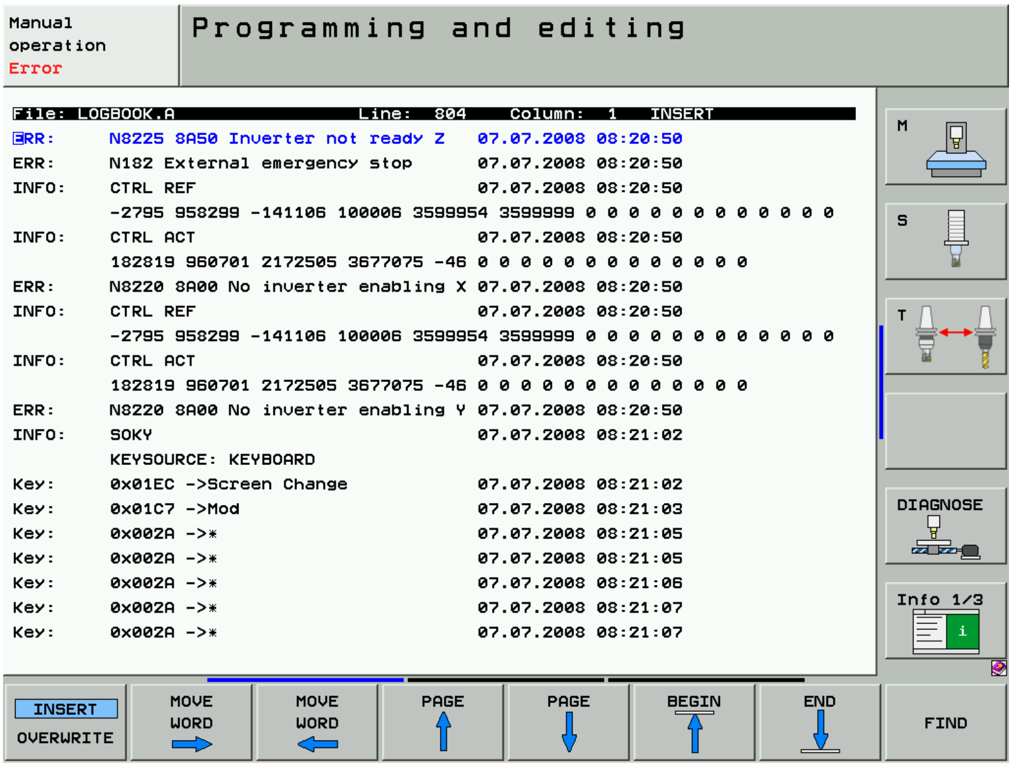


Log

HEIDENHAIN controls feature a log. Information on key strokes, error messages etc. are recorded in these logs.

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 Compact Inverters

On the front of the compact inverters are several LEDs for functional control, with the following meaning:

UE 1xx

LED	Meaning	Signal direction	Signal
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
SH1 (RED) RDY (GREEN)	Safe stop 1; no enable from control (main contactor not active, DSP error, PLC error with EMERGENCY STOP, hardware or software error of LE, CC) Axis/spindle enabled	LE, CC → UE UE → LE, CC	$\overline{\text{SH1B}}$ RDY
SH2	Safe stop 2; no drive enable from control (e.g. by the PLC, active via external signal or SH1)	LE, CC → UE	$\overline{\text{SH2}}$
PWR RESET	Reset signal from UE to LE, CC	UE → LE, CC	$\overline{\text{RES.PS}}$
READY	Inverter ready	UE → LE, CC	RDY
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 850 V); power modules are switched off	UE → LE, 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 → LE, CC	$\overline{\text{PF.PS}}$
NC reset	Reset signal from LE, CC to UE	LE, CC → UE	$\overline{\text{RES.LE}}$
TEMP >>	Temperature of heat sink too high (> 100 °C)	UE → LE, CC	$\overline{\text{ERR.TEMP}}$
X 71 SP.	Safety relay for spindle triggered	–	–
X 72 AXES	Safety relay for axes triggered	–	–

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 → LE, CC	$\overline{\text{ERR.UZ.GR}}$
TEMP >>	Temperature of heat sink too high (> 100 °C)	UE → LE, CC	$\overline{\text{ERR.TEMP}}$
AXIS FAULT	Short circuit between a phase of the motor output and U_Z (axes only)	UE → LE, 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 → LE, CC	$\overline{\text{PF.PS}}$
POWER RESET	Reset signal from UE to LE	UE → LE, CC	$\overline{\text{RES.PS}}$
AXIS/SPINDLE RESET	Axes/spindle disabled by LE	LE, CC → UE	$\overline{\text{SH2}}$
AXIS/SPINDLE READY	Inverter ready	UE → LE, 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 → LE, CC	RDY
X11x SH1	DSP error, PLC error with emergency stop, LE hardware or software error	LE, CC → UE	$\overline{SH1B}$
X11x SH2	No drive enable (e.g. by the PLC, active via external signal or SH1)	LE, CC → UE	$\overline{SH2}$
READY	Inverter ready	UE → LE, CC	RDY
POWER RESET	Reset signal from UE to LE	UE → LE, 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 → LE, CC	$\overline{PF.PS}$
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UE → LE, CC	$\overline{ERR.UZ.GR}$
TEMP >> (left)	Heat sink temperature too high for axis 4 and spindle (> 100 °C)	UE → LE, CC	$\overline{ERR}$
TEMP >> (right)	Heat sink temperature too high for axis 1 to axis 3 (> 100 °C)	UE → LE, CC	$\overline{ERR}$
NC reset	Reset signal from the LE to the UE	LE, 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 → LE, CC	RDY
X11x SH1	DSP error, PLC error with Emergency Stop, LE hardware or software error	LE, CC → UR	$\overline{SH1B}$
X11x SH2	No drive enable (e.g. by the PLC, active via external signal or SH1)	LE, CC → UR	$\overline{SH2}$
READY UV	Inverter ready	UR → LE, CC	RDY
POWER RESET	Reset signal from UR to LE	UR → LE, CC	$\overline{RES.PS}$
POWER FAIL	U_Z too low, U_Z < 410 V (because the main contactor is off, for example)	UR → LE, CC	$\overline{PF.PS}$
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UR → LE, CC	$\overline{ERR.UZ.GR}$
$I_{DC\ LINK}$ >>	I_Z > 52 A, warning signal to control at 58 A	UR → LE, CC	$\overline{ERR.IZ.GR}$
I_{LEAK} >>	Error current, e.g. through ground fault; warning signal to control	UR → LE, CC	$\overline{ERR.ILEAK}$
TEMP >> (left)	Heat sink temperature too high for axis 4 and spindle (> 100 °C)	UR → LE, CC	$\overline{ERR}$
TEMP >> (right)	Heat sink temperature too high for axis 1 to axis 3 (> 100 °C)	UR → LE, CC	$\overline{ERR}$
AC FAIL	Phase missing	UR → LE, CC	$\overline{PF.PS.AC}$
NC reset	Reset signal from the LE to the UR 2xx	LE, CC → UR	$\overline{RES.LE}$
AXES	Safety relay for axes triggered	–	–
SPINDLE	Safety relay for spindle triggered	–	–

Red LED SH1

The **SH1** signal (safe stop 1, red LED at the inverter) is generated by the main computer (MC) of the HEIDENHAIN control. The signal is low-active, i.e. line-break proof.
If the main computer is not ready for operation or if an error is pending, SH1 is output. The red SH1 LED and the green READY LED at the inverter can never be lit at the same time. They are mutually locked.

Red LED SH2

The **SH2** signal (safe stop 2, red LED at the inverter) is generated by the controller computer (CC) of the HEIDENHAIN control.
The signal is low-active, i.e. line-break proof.
If an axis or spindle is not controlled, SH2 is pending and the red LED is on.
This is for example the case with clamped axes or if a spindle is not controlled.
SH2 and READY are on simultaneously.

4.2 Power supply units

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

LED	Meaning	Signal direction	Signal
READY	End stage ready (only for service purposes)	–	–
RESET	Reset for end stage (only for service purposes)	–	–
TEMP >>	Temperature of heat sink too high (> 95 °C)	UV → LE, CC	$\overline{\text{ERR.TEMP}}$
$U_{DC\ LINK\ ON}$	Main contactor triggered	–	–
READY UV	Power supply unit is ready	UV → LE, CC	RDY.PS
POWER RESET	Reset signal from power supply unit to control	UV → LE, CC	$\overline{\text{RES.PS}}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. line power < 290 V)	UV → LE, CC	$\overline{\text{PF.PS}}$
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UV → LE, CC	$\overline{\text{ERR.UZ.GR}}$
$I_{DC\ LINK}$ >>	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 > 119.0 A UV 150: I_Z > 103 A UVR 150D: I_Z > 126 A UVR 160D: I_Z > 126 A UVR 160DW: I_Z > 126 A	UV → LE, CC	$\overline{\text{ERR.IZ.GR}}$
I_{LEAK} >>	Error current, e.g. through ground fault; warning signal to control	UV → LE, CC	$\overline{\text{ERR.ILEAK}}$
AC FAIL	Phase missing	UV → LE, CC	$\overline{\text{PF.PS.AC}}$
NC reset	Reset signal from control to power supply unit	LE, CC → UV	$\overline{\text{RES.LE}}$
AXES	Safety relay for axes triggered	–	–
SPINDLE	Safety relay for spindle triggered	–	–

a. A further increase of around 10% results in the drives being switched off.
This also applies for 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 is ready	UV → LE, CC	RDY.PS
POWER RESET	Reset signal from power supply unit to control	UV → LE, CC	$\overline{\text{RES.PS}}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. line power < 290 V)	UV → LE, CC	$\overline{\text{PF.PS}}$
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 760 V); power modules are switched off	UV → LE, CC	$\overline{\text{ERR.UZ.GR}}$
$I_{DC\ LINK}$ >>	Warning signal to control at I_Z > 75 A[a]	UV → LE, CC	$\overline{\text{ERR.IZ.GR}}$
I_{LEAK} >>	Error current, e.g. through ground fault; warning signal to control	UV → LE, CC	$\overline{\text{ERR.ILEAK}}$
TEMP >>	Temperature of heat sink too high (> 95 °C)	UV → LE, CC	$\overline{\text{ERR.TEMP}}$
NC reset	Reset signal from control to power supply unit	LE, CC → UV	$\overline{\text{RES.LE}}$
SPINDLE	Safety relay for spindle triggered	–	–
AXES	Safety relay for axes 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 is ready	UV → LE, CC	RDY.PS
POWER RESET	Reset signal from power supply unit to control	UV → LE, CC	$\overline{\text{RES.PS}}$
POWER FAIL	U_Z too low, U_Z < 410 V (e.g. line power < 290 V)	UV → LE, CC	$\overline{\text{PF.PS}}$
$U_{DC\ LINK}$ >>	U_Z too high (> approx. 800 V); power modules are switched off	UV → LE, CC	$\overline{\text{ERR.UZ.GR}}$
$I_{DC\ LINK}$ >>	Warning signal to control at I_Z > 85.2 A[a]	UV → LE, CC	$\overline{\text{ERR.IZ.GR}}$
I_{LEAK} >>	Error current, e.g. through ground fault; warning signal to control	UV → LE, CC	$\overline{\text{ERR.ILEAK}}$
AC FAIL	Phase missing	UV → LE, CC	$\overline{\text{PF.PS.AC}}$
NC reset	Reset signal from control to power supply unit	LE, CC → UV	$\overline{\text{RES.LE}}$
AXES	Safety relay for axes triggered	–	–
SPINDLE	Safety relay for spindle triggered	–	–
TEMP >>	Temperature of heat sink too high (> 95 °C)	UV → LE, CC	$\overline{\text{ERR.TEMP}}$

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

4.3 Power Modules

UM 1xx

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

Red SH1 LED

The **SH1** signal (safe stop 1, red LED at the inverter) is generated by the main computer (MC) of the HEIDENHAIN control. The signal is low-active, i.e. line-break proof.
If the main computer is not ready for operation or if an error is pending, SH1 is output. The red SH1 LED and the green READY LED at the inverter can never be lit at the same time. They are mutually locked.

Red SH2 LED

The **SH2** signal (safe stop 2, red LED at the inverter) is generated by the controller computer (CC) of the HEIDENHAIN control.
The signal is low-active, i.e. line-break proof.
If an axis or spindle is not controlled, SH2 is pending and the red LED is on.
This is for example the case with clamped axes or if a spindle is not controlled.
SH2 and READY are on simultaneously.

4.4 HEIDENHAIN Interface Cards for the SIMODRIVE System

4.4.1 Boards with Ribbon Cable Connection for the PWM Interface

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

The signal **SH1** (safe stop 1, red LED at the inverter) is generated by the main computer (MC) of the HEIDENHAIN control. The signal is low-active, i.e. line-break proof.
If the main computer is not ready for operation or if an error is pending, SH1 is output. The red SH1 LED and the green READY LED at the inverter can never be lit at the same time. They are mutually locked.

The **SH2** signal (safe stop 2, red LED at the inverter) is generated by the controller computer (CC) of the HEIDENHAIN control.
The signal is low-active, i.e. line-break proof.
If an axis or spindle is not controlled, SH2 is pending and the red LED is on.
This is for example the case with clamped axes or if a spindle is not controlled.
SH2 and READY are on simultaneously.

4.4.2 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	UV → LE, CC
NB	"Not ready“, power module does not provide a ready signal	UV → LE, CC

Id.Nr. 324 952-0x

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

RESET X1 and RESET X2 correspond here to signal SH2.

5 Procedures and Tips for Error Diagnosis

5.1 Introduction

The following **systematic procedures** have proven themselves for error diagnosis on drives for machine tools.

They are described below.

Note

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

Refer also to the notes and tips in Chapter 5.5!

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 ruled out before further examinations.

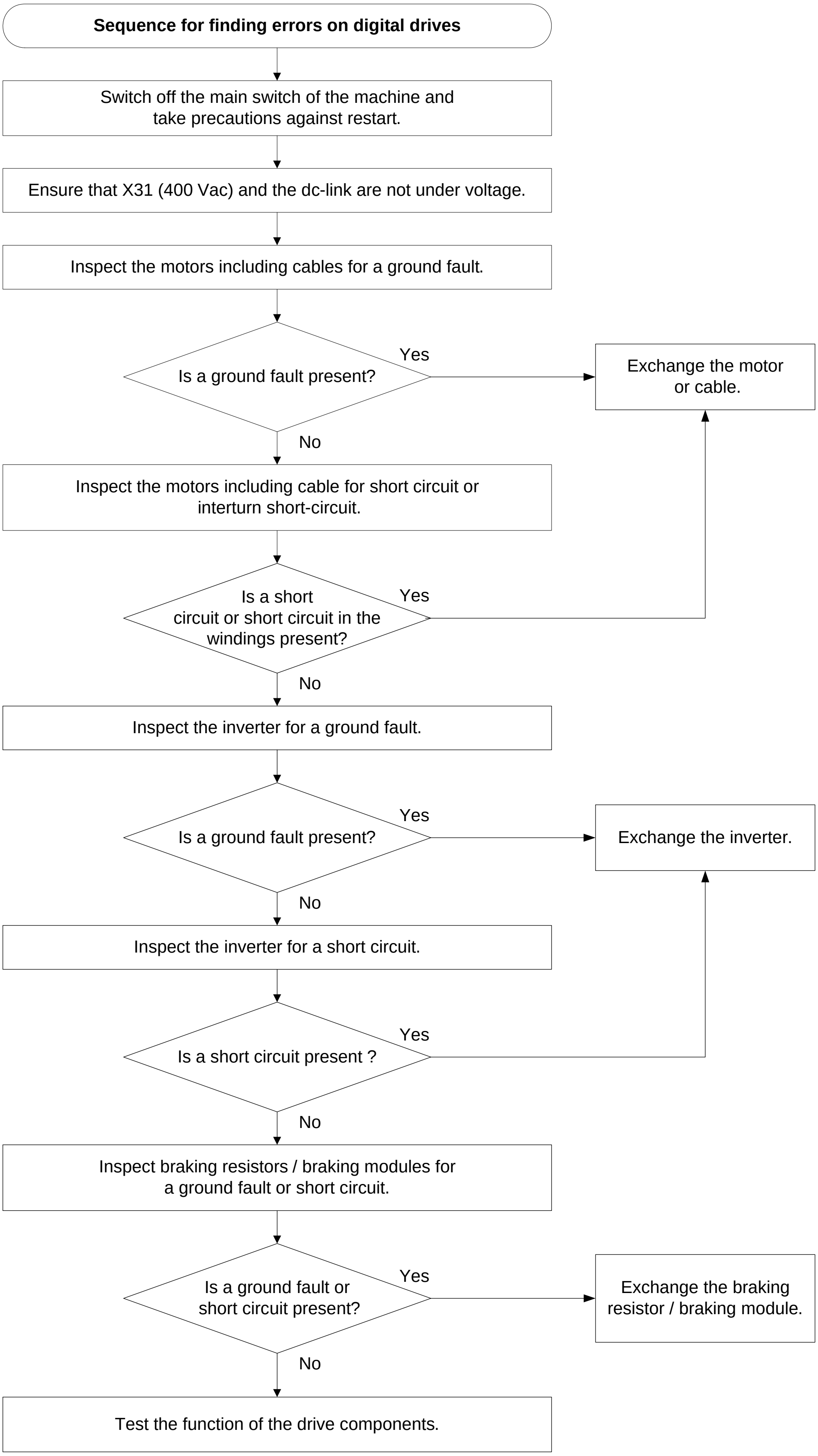
A **ground fault or short circuit** may be suspected in case of:

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

Note

The chapters about corrective action on motors and inverter systems give you detailled information on the examination of ground-fault and short-circuit.

Flowchart


Sequence for finding errors on digital drives
Switch off the main switch of the machine and take precautions against restart.
Ensure that X31 (400 Vac) and the dc-link are not under voltage.
Inspect the motors including cables for a ground fault.
Is a ground fault present?
Yes
Exchange the motor or cable.
No
Inspect the motors including cable for short circuit or interturn short-circuit.
Is a short circuit or short circuit in the windings present?
Yes
No
Inspect the inverter for a ground fault.
Is a ground fault present?
Yes
Exchange the inverter.
No
Inspect the inverter for a short circuit.
Is a short circuit present ?
Yes
No
Inspect braking resistors / braking modules for a ground fault or short circuit.
Is a ground fault or short circuit present?
Yes
Exchange the braking resistor / braking module.
No
Test the function of the drive components.

5.3 Sequence for Finding Errors in the Control Loop

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

- `Excessive servo lag`
- `Movement monitoring`
- `Standstill monitoring`

or in case of errors, for example:

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

... machine components are to be checked in a certain sequence for finding errors. --> See flow chart on the next page!

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.

Contaminated or defective encoders

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

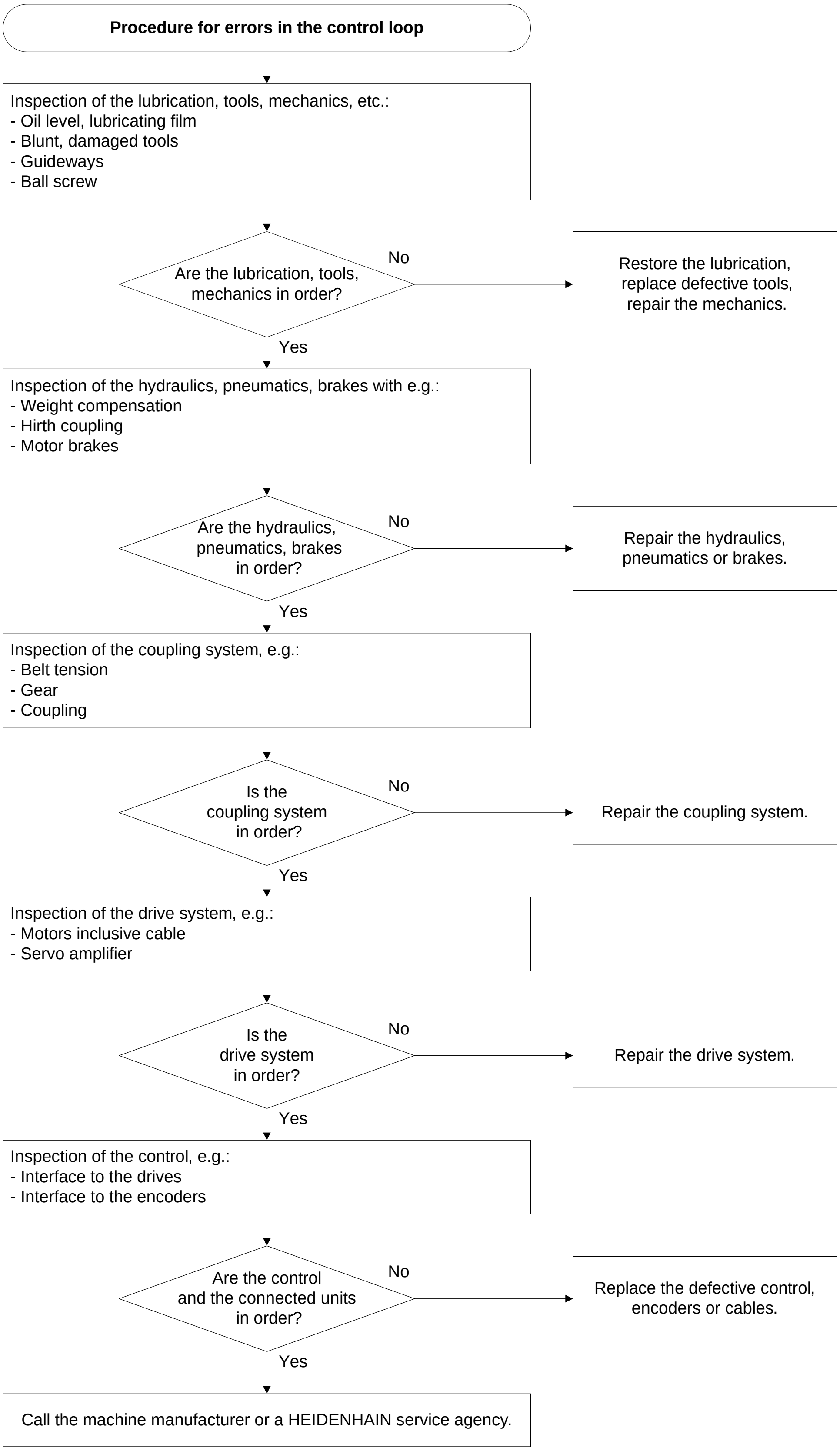
For example, a contaminated field of a scanning head with 4-field scanning can degrade the on-to-off ratio which has a negative effect on the feedback control of the machine axis. As long as the on-to-off-ratio is not outside the tolerance, **no encoder error message** is generated.

In exceptional cases, due to defective electronics or a damaged cable, constant voltage values are supplied to the control that are within the tolerance range of the encoder specifications. Consequently, also here **no encoder error message** is generated!

For the 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.
- Now inspect the encoder signals with an appropriate measuring device (e.g. PWM 9, see "PWM 9 Encoder Diagnostic Set" on page 14 – 340). -->
  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, the encoder must be cleaned or replaced.

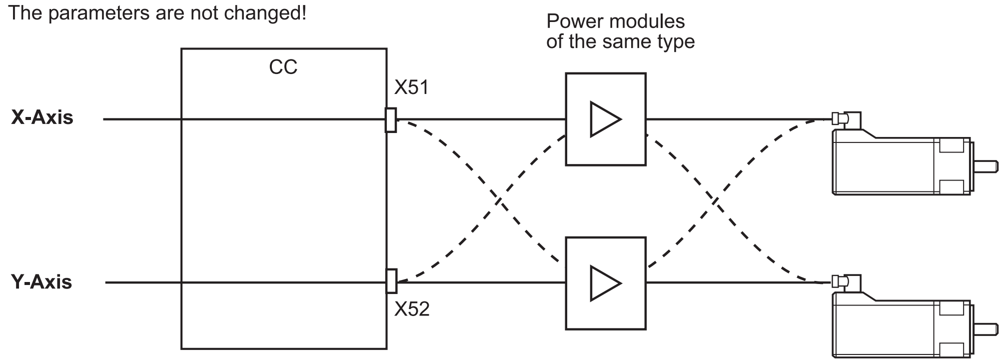
Flowchart


Procedure for errors in the control loop
Inspection of the lubrication, tools, mechanics, etc.:
- Oil level, lubricating film
- Blunt, damaged tools
- Guideways
- Ball screw
Are the lubrication, tools, mechanics in order?
No
Restore the lubrication, replace defective tools, repair the mechanics.
Yes
Inspection of the hydraulics, pneumatics, brakes with e.g.:
- Weight compensation
- Hirth coupling
- Motor brakes
Are the hydraulics, pneumatics, brakes in order?
No
Repair the hydraulics, pneumatics or brakes.
Yes
Inspection of the coupling system, e.g.:
- Belt tension
- Gear
- Coupling
Is the coupling system in order?
No
Repair the coupling system.
Yes
Inspection of the drive system, e.g.:
- Motors inclusive cable
- Servo amplifier
Is the drive system in order?
No
Repair the drive system.
Yes
Inspection of the control, e.g.:
- Interface to the drives
- Interface to the encoders
Are the control and the connected units in order?
No
Replace the defective control, encoders or cables.
Yes
Call the machine manufacturer or a HEIDENHAIN service agency.

5.4 Error Localization by Process of Interchange

For checking machine-tool components that are available more than once (servo amplifiers, motors, expansion boards, etc.) the "interchange method" can be used.
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 “Exchanging Power Modules or Output Stages of the Same Type” on page 7 – 100,
  see “Exchanging Output Stages of the Same Type” on page 7 – 128

- Interchange of expansion boards-->
  see “Exchanging the HEIDENHAIN Expansion Boards for the SIMODRIVE 611 System” on page 7 – 135

5.5 Notes and Tips

What is the cause of this error?

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

Have there been any particular incidences, such as …

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

Have there been repeated error messages indicating an overload (e.g., **`I2T monitoring`**, **`Motor temperature too high`**, **`Motor current too high`**, **`Load is too high`**) or a defect (e.g., **`overcurrent cutoff`**)?

> **Note**
>
> Pointed questions and precise answers will make the error diagnosis a lot easier for you!

First steps

- If possible, ask the repective person 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).
- You can now start the troubleshooting!

Visual inspection

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

- Was there a crash on the machine?
- Are the devices heavily contaminated?
- Are the cables defective?
- Are there defective tubes, sealings, screw connections, etc.?
- Are the fuses defective?
- Are the power amplifiers obviously destroyed?
- Are the couplings, belts, gears, etc. defective?
- Has the fan come off from the motor?
- Are there mechanical defects on the motor?
- Has humidity penetrated into the devices?

Are there any scorch marks or a burnt smell (burnt electronic components, cables, etc.?)

Comparison with functioning machines or units

You can compare the functions on identical machines or units.

This can be very helpful for troubleshooting!

Males and females

Observe the following instructions for connecting and disconnecting any connectors:

D-Sub connectors or females

- Connect and disconnect straightly! Otherwise the spring contacts in the D-sub connectors could be widened.

Ribbon connectors or females

- Connect carefully and straightly with constant pressure to prevent a deflection of the males.

Signal socket on the motor

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

Terminals

Ensure that the terminals are tightened and that the wires are not damaged or corroded.

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 cables), cover plates, grounding bars, contact plates, etc.

Caution

If HEIDENHAIN expansion boards for the SIMODRIVE system are used, please check the mandatory grounding. --> see “HEIDENHAIN Interface Cards for the SIMODRIVE System” on page 4 – 31

Sources of interference

Also observe **likely sources of interference** that may have a negative effect on the connected units.

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 equipment 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 **min. 10 mm^2**.
- Only genuine HEIDENHAIN cables, connectors and couplings were used.
- Covers for the ribbon cables are used.

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 graphite and cast iron
- Coolant and coolant vapor
- Defective filter system in the electrical cabinet (filter pads)
- Oil or oil vapor
- Oil in the compressed-air system
- Open door of the electrical cabinet

Caution

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 inverter's live parts 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 fan
- Motors and servo drives are overloaded
- Defective temperature sensors
- Unfavorable mounting of components

Danger

The permissible ambient temperature for operation of the inverter systems is between 0 °C to 40 °C. Any deviation from this will impair the operating safety.

Caution

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
- Coolant or coolant vapor
- Condensation of boards due to changes in temperature
- Defective tubes, sealings, screw connections, etc.

Caution

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 was used.
- a suitable HEIDENHAIN line filter was used.

Inverters	UV 120, UVR 120 D, UR 2xx (D)	UVR 130 D	UV 140, UVR 140 D	UVR 150, UVR 150 D	UVR 160 D, UVR 160 DW
Suitable commutating reactor	KDR 120	KDR 130 B/C	KDR 140	KDR 150	KDR 160
Suitable line filter	EPCOS 35 A	EPCOS 80 A	EPCOS 80 A	EPCOS 80 A	EPCOS 120 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 filter EPCOS 120 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 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.

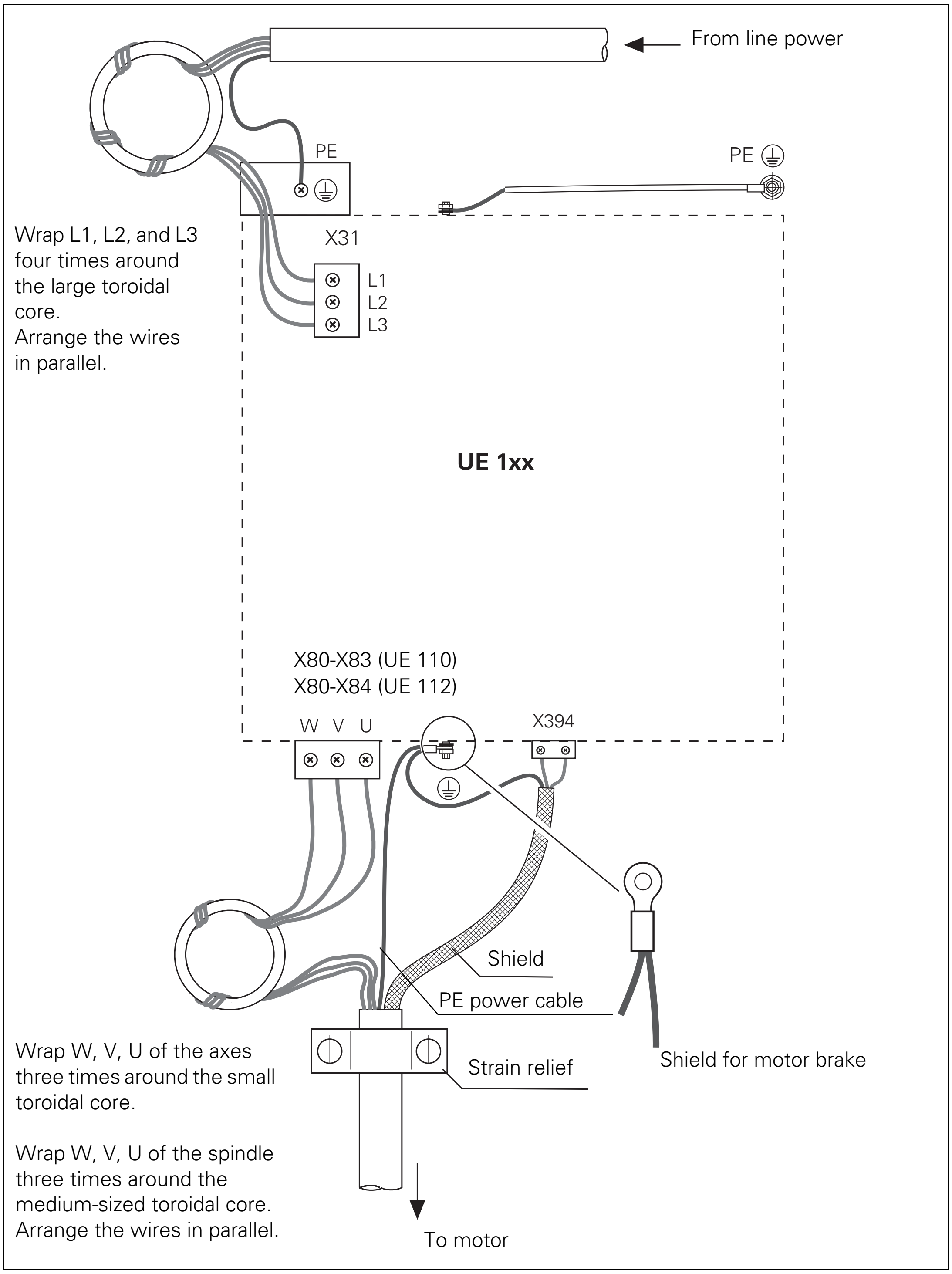
With **compact inverters** UE 1xx, UE 2xx und UE 2xx B observe, whether ...

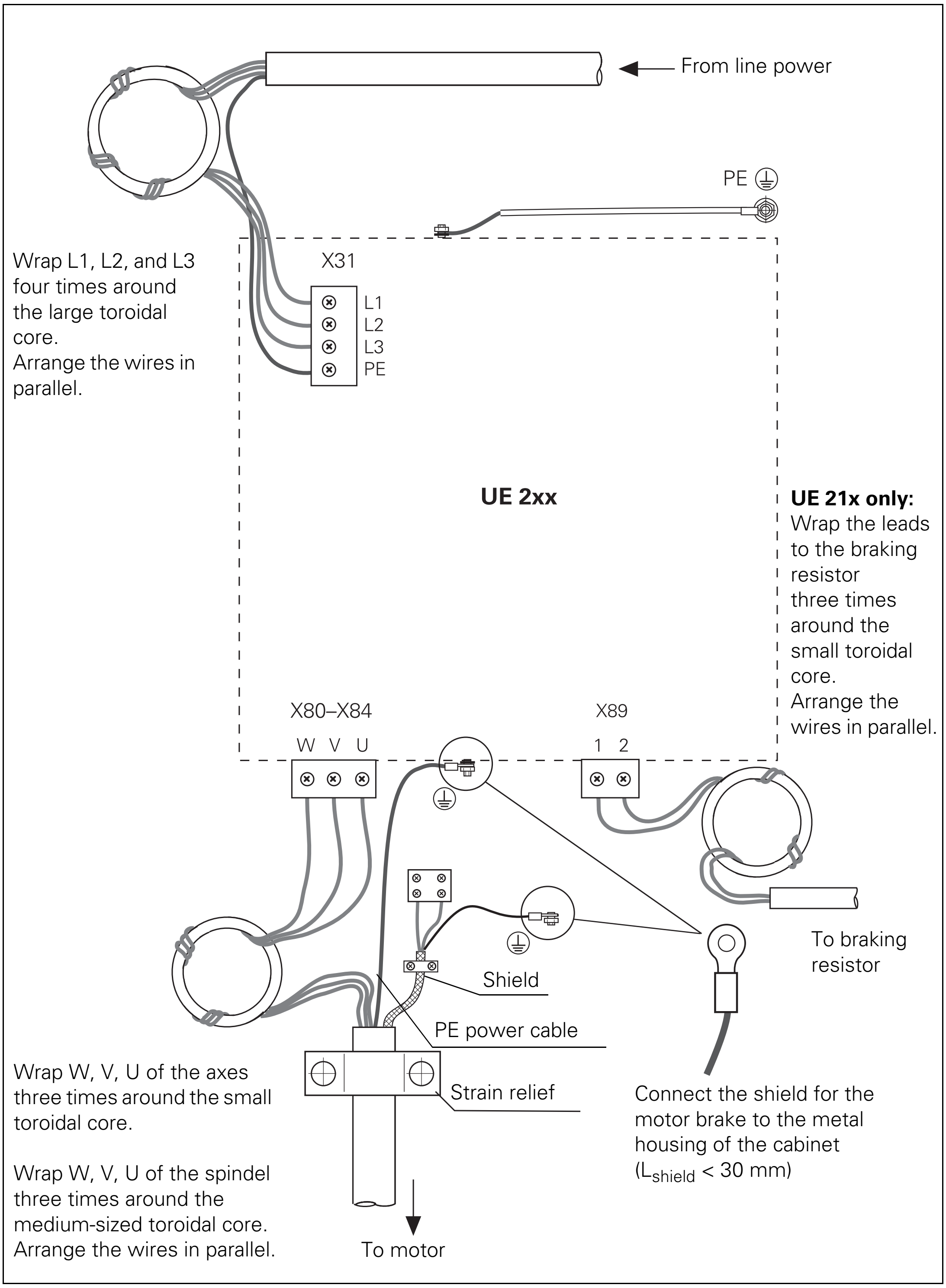
- Toroidal cores are integrated in the motor leads (X80 to X84).
- One toroidal core is integrated in the voltage supply lead (X31).
- Toroidal cores are integrated in braking resistor leads (**only UE 21x**)

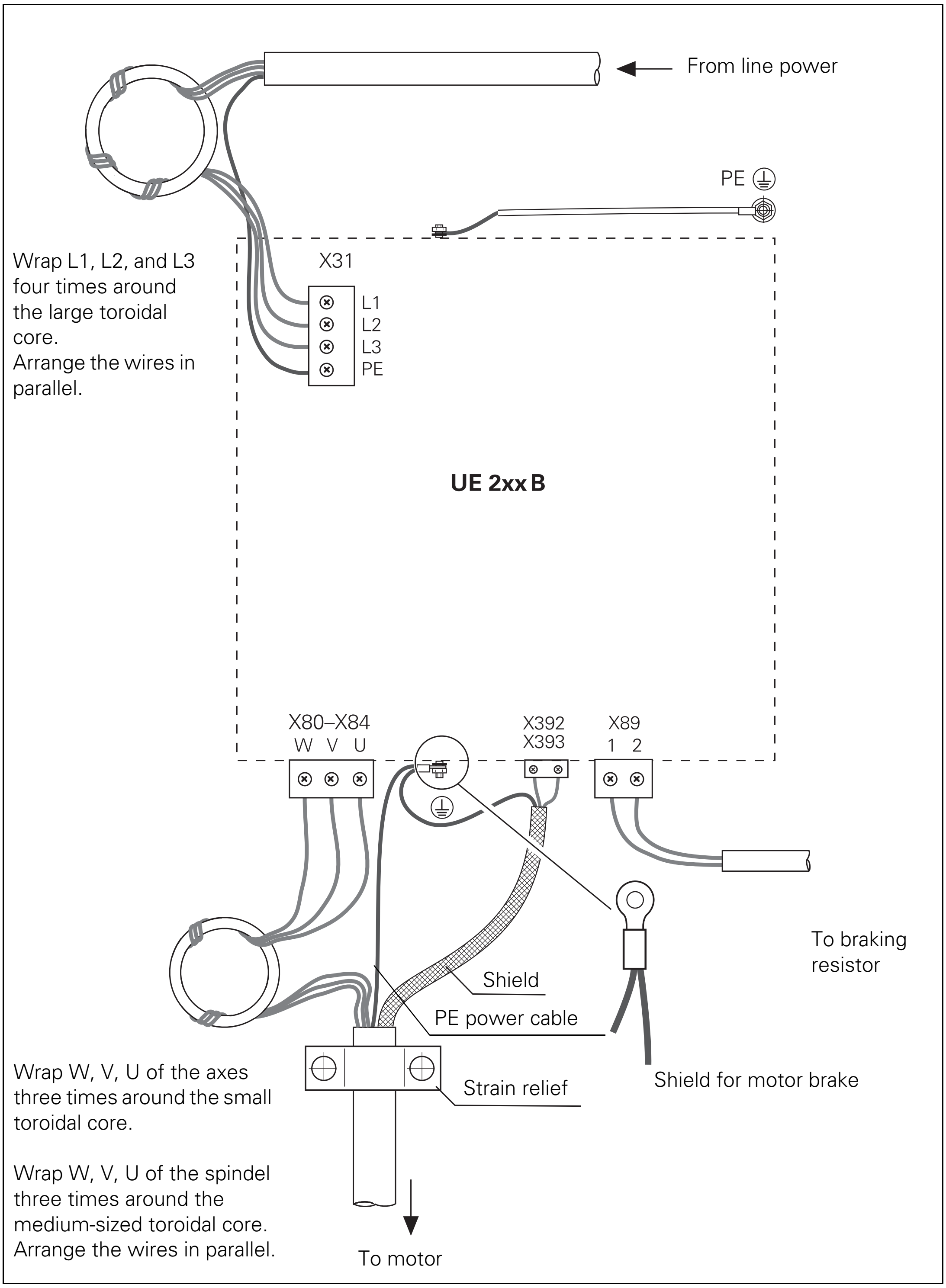
These measures serve to suppress conducted interference (power line disturbance according to EN 55011 / 55022 Class A).

Caution

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




From line power
PE
X31
L1
L2
L3
PE
Wrap L1, L2, and L3 four times around the large toroidal core.
Arrange the wires in parallel.
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
Connect the shield for the motor brake to the metal housing of the cabinet (L_{shield} < 30 mm)
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.
To motor



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

a. only for UE 21x

6 Troubleshooting 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 1 – 7!

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, edgeless tool, insufficient lubrication)
- Excessive temperatures for an extended 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 encoder 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
- 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.

Please note the following:

- Is the motor or the area where it is mounted severely contaminated?
- Does the motor show mechanical defects?
- Has the fan become loose?
- Has humidity entered 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?

Photo: Defective and severely contaminated motor

6.4 Trouble Shooting on Ground Fault

A ground fault or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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`
- Scorch marks and/or burnt smell
- Destroyed units

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is not under voltage, see “Voltage Test Unit” on page 14 – 333
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement, see “Insulation Tester” on page 14 – 334

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

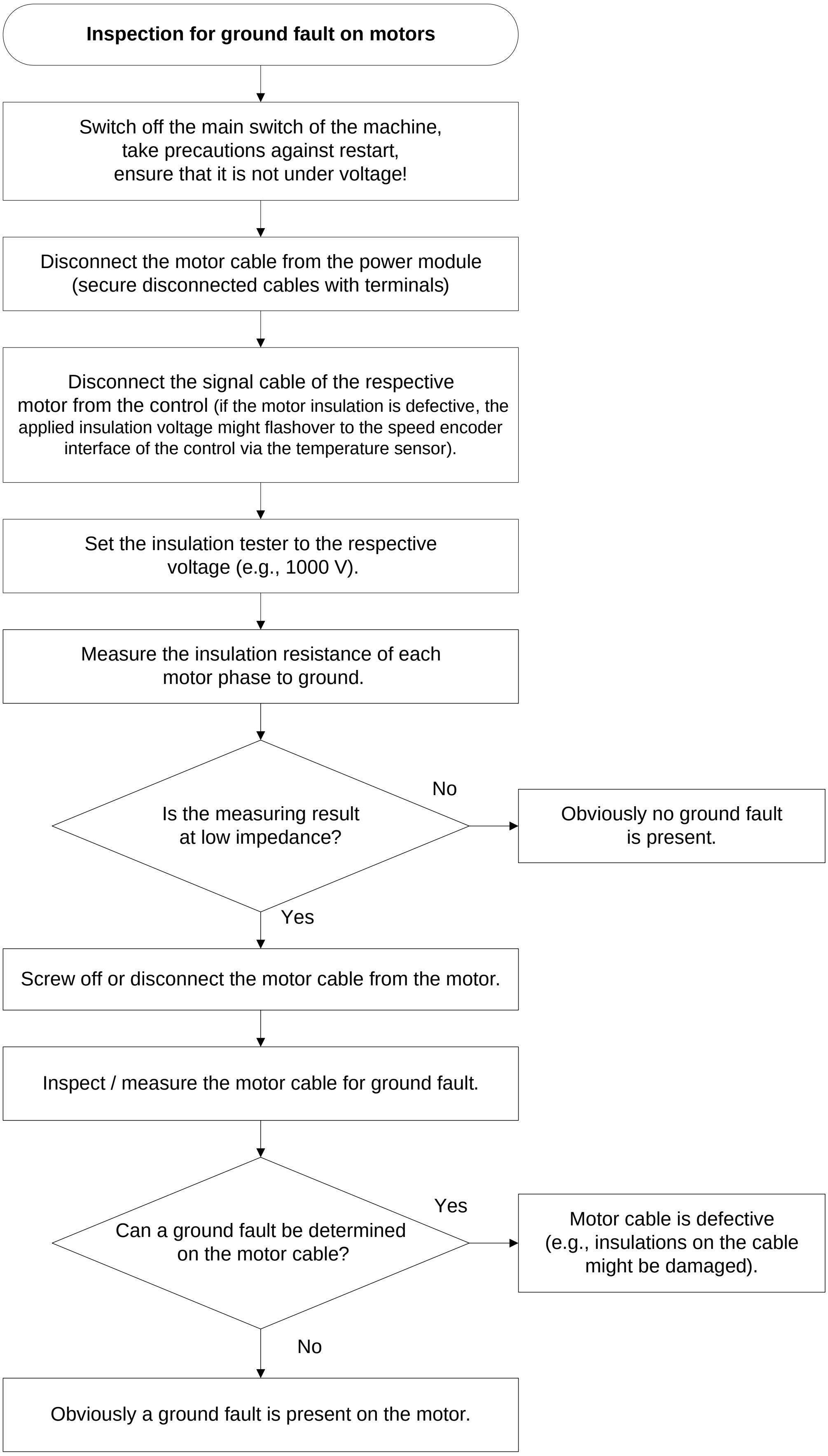
Observe the voltage specifications for the insulation test as per the corresponding manuals **(sometimes below 1000 V)** when checking **linear and torque motors for ground faults!**

Execution

DANGER

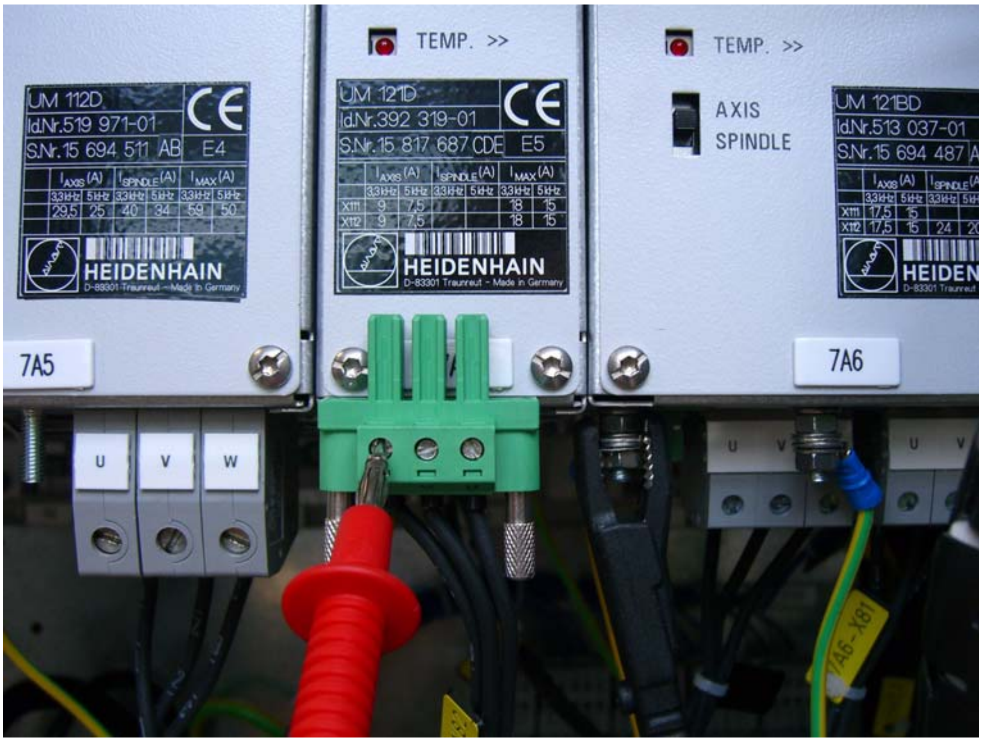
Danger of electrical shock!
The units must not be under voltage for the following measurements.
Ensure that the machine is switched off and is not under voltage!

Flowchart


Inspection for ground fault on motors
Switch off the main switch of the machine, take precautions against restart, ensure that it is not under voltage!
Disconnect the motor cable from the power module (secure disconnected cables with terminals)
Disconnect the signal cable of the respective motor from the control (if the motor insulation is defective, the applied insulation voltage might flashover to the speed encoder interface of the control via the temperature sensor).
Set the insulation tester to the respective voltage (e.g., 1000 V).
Measure the insulation resistance of each motor phase to ground.
Is the measuring result at low impedance?
No
Obviously no ground fault is present.
Yes
Screw off or disconnect the motor cable from the motor.
Inspect / measure the motor cable for ground fault.
Can a ground fault be determined on the motor cable?
Yes
Motor cable is defective (e.g., insulations on the cable might be damaged).
No
Obviously a ground fault is present on the motor.

> **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 motor and cable type and the specifications of the insulation tester.
> If possible, you can compare the measured values with a dimensionally identical motor.

Photo: Ground fault measuring



> **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!

Fault repair

Motors with ground faults must be replaced. -->
see “Exchanging the Complete Motor” on page 10 – 180!

Severely contaminated motors

If you do not detect a ground fault on severely contaminated motors, it might still be possible that unwanted leakage currents occur.
With regard to the operating safety, please send severely 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 not under voltage, see "Voltage Test Unit" on page 14 – 333.
- Standard commercial **multimeter** that can be set to ohm measurement.
  It is used to check the symmetry of the motor coils fast and easily.

Execution

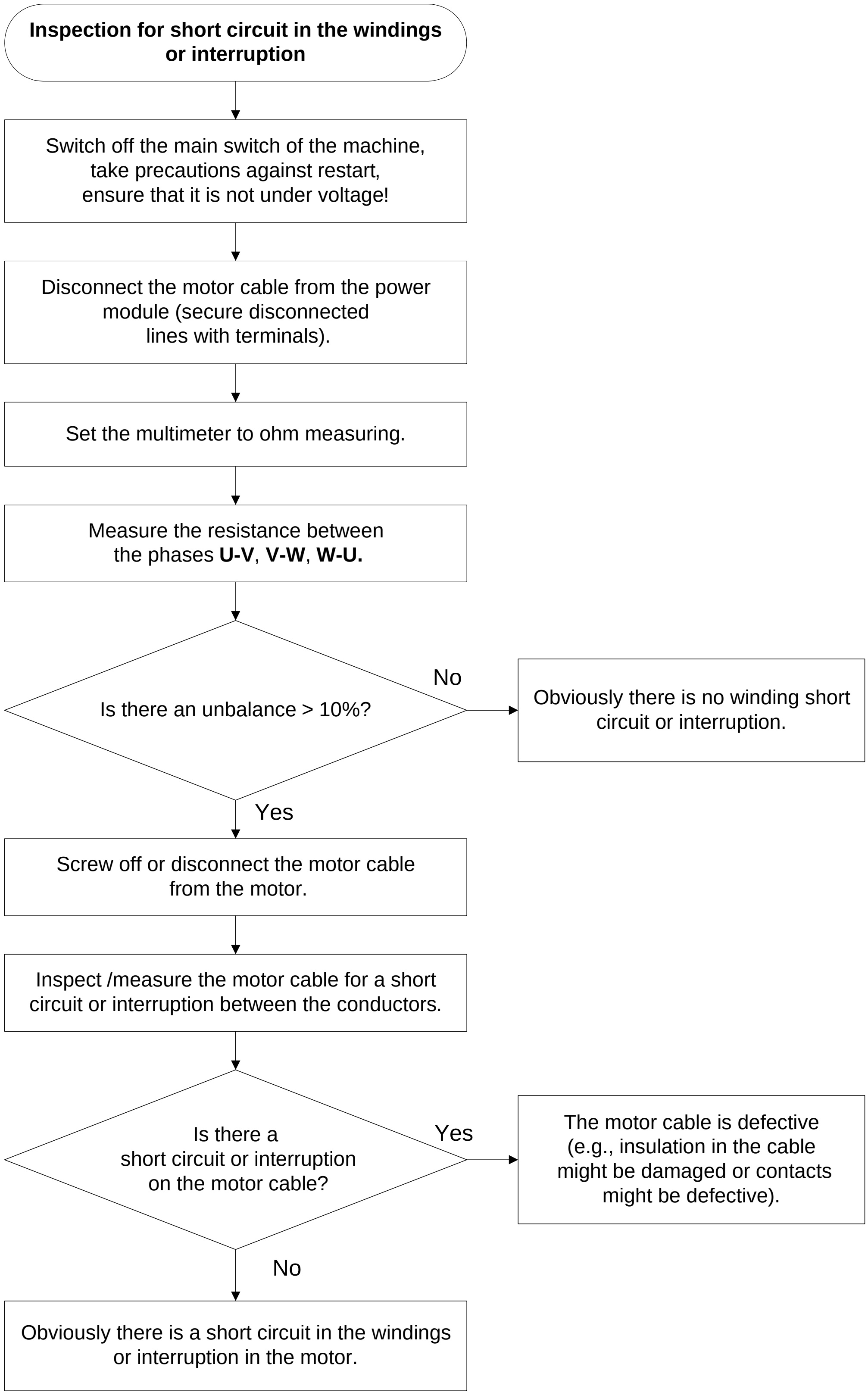
Note

Before inspecting the motors for winding short circuit, ensure that there are no ground faults. --> see "Trouble Shooting on Ground Fault" on page 6 – 47

DANGER

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

Flowchart

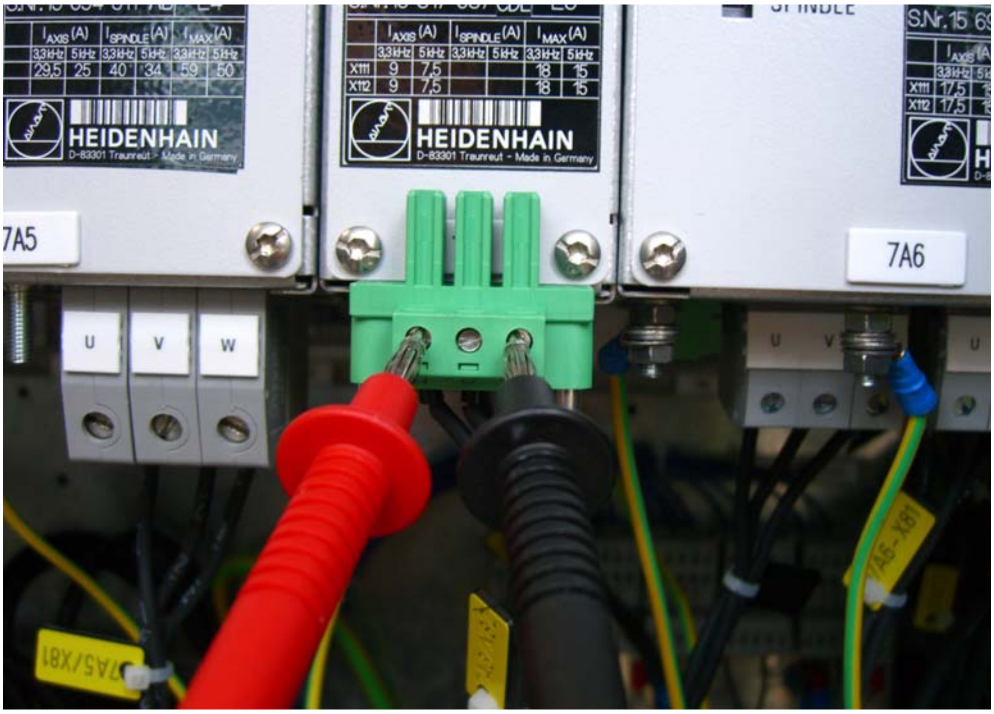

Inspection for short circuit in the windings or interruption
Switch off the main switch of the machine, take precautions against restart, ensure that it is not under voltage!
Disconnect the motor cable from the power module (secure disconnected lines with terminals).
Set the multimeter to ohm measuring.
Measure the resistance between the phases U-V, V-W, W-U.
Is there an unbalance > 10%?
No
Obviously there is no winding short circuit or interruption.
Yes
Screw off or disconnect the motor cable from the motor.
Inspect /measure the motor cable for a short circuit or interruption between the conductors.
Is there a short circuit or interruption on the motor cable?
Yes
The motor cable is defective (e.g., insulation in the cable might be damaged or contacts might be defective).
No
Obviously there is a short circuit in the windings or 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 insulation multimeter.
If possible, you can compare the measured values with a dimensionally identical motor.

Photo: Measuring winding short circuits

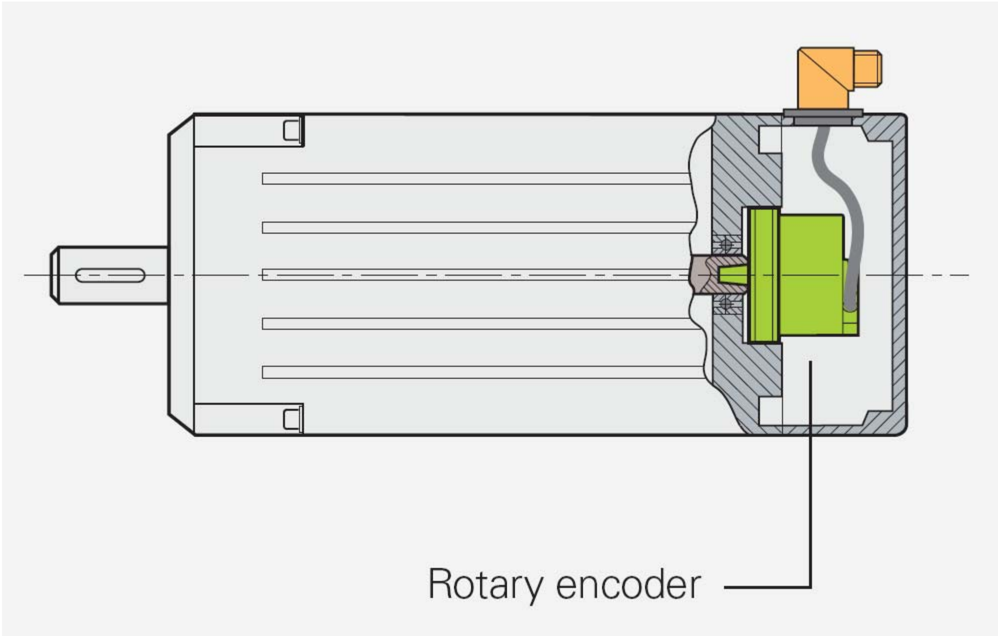


Fault repair

Motors with winding short circuits or interruptions must be replaced. --> see “Exchanging the Complete Motor” on page 10 – 180.

6.6 Inspection of the Motor Encoder

Photo: Motor encoder in the HEIDENHAIN motor



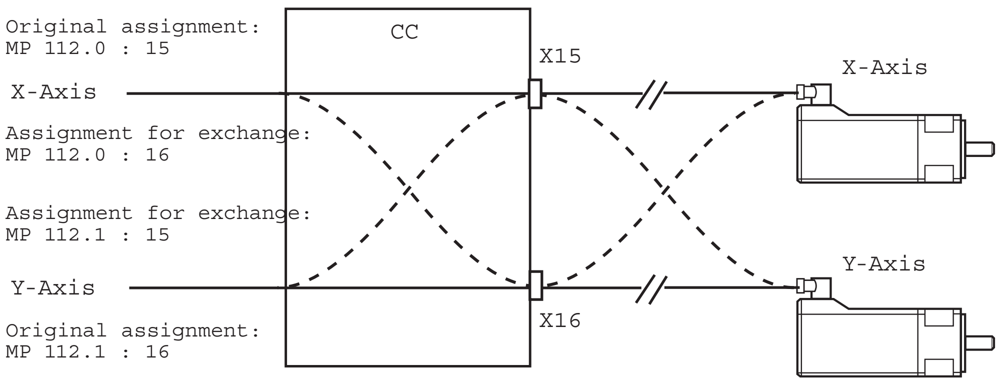
DANGER

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 could 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 signal cable or the signal socket are not defective or replace these components.
--> see "Exchanging the Signal Socket of the Motor" on page 10 – 184,
see "Exchanging Cables and Connectors" on page 10 – 196.

Fault repair

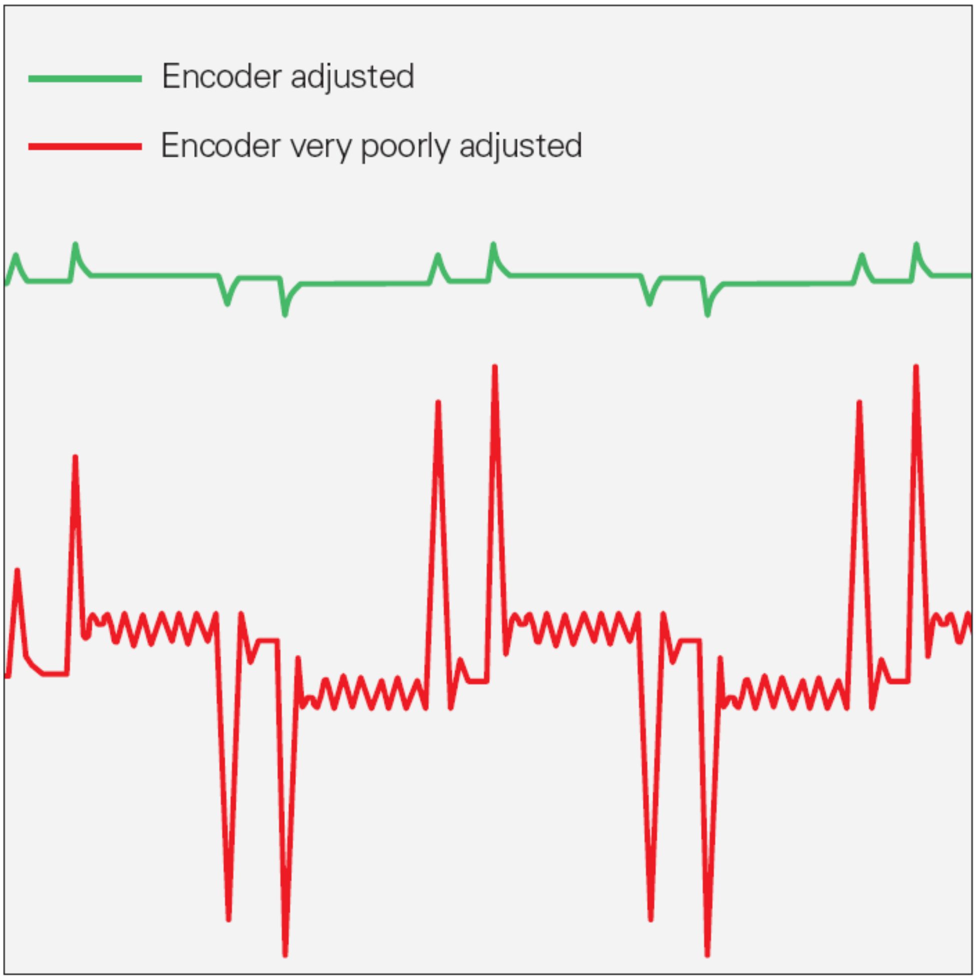
If the **motor encoder of a synchronous motor (QSY xxx) is defective**:

▶ Replace the complete motor and send it in for repair. --> see "Exchanging the Complete Motor" on page 10 – 180.

Caution

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

In additon, many motors have so-called electronic ID labels. This electronic ID label for the motor is stored in the motor encoder with EnDat interface. When exchanging the motor encoder, the electronic ID label must be written again. This is made at HEIDENHAIN.



Motor current of adjusted and very poorly adjusted rotary encoder

If the **motor encoder of a synchronous 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 – 181

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 Set” on page 14 – 340.

DANGER

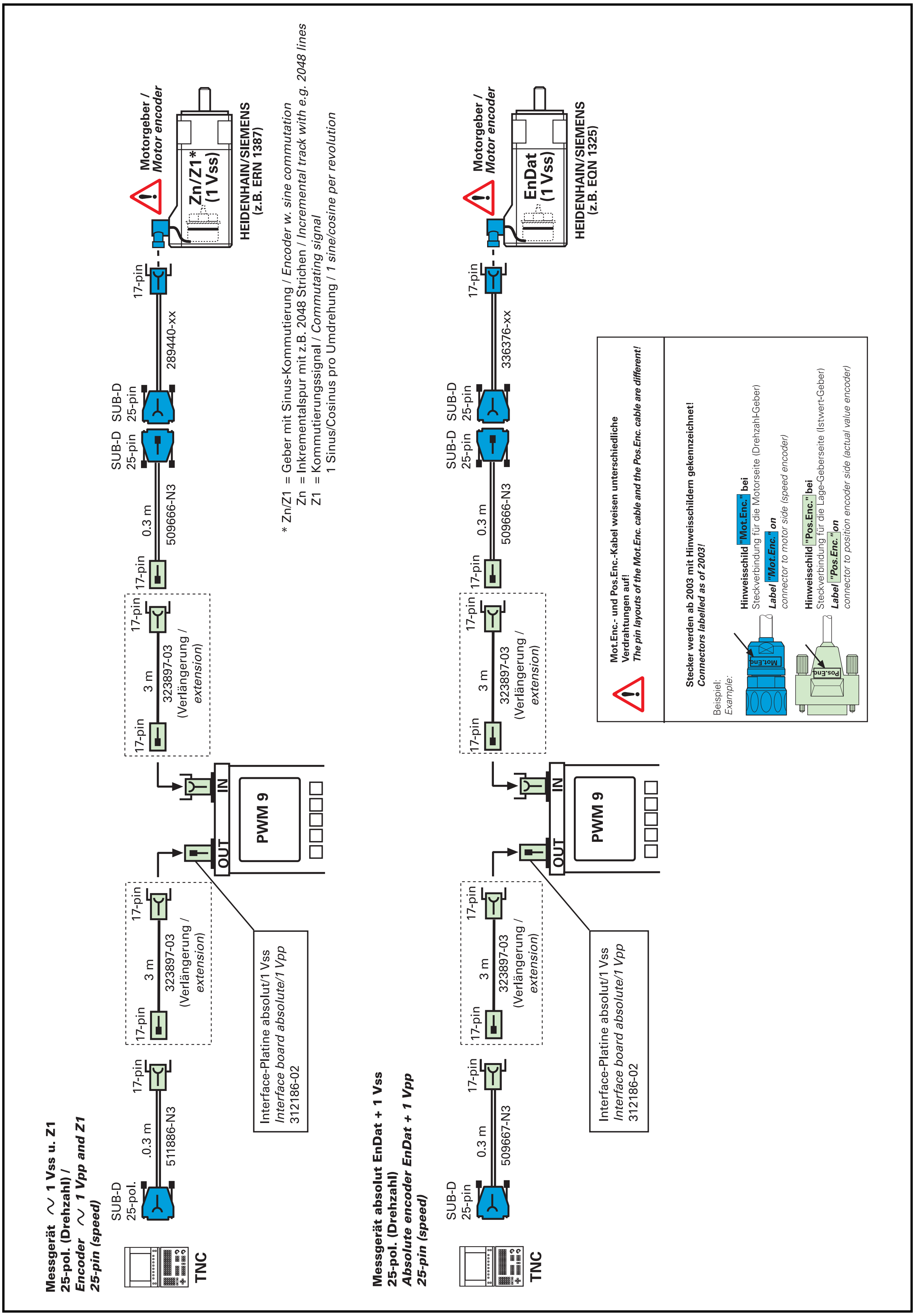
If the PWM 9 is connected in the signal path between the motor encoder and the control: Do not change the settings of the PWM 9 (e.g., parameters, encoder voltages) and do not switch it off while the machine tool is operating.
This could lead to damage or injury to the machine or persons!
Read the **operating instructions** of the PWM 9 in detail, before you use the unit.

Note

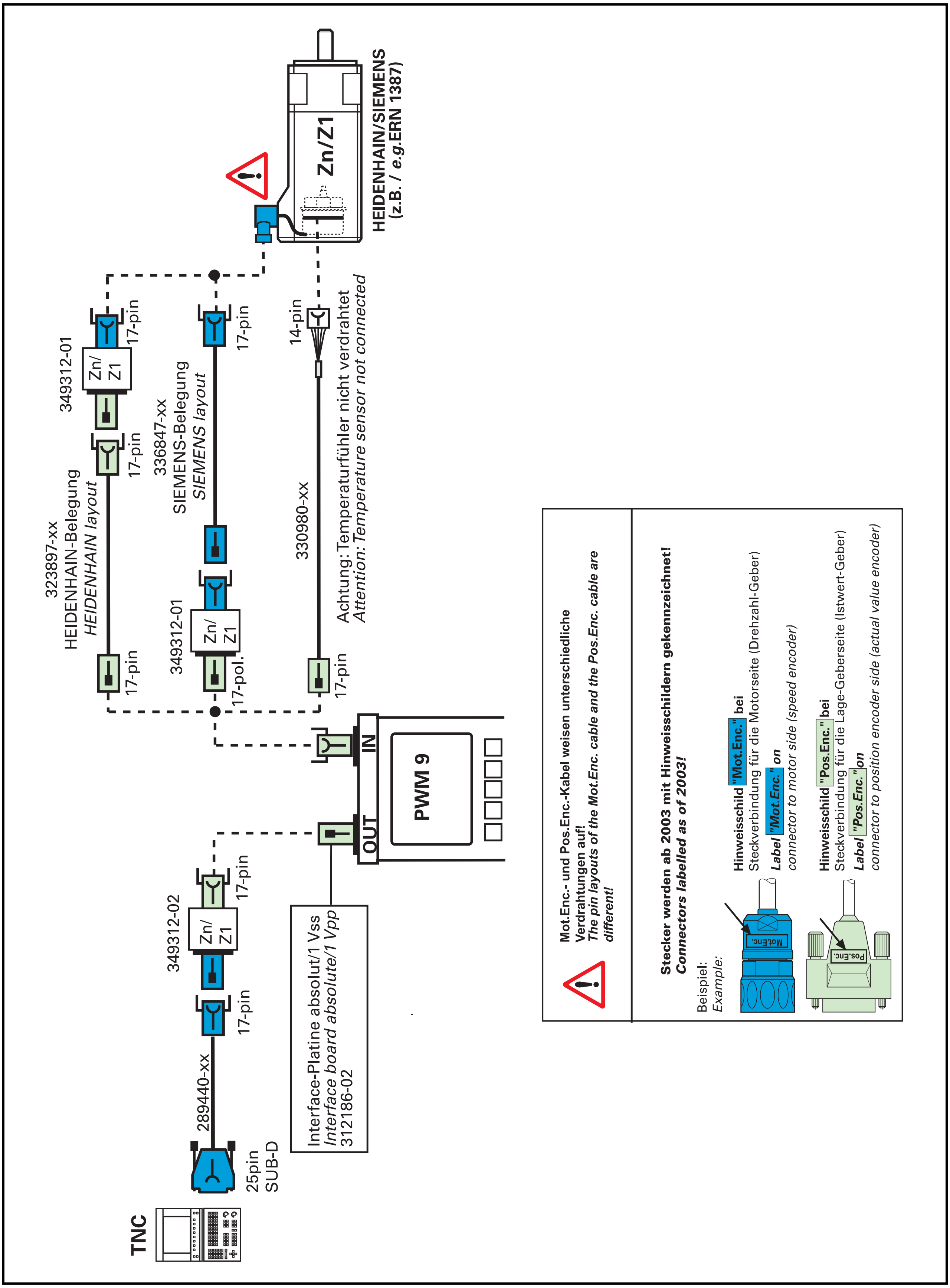
During our **training courses on measuring systems** or special **PWM 9 trainings** the PWM 9 is explained in detail.
We recommend that you participate in a HEIDENHAIN service training course so that you can use the PWM 9 correctly and effectively.
Contact HEIDENHAIN Traunreut or your regional agency.

Photo: Example of a recording with the PWM 9

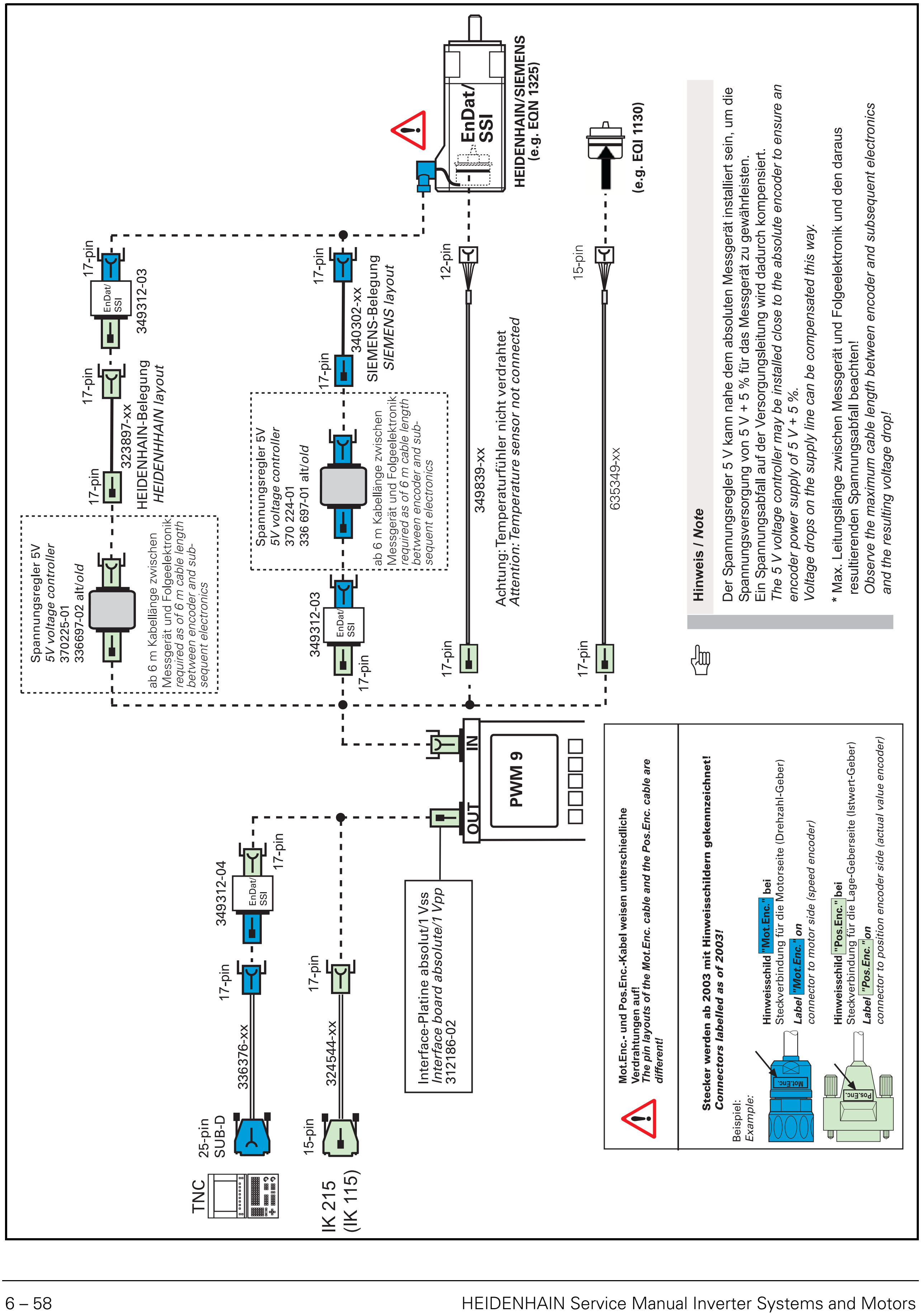
Motor with conventional encoder and EnDat encoder.
Separation of the signal path from the motor encoder to the control directly at the interface of the control (in the electrical cabinet) to connect the PWM 9 in series.
Excerpt from the PWM 9 Operating Instructions:



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:



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 “PWT 18 Test Unit” on page 14 – 342.

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 not an 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

Each **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 signal 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 for inspecting and testing an EnDat motor encoder. --> see “IK 215 Adjusting and Testing Package” on page 14 – 343

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)

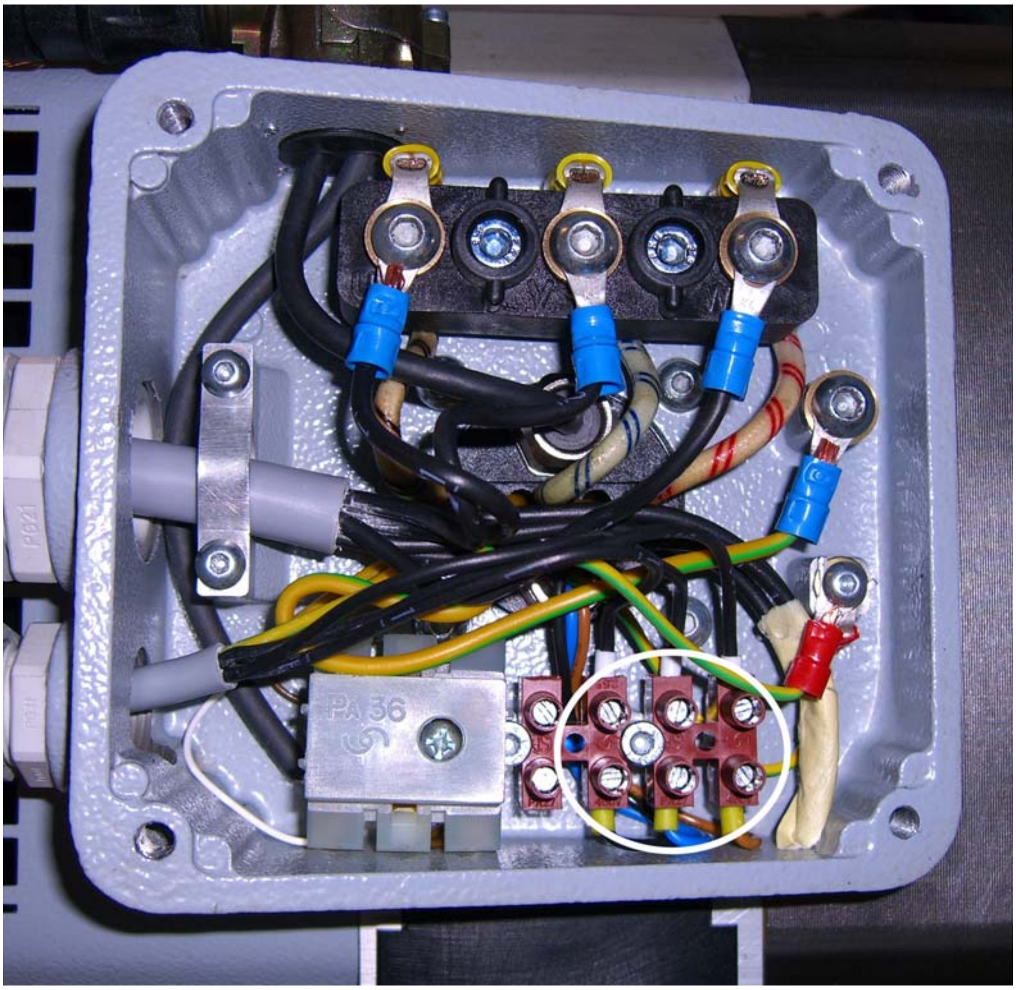
DANGER

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.

Photo: Measuring the fan voltage



Fault repair

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 – 186, see “Exchanging the Fan Guard of a Spindle Motor” on page 10 – 191.

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

alle Angaben ohne Gewähr

Execution

DANGER

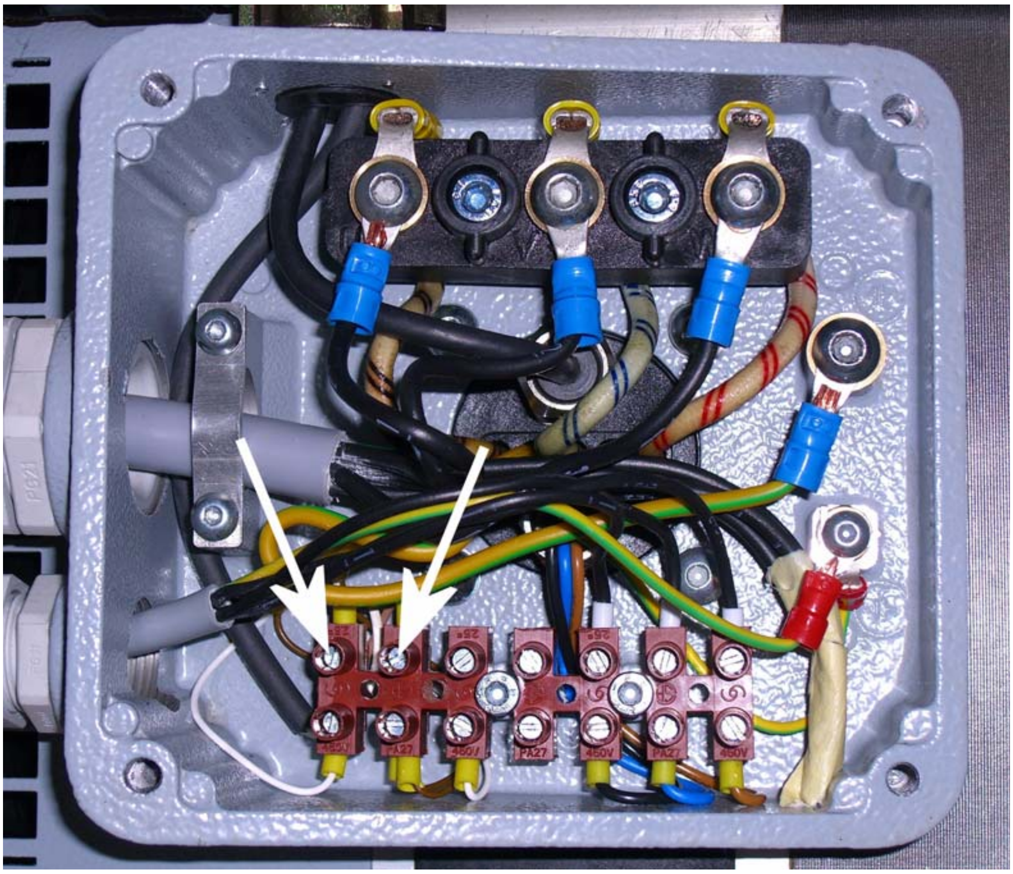
Danger of electrical shock!
The units must not be under voltage for the following measurements.
Ensure that the machine is switched off and is not under voltage!

- Screw off the 25-pin D-sub connector of the signal cable from the speed encoder interface of the control.
- Use an ohm measuring device.
- Measure at the pins 13 and 25 whether the resistance value corresponds to the motor temperature (see value table).

Note

If possible, measure directly at the spindle motor. --> Open the terminal box where the temperature sensor is connected.
On some motors it is necessary to screw off the protective cover to perform the measurement on the terminals for the temperature sensor.

Photo: Measuring the temperature sensor of the spindle motor



☞ **Note**

If possible, measure directly at the signal socket of the axis motor. –> The temperatur sensor is connected to the pins 8 and 9.

Fault repair

On the **spindle motor**, connections may be changed to a **reserve temperature sensor**. –> see “Changing Connections to the Reserve Temperature Sensor” on page 10 – 194

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 vertical axes before 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 not be under voltage 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 control lines whether the resistance value corresponds to the power of the motor brake (see value table).

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

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

Fault repair

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 – 180.

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!

Fault repair

An unbalance of the motor outside the specification can only be inspected and corrected at the manufacturer. --> see “Exchanging the Complete Motor” on page 10 – 180.

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 1 – 7!

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 defective
- Contamination
- Humidity
- Overload
- 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

- Defective axis or spindle motor
- Defective PWM interface 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.
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 pressure tubings or screw connections for water-cooled devices leaky?
- Are there any scorch marks or a burnt smell?

Phot: Severely contaminated inverter

7.4 Checking the 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 must be > 100 mm.
- The cooling circuit must be closed.
- The following applies for the temperature of the coolant: 20°C < coolant/water < 40°C.

DANGER

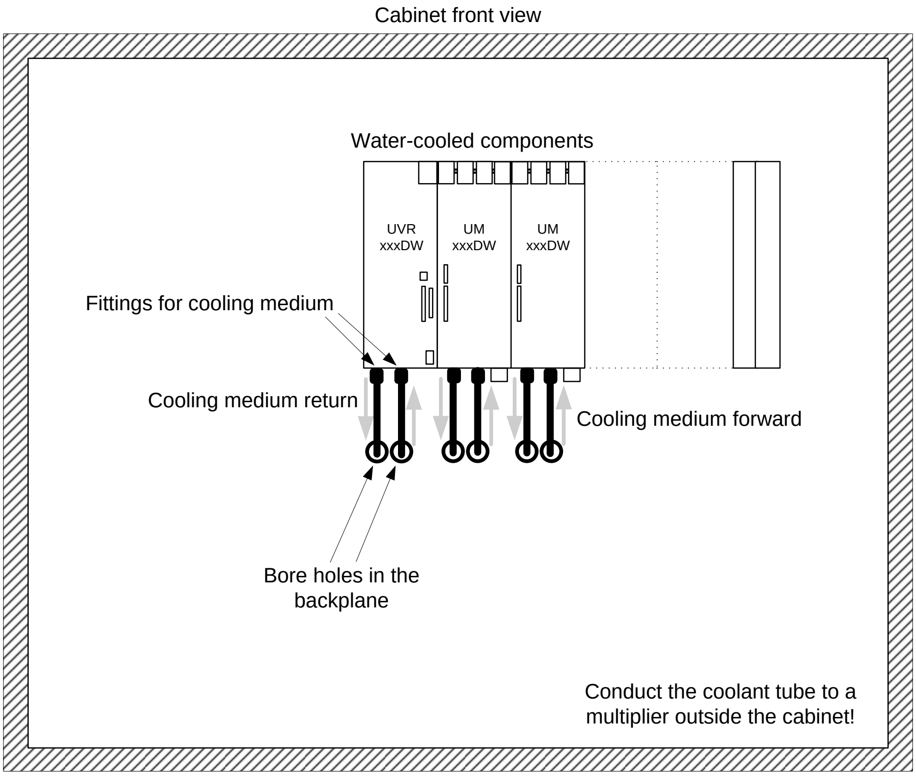
The temperature of the coolant must be no more than 5 °K lower than the ambient temperature of the components to be cooled in order to avoid condensation in the electronic components.

- **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.
- If required, filters should be used to prevent the coolant from being contaminated. The filter fineness must be < 100 µm.
- The pH value of the coolant should be approx. 7 to ensure that the service life of the coolant hoses is not impaired.
- HEIDENHAIN recommends using, for example, Waterdos CAN11 with a ratio of 1% to 2% to protect the coolant from corrosion.
- 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 the coolant hose does not rest on sharp edges** in order to prevent damage to the hose. A permanently safe operation of the water cooling system can only be ensured if this is adhered to.

DANGER

Check the complete cooling circuit for tightness before supplying power to the components (max. pressure of coolant = 5 bar)!

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



7.5 Error Diagnosis on the UV, UVR Power Supply Unit

7.5.1 Inspection for Ground Fault

A ground fault or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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`**
- 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 “Trouble Shooting on Ground Fault” on page 6 – 47

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 divider

Potential dividers for the **dc-link voltage measurement** are integrated in all power supply modules (UV, UVR). These potential dividers consist of resistors connected in series. The resistors are included when the isolation voltage 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 Test Unit” on page 14 – 333
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement. see “Insulation Tester” on page 14 – 334

> **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**!

Caution

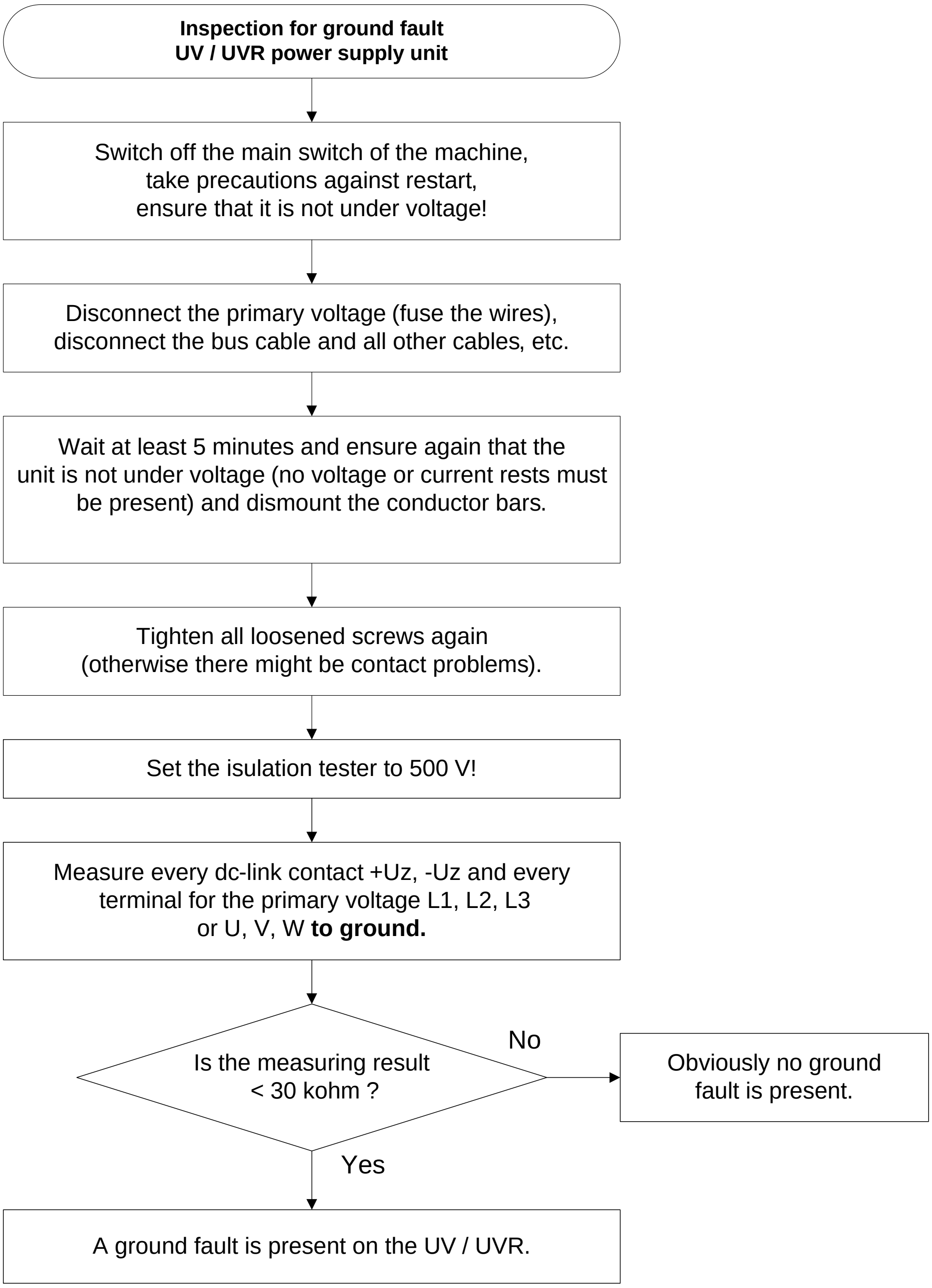
A higher test voltage could damage the inverter!

Execution

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!

Flowchart



Note

Defined resistance values cannot be specified here as they depend on the "inner life" of the inverter and the specifications of the insulation tester. If possible, you can compare the measured values with 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!

Photo: Ground fault measuring

Fault repair

Inverters with ground faults must be replaced. –>
see "Exchanging the Complete Inverter" on page 10 – 178.

Severely contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on severely contaminated inverters (this can be seen best in the area of the fan).
With regard to the operating safety, please send severely contaminated inverters for cleaning to a HEIDENHAIN agency.

7.5.2 Inspection for Short Circuit or Interruption

A ground fault or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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`
- 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 – 71

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 Test Unit” on page 14 – 333.
- 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.

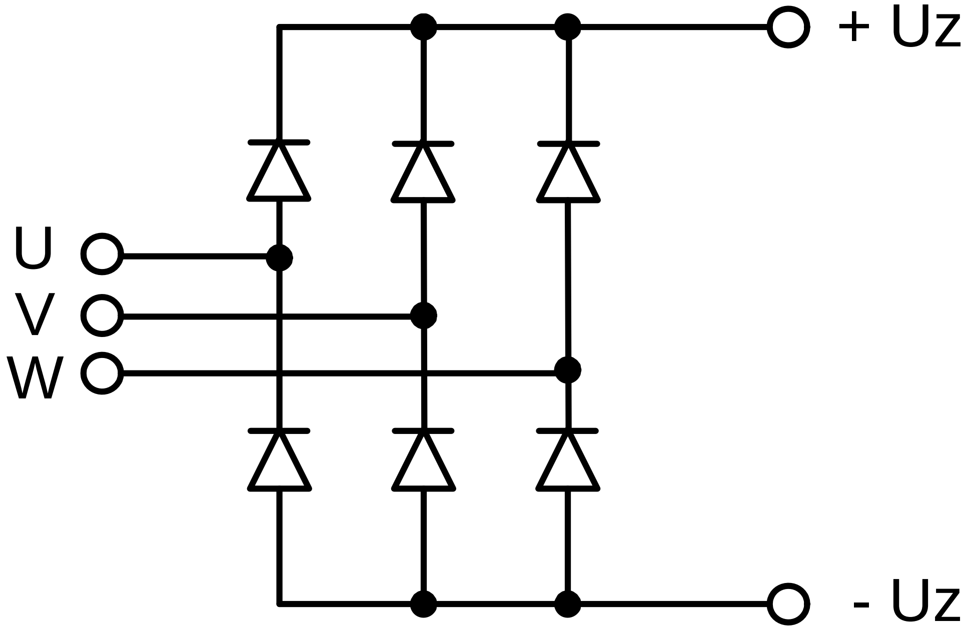
The dc-link voltage of non-controlled bridge rectifiers for non-regenerative power supply units (UV 130, UV 130 D) is generated with rectifier diodes.

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

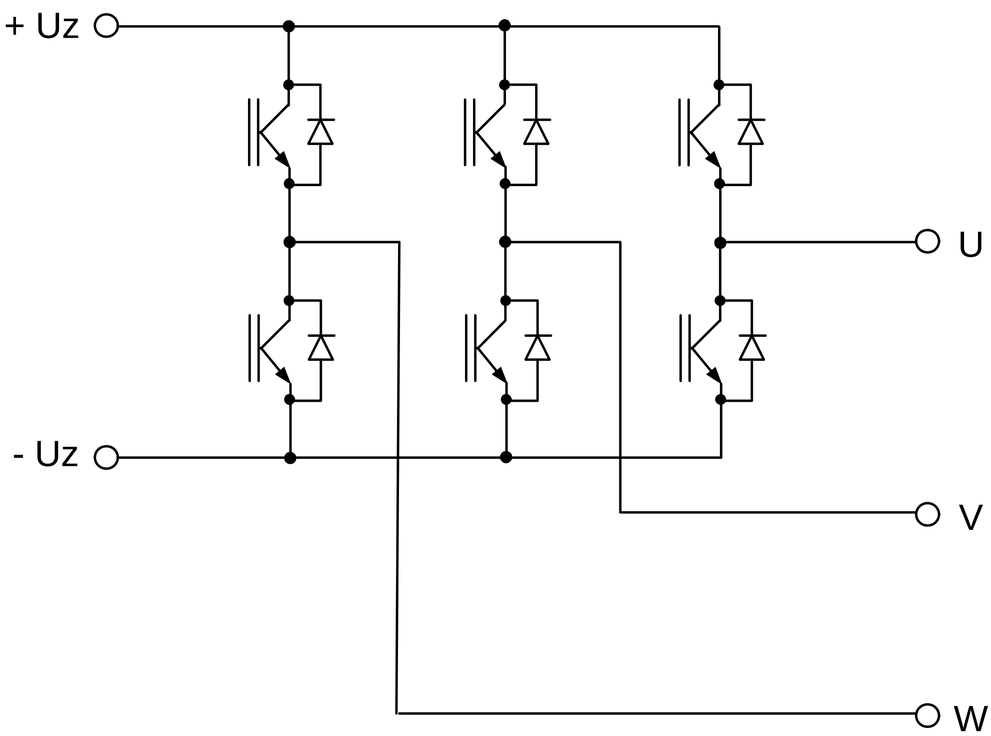
When measuring the diodes, the diffusion voltage (forward voltage) of these diodes is measured.

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: Noncontrolled bridge rectifier



Block diagram: Controlled bridge rectifier with IGBTs

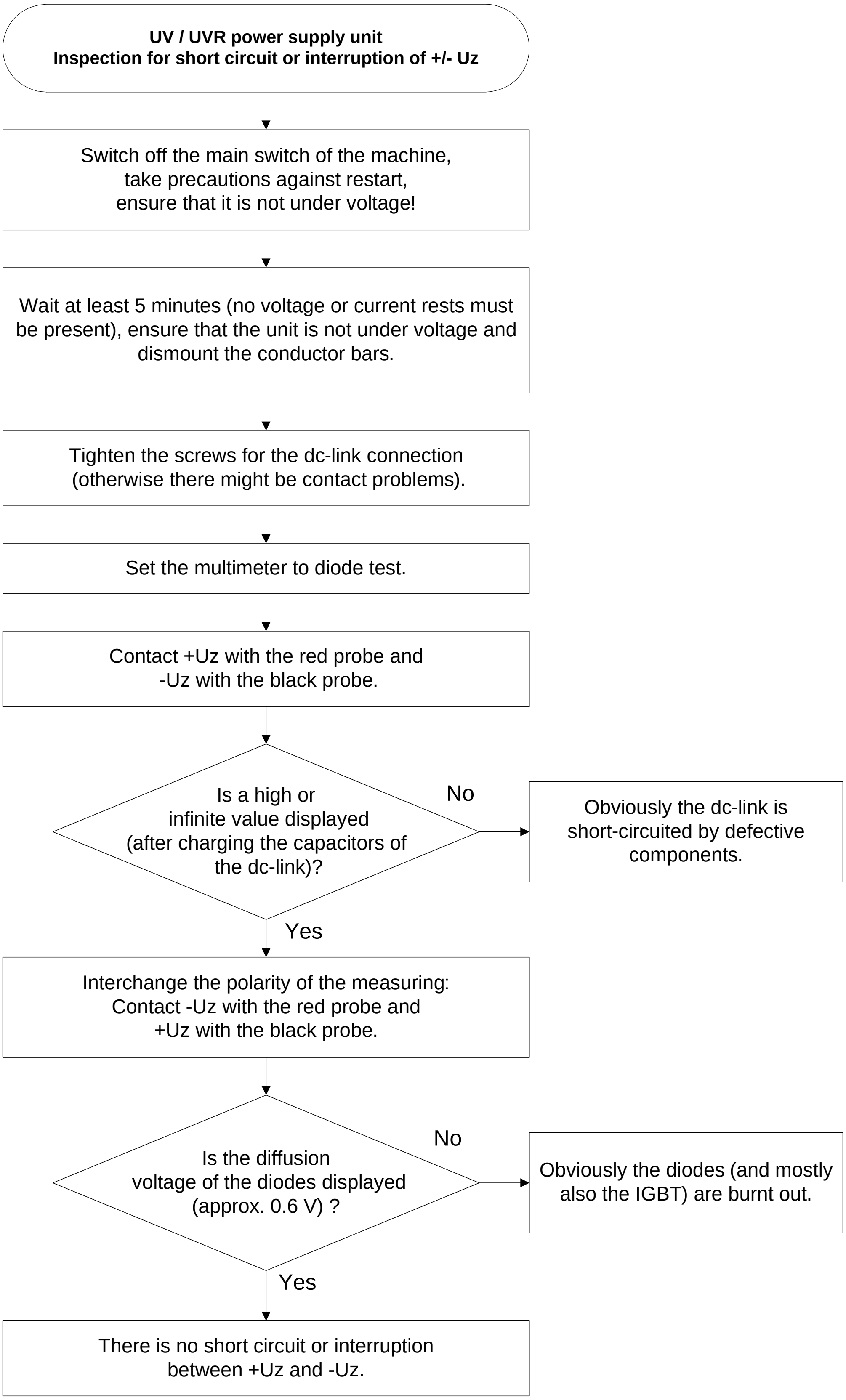


Execution

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!

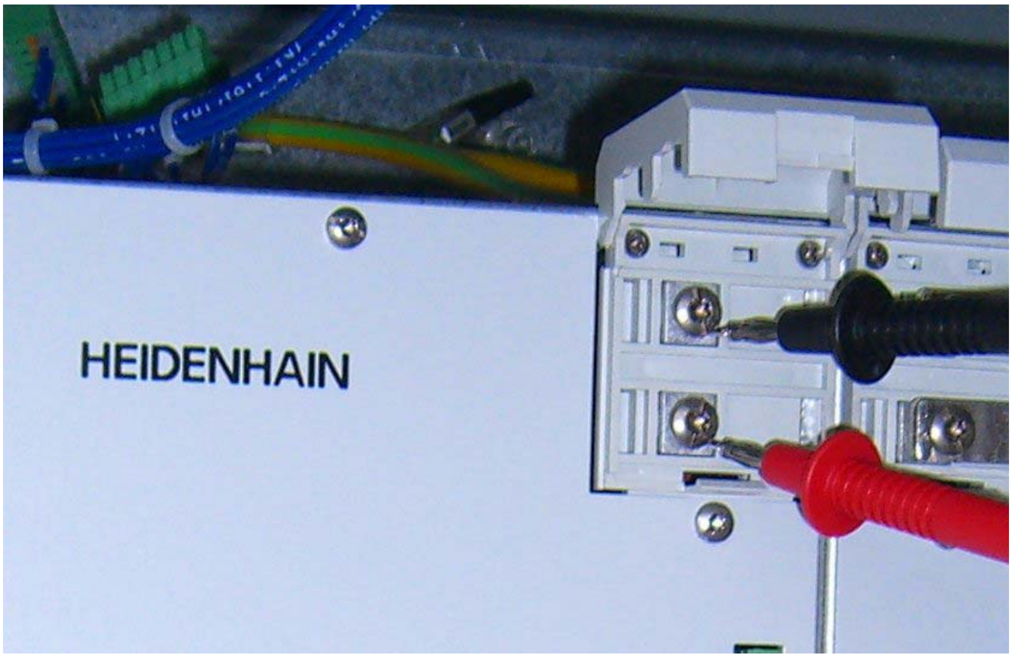
Flowchart


UV / UVR power supply unit
Inspection for short circuit or interruption of +/- Uz
Switch off the main switch of the machine, take precautions against restart, ensure that it is not under voltage!
Wait at least 5 minutes (no voltage or current rests must be present), ensure that the unit is not under voltage and dismount the conductor bars.
Tighten the screws for the dc-link connection (otherwise there might be contact problems).
Set the multimeter to diode test.
Contact +Uz with the red probe and -Uz with the black probe.
Is a high or infinite value displayed (after charging the capacitors of the dc-link)?
No
Obviously the dc-link is short-circuited by defective components.
Yes
Interchange the polarity of the measuring: Contact -Uz with the red probe and +Uz with the black probe.
Is the diffusion voltage of the diodes displayed (approx. 0.6 V) ?
No
Obviously the diodes (and mostly also the IGBT) are burnt out.
Yes
There is no 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.

Photo: Diode measurement



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 contaminated devices are still functioning, might fail soon.

Fault repair

Inverters with short circuits or interruptions must be replaced
--> see “Exchanging the Complete Inverter” on page 10 – 178.

Severely contaminated inverters

In case you do not detect a short circuit, there might still be short circuits in the inverter if it is severely contaminated (this can be seen best in the area of the fan).
With regard to the operating safety, please send severely 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.

Photo: 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

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) is used 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.

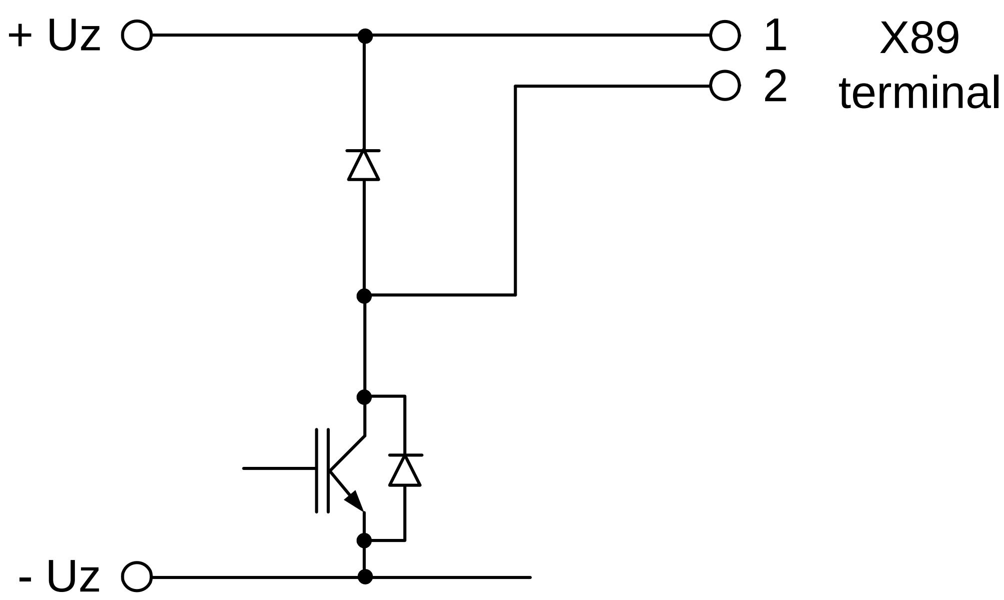
If the diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the braking resistor switch also functions.

Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential, see “Voltage Test Unit” on page 14 – 333
- Standard commercial **multimeter** that can be set to **"diode test"**.

Block diagram

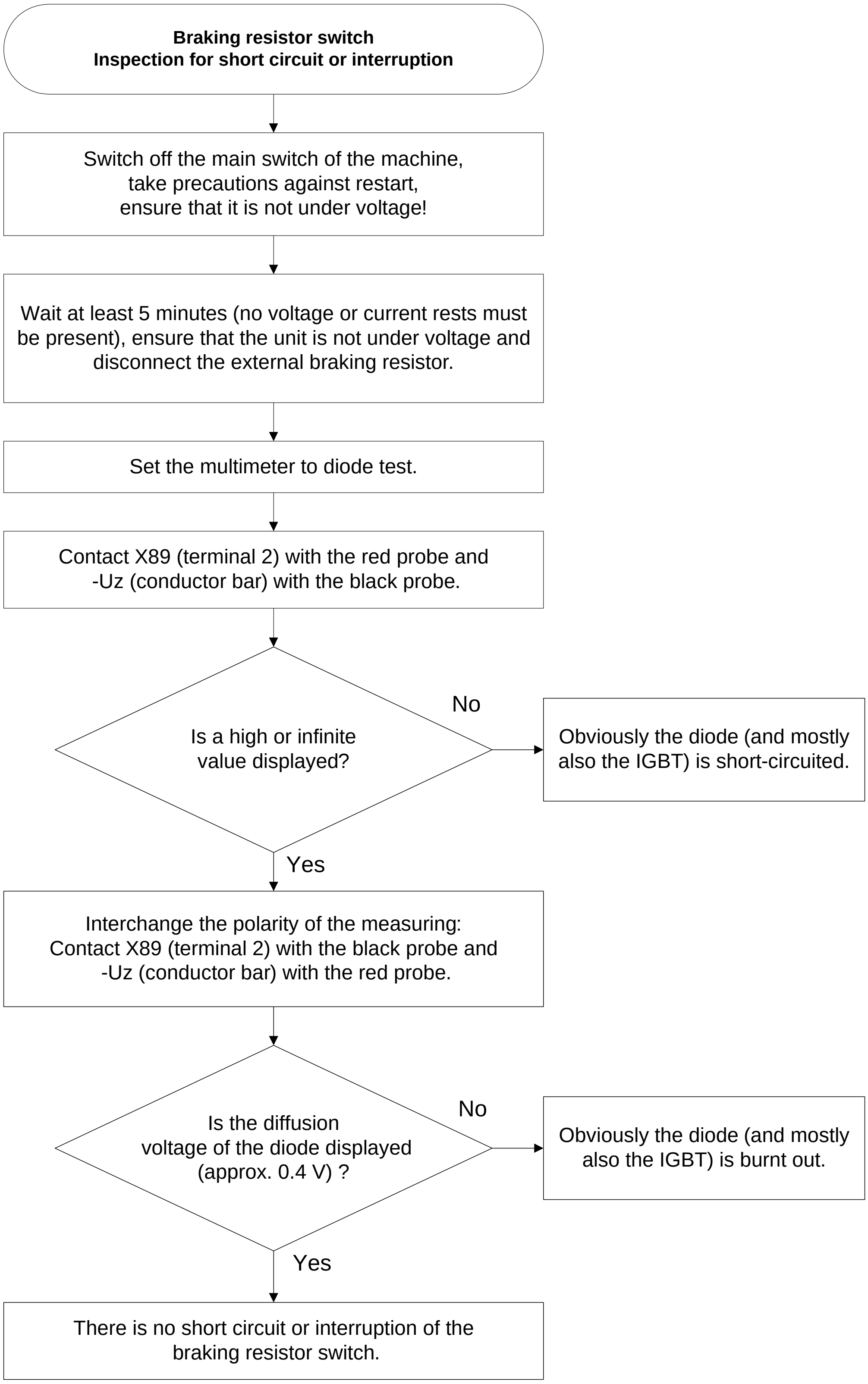
UV 130, 130D:
An external braking resistor is connnected (two braking resistors may also be connected in parallel).



Execution

> **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!

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!

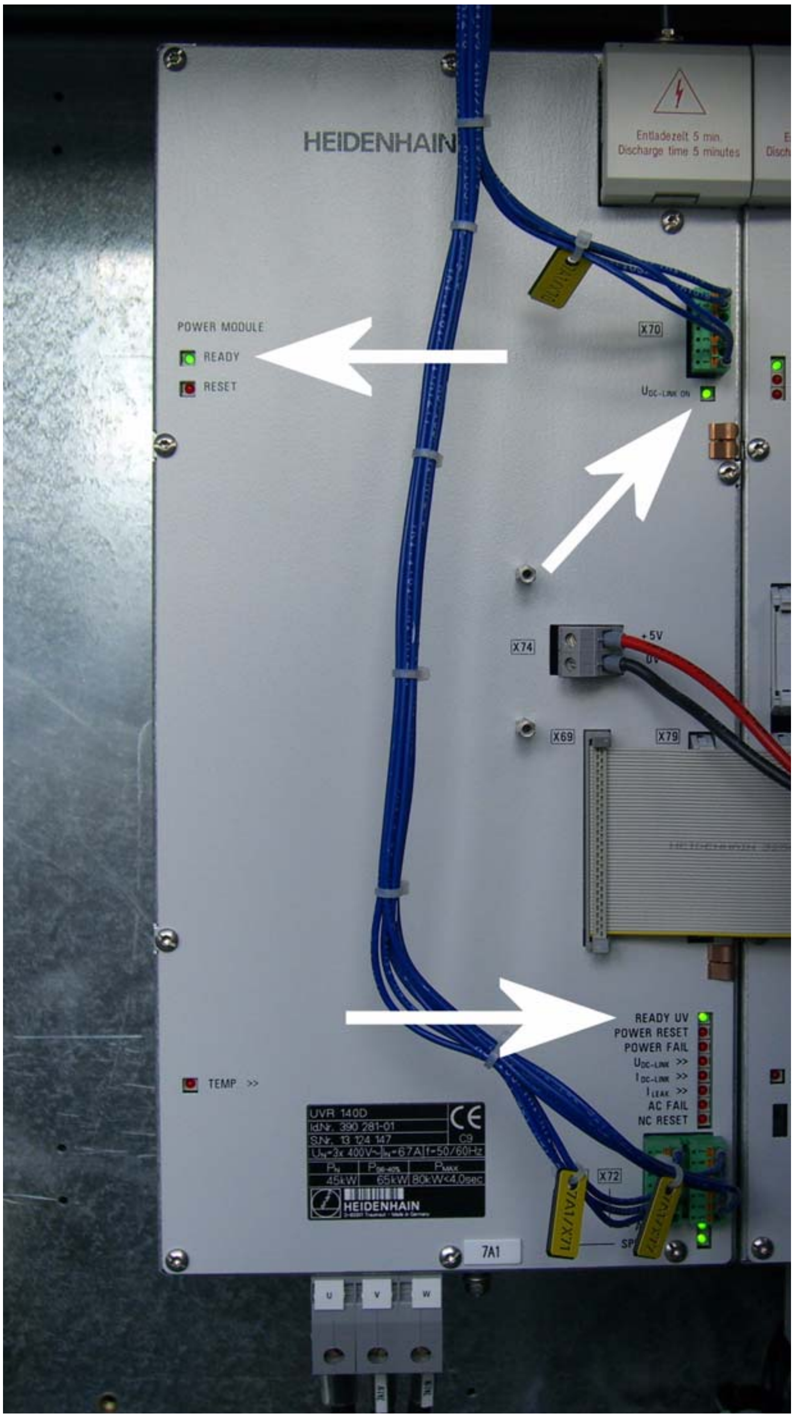


Photo: Green LEDs on the UVR 140D power supply unit

If the mentioned green LEDs are not lit:

▶ Check the voltages. --> see “Checking the Voltages” on page 7 – 82

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 Test Unit" on page 14 – 333.
> Please proceed carefully and concentratedly!

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

> **Note**
>
> When performing measurements on regenerative devices a 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 unsymmetries > 10 % or if one or several phases are missing:

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

24 Vdc 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 a 24 V control voltage is present on contact 3 (between contact 2 or 0 V) of connector X70.

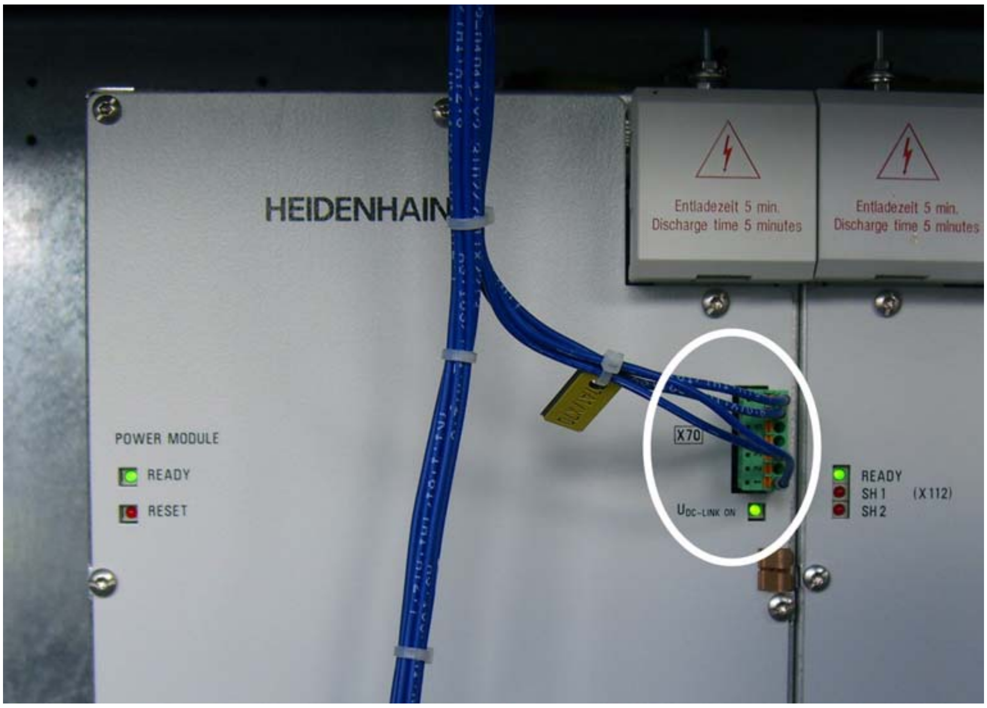


Photo: Connector X70 on the UVR 140 D power supply unit

> **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 Test Unit" on page 14 – 333.
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!

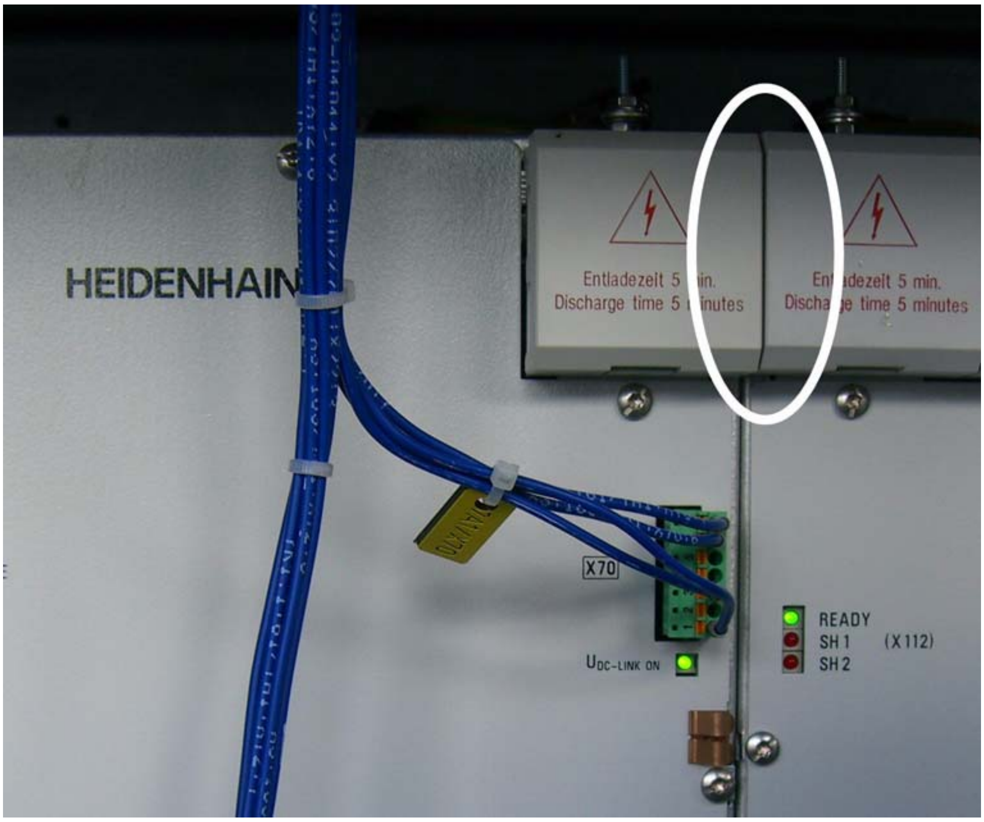


Photo: Protective covers over the conductor bars

If the dc-link voltage is not available:

- Disconnect the power supply unit from the other units and check the functions. --> see "Testing the UV/UVR without connected units" on page 7 – 85.

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.
- Disconnect the following connectors in 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

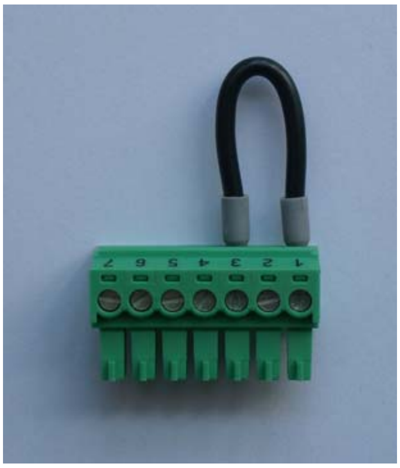
If ground fault and short circuit examinations have been made before, the power supply unit is already disconnected from the periphery.

- 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).
- Insert the connector with a bridge from contact 1 to 3 in X70 (see enabling connector).
- For saftey 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 in order. --> Test the function during operation!

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

Enabling connector

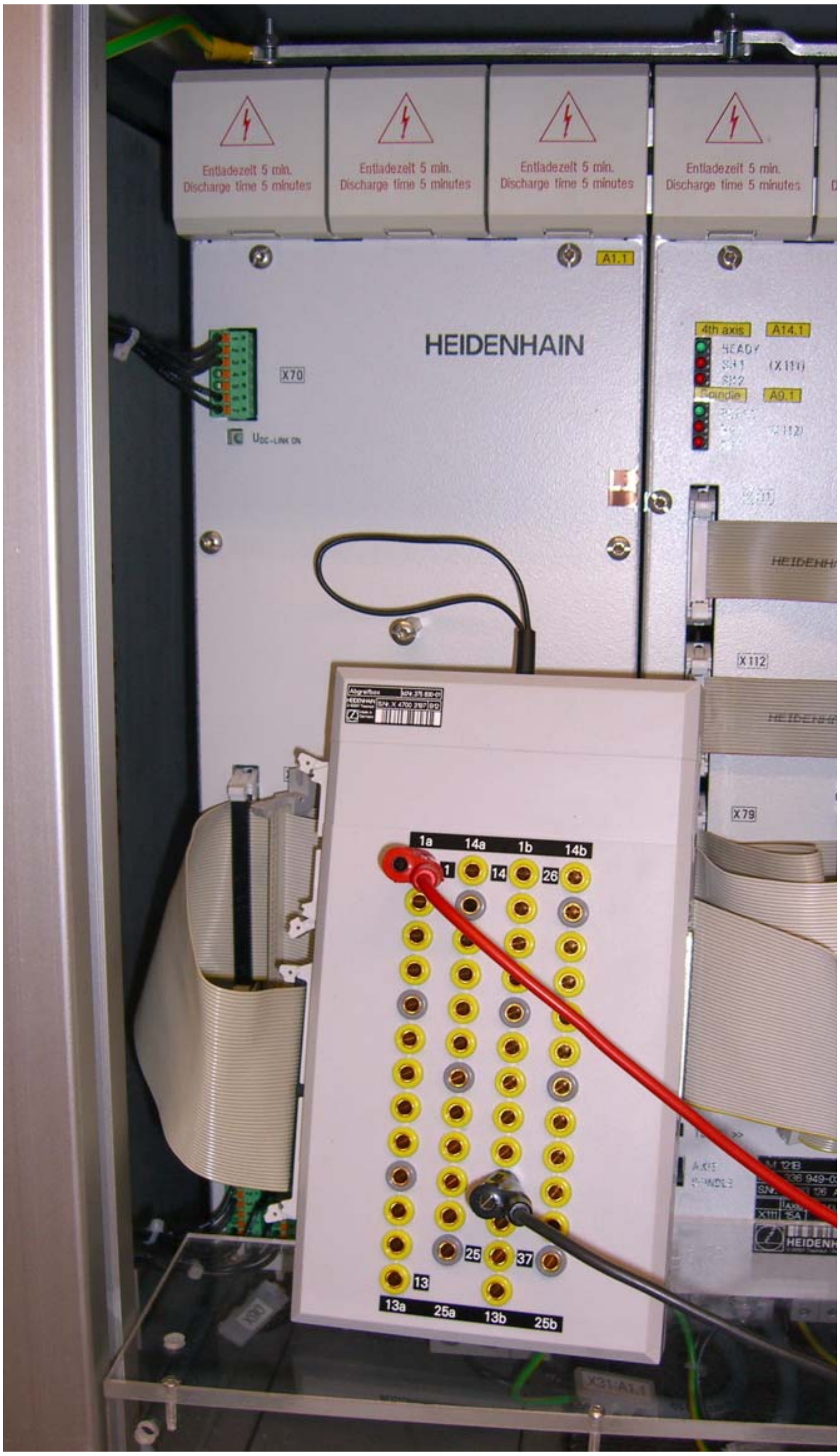


You need the shown connector with bridge from contact 1 to 3 for the described error diagnosis. You can use the original connector if you have marked, unclamped and secured the wires before. You may also order the 7-pin connector ID 282143-02 from HEIDENHAIN and insert a bridge.

Photo:
UV without connected units

Setup with test adapter

If you have a test adapter (see “Test Adapter” on page 14 – 335) you can observe **low voltages and signal conditions during operation** on the power supply bus X69 and the 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 or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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`
- 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 "Trouble Shooting on Ground Fault" on page 6 – 47

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 Test Unit" on page 14 – 333.
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement, see "Insulation Tester" on page 14 – 334.

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**!

Caution

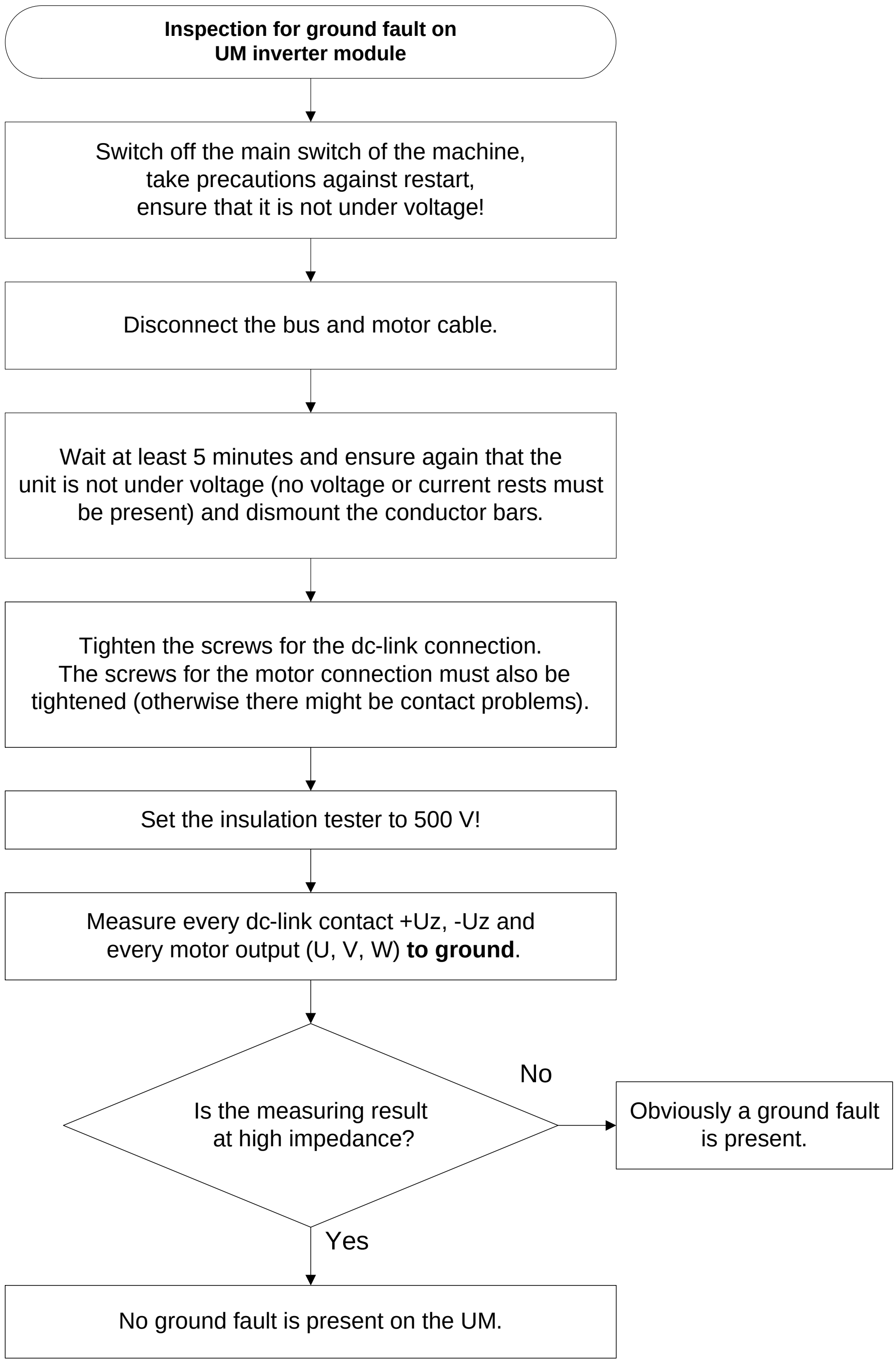
A higher test voltage could damage the inverter!

Execution

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!

Flowchart



Note

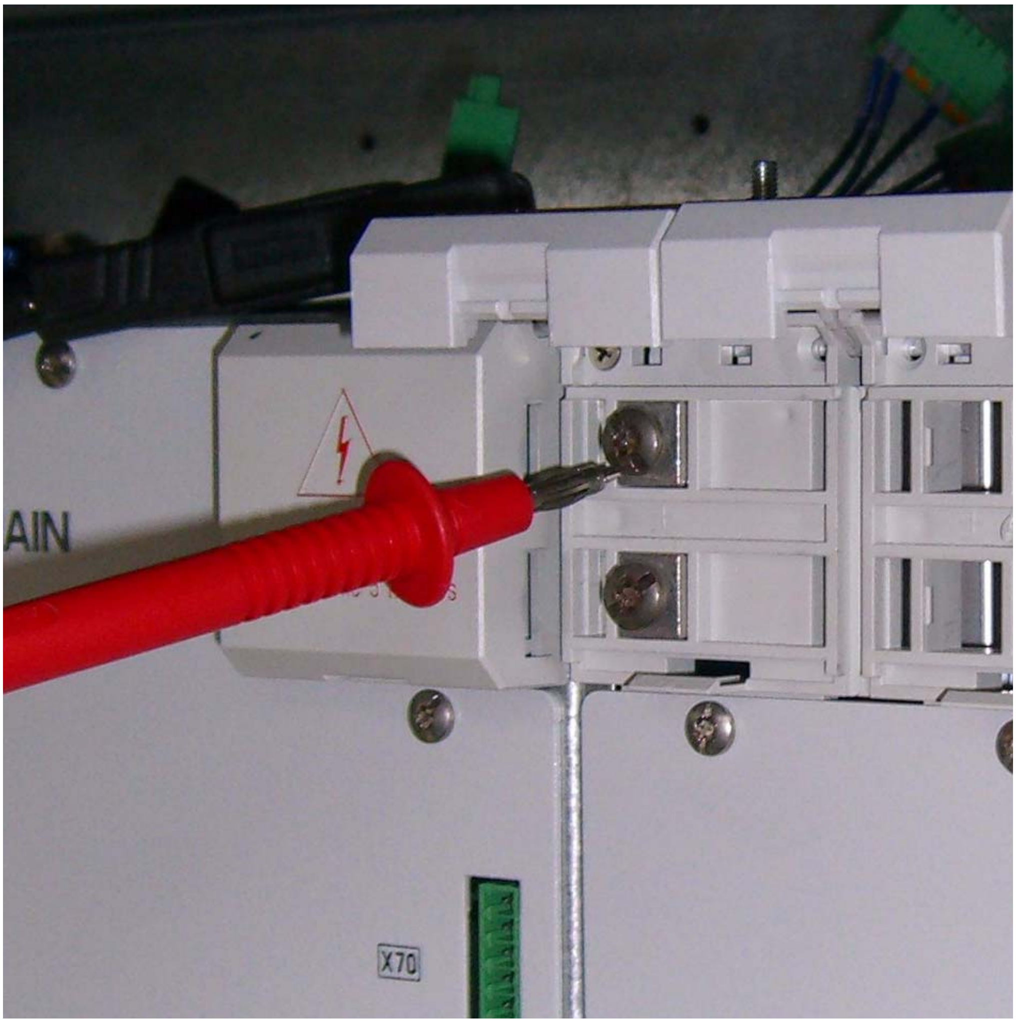
On all UM the **resistance value of the above connectors to ground** must be at **high-impedance** (experience has shown that the measured values are in the **gigaohm range**)!

Defined resistance values cannot be specified here as they depend on the "inner life" of the inverter and the specifications of the insulation tester. If possible, you can compare the measured values with 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!

Photo: Ground fault measuring



Fault repair

Inverters with ground faults must be replaced. -->
see “Exchanging the Complete Inverter” on page 10 – 178.

Severely contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on severely contaminated inverters (this can be seen best in the area of the fan).
With regard to the operating safety, please send severely contaminated inverters for cleaning to a HEIDENHAIN agency.

7.6.2 Inspection for Short Circuit or Interruption

A ground fault or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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`
- 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 – 88

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 Test Unit" on page 14 – 333.
- Standard commercial **multimeter** that can be set to **"diode test"**.

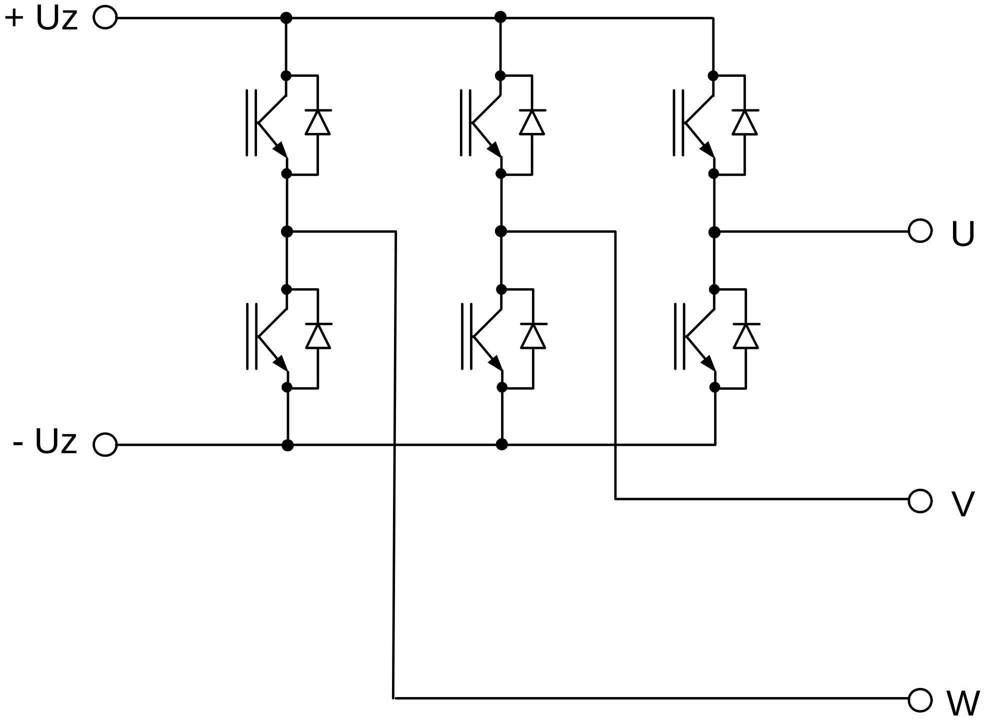
Diode measurement

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!

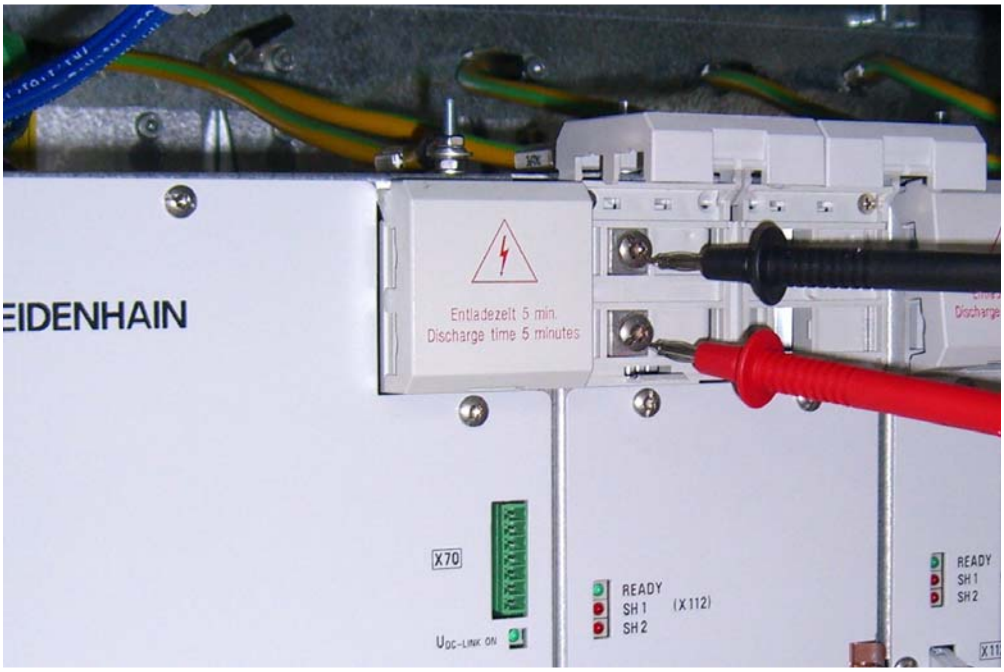
Block diagram:
IGBT



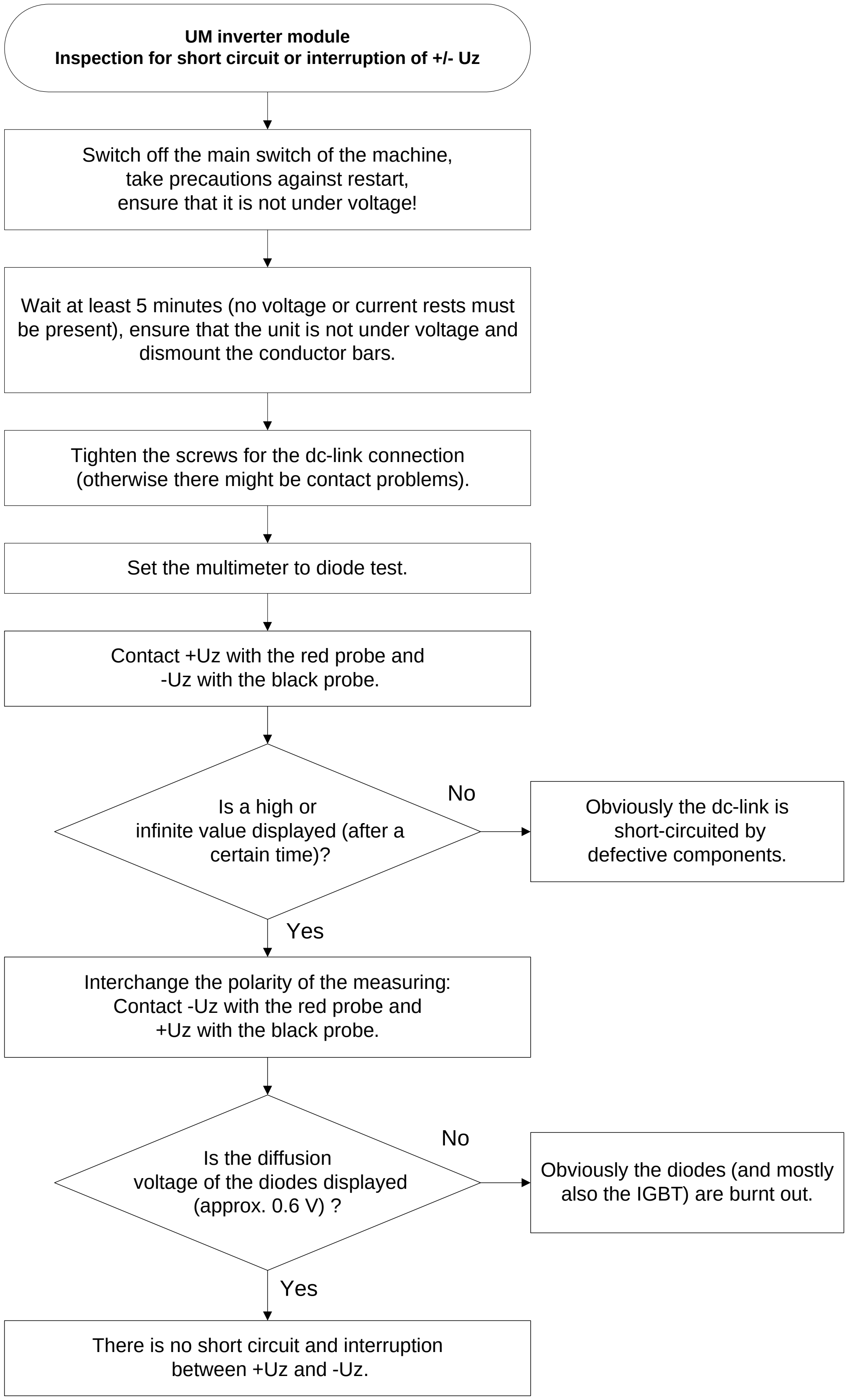
Execution

> **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!

Photo:
Diode measurement +/- Uz



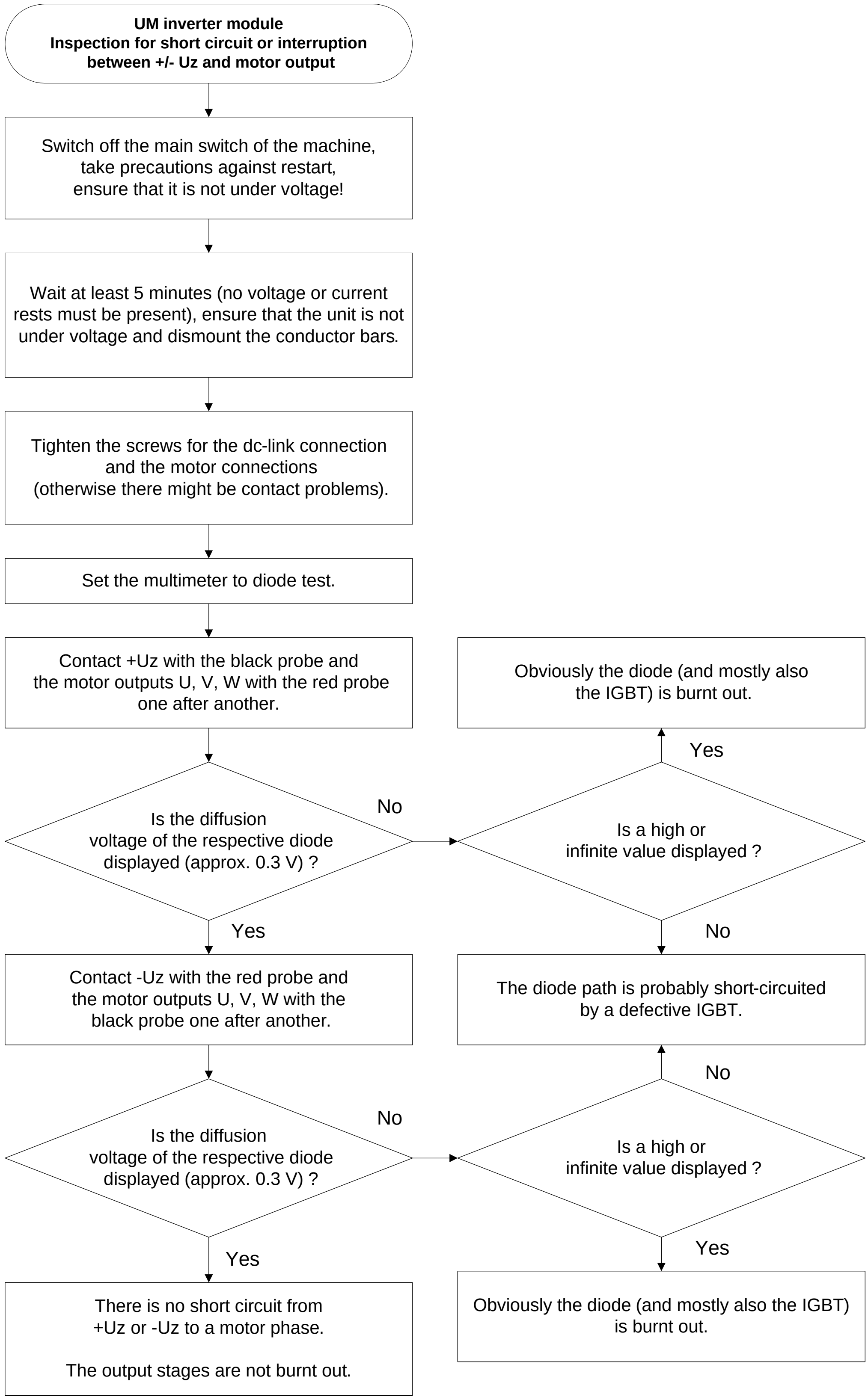
Flowchart: Short circuit or interruption between +Uz and -Uz



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.

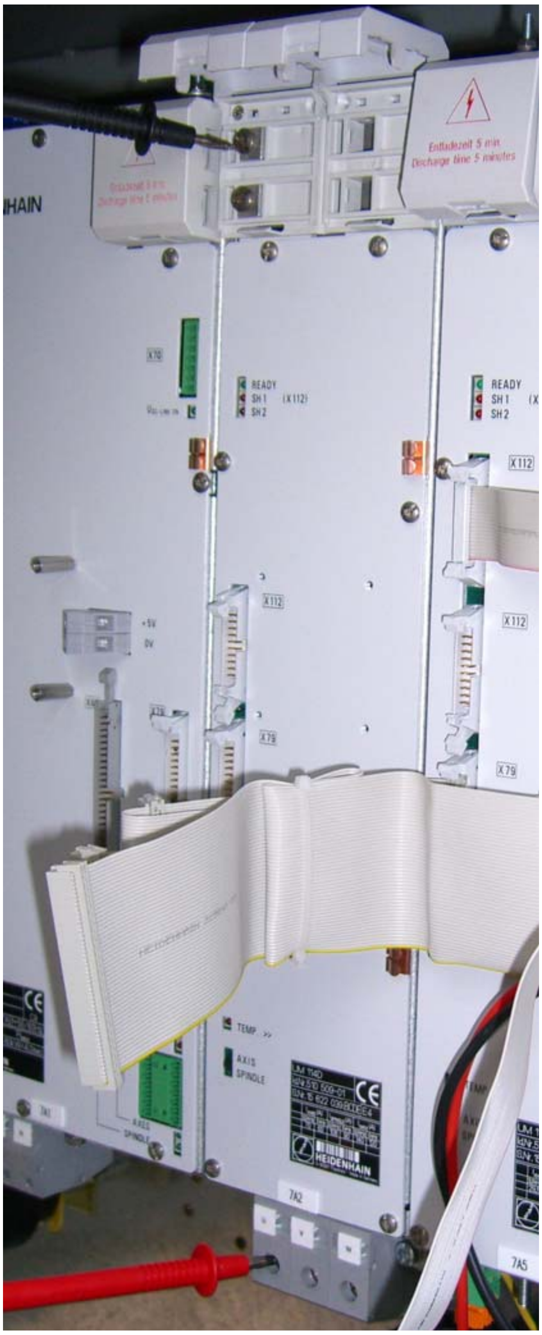
Flowchart:
Short circuit or interruption between +/- Uz and motor output



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.

Photo: Diode measurement Uz on motor output



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.

Fault repair

Inverters with short circuits or interruptions must be replaced.
--> see "Exchanging the Complete Inverter" on page 10 – 178!

Severely 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 severely contaminated (this can be seen best in the area of the fan). With regard to the operating safety, please send severely 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!

When the axis or the spindle are still operating, the red LEDs **SH1** and **SH2** must not be lit!

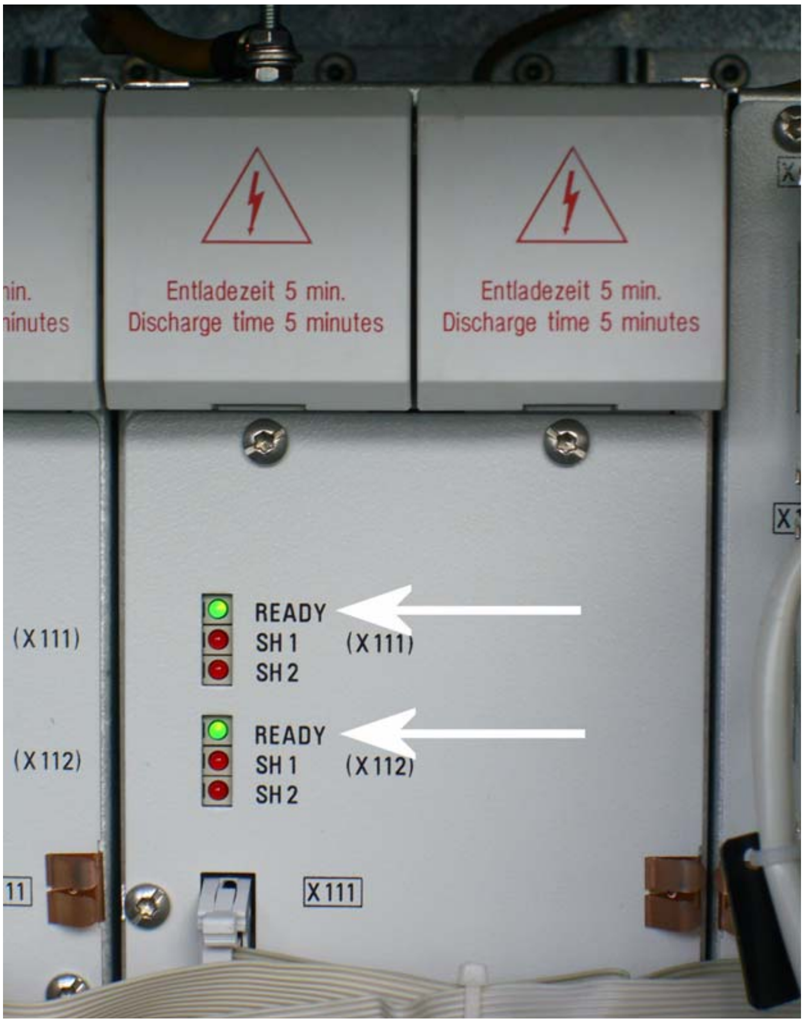


Photo: Green LEDs on the UM 121 B power module

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.

Photo: LEDs for axis 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.

Caution

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.

Caution

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 (between 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 Test Unit" on page 14 – 333.
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!

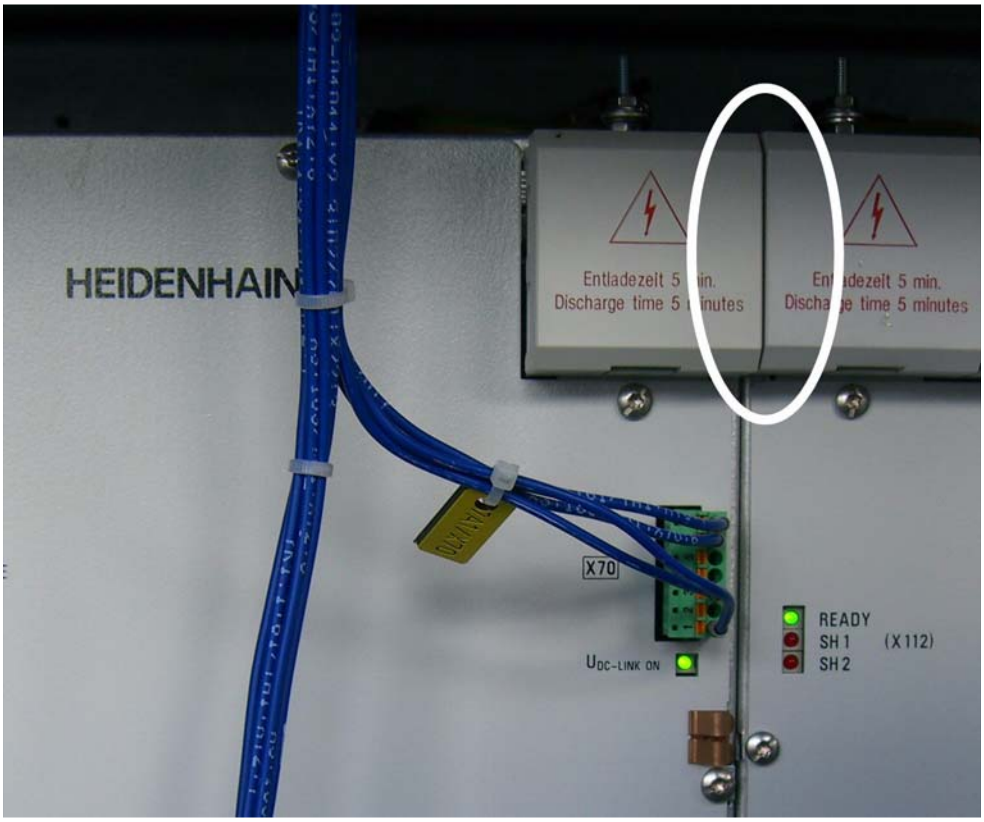


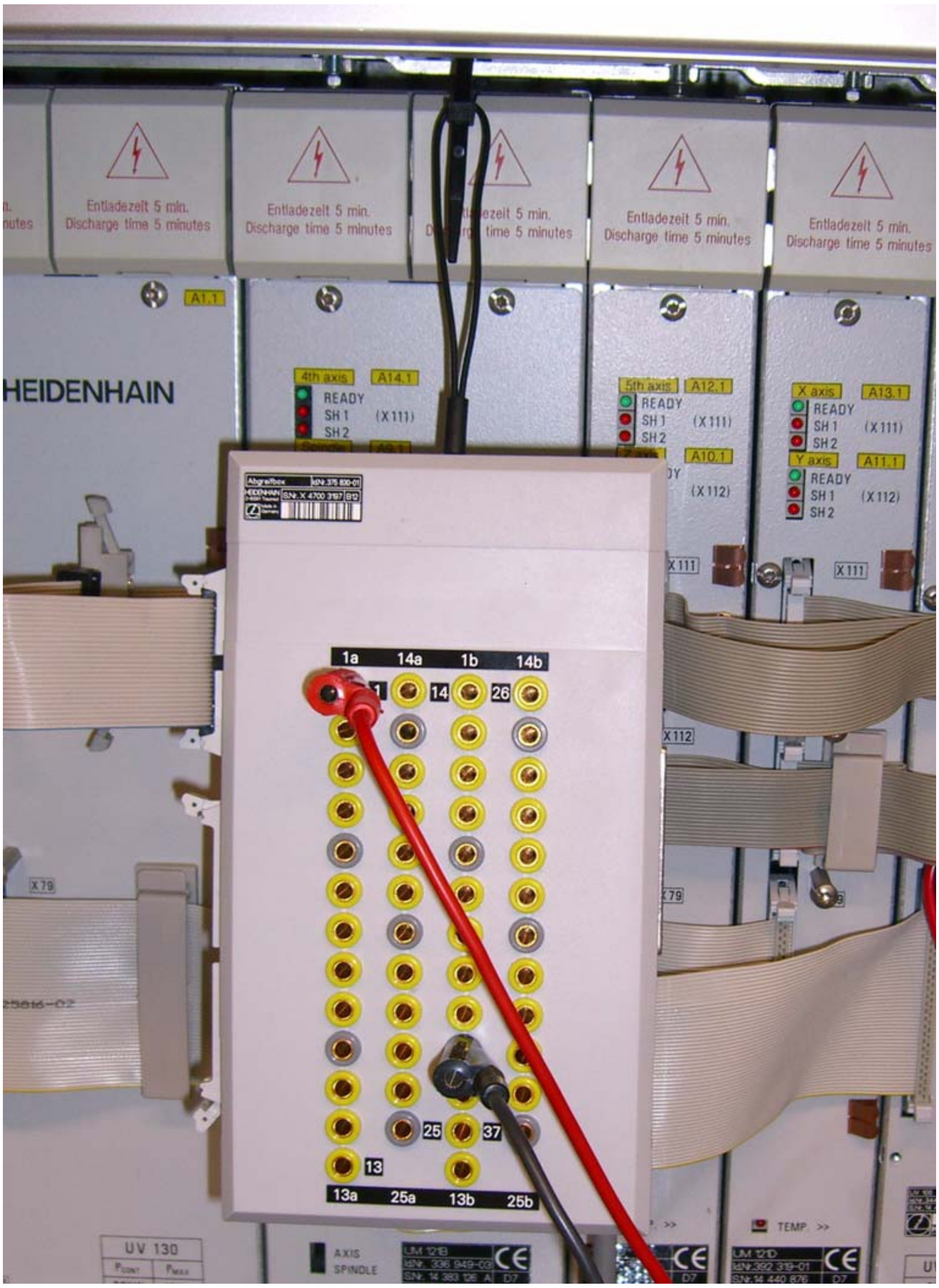
Photo: Protective covers over the conductor bars

If the dc-link voltage is not available:

- Examine the UV or UVR power supply unit. --> see "Checking the Voltages" on page 7 – 82.

Setup with test adapter

If you have a test adapter (see “Test Adapter” on page 14 – 335) 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 Exchanging Power Modules or Output Stages of the Same Type

General

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)
- 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

Caution

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 “Trouble Shooting on Ground Fault” on page 6 – 47, see “Inspection for Winding Short Circuit or Interruption” on page 6 – 50.

DANGER

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

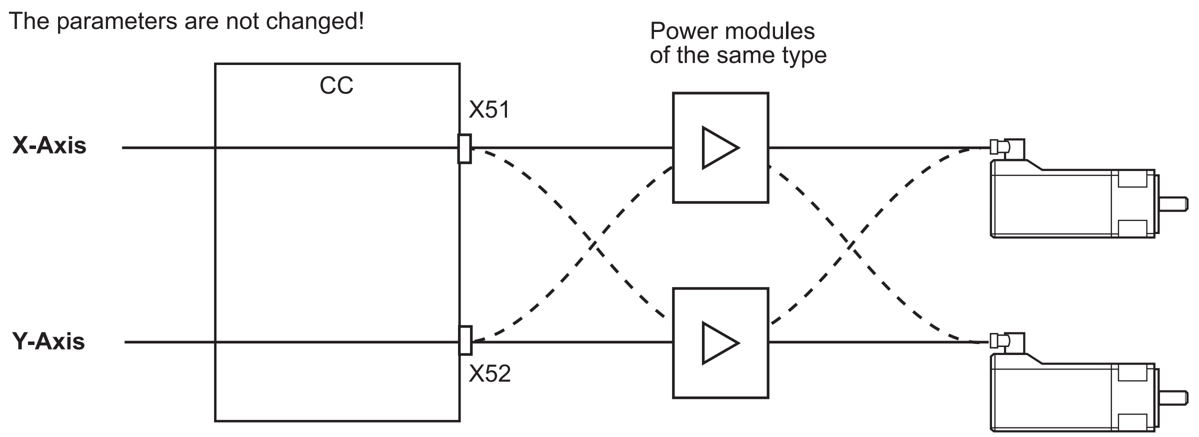
DANGER

Danger of electrical shock!
Make sure that the main switch of the machine is switched off and that any 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 **Y-axis**

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

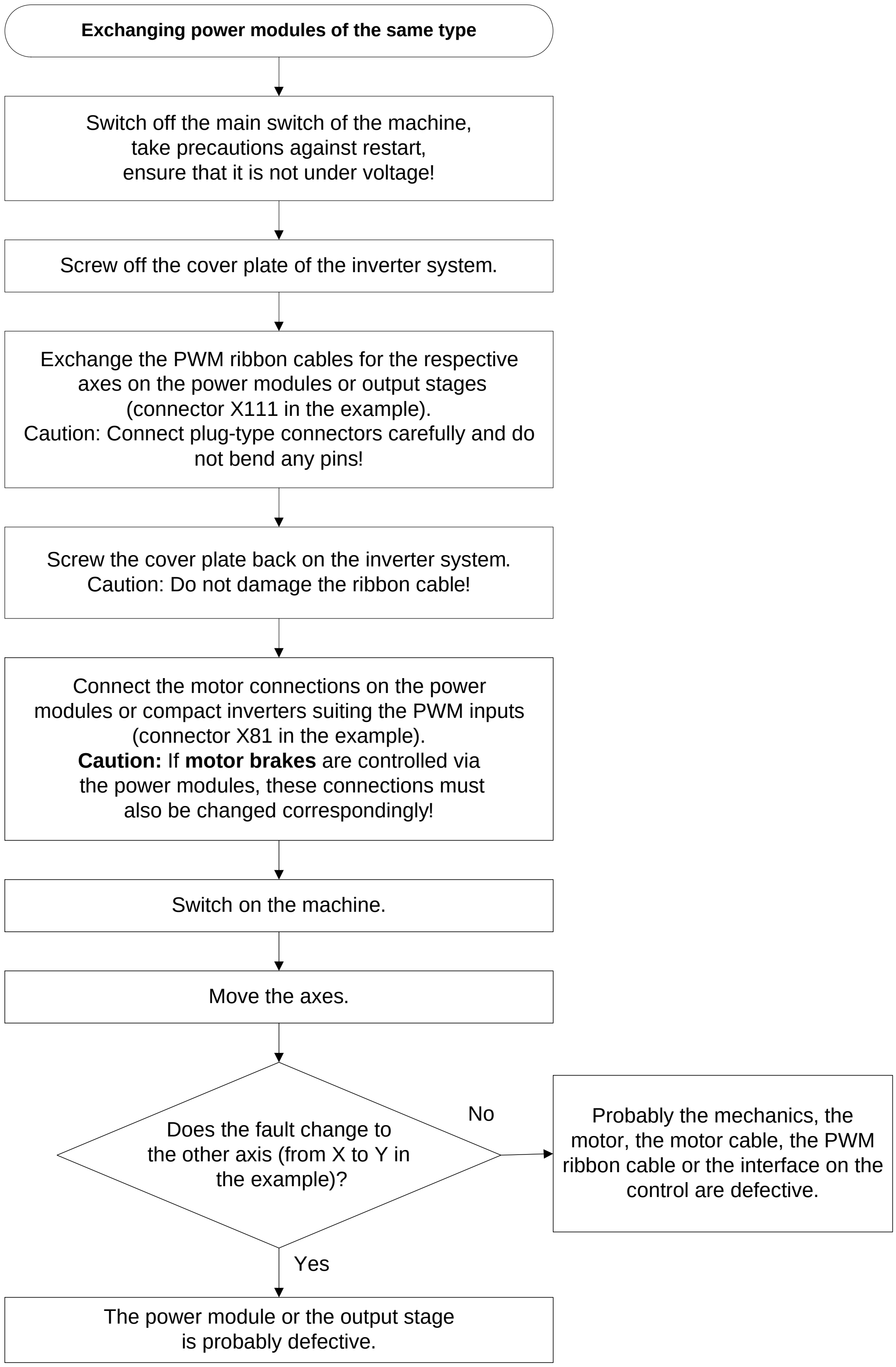
Block diagram for two 1-axis modules



Caution

If motor brakes are connected to the power modules, they must also be replaced (X392 --> see "Connector Designation and Layout" on page 12 – 229)!
Motor brakes can be connected to current HEIDENHAIN inverter modules and compact inverters. The motor brake is 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

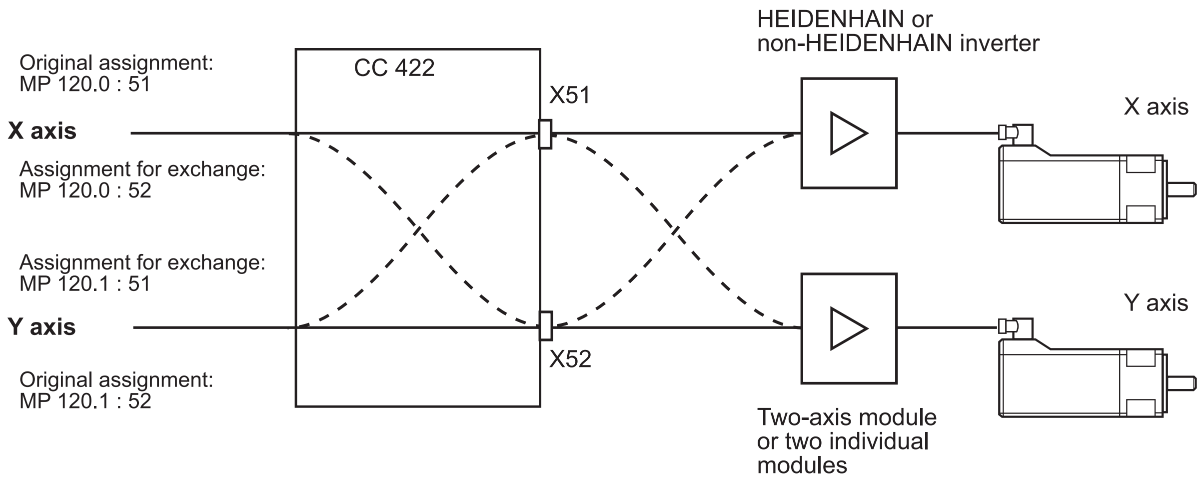


7.6.6 Exchanging the PWM Interfaces

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 type of control. 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 or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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`
- 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 “Trouble Shooting on Ground Fault” on page 6 – 47

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 divider

Potential dividers for the **dc-link voltage measurement** are integrated in the compact inverters (UR, UE xxx B, except UE xxx). These potential dividers consist of resistors connected in series. The resistors are included when the isolation voltage 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 Test Unit” on page 14 – 333.
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement. see “Insulation Tester” on page 14 – 334.

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**!

Caution

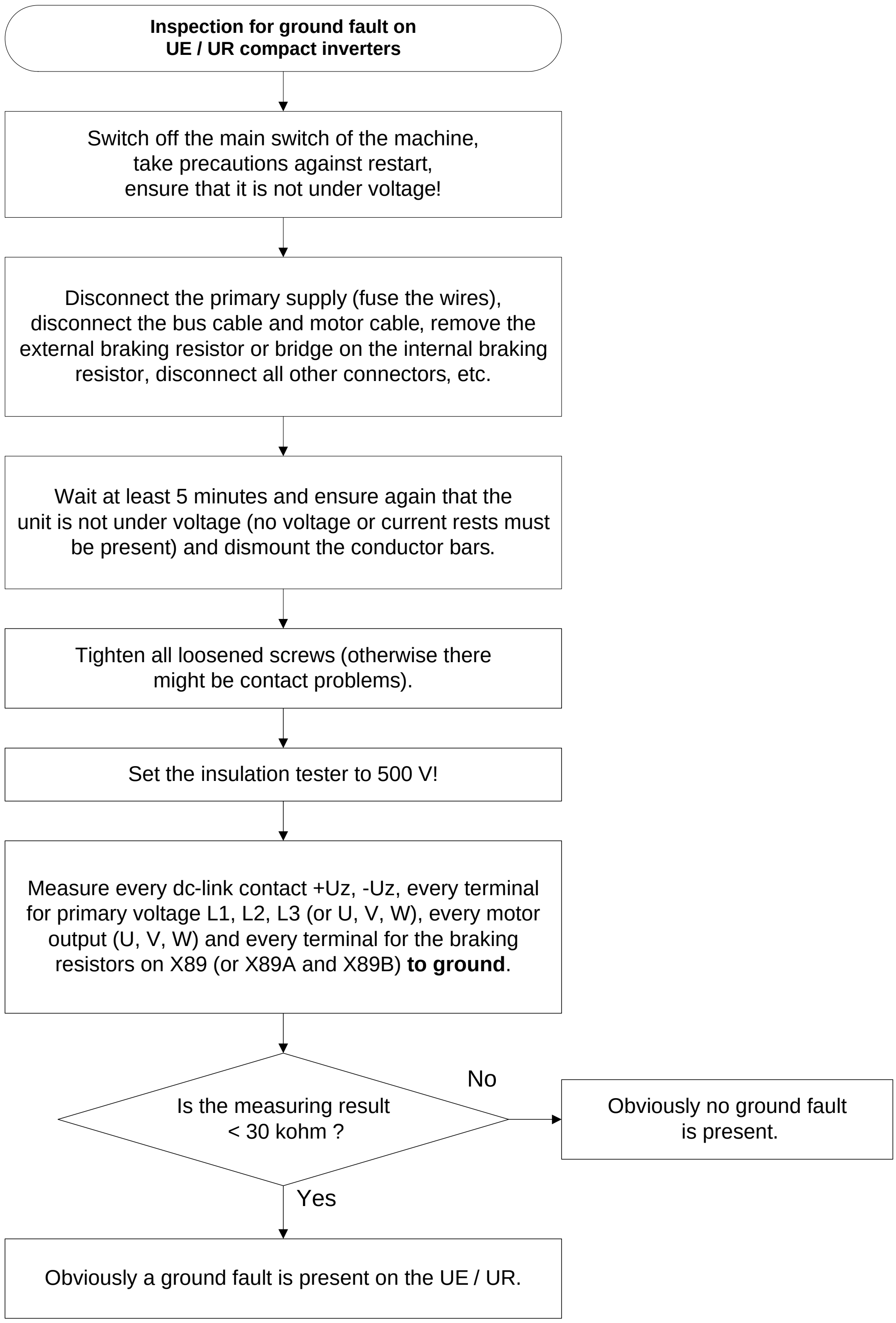
A higher test voltage could damage the inverter!

Execution

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!

Flowchart



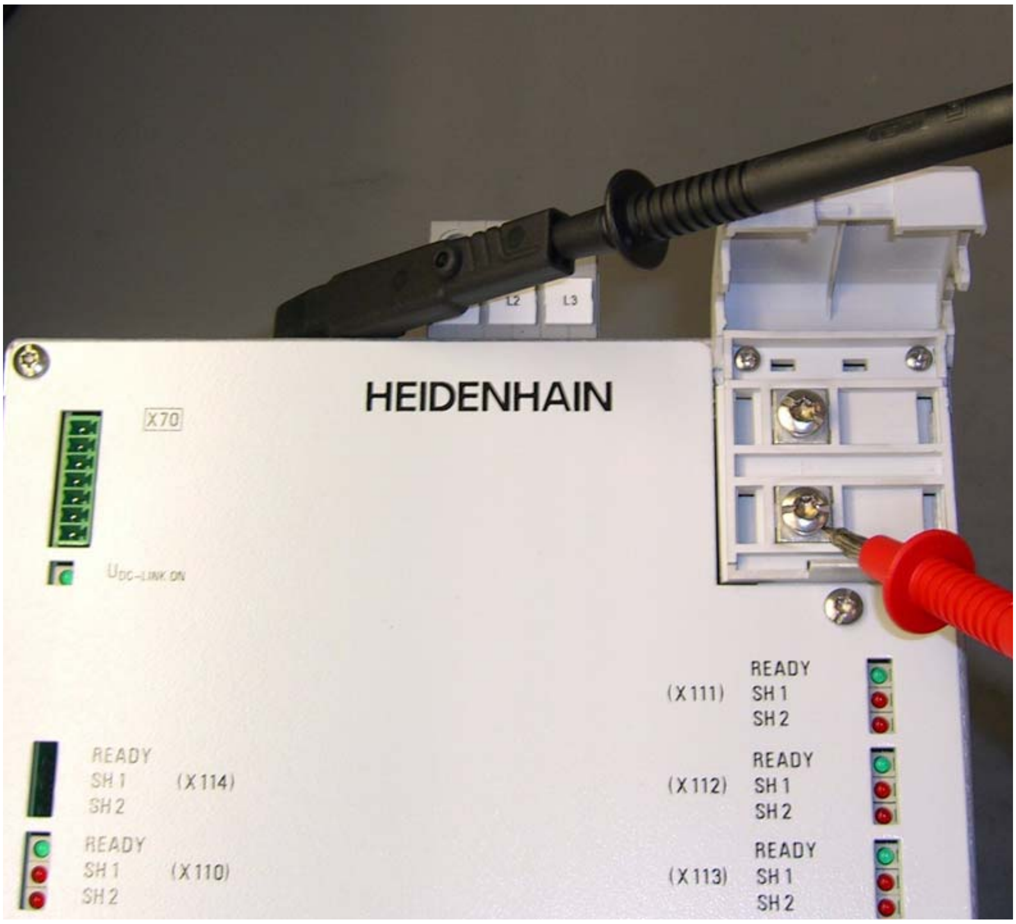
Note

Defined resistance values cannot be specified here as they depend on the "inner life" of the inverter and the specifications of the insulation tester. If possible, you can compare the measured values with 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!

Photo: Ground fault measuring



Fault repair

Inverters with ground faults must be replaced. -->
see “Exchanging the Complete Inverter” on page 10 – 178.

Severely contaminated inverters

If you do not detect a ground fault, it might still be possible that unwanted leakage currents occur on severely contaminated inverters (this can be seen best in the area of the fan).
With regard to the operating safety, please send severely contaminated inverters for cleaning to a HEIDENHAIN agency.

7.7.2 Inspection for Short Circuit or Interruption

A ground fault or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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`
- 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 – 104

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 Test Unit" on page 14 – 333
- 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.

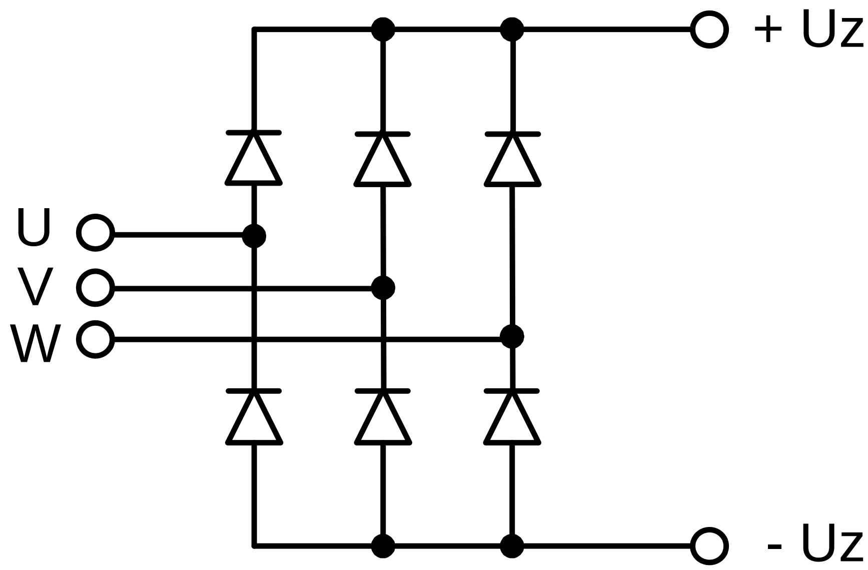
The dc-link voltage of controlled bridge rectifiers for regenerative compact inverters is generated with IGBTs (Isolated Gate Bipolar Transistor). Every IGBT is combined with an antiparallel connected diode.

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

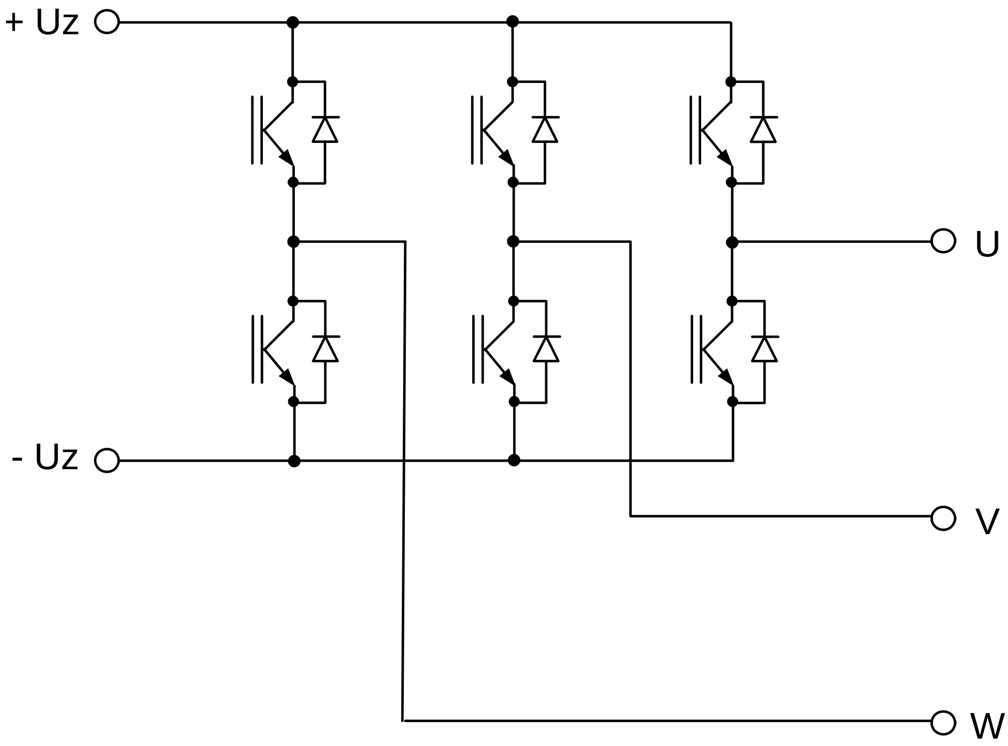
When measuring the diodes, the diffusion voltage (forward voltage) of these diodes is measured.

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: Noncontrolled bridge rectifier



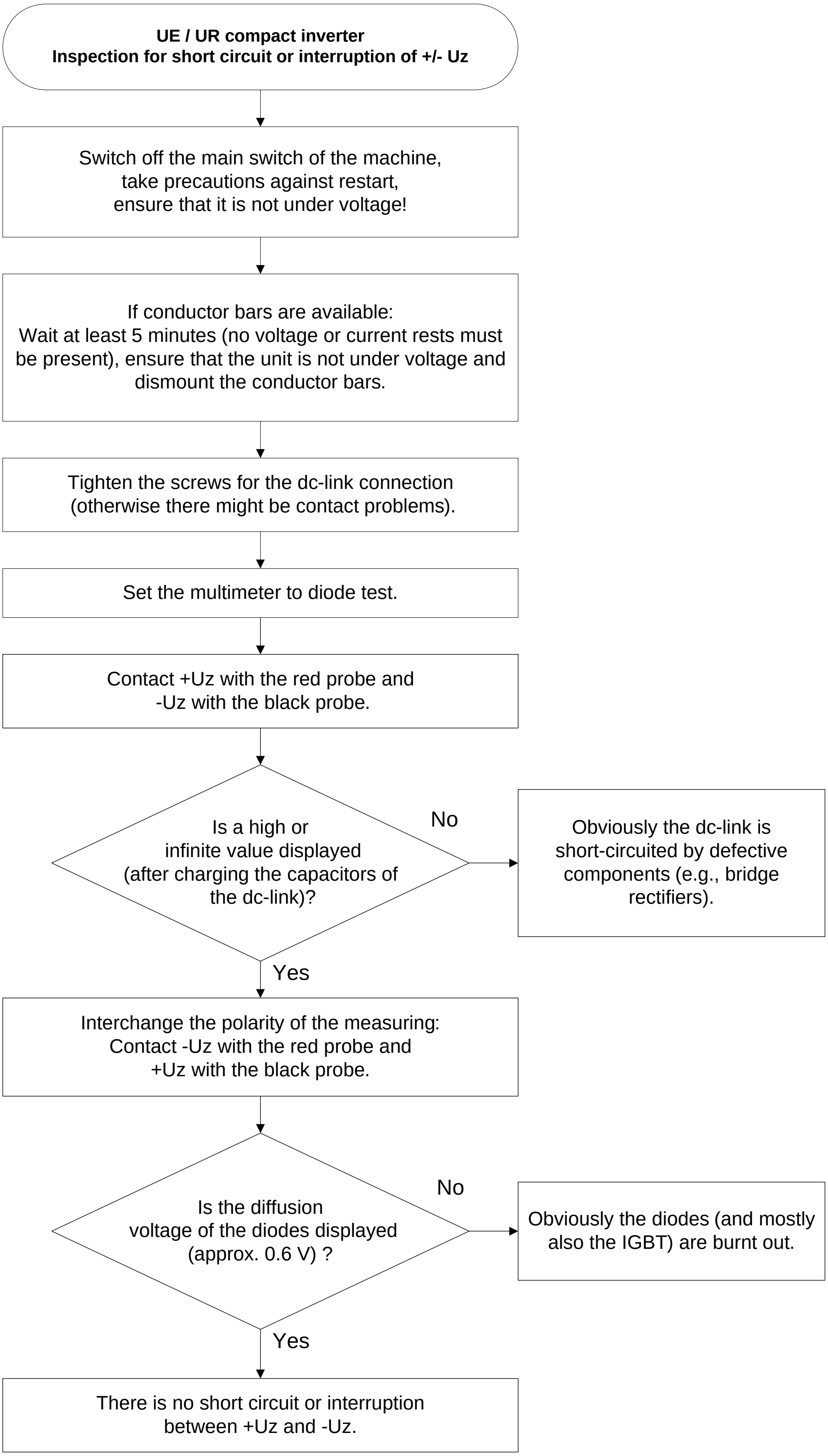
Block diagram: IGBT for controlled bridge rectifier and output stage



Execution

> **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!

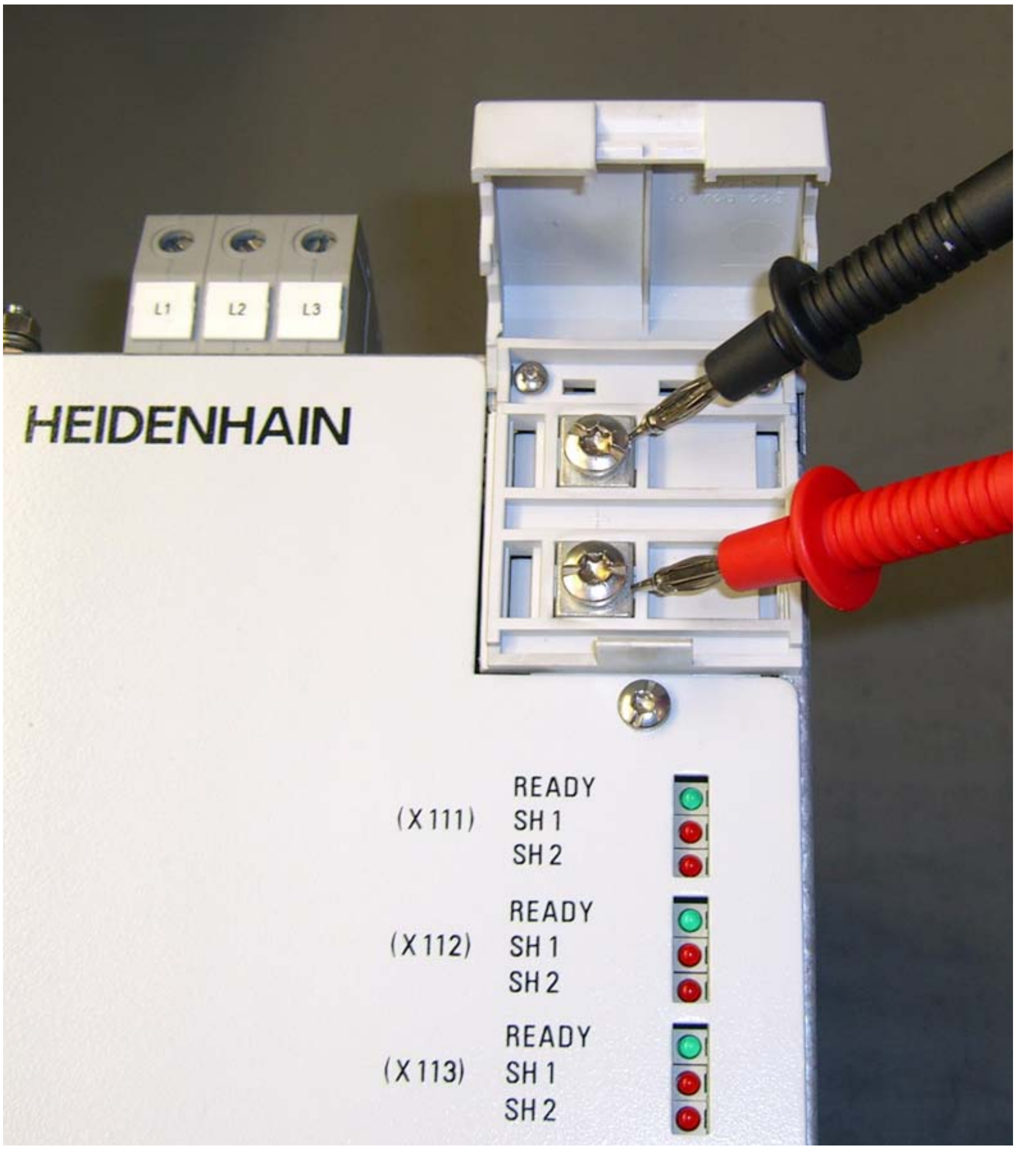
Flowchart: Short circuit or interruption between +Uz and -Uz



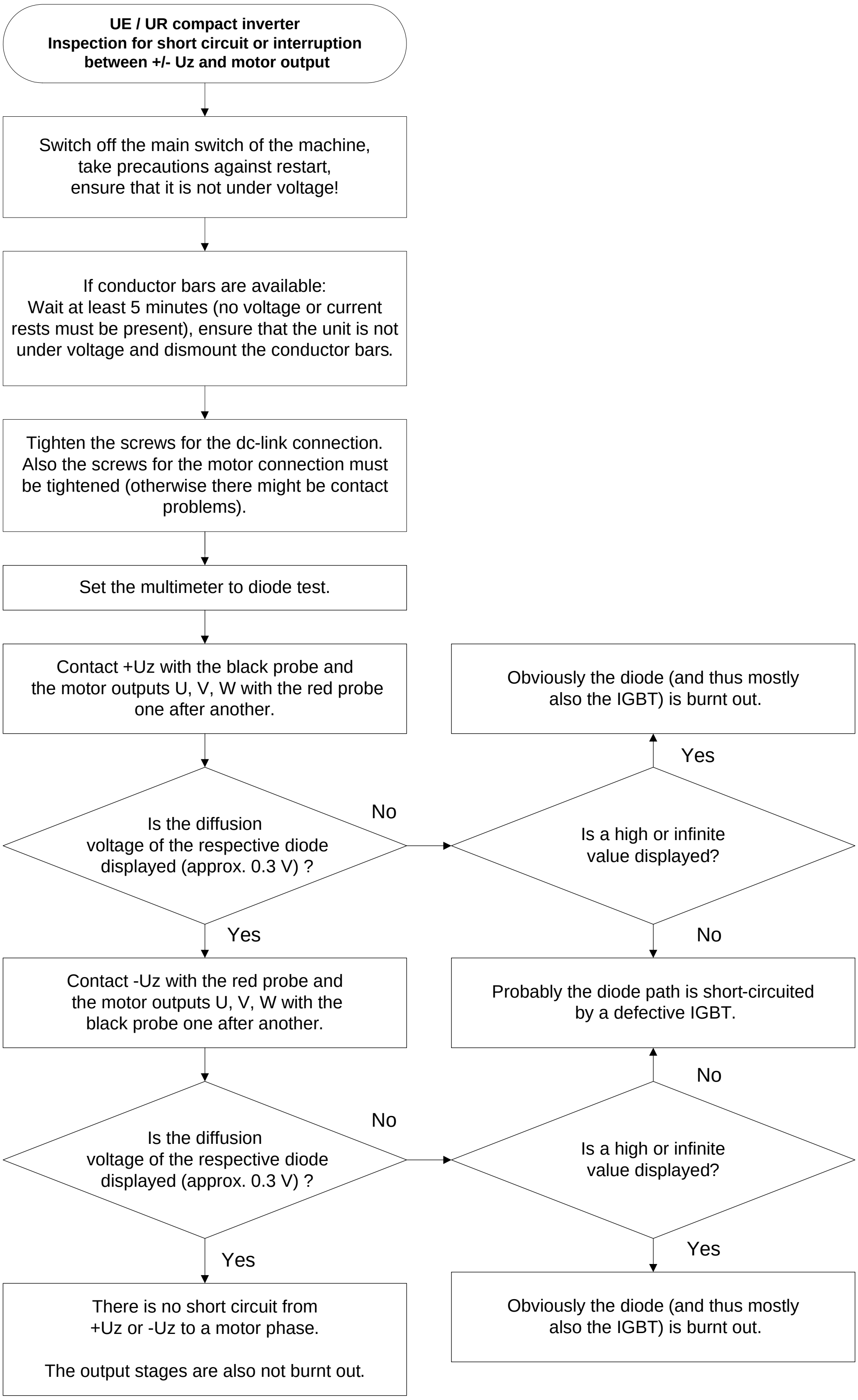
Note

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.

Photo: Diode measurement +/- Uz



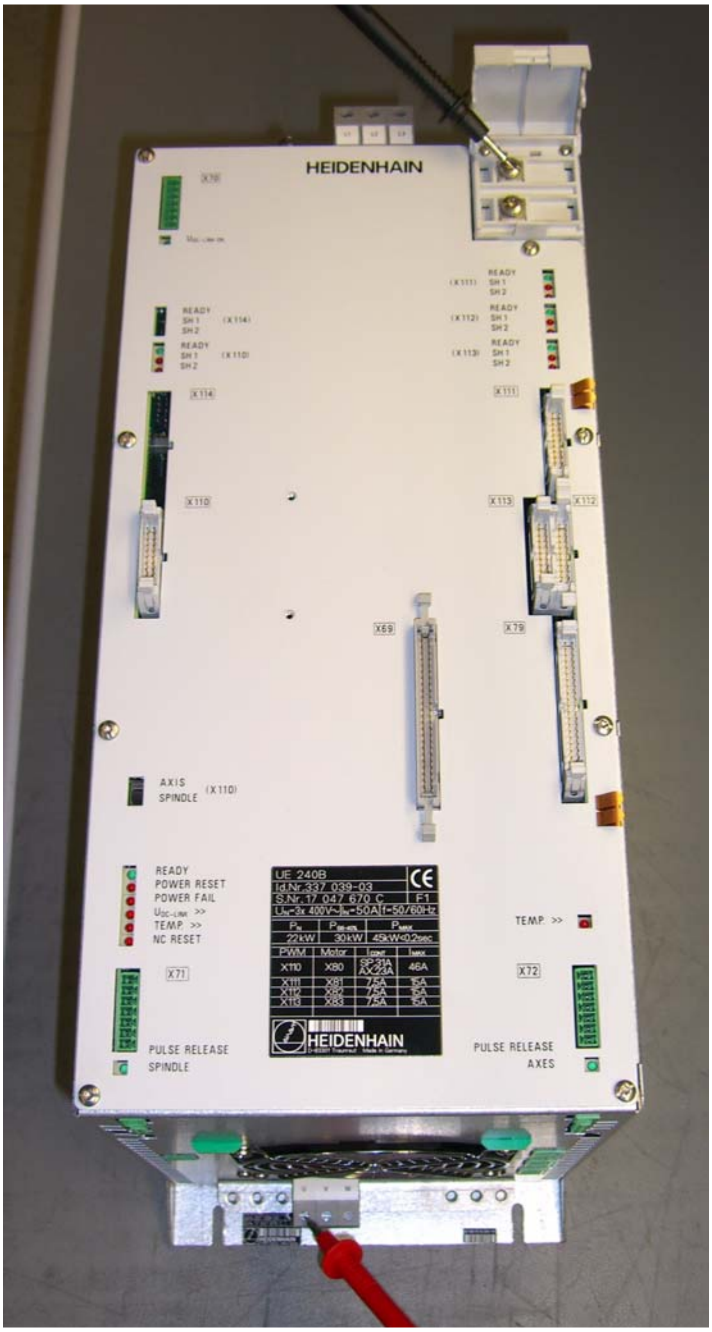
Flowchart:
Short circuit or interruption between +/- Uz and motor output



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.

Photo: Diode measurement Uz on motor output



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.

Fault repair

Inverters with short circuits or interruptions must be replaced.
–> see “Exchanging the Complete Inverter” on page 10 – 178!

Severely 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 severely contaminated (this can be seen best in the area of the fan). With regard to the operating safety, please send severely contaminated motors 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 and UE 212B compact inverters are equipped with integrated braking resistors.

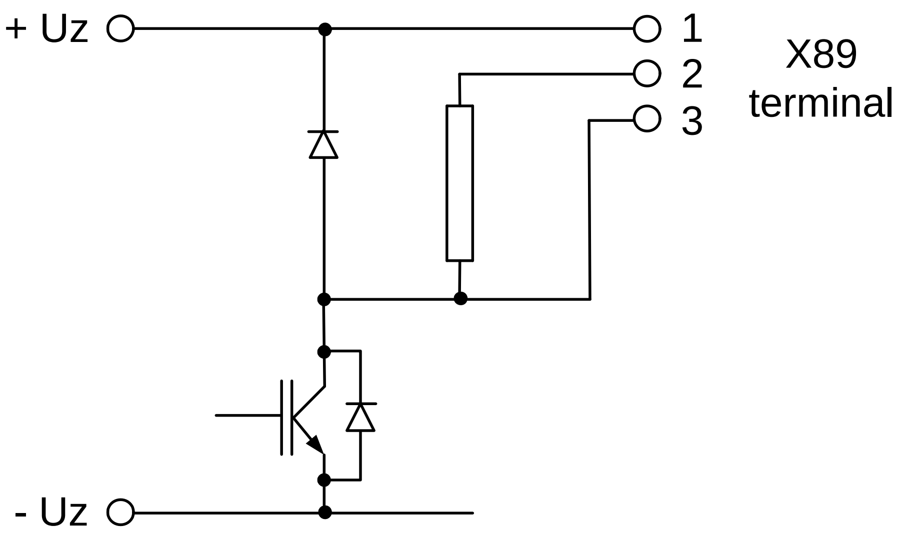
The resistance value is **21 ohm +/- 10 %** and can be measured from outside.

Required measuring devices

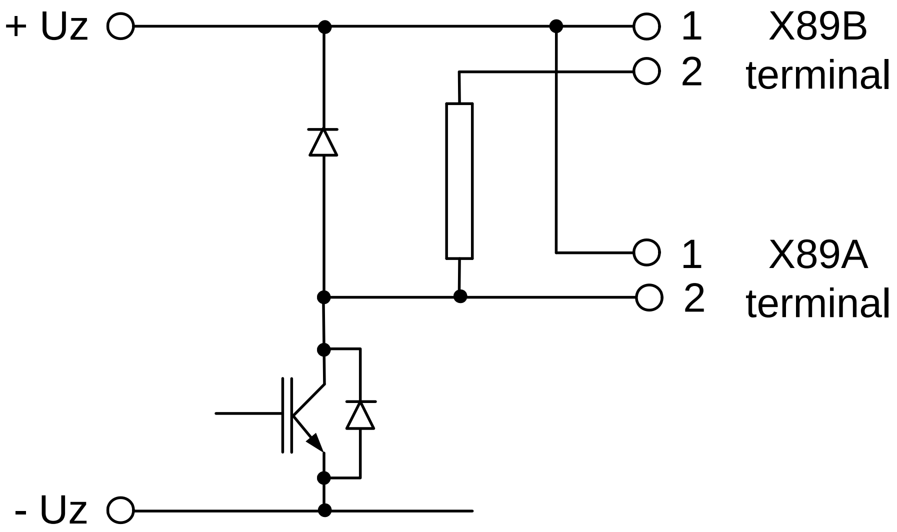
- Appropriate **voltage test unit** to ensure that the unit is free of potential. see "Voltage Test Unit" on page 14 – 333.
- Standard commercial **multimeter**

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. When using an external braking resistor, it will 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:
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!

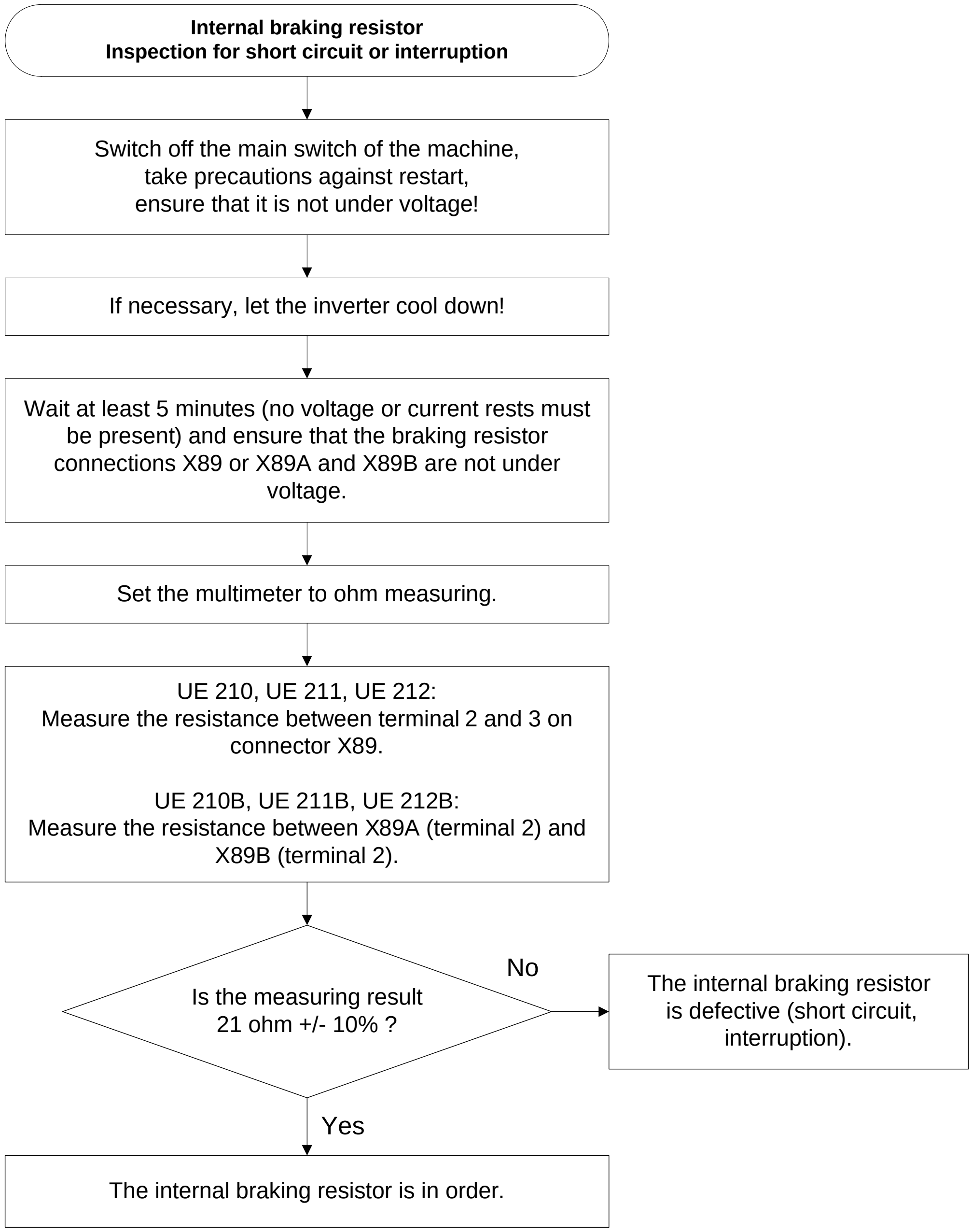


Execution

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!

Flow chart: 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 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 diodes, the diffusion voltage (forward voltage) of this diode is measured.

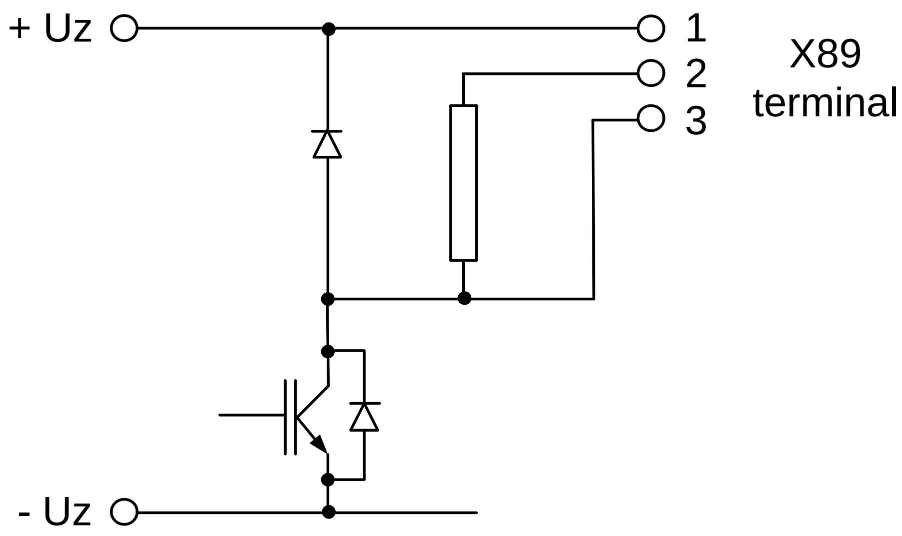
If the diode is burned out, the respective IGBT is normally also affected.
If a diode is short-circuited, also the respective IGBT does not function any more.
This means, if the diode measuring is in order, the IGBT also functions!

Required measuring devices

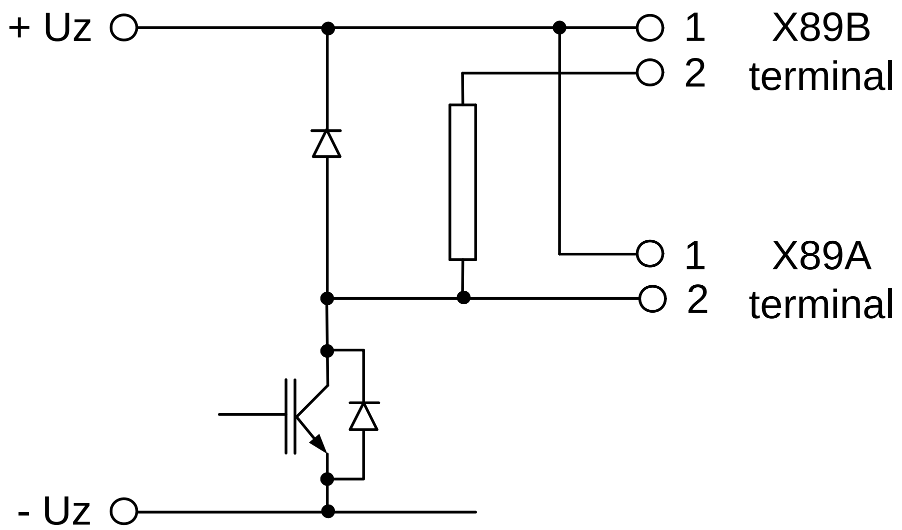
- Appropriate **voltage test unit** to ensure that the unit is free of potential, see “Voltage Test Unit” on page 14 – 333.
- Standard commercial **multimeter** that can be set to **"diode test"**.

Block diagrams

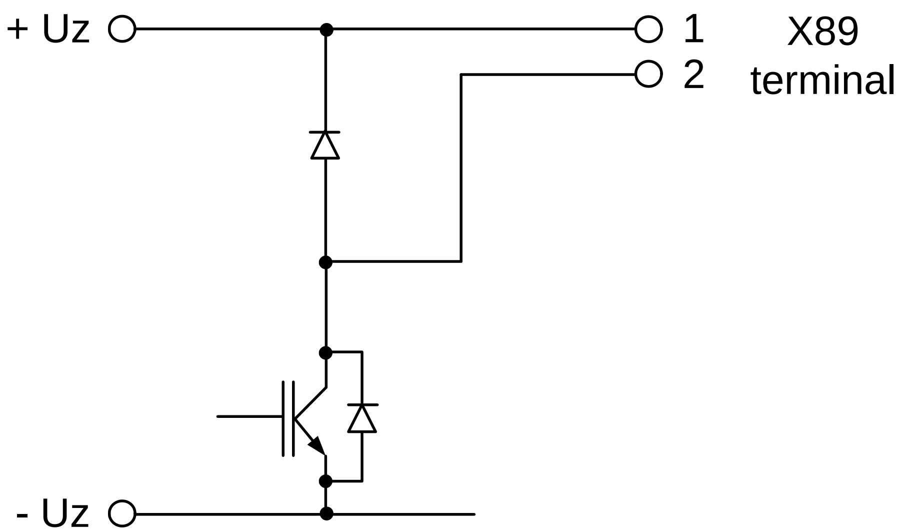
UE 210, 211, 212:
For the operation of the internal braking resistor, a bridge is mounted between terminal 1 and 2 on connector X89. An external braking resistor would be connected to terminal 1 and 3. The bridge for the internal braking resistor must not be mounted in that case!



UE 210B, 211B, 212B:
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!



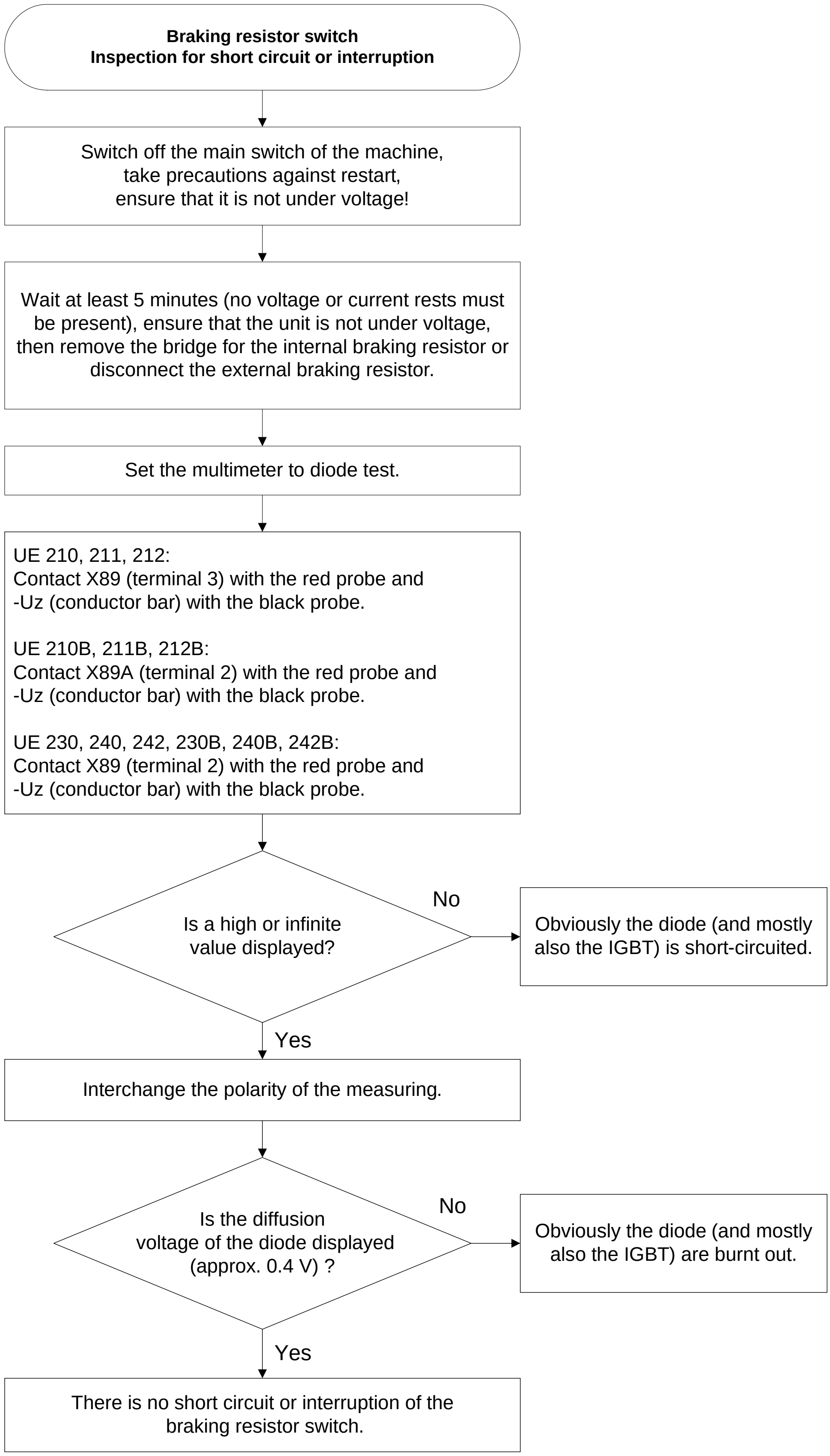
UE 230, 240, 242, 230B, 240B, 242B:
An external braking resistor is connnected (two braking resistors may also be connected in series or parallel).



Execution

> **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!

Flowchart: Damage 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)

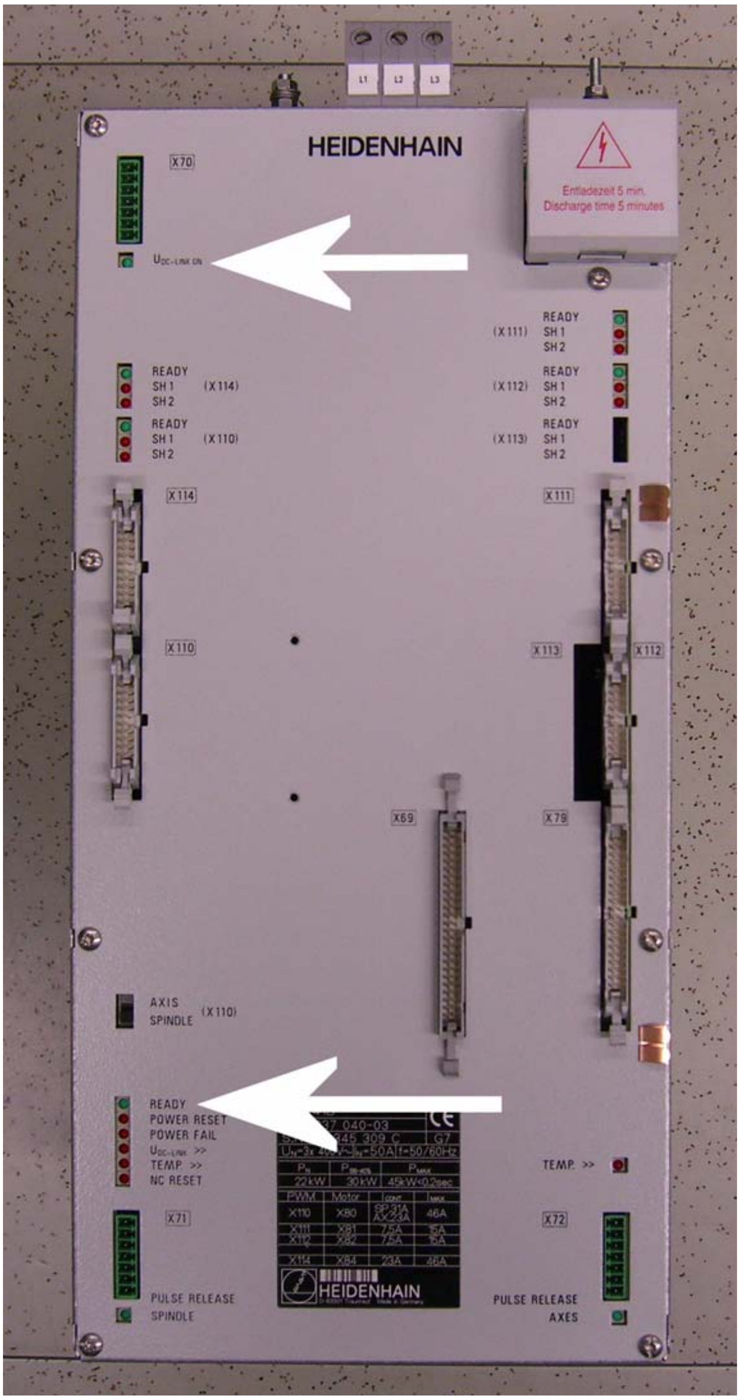


Photo: Green LEDs on the UE 241 B compact inverter

If the mentioned green LEDs are not lit:

▶ Check the voltages. --> see “Checking the Voltages” on page 7 – 122

▶ Move the respective axis or turn the spindle.

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

When the axis or the spindle are still operating, the red LEDs **SH1** and **SH2** must not be lit!

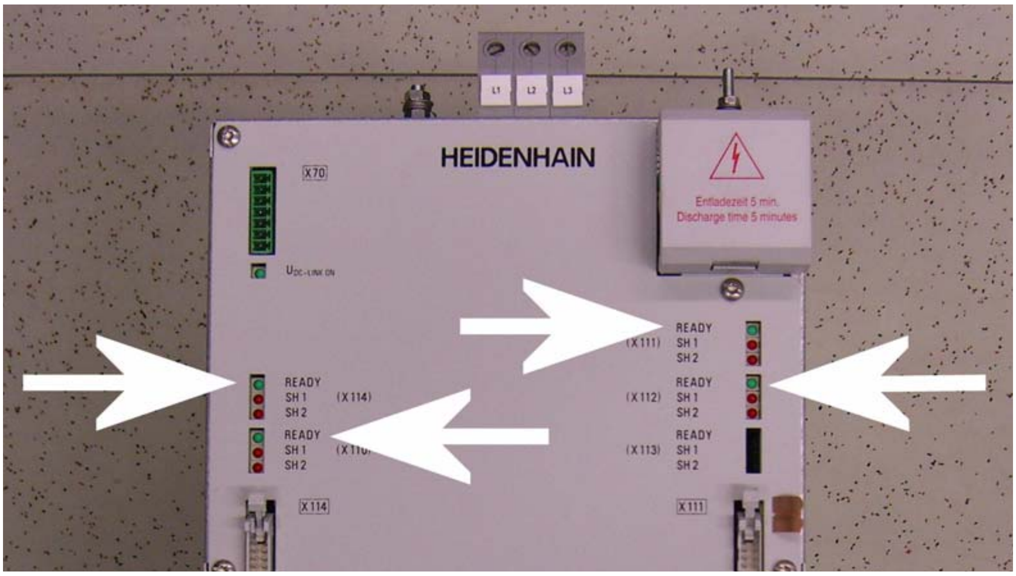


Photo: Green LEDs on the UE 241 B compact inverter

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.

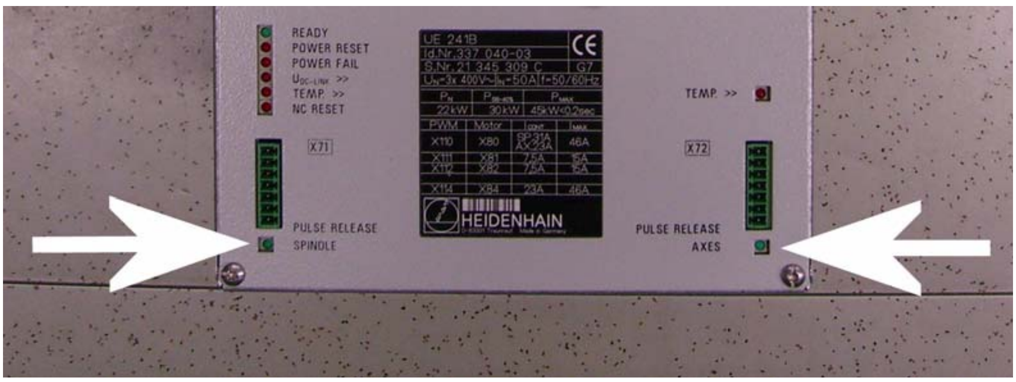


Photo: LEDs for axis and spindle release on the UE 241 B compact inverter

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.

Caution

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 (between 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 Test Unit” on page 14 – 333.
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 %.

Photo: 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 Vdc 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 (between contact 2 or 0 V) of connector X70.

5-pin connector:

▶ Measure whether 24 V control voltage is available on contact 2 (between contact 2 and zero potential) of connector X70.

Photo: 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 a 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 Test Unit” on page 14 – 333.
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 plates!

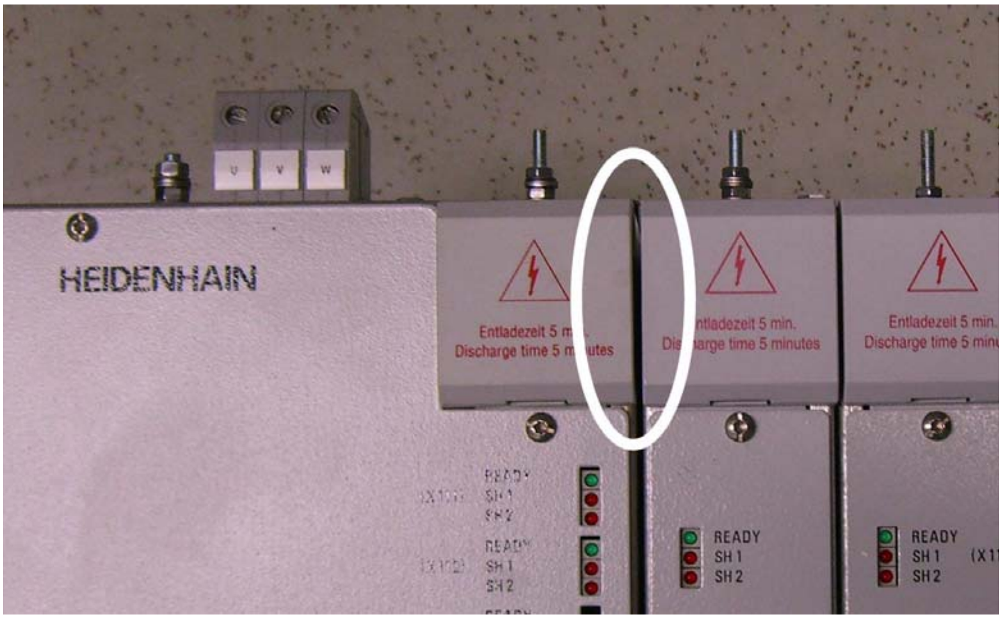


Photo: Protective covers over the conductor bars

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 – 125.

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 the 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.
- Disconnect the following connectors (if available) in 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.

- 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).
- Insert the connector with bridge in X70 (see enabling connector).
- For saftey 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.

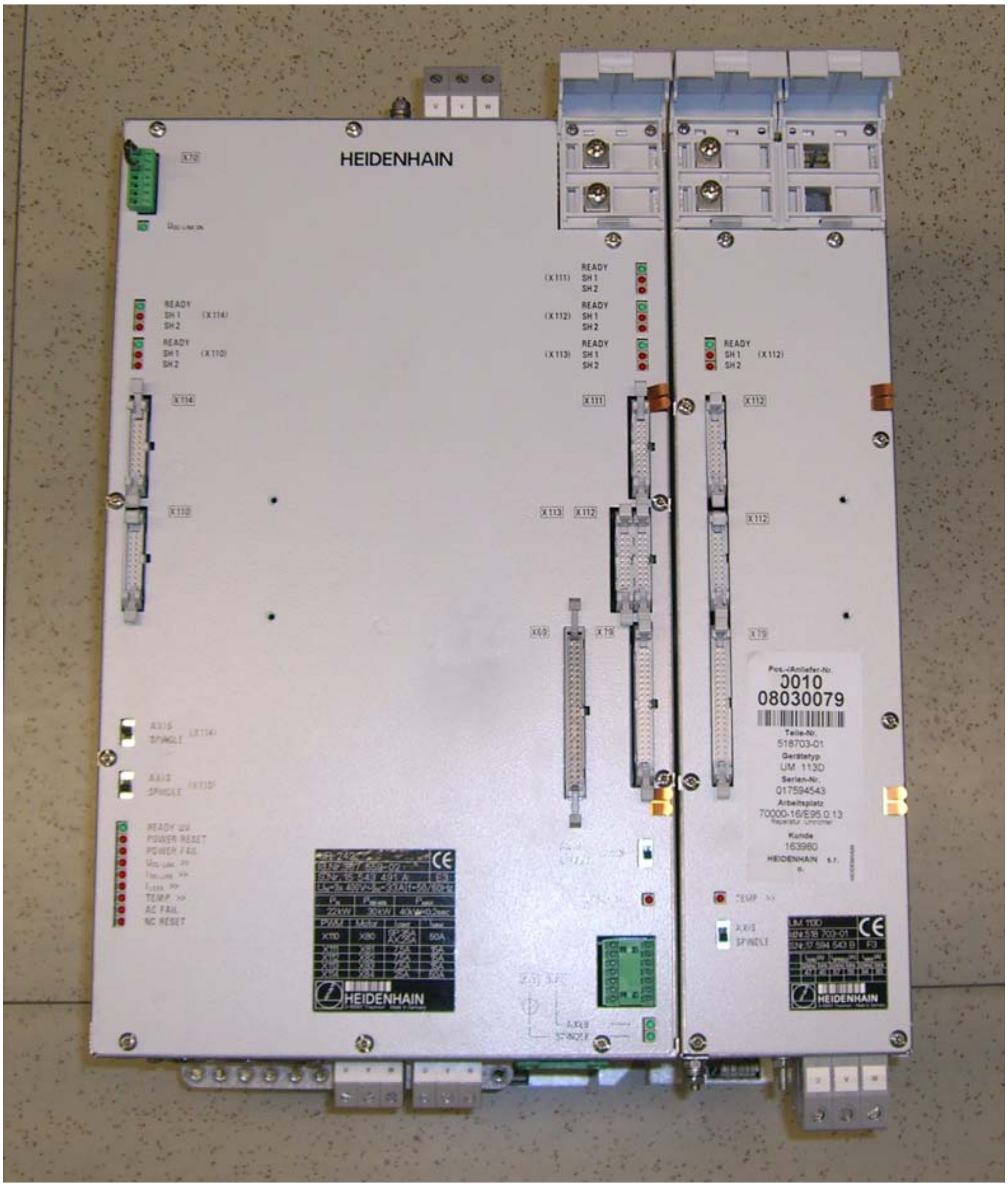
If Uz is present, the UE/UR is obviously in order. --> Test the function during operation!

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

Enabling connector

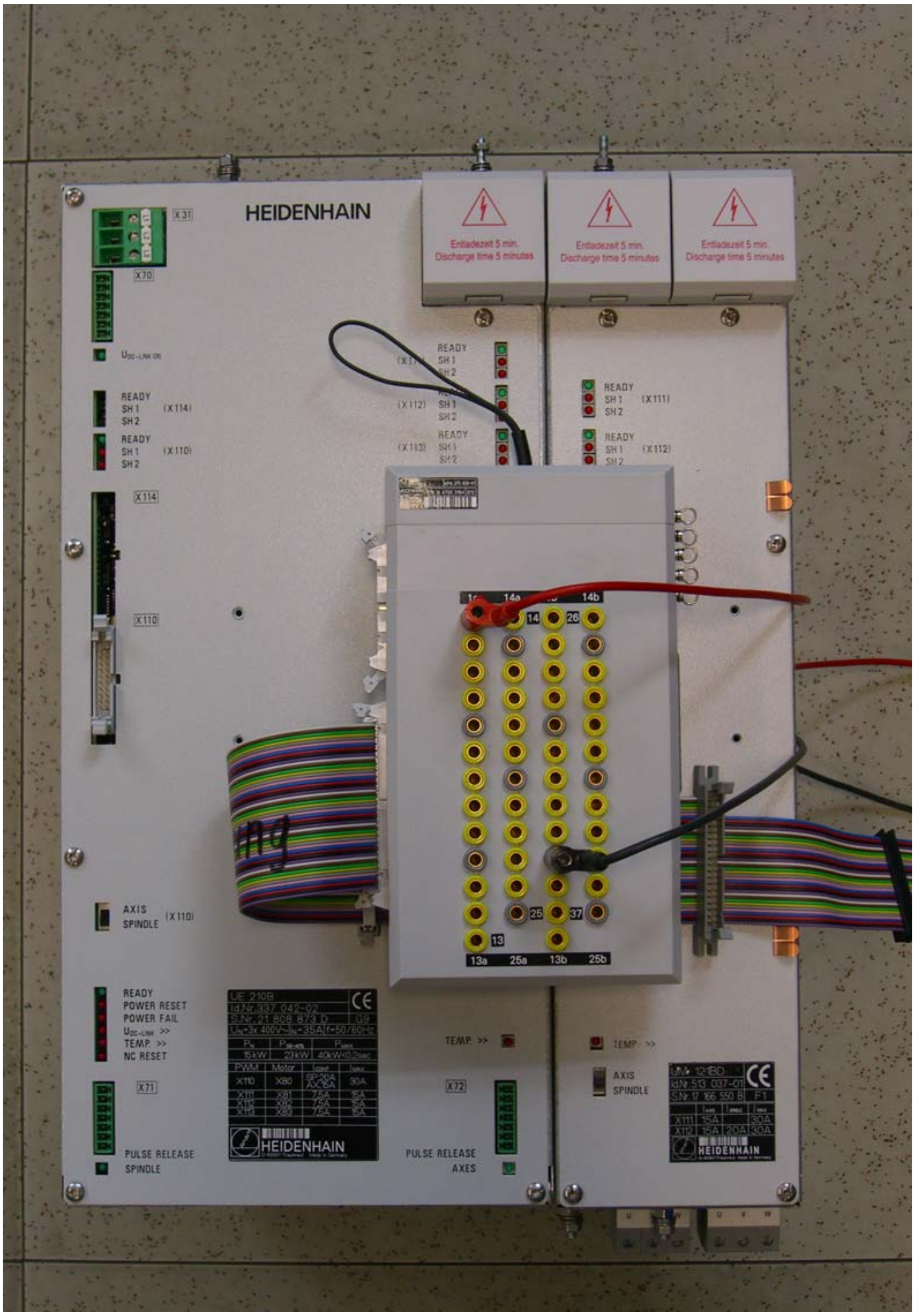
For the 7-pin socket the shown connector with a bridge from contact 1 to 3 is required. The bridge on the 5-pin connector connects contact 1 and 2.
You can use the original connector if you have marked, unclamped and secured the wires before.
You may also order the 7-pin connector ID 282143-02 from HEIDENHAIN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

Photo:
UR without connected units



Setup with test adapter

If you have a test adapter (see “Test Adapter” on page 14 – 335) you can observe the **low voltages and signal conditions during operation** on the supply bus X69, the unit bus X79 and the PWM ribbon cable X111 - X114.



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

7.7.8 Exchanging Output Stages of the Same Type

General

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

Caution

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 "Trouble Shooting on Ground Fault" on page 6 – 47, see "Inspection for Winding Short Circuit or Interruption" on page 6 – 50

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 any connectors and terminals are free of potential before you engage or disengage them.

Assumed configuration

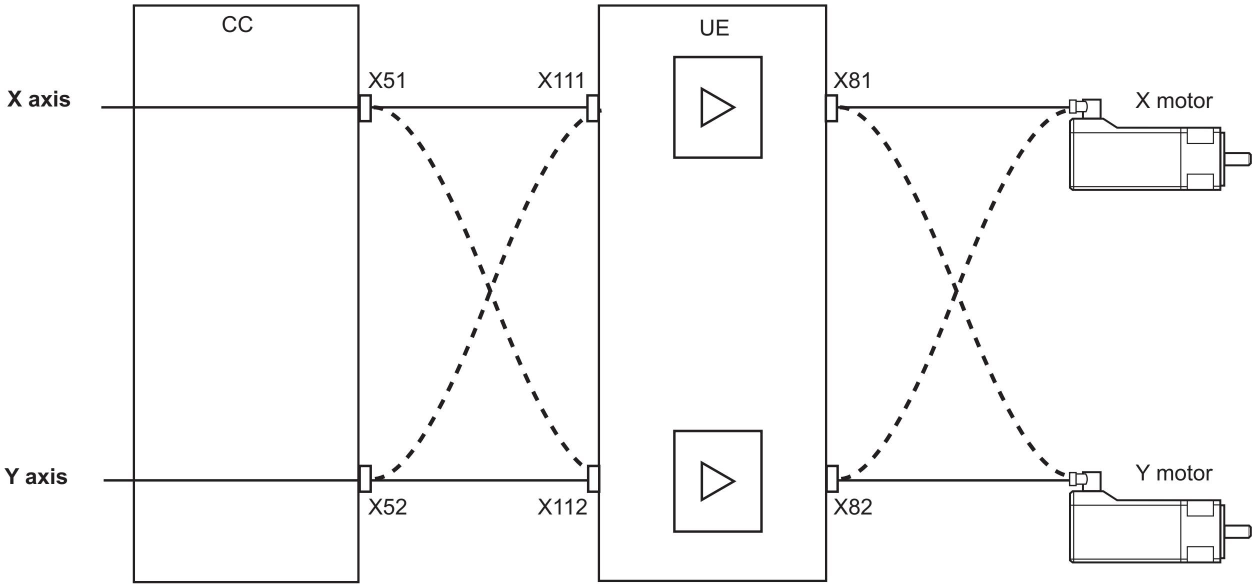
UE 242 B:

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, X 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 **Y axis**
X83 (motor connection of channel 3) connected with **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



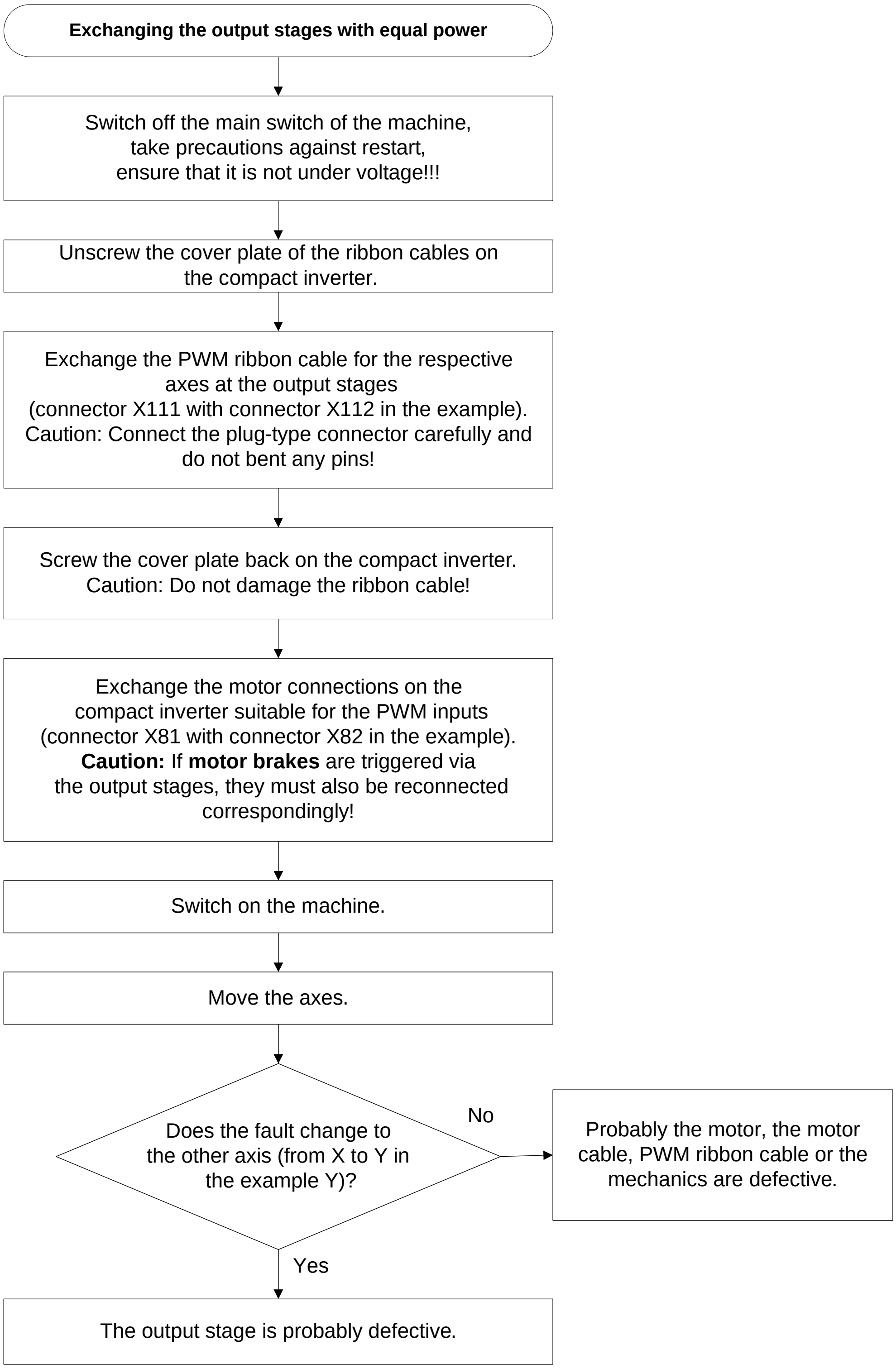
Caution

If motor brakes are connected to the power modules, they must also be replaced (X392, X393, X394, depending on the model. --> see “Connector Designation and Layout” on page 12 – 229)!
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 changed must be long enough.

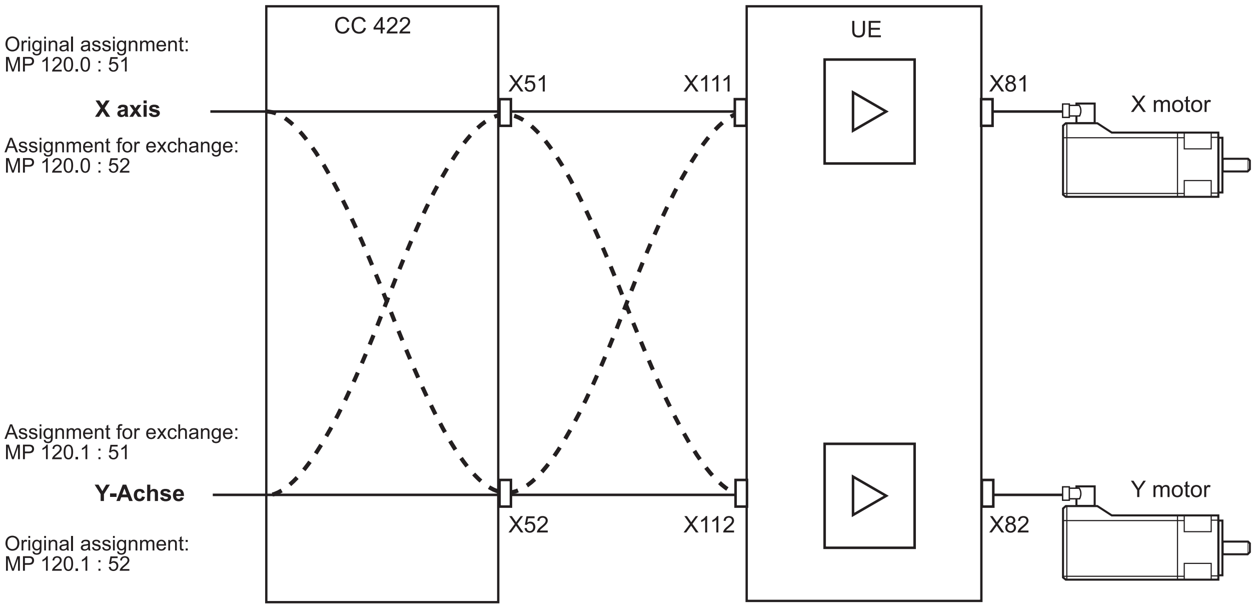
Flowchart


Exchanging the output stages with equal power
Switch off the main switch of the machine, take precautions against restart, ensure that it is not under voltage!!!
Unscrew the cover plate of the ribbon cables on the compact inverter.
Exchange the PWM ribbon cable for the respective axes at the output stages (connector X111 with connector X112 in the example). Caution: Connect the plug-type connector carefully and do not bent 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 (connector X81 with connector X82 in the example). Caution: If motor brakes are triggered via the output stages, they must also be reconnected correspondingly!
Switch on the machine.
Move the axes.
Does the fault change to the other axis (from X to Y in the example Y)?
No
Probably the motor, the motor cable, PWM ribbon cable or the mechanics are defective.
Yes
The output stage is probably defective.

7.7.9 Exchanging the PWM Interfaces

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).



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 changed must be long enough.

7.8 Error Diagnosis on Non-HEIDENHAIN Inverter Systems

7.8.1 Inspection for Ground Fault

A ground fault or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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 regarding leakage current, overcurrent, etc.
- 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 “Trouble Shooting on Ground Fault” on page 6 – 47

Instruction of the manufacturer

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

7.8.2 Inspection for Short Circuit or Interruption

A ground fault or short circuit is the most severe electrical error on the drives and must be ruled out before further examination.

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 regarding leakage current, overcurrent, etc.
- 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 132.

Instruction of the manufacturer

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

7.8.3 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 – 134

7.8.4 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 **SH1** and **SH2** (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.

Caution

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.

Caution

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

7.8.5 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 Test Unit” on page 14 – 333.
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 Test Unit” on page 14 – 333.
Proceed carefully and concentratedly!

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

7.8.6 Exchanging the HEIDENHAIN Expansion 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 must not be under power when you exchanging the boards.
- Boards of the same type are exchanged (1-axis module or 2-axis module, metallically isolated or not metallically isolated. --> see “Important Notes on the Use of HEIDENHAIN Expansion Boards in the SIMODRIVE System” on page 3 – 17)
- The grounding must be correct. --> see “Important Notes on the Use of HEIDENHAIN Expansion Boards in the SIMODRIVE System” on page 3 – 17

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.
Difficulties can 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 complete board is not released.
- If a 1-axis module board is inserted in a 2-axis module for test purposes, 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 axes that cannot be contolled by MP 10. With some machines this might be difficult.

  --> If necessary, ask the HEIDENHAIN service agency!

Caution

Boards with metallic isolation of HEIDENHAIN PWM signals to the Siemens interface must not be replaced by boards without metallic isolation and vice versa!
--> see “Important Notes on the Use of HEIDENHAIN Expansion Boards in the SIMODRIVE System” on page 3 – 17

Caution

"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 3 – 22.

7.8.7 Exchanging Output Stages of the Same Type

Instruction of the manufacturer

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

General

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

Caution

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 "Trouble Shooting on Ground Fault" on page 6 – 47, see "Inspection for Winding Short Circuit or Interruption" on page 6 – 50.

DANGER

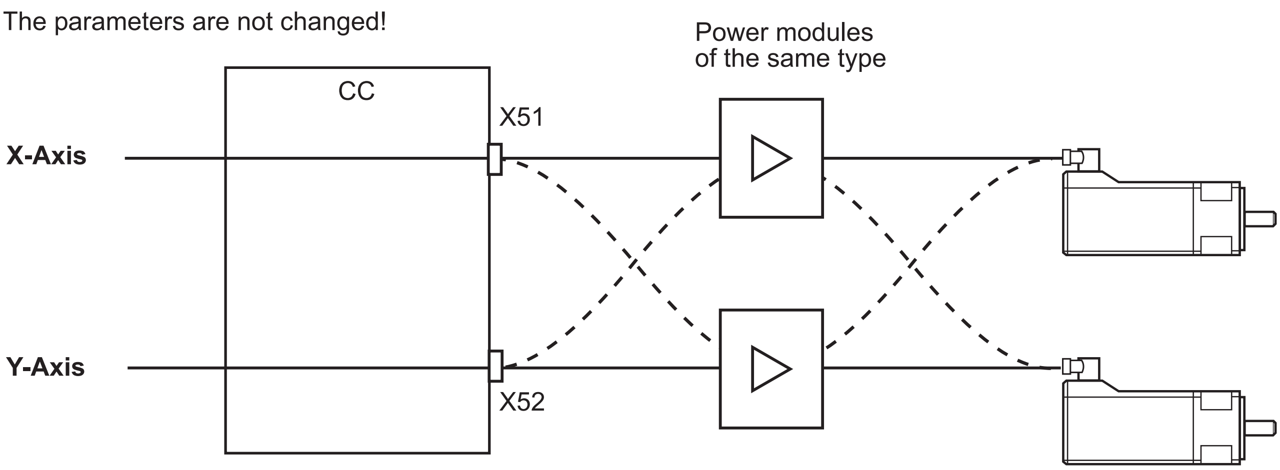
Always secure vertical axes from falling down before you perform this test!

DANGER

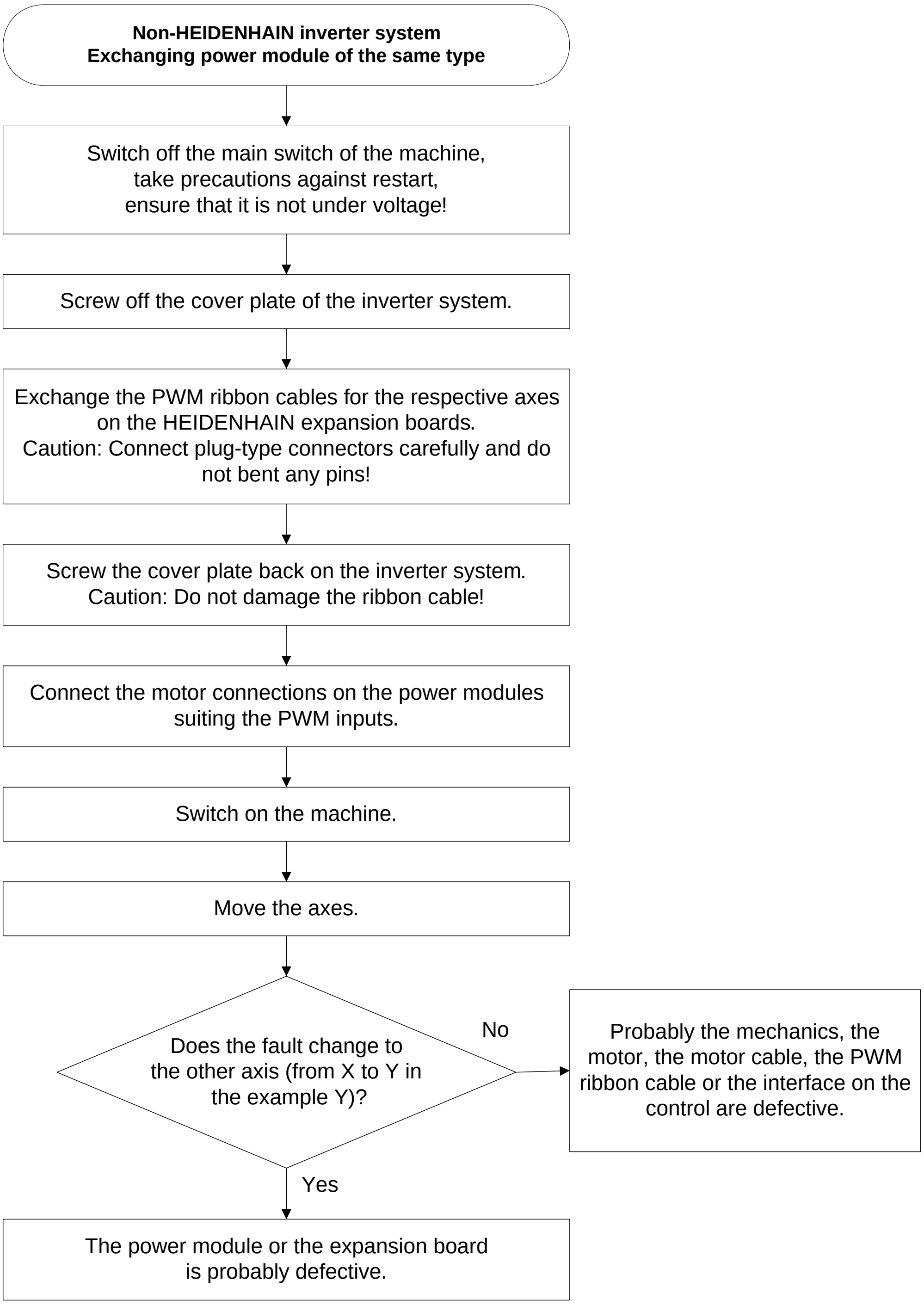
Danger of electrical shock!
Make sure that the main switch of the machine is switched off and that any connectors and terminals are free of potential before you engage or disengage them.

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

Block diagram for two 1-axis modules



Flowchart for two 1-axis modules

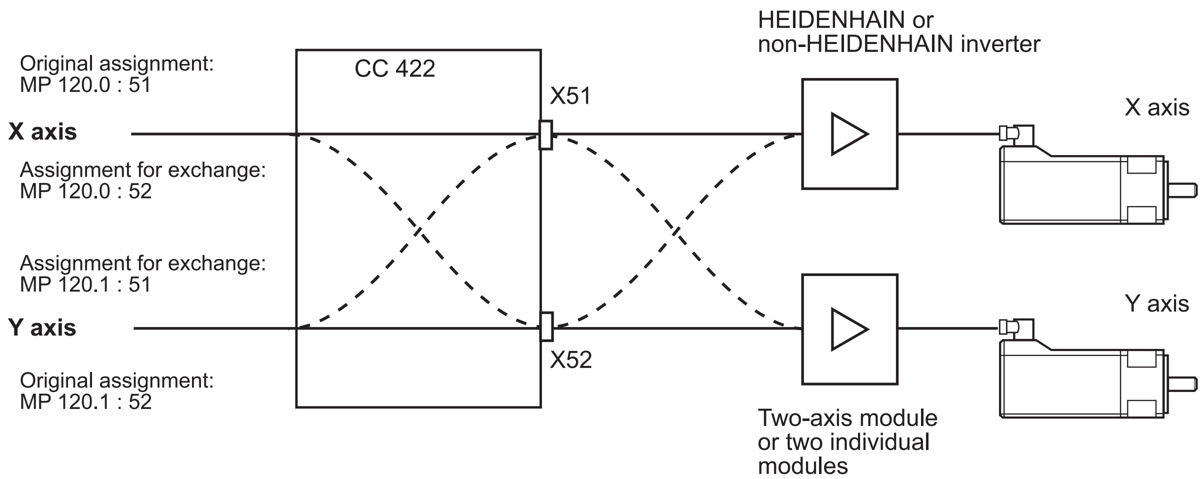


7.8.8 Exchanging the PWM interfaces

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 1 – 7!

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
- Winding short circuit
- Short circuit in the unit
- Overload
- Excessive temperatures for an extended 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 severely 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 or short circuit is the most severe electrical error and must be excluded from further examination.

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`**
- 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 "Trouble Shooting on Ground Fault" on page 6 – 47 and See "Inspection for Ground Fault" on page 7 – 71

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 Test Unit" on page 14 – 333
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement, See "Insulation Tester" on page 14 – 334

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**.

Execution

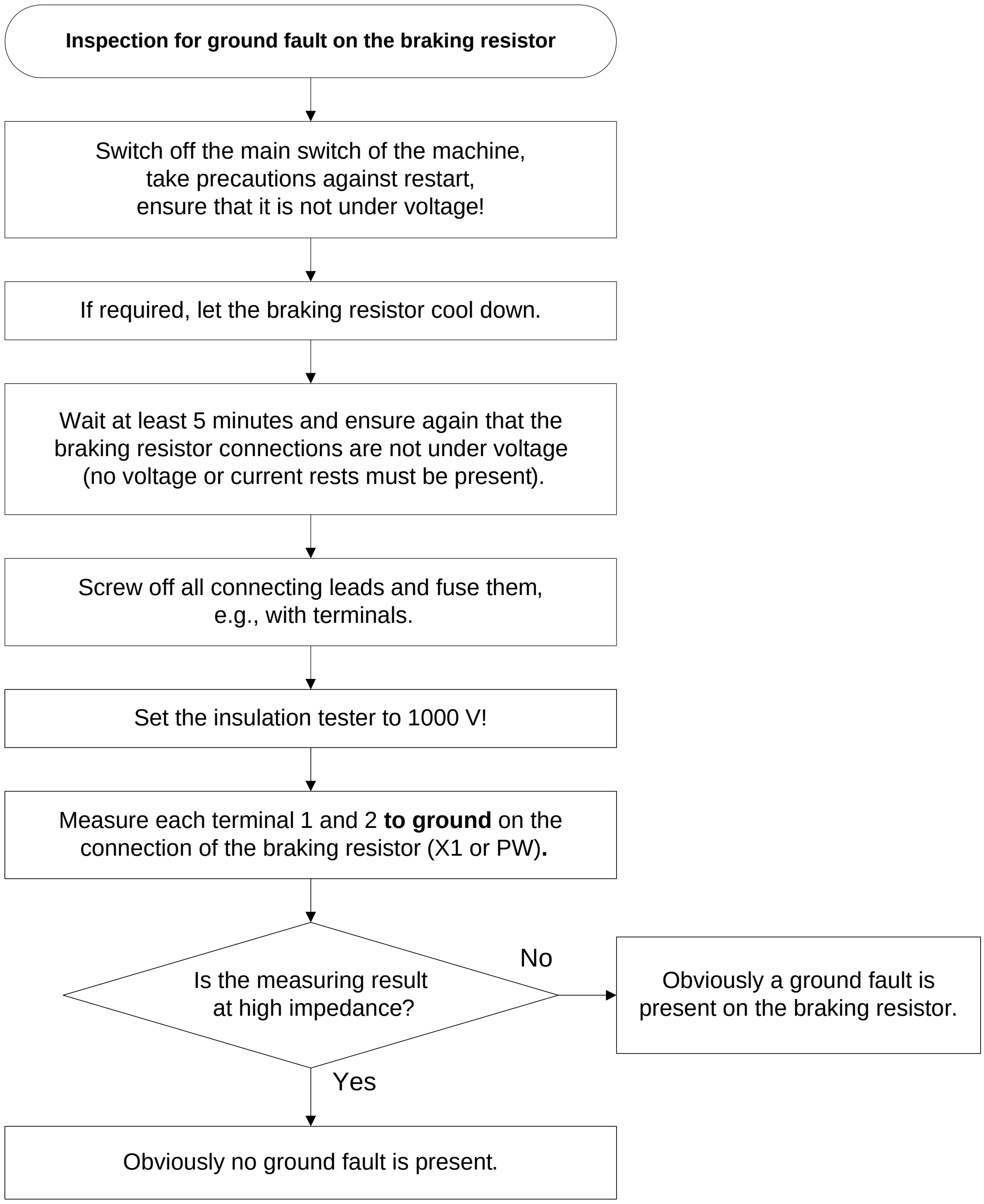
DANGER

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!

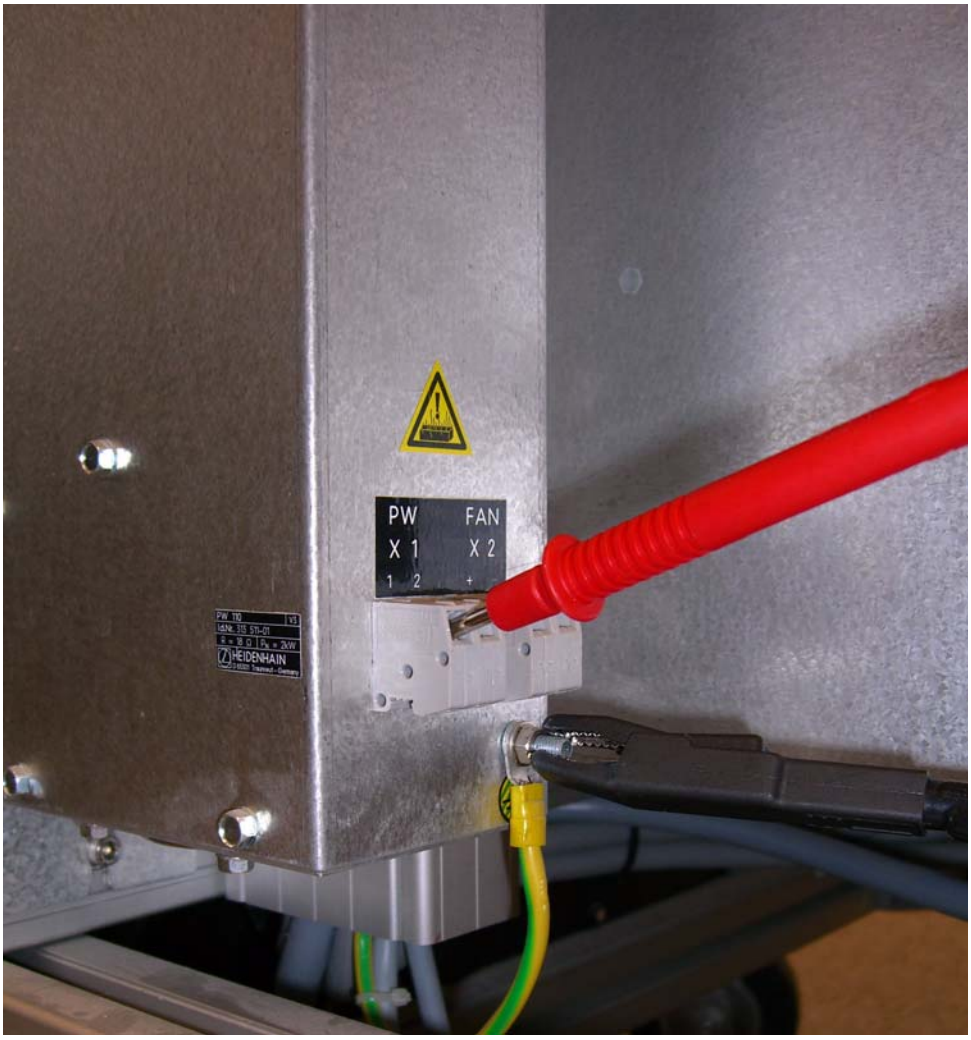
Flowchart



Note

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.

Photo: Ground fault measuring with insulation tester



> **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!

Fault repair

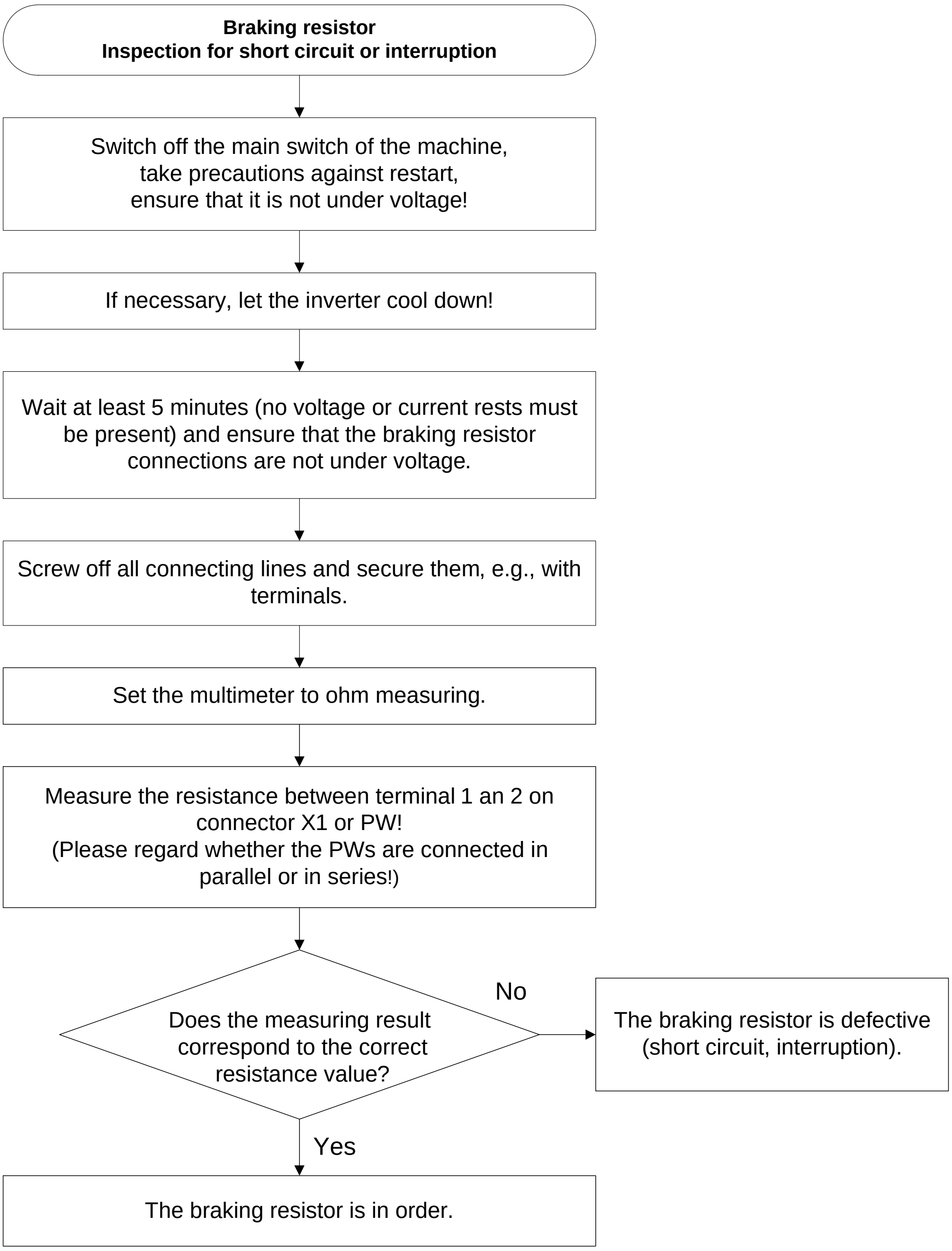
Braking resistors with ground faults must be replaced!

Severely contaminated braking resistors

Also if you do not detect a ground fault, --> it might still be possible that unwanted leakage currents occur on severely contaminated braking resistors.
With regard to the operating safety, please send severely 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.

In case the braking resistor is "cold", the switch is closed and if the braking resistor is "hot", it opens.

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.
- Use an ohmmeter to measure whether the switch is closed when the braking resistor is "cold".

8.5 Error Diagnosis on the UP 1x0 Braking Resistor Module

8.5.1 Inspection for Ground Fault

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

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`**
- 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 "Trouble Shooting on Ground Fault" on page 6 – 47 and See "Inspection for Ground Fault" on page 7 – 71

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 divider

Potential dividers for the **dc-link voltage measurement** are integrated in all braking resistor modules (UP). These potential dividers consist of resistors connected in series. The resistors 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 Test Unit" on page 14 – 333
- **Insulation tester** that charges up to the selection isolation voltage and discharges after the measurement, See "Insulation Tester" on page 14 – 334

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**!

Caution

A higher test voltage could damage the braking resistor module!

Execution

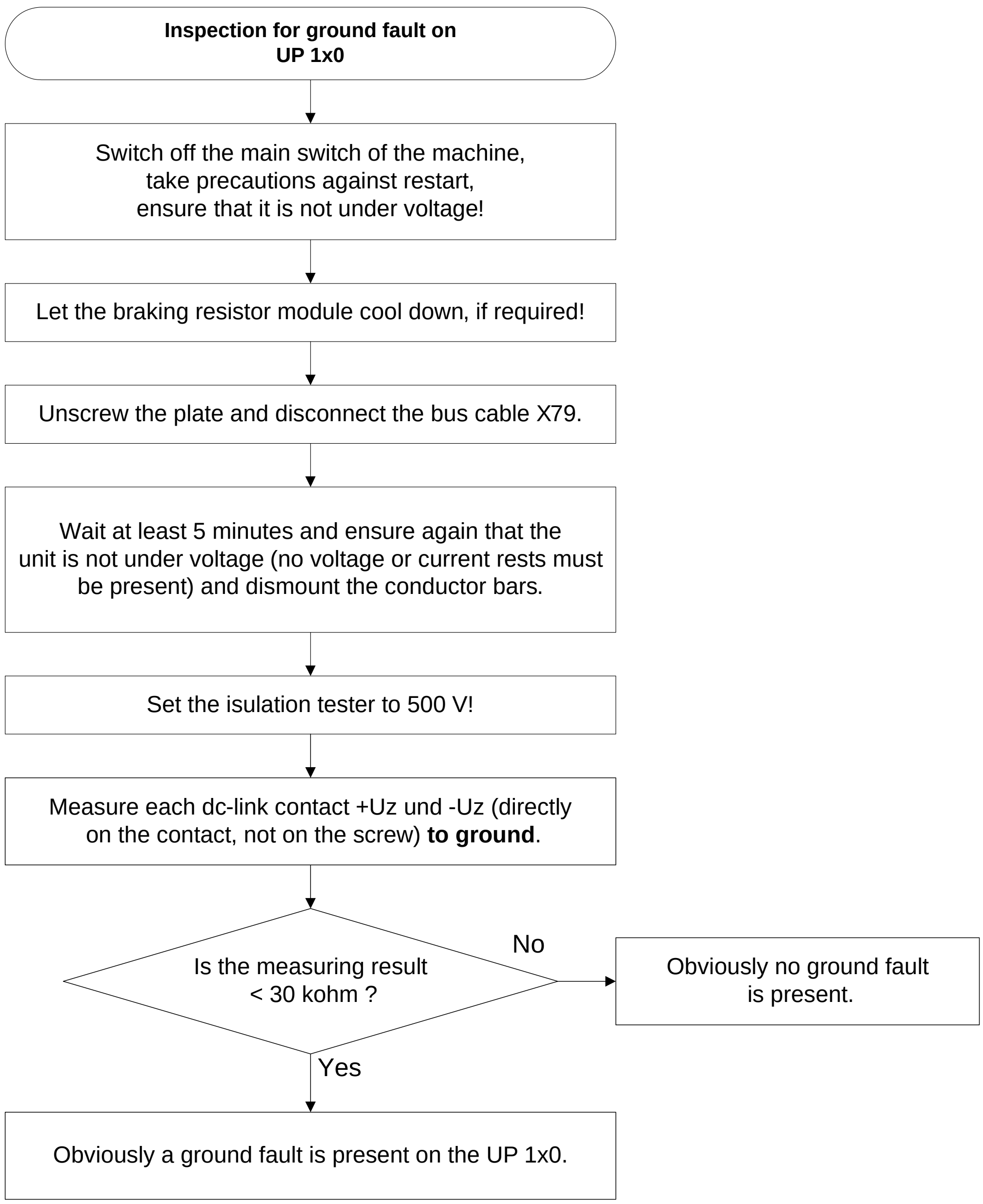
DANGER

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

Defined resistance values cannot be specified here as they depend on the "inner life" of the UP and the specifications of the insulation tester, among other things. 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!

Fault repair

Braking resistor modules with ground faults must be replaced!

Severely contaminated UPs

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

8.5.2 Inspection for Short Circuit

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

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`
- 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 – 145

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 Test Unit" on page 14 – 333
- Standard commercial **multimeter**.

Execution

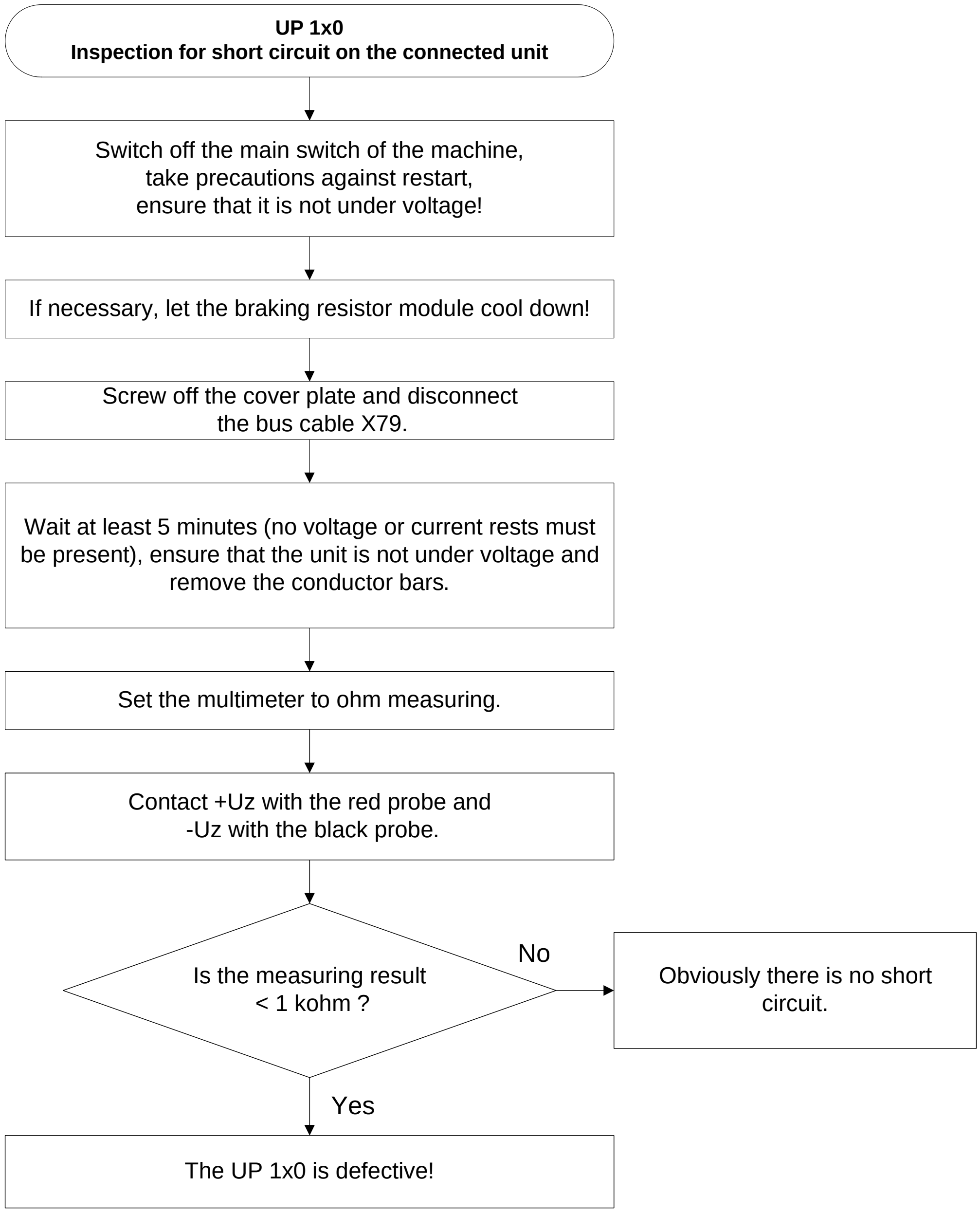
DANGER

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



Fault repair

Braking resistor modules with short circuits must be replaced!

Severely contaminated UPs

Also if you do not detect a short circuit, it might still be possible that unwanted leakage currents occur on severely contaminated UPs.
With regard to the operating safety, please send severely 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.
- If necessary, let the braking resistor module cool down.

DANGER

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

- Unscrew the grounding bars or ground lead on the top of the UP 1x0.
- Unscrew the cover plate and disconnect the bus cable X79.

DANGER

Wait at least 5 minutes before you unscrew the conductor bars (there is a corresponding warning on the protective covers 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.
- 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 ohm +/- 10 %** (on UP 110) or **3.6 ohm +/- 10 %** (on UP 120).

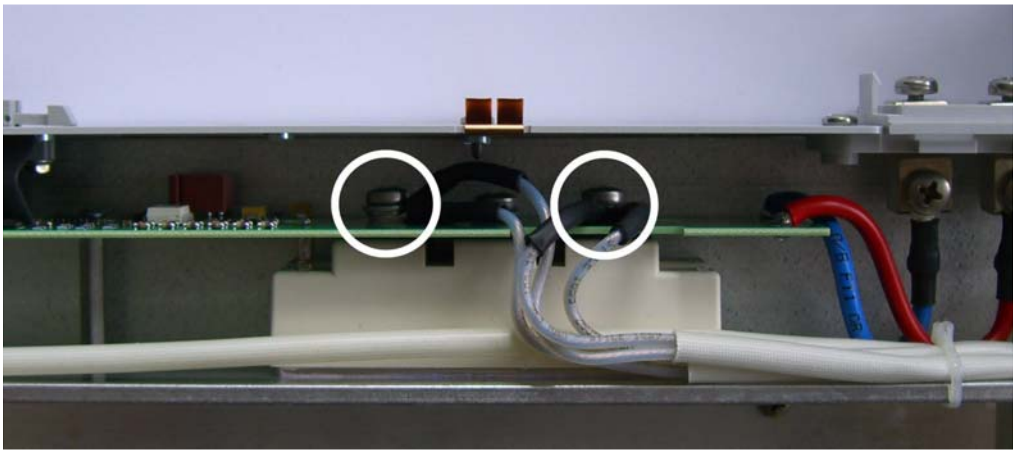


Photo: Open UP 110 braking resistor module

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 that can be measured.

Diode measurement

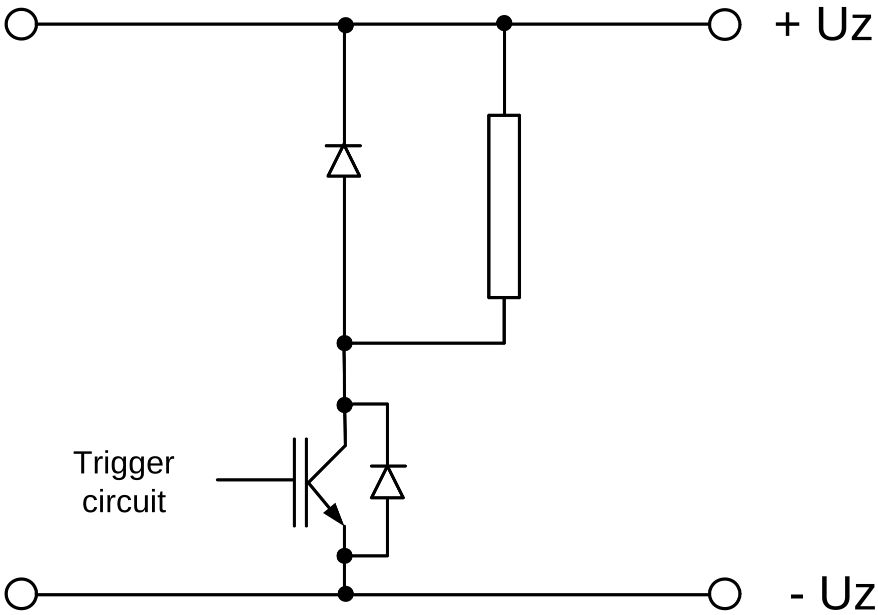
When measuring the diodes, the diffusion voltage (forward voltage) of this diode is measured.

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,
- Standard commercial **multimeter** that can be set to **"diode test"**.

Block diagram

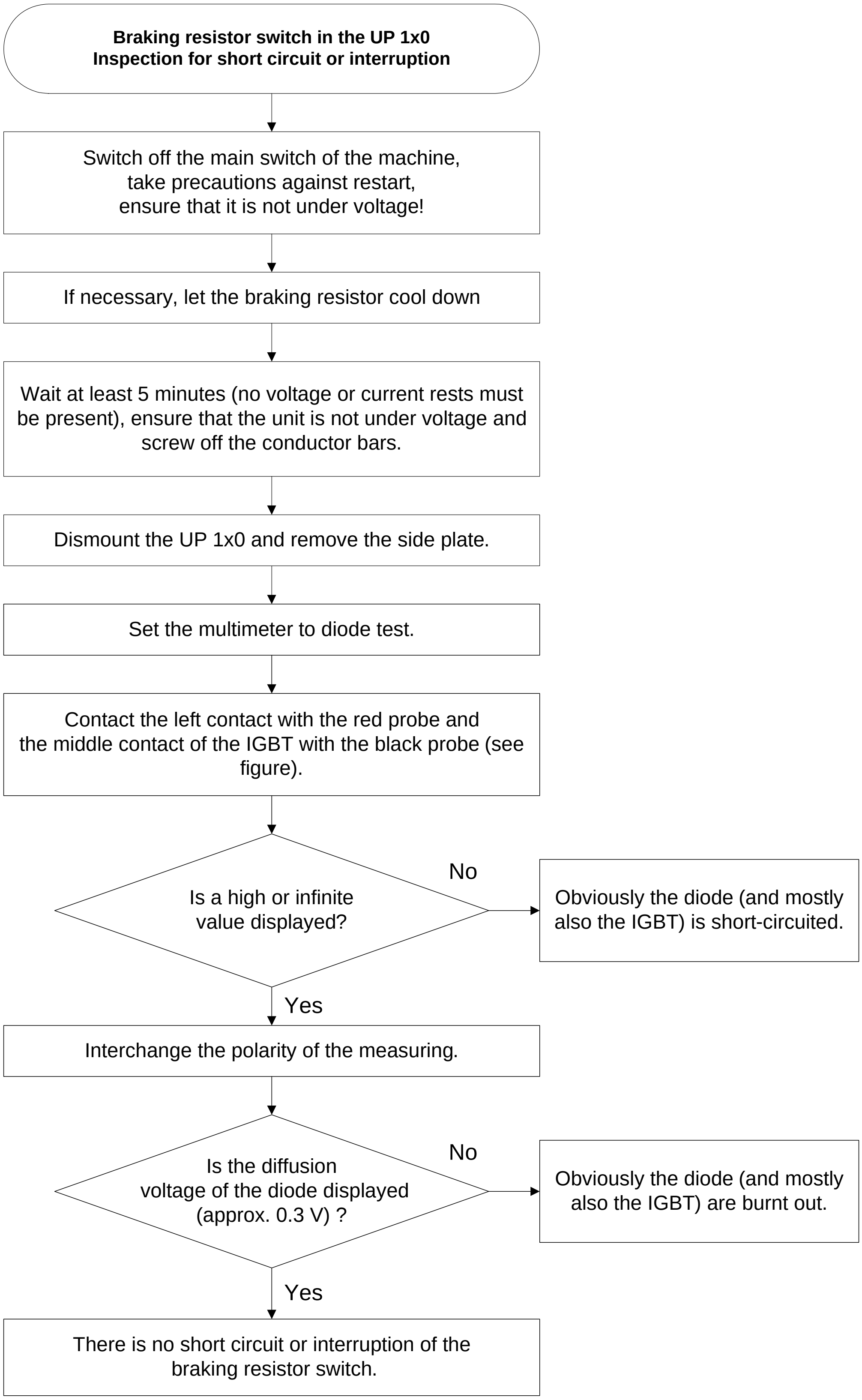


Execution This examination is only possible when the UP 1x0 is open.

DANGER

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

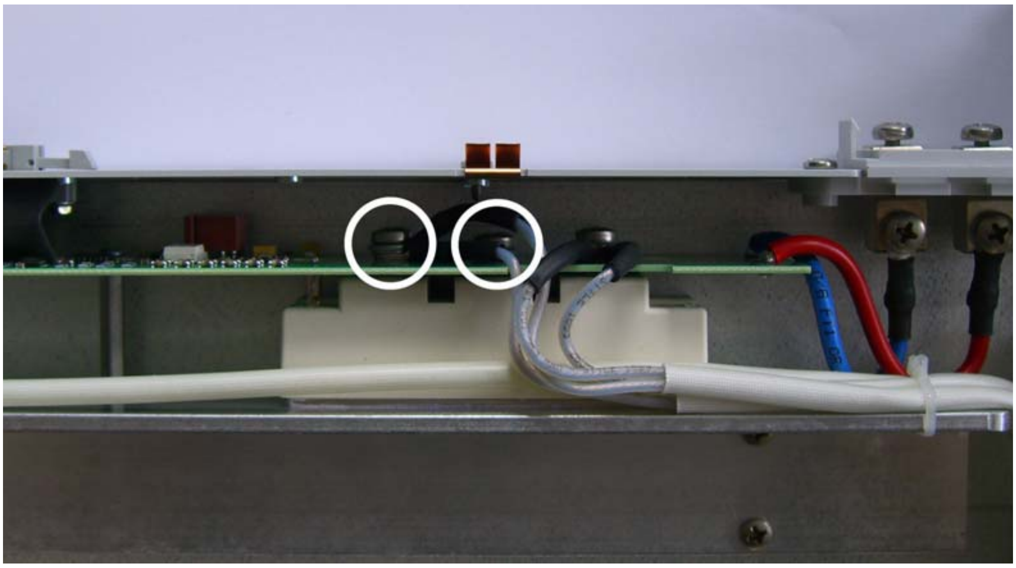
Flowchart: Short circuit or interruption of the braking resistor switch



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.

Photo: Diode measurement



8.5.5 Checking the Temperature Switch

The UP 1x0 features a temperature switch.

In case the braking resistor is “cold“, the switch is closed and if the braking resistor is “hot“, it opens.

Note

When the temperature switch opens, a temperature error message is output to the control via the unit bus X79.

Execution

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.
- If necessary, let the braking resistor module cool down.

DANGER

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

- Unscrew the grounding bars or ground lead on the top of the UP 1x0.
- Unscrew the cover plate and disconnect the bus cable X79.

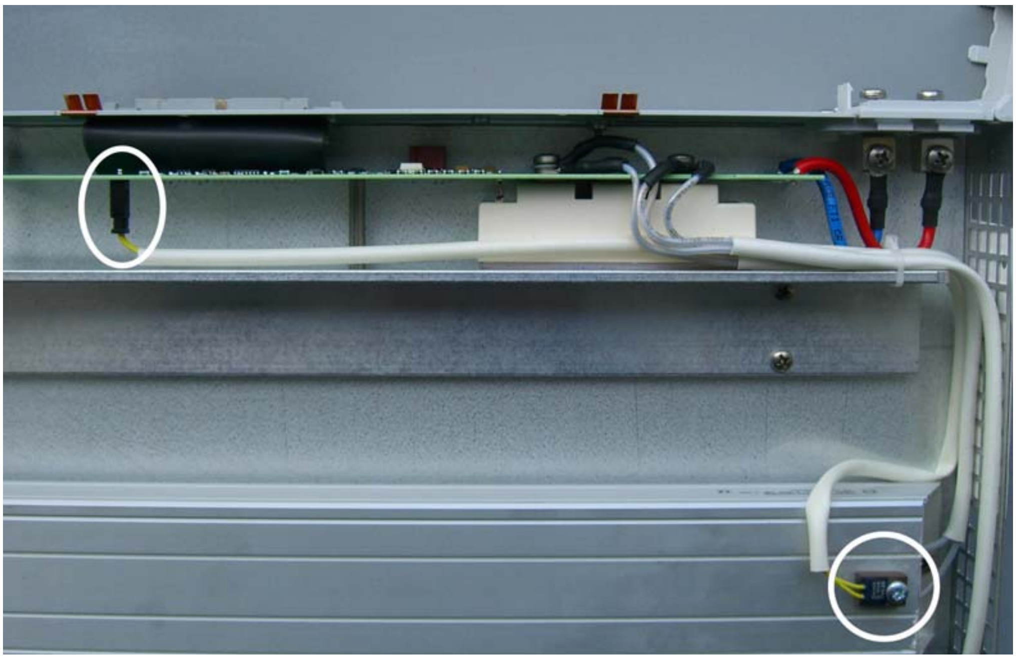
DANGER

Wait at least 5 minutes before you unscrew the conductor bars (there is a corresponding warning on the protective covers of the conductor bars)!
Use an appropriate voltage tester to check whether the dc-link voltage is reduced completely!

- Open the protective covers and unscrew the conductor bars.
- 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. 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**.

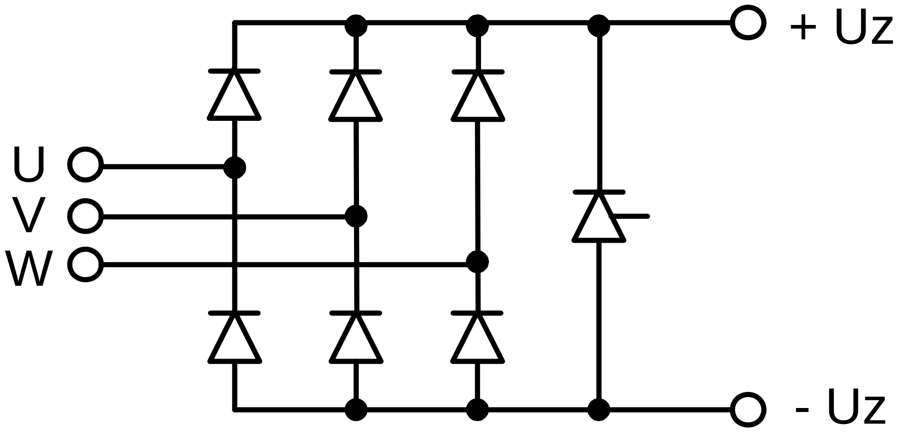
Required measuring devices

- Appropriate **voltage test unit** to ensure that the unit is free of potential, See "Voltage Test Unit" on page 14 – 333
- 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: Rectifier diodes and thyristor

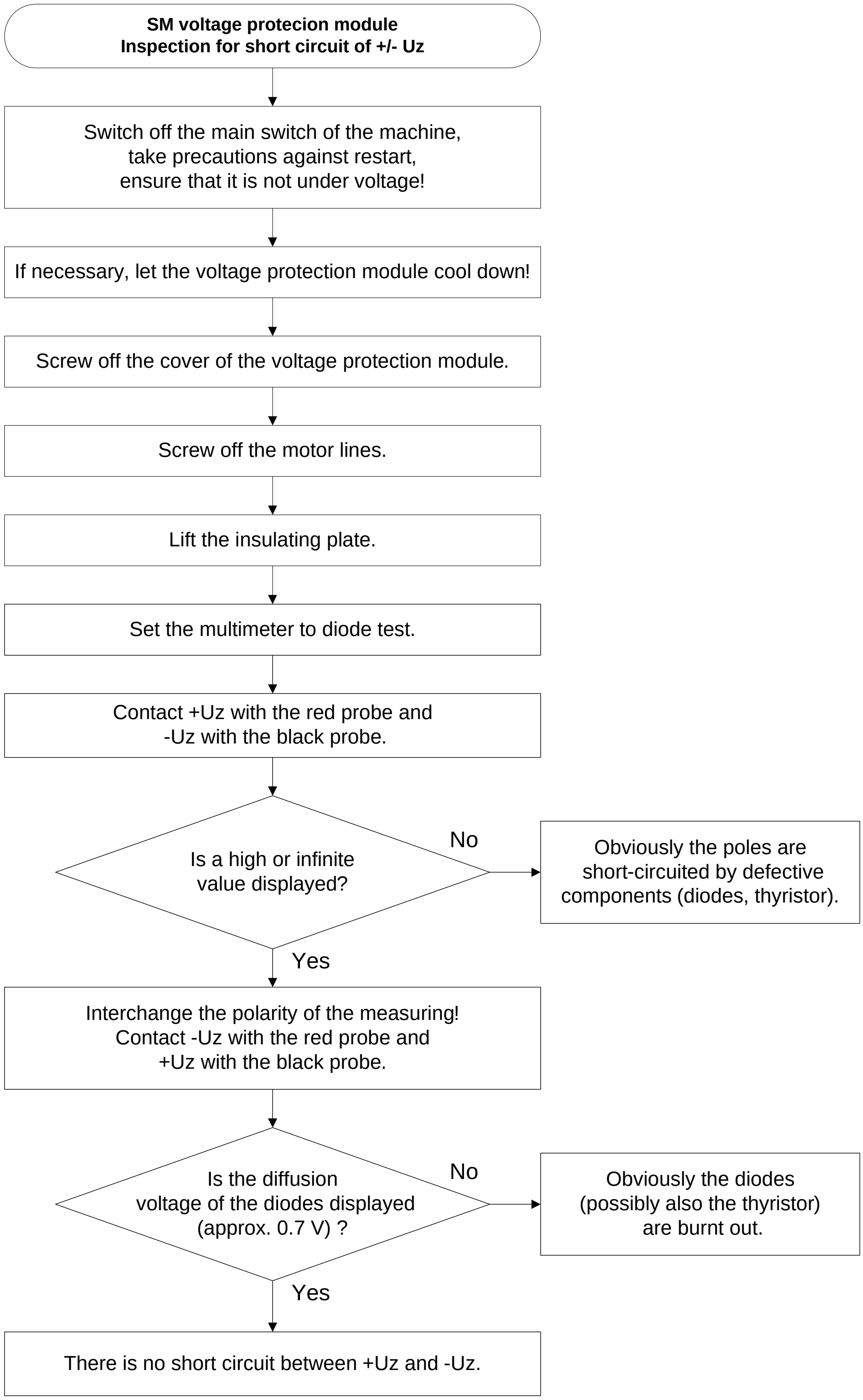


Execution

> **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!

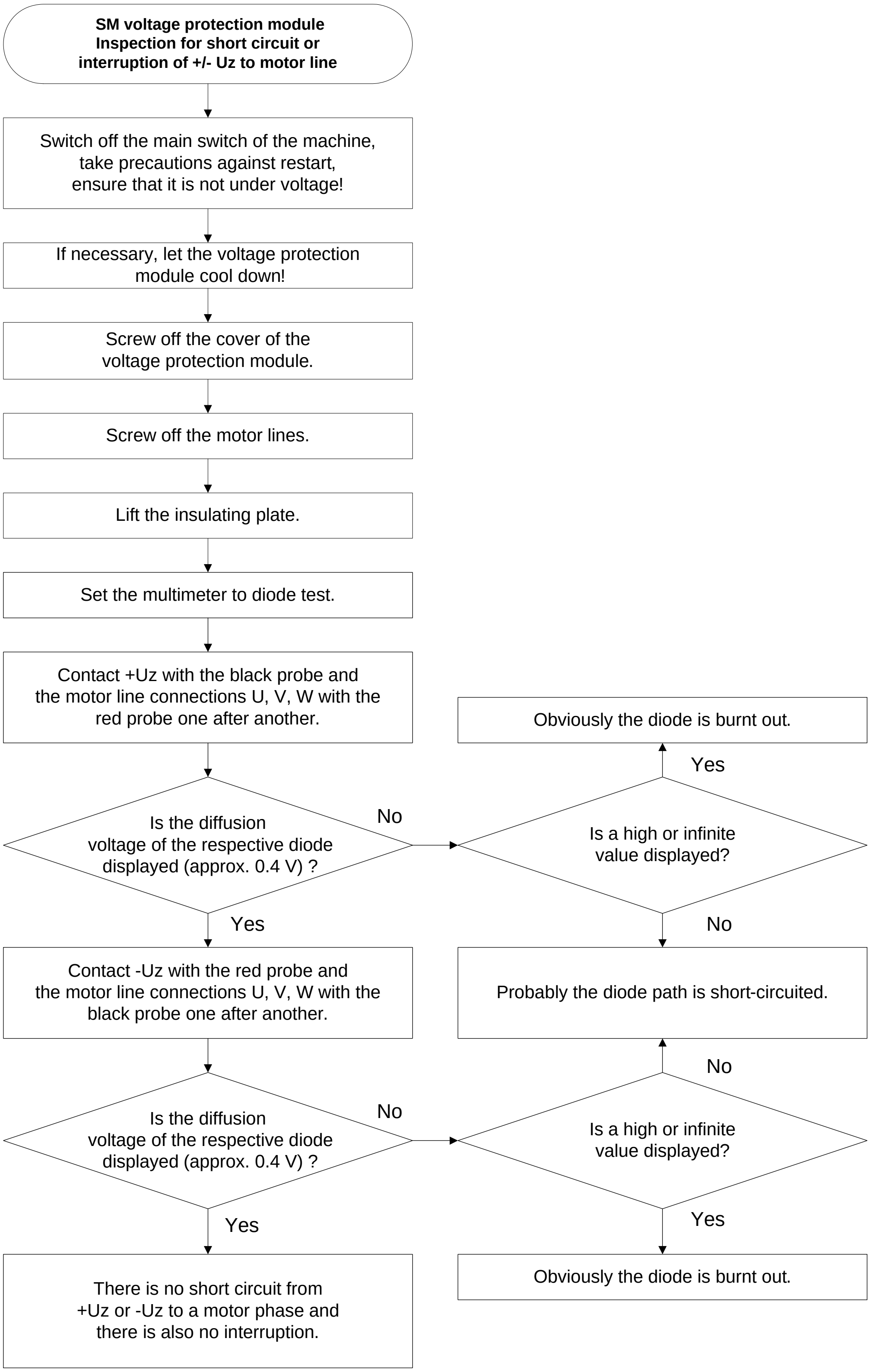
Flowchart: Short circuit between +Uz and -Uz



Note

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

Flowchart: Short circuit of +/- Uz to motor line



Note

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

Photo:
Open SM

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 1 – 7!

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 Test Unit” on page 14 – 333.
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 %.

Caution

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:

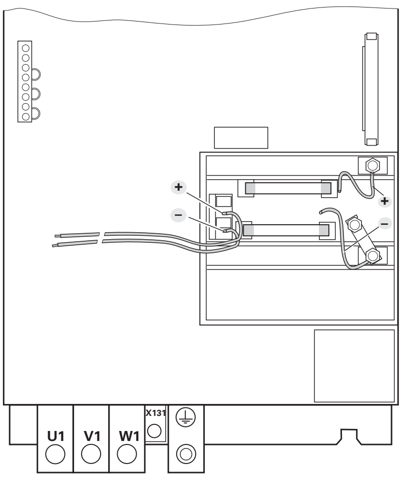
- Measure carefully whether the dc-link voltage on connector X31 on the bottom of the UV 101 B is available (the voltage depends on the inverter system).

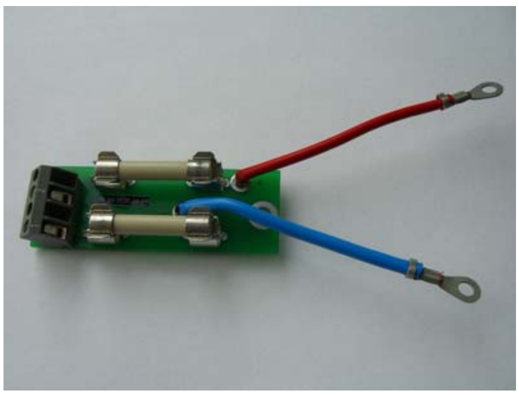
If the dc-link voltage is not available:

- Check the function of the power supply unit. --> see “Checking the Voltages” on page 7 – 134
- 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.





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!

- 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 - 335.
See "X69, X169: NC supply voltage and control signals" on page 12 - 313.

Fuses in 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.

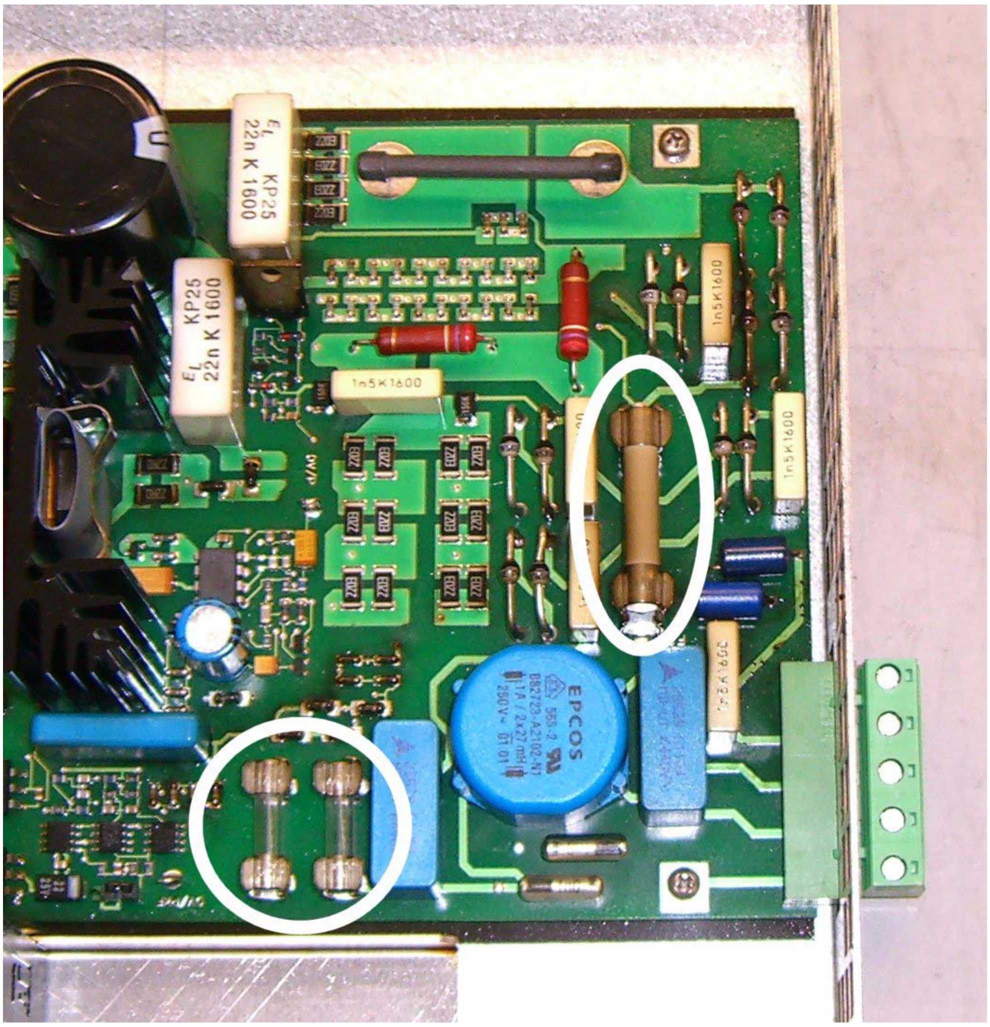
DANGER

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 seperated from the power source (without current consuming unit, the voltage on the board is only reduced slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Caution

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.

Fault repair

Defective power supply units are replaced. –>
see “Exchanging Power Supply Units” on page 10 – 197.

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 Test Unit” on page 14 – 333.
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).

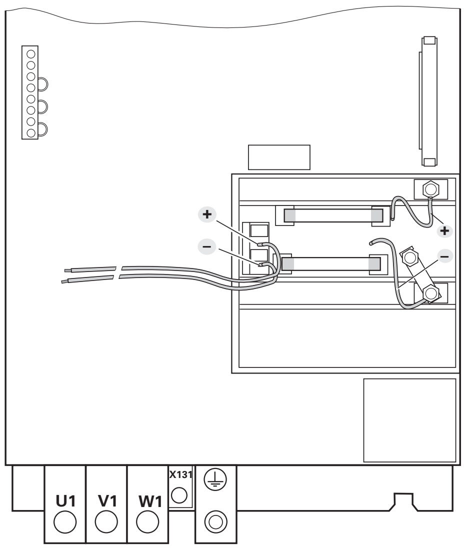
If the dc-link voltage is not available:

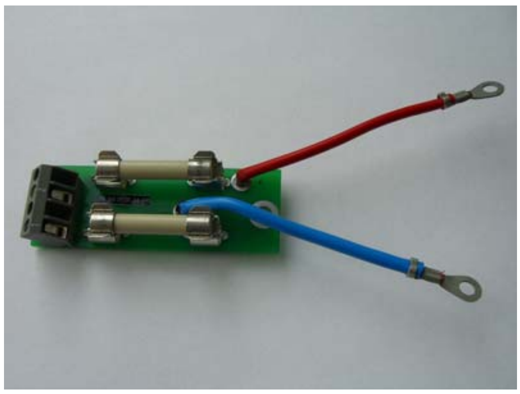
▶ Check the function of the power supply unit. –> see “Checking the Voltages” on page 7 – 134

▶ 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 bars on the non-HEIDENHAIN inverter.





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!

- 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 - 335.
See ”X69, X169: NC supply voltage and control signals” on page 12 - 313.

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 seperated from the power source (without current consuming unit, the voltage on the board is only reduced slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Caution

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.

Fault repair

Defective power supply units are replaced. -->
see “Exchanging Power Supply Units” on page 10 – 197.

9.5 Error Diagnosis on 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 released.
- 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 Test Unit" on page 14 – 333.
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 %.

Caution

If the UV 105 (B) is used in combination 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.

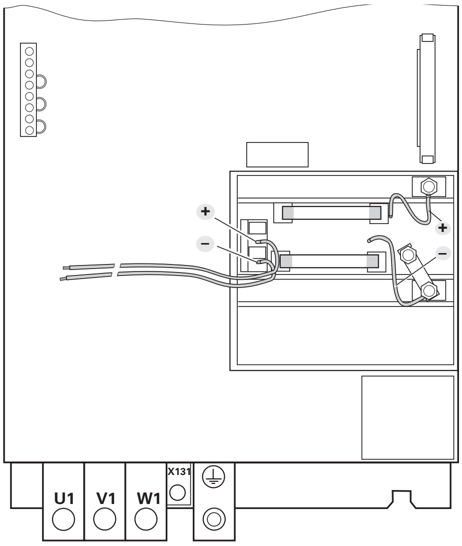
Photo: UV 105 in a single-row HEIDENHAIN inverter system

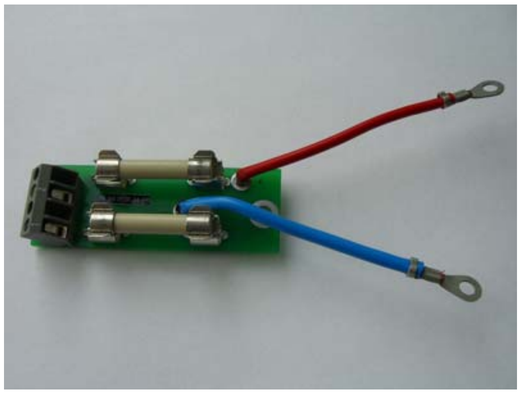
If the dc-link voltage is not available:

- Check the function of the power supply unit. --> see “Checking the Voltages” on page 7 – 82, see “Checking the Voltages” on page 7 – 134
- 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.





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!

- 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 105 (B) and measure the corresponding low voltages.

See "Test Adapter" on page 14 - 335.
See "X69, X169: NC supply voltage and control signals" on page 12 - 313.

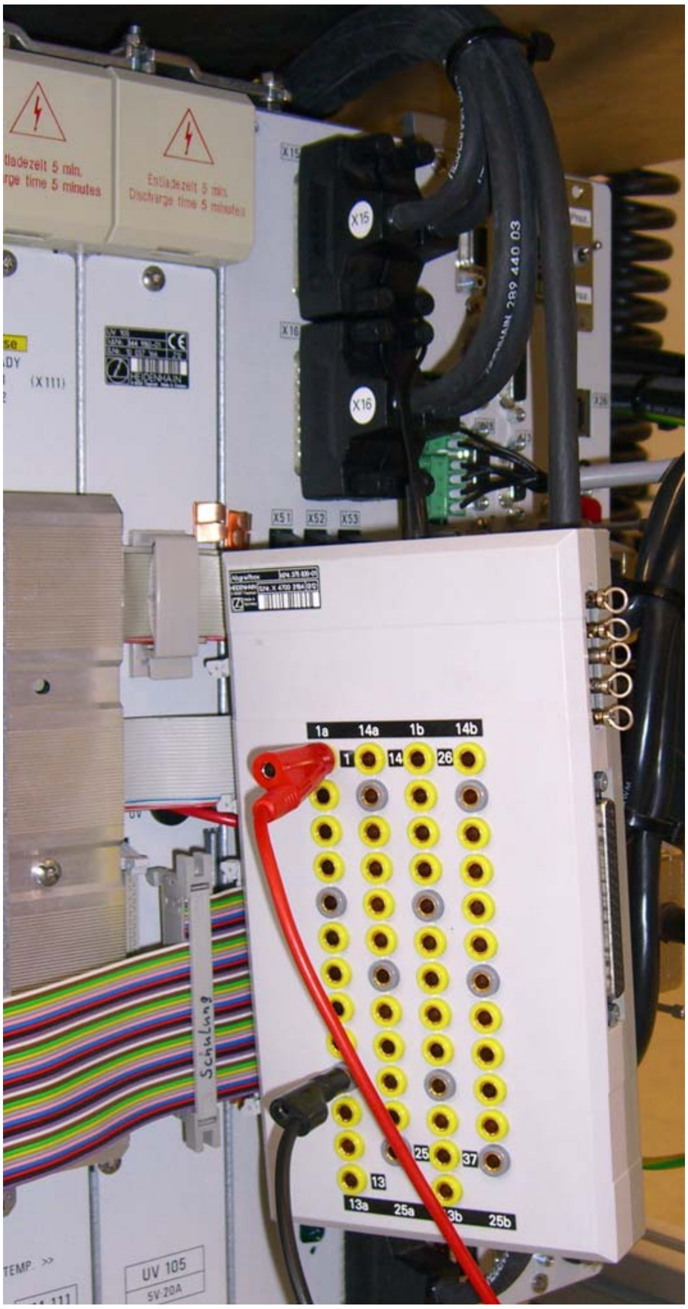


Photo: Connection of the test adapter to the power supply bus

Fuses in 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 seperated from the power source (without current consuming unit, the voltage on the board is only reduced slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Caution

Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

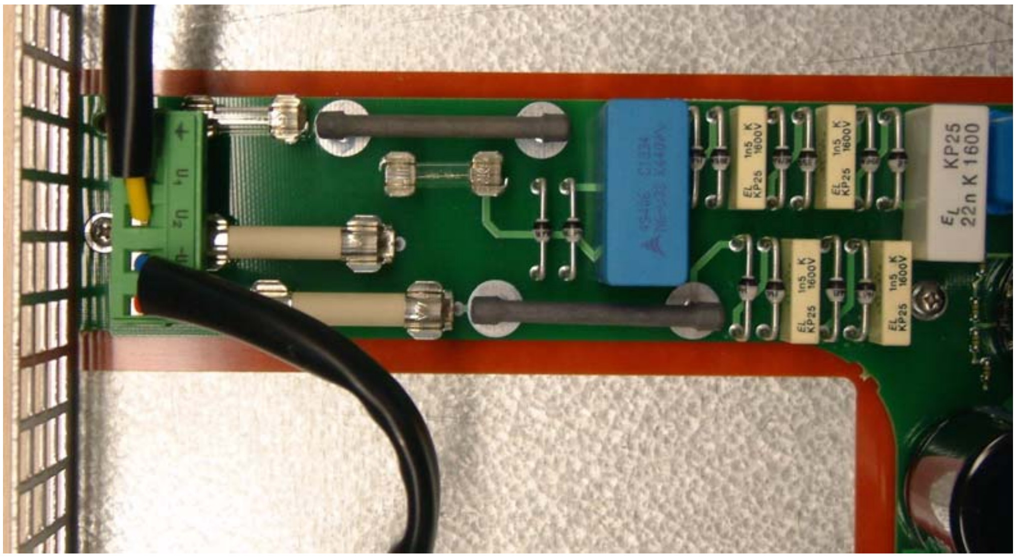


Photo: Position of the fuses in the UV 105

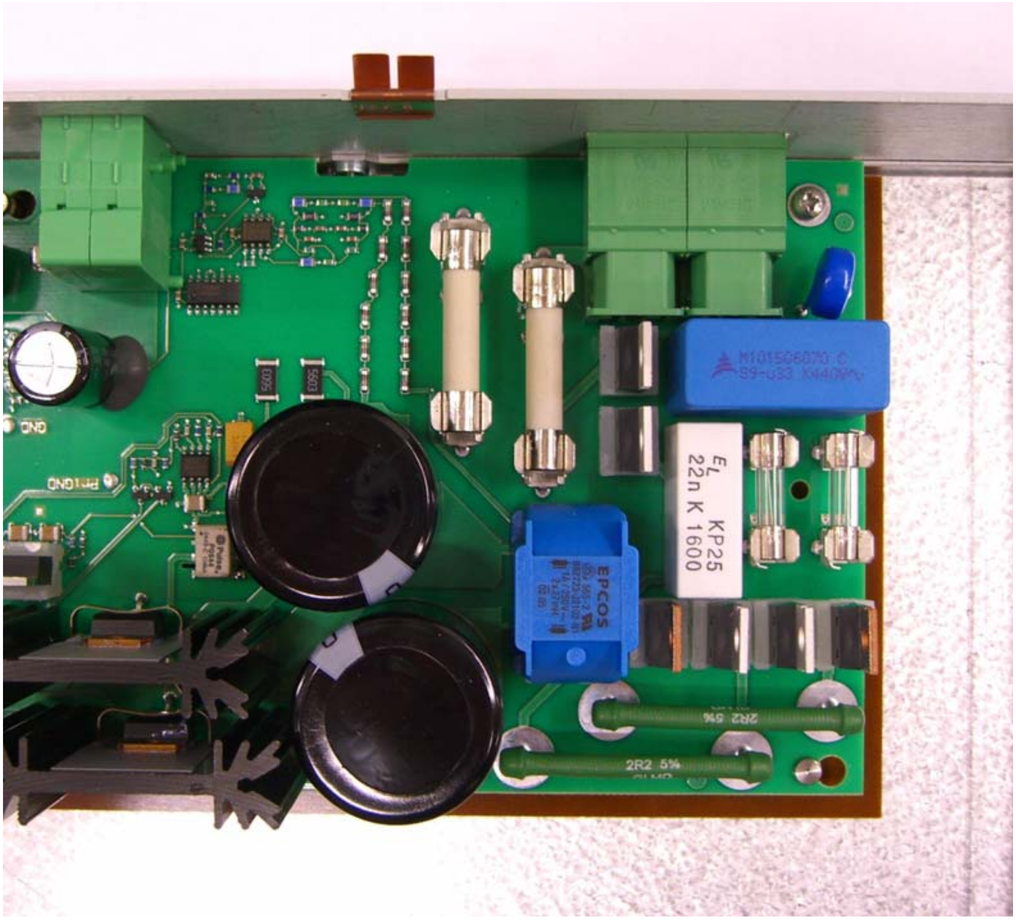


Photo: Position of the fuses in the UV 105

Note

If any of the fuses is defective, the UV 105 (B) power supply unit must be replaced. Replacing the fuses is not advised.

Fault repair

Defective power supply units are replaced. -->
see "Exchanging Power Supply Units" on page 10 – 197.

9.6 Error Diagnosis on 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 released.
- 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 device for the following measurement, see “Voltage Test Unit” on page 14 – 333.
> Proceed carefully and concentratedly!

- Measure phase U to phase V on connecotr 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 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 seperated from the power source (without current consuming unit, the voltage on the board is only reduced slowly).
> Do not touch the board or the fuses with bare hands!
> Use insulated pincers when removing the fuses!

Caution

Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

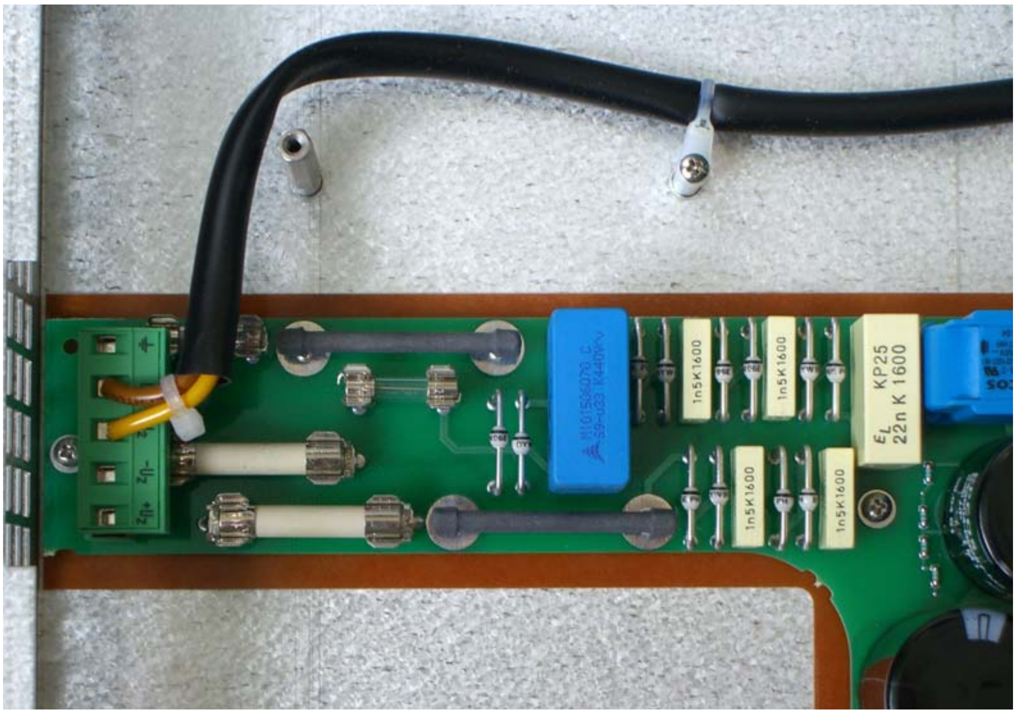


Photo: Position of the fuses in the UV 106

Note

If any of the fuses is defective, the UV 106 B power supply unit must be replaced. Replacing the fuses is not advised.

Fault repair

Defective power supply units are replaced. -->
see “Exchanging Power Supply Units” on page 10 – 197.

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 Test Unit” on page 14 – 333.
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:

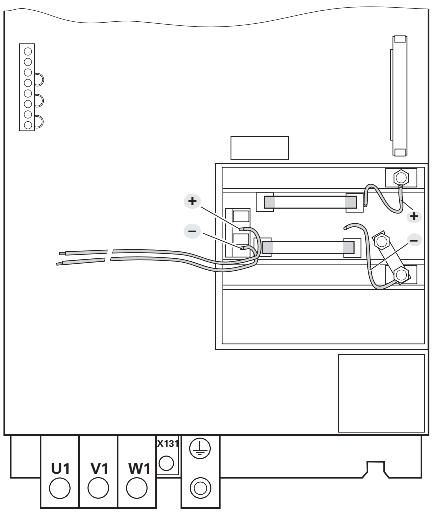
- Measure carefully whether the dc-link voltage on connector X31 on the bottom of the UV 111 is available (the voltage depends on the inverter system).

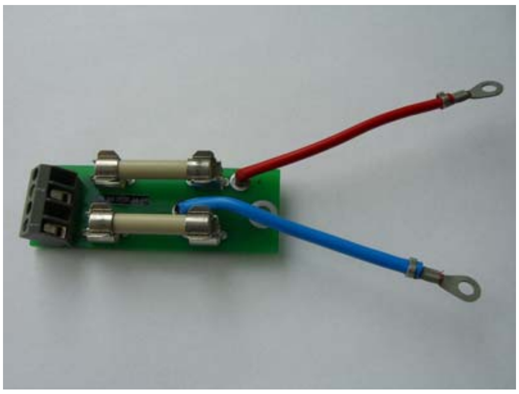
If the dc-link voltage is not available:

- Check the function of the power supply unit. --> see “Checking the Voltages” on page 7 – 134
- 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 which is secured to the conductor bar on the non-HEIDENHAIN inverter.





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!

- 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 111x and measure the corresponding low voltages.
See "Test Adapter" on page 14 - 335.
See "X69, X169: NC supply voltage and control signals" on page 12 - 313.

Fuses in 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 seperated from the power source (without current consuming unit, the voltage on the board is only reduced slowly).
Do not touch the board or the fuses with bare hands!
Use insulated pincers when removing the fuses!

Caution

Be careful not to touch any components on the power supply board sensitive to electrostatic discharge and observe the ESD regulations!

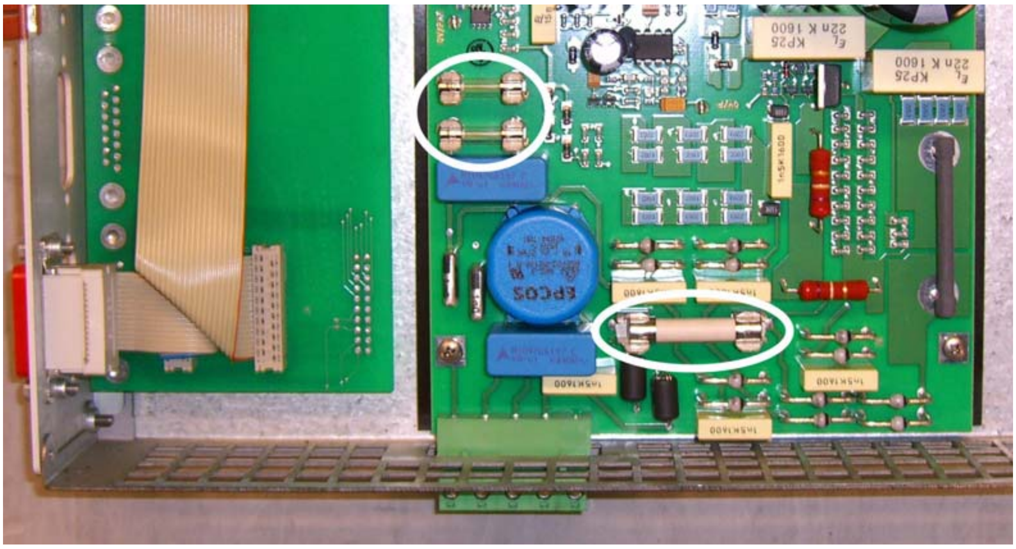


Photo: Position of the fuses in the UV 111x

Note

If any of the fuses is defective, the UV 111x power supply unit must be replaced. Replacing the fuses is not advised.

Fault repair

Defective power supply units are replaced. –>
see "Exchanging Power Supply Units" on page 10 – 197.

10 Exchanging 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 1 – 7.

Caution

Use only original HEIDENHAIN components!

Which items can be exchanged?

- **Complete inverter**
- **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, connectors and various 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 at HEIDENHAIN.)
- **Contacts in power sockets**
  (Special crimp pliers are required.)

Replacement units and spare parts

For replacement units and spare parts, ask your **machine manufacturer**!

Please observe the following:

- **Always use original HEIDENHAIN components as replacements!**
- Please send the defective unit in its **original packaging** to your machine manufacturer or your HEIDENHAIN agency.

Information on possible errors

If possible, 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.

Repair

Many HEIDENHAIN devices are not repaired on site but are exchanged or replaced.
These devices are exclusively repaired by HEIDENHAIN specialists in well-equipped workshops.
The devices are also updated to the latest state-of-the-art and subjected to tests.

ID numbers

When placing a service order, always indicate the ID number of the HEIDENHAIN device concerned.

Electronic ID label

Following HEIDENHAIN units feature an electronic ID label:

- **Inverter components**, that contain a **"D"** in the designation
- **Synchronous motors** with absolute encoders with **EnDat interface**

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").

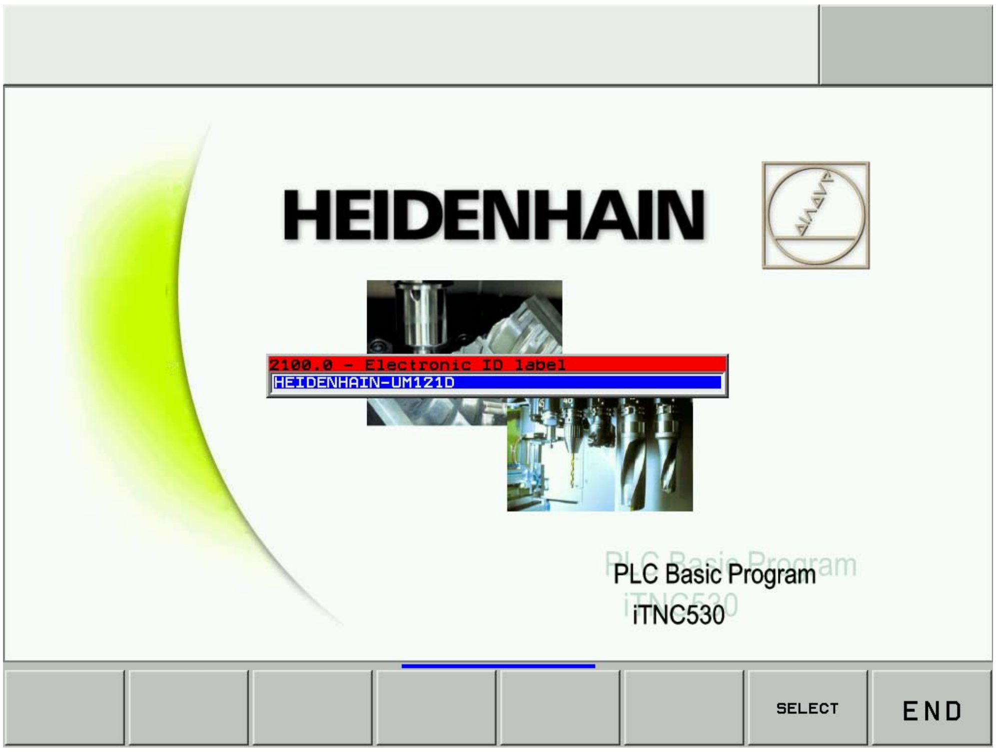


Photo: The electronic ID label of a HEIDENHAIN power module is reported to the monitor of the control

Each time the control is started it is checked whether the connected unit with electronic ID label corresponds to the respective entries in the MP list (MP2100.x or MP2200.x).

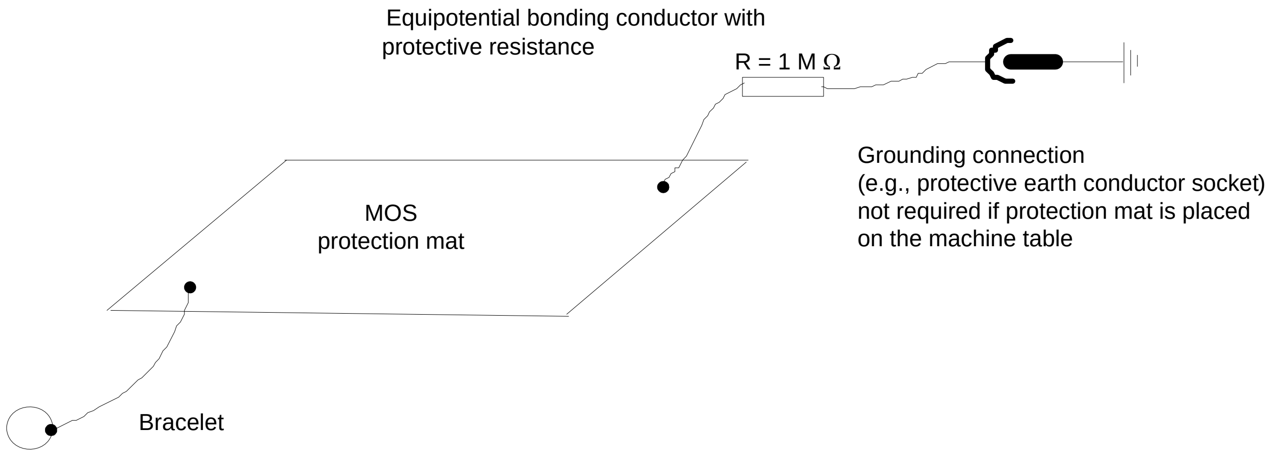
ESD protection

When you exchange HEIDENHAIN components, you might come into contact with electronic components. This may also happen via contacts in connectors of units or cables.

These ESD-sensitive components may also come into contact with a statically charged object (tool, tool table, packaging, etc.).

Caution

Therefore observe the ESD protective measures, when you exchange HEIDENHAIN components with directly or indirectly accessible electronic components (connectors, cables)!



10.2 Exchanging the Complete Inverter

Removing the defective inverters

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see "Safety Precautions" on page 1 – 7!

DANGER

If the defective inverter is a **water-cooled unit**:
Ensure that water conduits are cut outside the electrical cabinet to drain the water here. Only then may the conduits unscrewed from the inverter.
In any case follow the **manufacturer's instructions** or ask a HEIDENHAIN agency for the exchange procedure!
In no case may water penetrate into electrical units or into the electrical cabinet!

- 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.

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 ground leads for the motors.

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 reduced completely!

- Open the protective covers and unscrew the conductor bars.
- Loosen the mounting screws on the sheet-metal housing of the electrical cabinet (do not unscrew completely).
- Lift the inverter slightly and remove it towards you.

Integrating the new inverter

- Hook the 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 to the 5V ribbon wires.

- Screw on the ground leads for the motors.

- Screw off the cover plate.

> **DANGER**
>
> If the replacement inverter is a **water-cooled unit**:
> Connect the water conduits again. --> see "Checking the Criteria for Water-Cooled Inverters" on page 7 – 69, turn on the water.
> In any case follow the **manufacturer's instructions** or ask a HEIDENHAIN agency for the exchange procedure!
> **In no case may water penetrate into electrical units or into the electrical cabinet!**

Testing the machine function

Now test the machine function:

- Switch on the power supply of the machine tool.
- Instruct the operator to mill the workpiece.

Return shipment

- If possible, 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 Exchanging the Complete Motor

Removing the defective motor

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see “Safety Precautions” on page 1 – 7!

DANGER

Secure vertical axes to prevent them from falling down before you remove motors on these axes!

- Label and remove all of the connections on the motor.

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 out the mounting screws for the motor.
- Remove the motor.

Integrating the new motor

- Insert the motor.
- Tighten the mounting screws for the motor.
- Re-establish and screw into place all of the connections.

Caution

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, MP 3430) 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 (MP 960) must be set again for this axis.

See TNC 426/430, iTNC 530 Service Manual or ask the machine manufacturer or a HEIDENHAIN agency.

Testing the functions

- Switch on the main switch of the machine.
- Ramp up the motor slowly to maximum speed.
- Check the rotational direction of the fan on the spindle motor.
- Check the function of the brake on the axis motor.

Now test the machine function:

- Instruct the operator to mill the workpiece.

Return shipment

- If possible, 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 motor.
- 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 Exchanging the Motor Encoder of the QAN Asynchronous Motor

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“)

Caution

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!

Caution

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 recommend 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 1 – 7.

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.

We recommend to send these motors to HEIDENENHAIN Traunreut or to a service agency for repair.

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.

Caution

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

- 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.

Caution

If there is no reverse-polarity protection, pay attention to the **TOP** label!

- Put the metal sleeve at the end of the signal 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 routing.
- 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, MP 3430) must be set again after the rotary encoder has been replaced.
See TNC 426/430, iTNC 530 Service Manual or ask the machine manufacturer or a HEIDENHAIN agency.

Testing the machine function

Now test the machine function:

- Switch on the main switch of the machine.
- Instruct the operator to mill the workpiece.

Return shipment

- If possible, 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.

10.5 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 (on 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 1 – 7.

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.

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 signal socket including signal line and temperature sensor wires from the cover.

Integrating the new signal socket

- 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.

Caution

If there is no reverse-polarity protection, pay attention to the **TOP** label!

- Put the metal sleeve at the end of the signal cable in the prepared depression of the cover cap.
- Insert and screw on the cover cap.
- Connect the temperature sensor line.

Caution

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.

10.6 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 1 – 7.

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 HEIDENENHAIN 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.

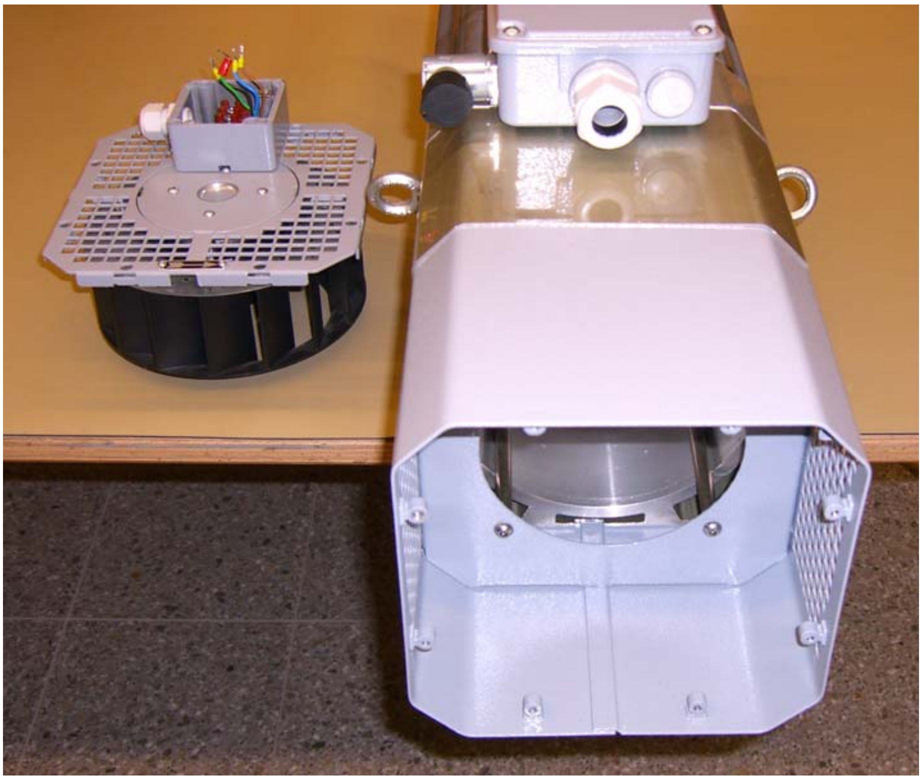
Example with QAN 200 UH:

▶ 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).

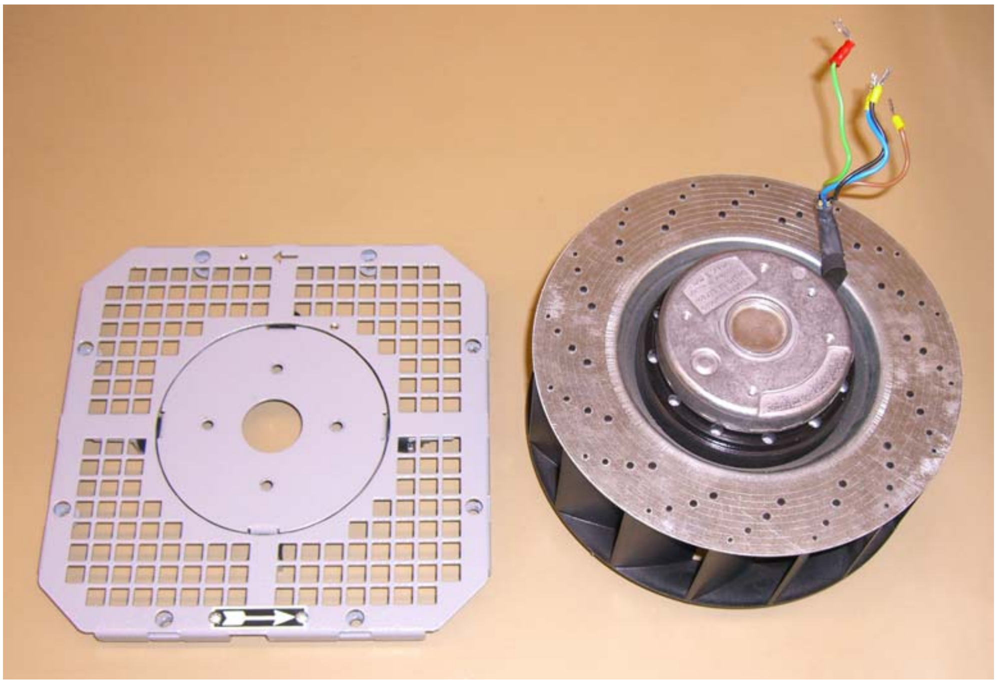
▶ Unclamp the supply and fan cable, screw of the ground leads.

▶ Screw off the fan guard including fan on the rear.



▶ Screw off and remove the small terminal box from the fan guard.

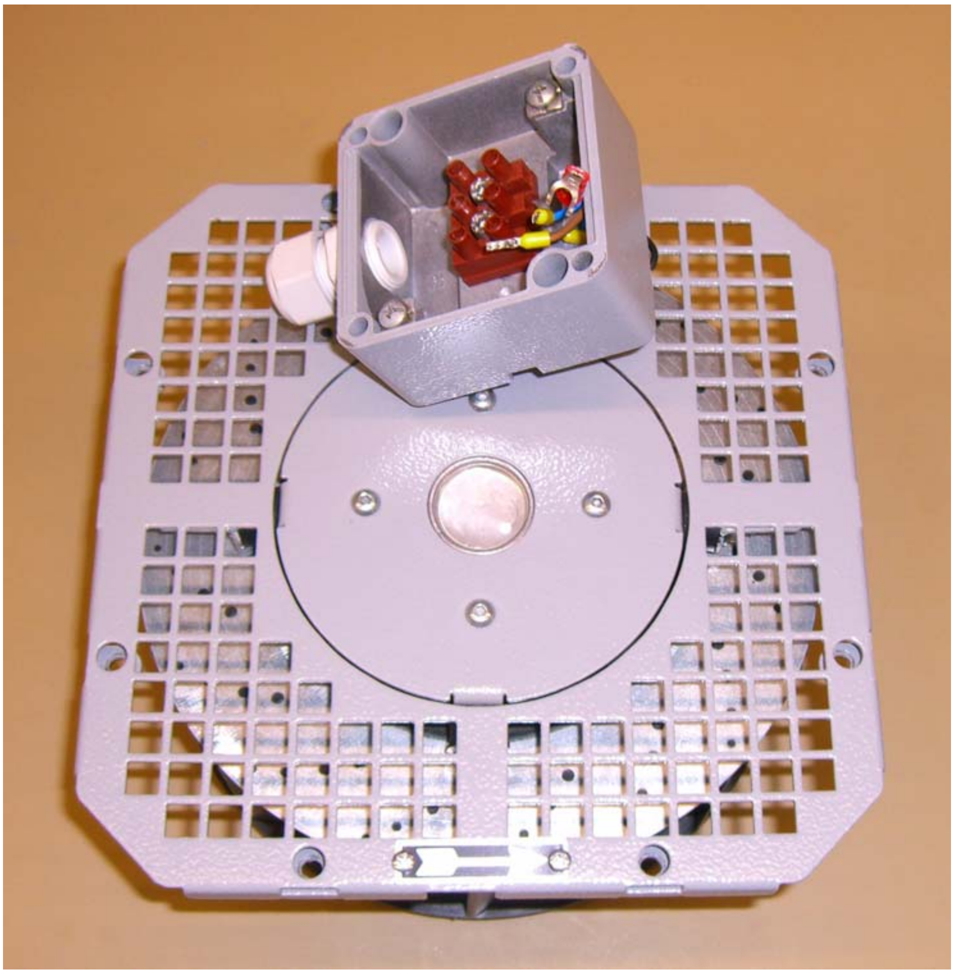
▶ Unscrew 4 screws on the rear. --> Separate the fan from the fan guard.



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.

Testing the functions

▶ Switch on the main switch of the machine.
▶ Check whether the fan is running properly.

Caution

Check the rotational direction of the fan. --> See arrow on the fan guard!

10.7 Exchanging the Fan Guard of a 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.

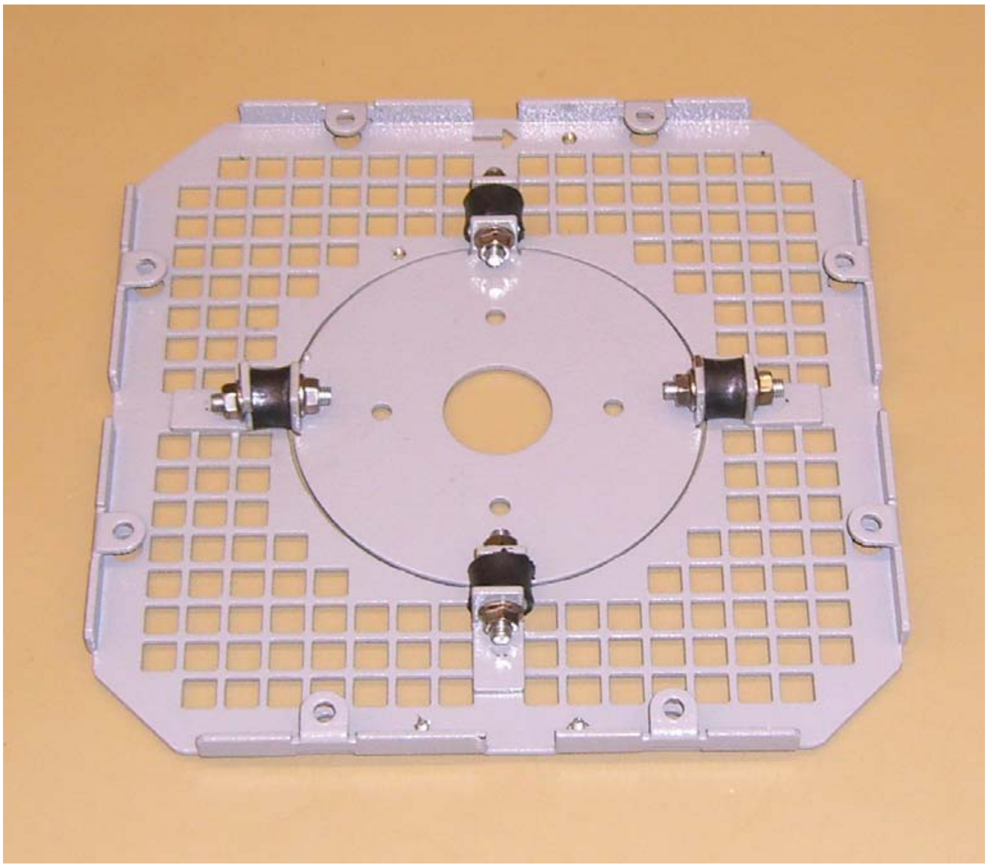


Photo: Fan guard with rubber buffers

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.

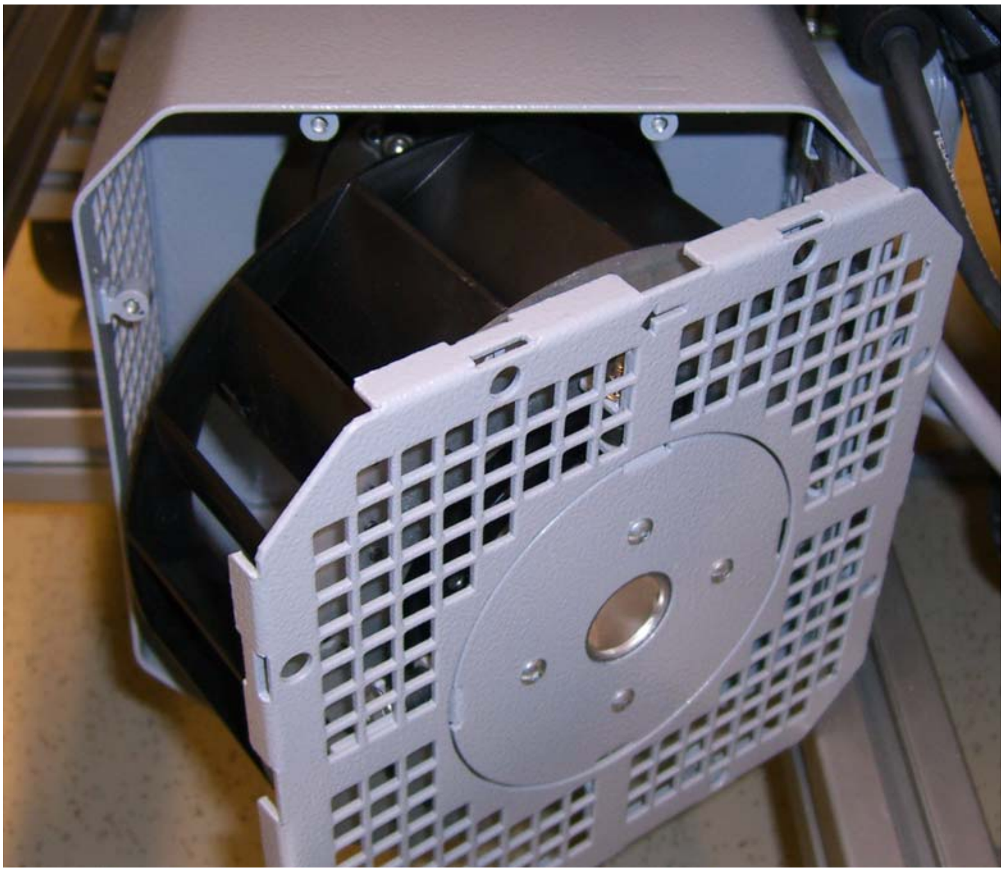
If larger spindle motors are affected it makes sense to perform the replacement while the motor is still incorporated.

DANGER

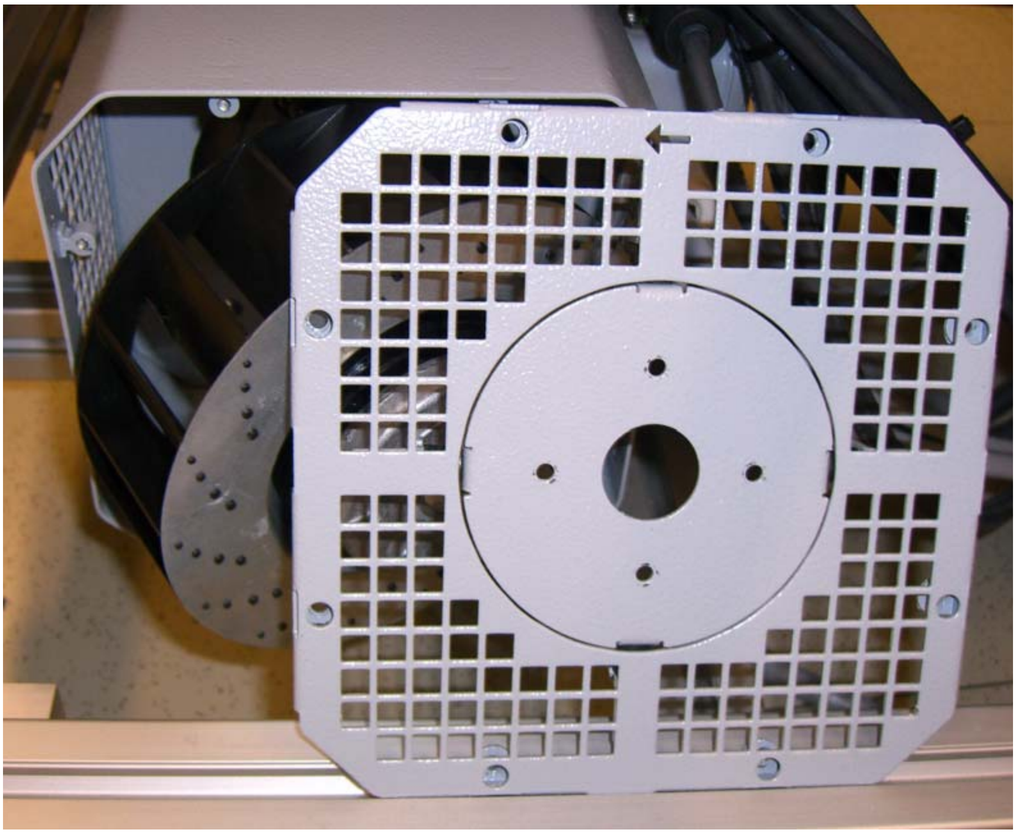
If you do not have removed the motor completely from the machine, ensure that the machine has been switched off and cannot be switched on again!
Check whether the machine is under voltage.
Observe the safety precautions to avoid injury or damage to persons or machines.
--> see "Safety Precautions" on page 1 – 7.

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.

10.8 Changing Connections to the Reserve Temperature Sensor

HEIDENHAIN spindle motors are equipped with reserve temperature sensors.

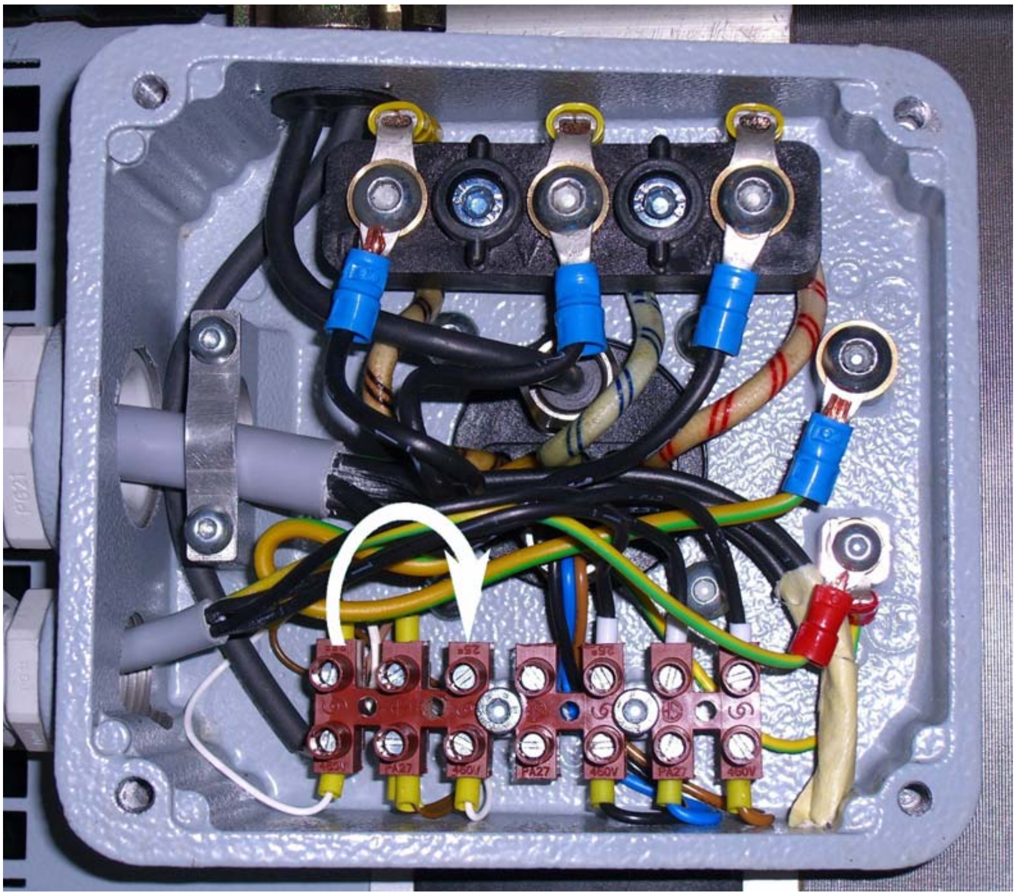
If the original temperatur sensor is defective, connections may be changed to the second sensor.

DANGER

Before performing following work, ensure that the devices are free of potential. --> Always comply with the safety precautions, see "Safety Precautions" on page 1 – 7!

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.

10.9 Exchanging Inverter Accessories

The exchange of accessories is not described in detail.
Please note the following:

General information

- The machine must be switched off before inverter accessories are exchanged. ---> see “Safety Precautions” on page 1 – 7
- 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 reduced completely**!

- 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 **original packagings** from HEIDENHAIN.

Note

If you have any questions, contact the **machine manufacturer** or a **HEIDENHAIN service agency.**

ZKF

- The **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**.

Return shipment

- If possible, 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.

10.10 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 1 – 7

- Many cables and connectors are connected directly or indirectly to the dc-link (high voltage and current).

DANGER

Wait at least 5 minutes before you unclamp and disconnect 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 reduced completely**!

- If required, ensure **proper shielding and grounding** of cables and components.

- The motor lines in the SM 130 must be tightened with 9 Nm.

- Exchange cables only for **original cables**!

- Do not exceed any **maximum lengths**!

- If possible, use **original packagings** from HEIDENHAIN.

Note

If you have any questions, contact the **machine manufacturer** or a **HEIDENHAIN service agency.**

10.11 Exchanging Power Supply Units

10.11.1 Exchanging the UV 101 B Power Supply Unit

Removing the defective power supply unit

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see "Safety Precautions" on page 1 – 7!
- Unscrew the grounding bars or ground lead on the top of the power supply unit.
- Screw off the cover plate.
- 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.

Return shipment

- If possible, 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.

10.11.2 Exchanging the UV 102 Power Supply Unit

Removing the defective power supply unit

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see "Safety Precautions" on page 1 – 7!
- 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.

☞ **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!

- 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.

Return shipment

- If possible, 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.

10.11.3 Exchanging the UV 105 Power Supply Unit

Removing the defective power supply unit

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see "Safety Precautions" on page 1 – 7!
- 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.

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 reduced completely!

- Screw off the conductor bars.
- 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 to the 5V ribbon wires.

- Screw on the cover plate.

Return shipment

- If possible, 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.

10.11.4 Exchanging the UV 105 B Power Supply Unit

Removing the defective power supply unit

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see "Safety Precautions" on page 1 – 7!
- 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 to the 5V ribbon wires.

- Screw on the cover plate.

Return shipment

- If possible, 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.

10.11.5 Exchanging the UV 106 B Power Supply Unit

Removing the defective power supply unit

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see "Safety Precautions" on page 1 – 7!
- Label and disconnect all of the connections on the control (MC).

> **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!

- 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.

Return shipment

- If possible, 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.

10.11.6 Exchanging the UV 111 A, UV 111 B Power Supply Units

Removing the defective power supply unit

- Switch off the main switch of the machine, take precautions against resetting, ensure that it is free of potential. --> see "Safety Precautions" on page 1 – 7!
- 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.

☞ **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!

- 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.

Return shipment

- If possible, 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.

11 Overview of Components

11.1 Compact Inverters

Compact inverters are available for up to 4 axes plus spindle or up to five axes.

11.1.1 Assembly

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

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
- UV 102 power module (only LE 426 M)

For operation with the non-regenerative HEIDENHAIN **UE 2xxB** compact inverters, you need the following components:

- UE 2xxB compact inverter
- PW 21x (or PW 110(B)) braking resistor (optional)
- Toroidal cores for interference suppression
- One UM 111D power module (optional)
- 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** compact inverters, you need the following components:

- UR 2xx compact inverter
- KDR 120 commutating reactor
- EPCOS 35 A line filter
- UP 110 braking resistor module (optional)
- One UM 111D power module (optional)
- In conjunction with direct drives (only via additional power module): One ZKF 1xx
- Ribbon cables for PWM signals and supply voltage (and optional unit bus)
- Covers for the ribbon cables

11.1.2 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.

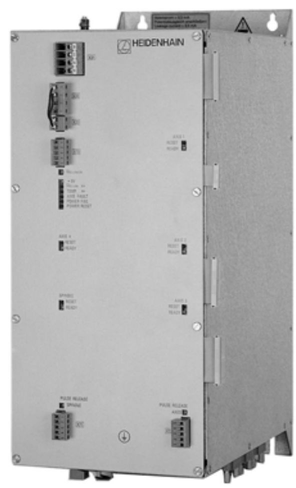
UE 112

Note

It is not possible to connect an external braking resistor or an additional UM xxx inverter module to the UE 1xx compact inverters.

11.1.3 UE 2xx compact inverter

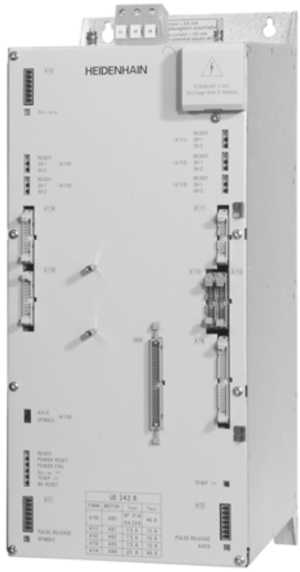
With the non-regenerative UE 2xx compact inverters, the power electronics for all of the axes and the spindle, as well as the power supply for the control are all contained in a single unit.
The PWM signals are transferred via **internal** 20-line ribbon cables.
If you are using an LE 426 M, you will require in addition the UV 102 power supply unit.



UE 212

11.1.4 UE 2xxB Compact Inverter

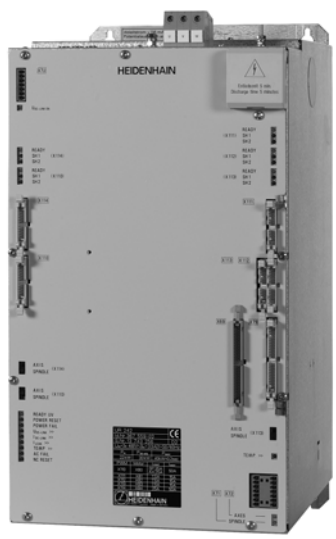
With the non-regenerative UE 2xxB compact inverters, the power electronics for all of the axes and the spindle, as well as the power supply for the control are all contained in a single unit. An additional UM 111D power module of the modular inverter system can be connected via conductor bars.
The PWM signals are transferred via **external** 20-line ribbon cables.



UE 242B

11.1.5 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

Caution

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 111 D that is connected to the dc-link of the UR 2xx(D) via a ZKF 1xx.

11.1.6 Toroidal Cores

To suppress occurrence of interference, toroidal cores are mounted in the motor leads and in the voltage supply lead if you are using 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)	∅ 87 mm (309 694-02)
Braking resistor (X89)[a]	∅ 42 mm (309 694-01)
Axes 1 to 3 (X81 to X83)	∅ 42 mm (309 694-01)
Axis 4 (X84)	∅ 59 mm (309 694-03)
Spindle (X80)	∅ 59 mm (309 694-03)

a. only for UE 21x

11.1.7 Ribbon Cables and Covers (Only for UE 2xxB, UR 2xx)

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**.

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 being operated with the compact inverter.

Ribbon cable covers

The ribbon cables must be covered **to protect them against interference**.

11.2 Modular Inverters

11.2.1 Assembly

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 filters
- 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

11.2.2 UV 130(D) Power Supply Unit

The non-regenerative UV 130(D) power supply units supply the dc-link voltage as well as the power for the electronics of the control and 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

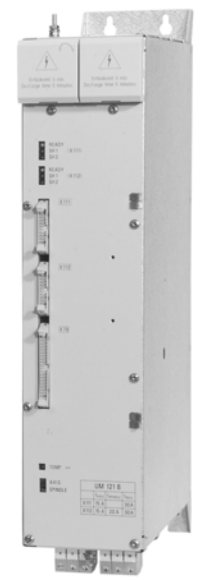
11.2.3 UV(R) 1x0(D) Power Supply Unit

The regenerative UV(R) 1x0(D) power supply units supply the dc-link voltage as well as the power for the electronics of the control and power modules.
During braking, the motors feed energy into the dc-link.
The UVR 1x0(D) returns this energy to the power line.
The UVR 1x0(D) can be driven only with commutating reactor and line filter.

UVR 140D

11.2.4 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 from the control via external 20-line ribbon cables.



UM 121BD

11.2.5 Ribbon Cables and Covers

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**.

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**.

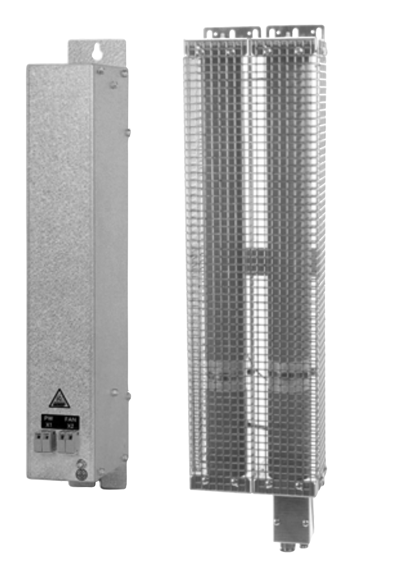
Ribbon cable covers

The ribbon cables must be covered **to protect them against interference**.

11.3 Accessories for Compact Inverters and Modular Inverters

11.3.1 PW 21x, PW 110(B), PW 120 Braking Resistors

The PW braking resistors convert the energy fed back into the dc-link during braking into heat.
The PW 110(B) and PW 120 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) or two PW 210 in parallel can be connected to the UE 2xxB compact inverters and UV 130 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.

11.3.2 UP 110, UP 120 Braking Resistor Module (Optional)

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 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 - 217

11.3.3 Line Filters

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 module used.

EPCOS 35A interference suppression filter

EPCOS 120A interference suppression filter

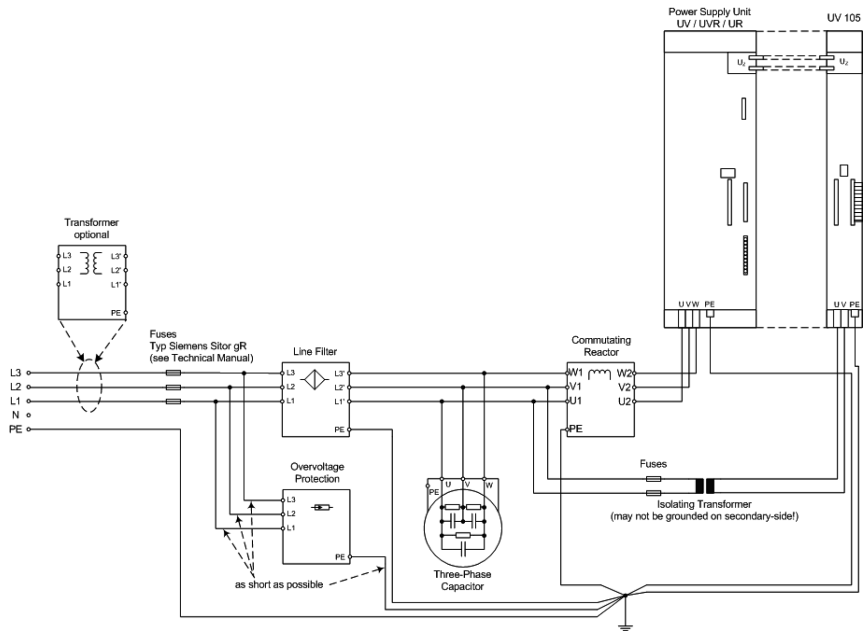
Specifications	**EPCOS 35 A line filter**	**EPCOS 80 A line filter**
suitable for	UR 2xx(D), UV 120, UVR 120D	UV 140, UVR 150, UVR 130D, UVR 140D, UVR 150D
Rated voltage	3 x 400 V	3 x 400 V
Rated frequency	50 Hz/60 Hz	50 Hz/60 Hz
Rated current	3 x 35 A	3 x 80 A
Power loss	Approx. 50 W	Approx. 75 W
Degree of protection	IP 20	IP 20

Specifications	**EPCOS 120 A line filter**
Suitable for	UVR 160D
Rated voltage	3 x 400 V
Rated frequency	50 Hz/60 Hz
Rated current	3 x 120 A
Power loss	Approx. 115 W
Degree of protection	IP 20

Application example

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.

11.3.4 Three-Phase Capacitor

If you are using regenerative inverter systems, we basically recommend that you use a three-phase capacitor.
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
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

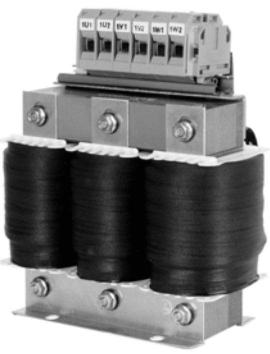
Note

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 - 213

11.3.5 KDR 1x0(B) Commutating Reactor

Regenerative inverter systems require a KDR 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 module used.



KDR 140

KDR 160

Specifications	KDR 120	KDR 130B	KDR 140	KDR 150	KDR 160
Rated voltage	3 x 400 V	3 x 400 V	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	50 Hz/60 Hz	50 Hz/60 Hz
Thermally permissible continuous current	3 x 35 A	3 x 45 A	3 x 70 A	3 x 80 A	3 x 130 A
Rated current	3 x 31.5 A	3 x 40.5 A	3 x 63 A	3 x 72 A	3 x 117 A
Power loss	Approx. 200 W	Approx. 250 W	Approx. 340 W	Approx. 350 W	Approx. 525 W
Degree of protection	IP 00	IP 00	IP 00	IP 00	IP 00

Caution

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 KDR 160 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 - 213

11.3.6 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
Rated power	30 kW	30 kW	55 kW
Peak power S6-40%	47 kW[a]	47 kW[a]	80[a] kW
Peak power S6-20%	67 kW[b]	67 kW[b]	100[b] kW
Peak power	110 kW[c]	110 kW[c]	110[c] kW
Max. leakage current	< 1.3 A	< 6.0 A	< 6.0 A
Current consumption 24 V	–	–	440 mA
Integral cooling	–	–	X
Degree of protection	IP 20	IP 20	IP 20

a. 40 % cyclic duration factor for duration of 10 min (S6-40%)
b. 20 % cyclic duration factor for duration of 10 min (S6-20%)
c. Pmax absolute

Caution

The total power of the direct drives must not exceed the power of the filter.

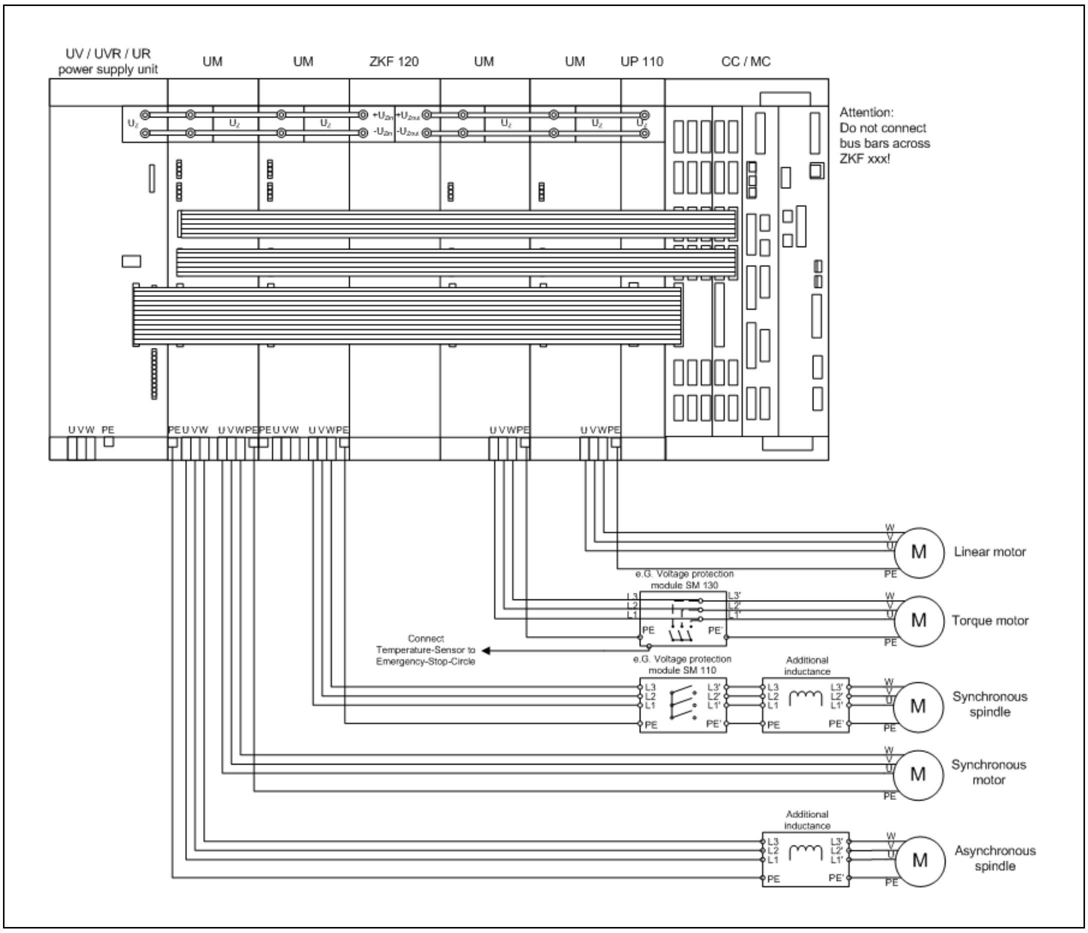
Caution

A ZKF dc-link filter is not permitted for non-HEIDENHAIN inverters!

Application example

Arrangement with .....

- ZKF 120 dc-link filter
- UP 110 braking resistor module
- SM 110 and SM 130 voltage protection module



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.

11.3.7 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.

Caution

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 !

Caution

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.

Caution

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.

Specifications	**SM 110**	**SM 130**
		
Switching voltage	850 V	850 V
Maximum phase current	3 x 63 A	3 x 300 A
Maximum braking time at maximum phase current	10 s	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!
Minimum duration between braking procedures	5 min	
Degree of protection	IP 20	IP 20

Example for the use of the three-phase current capacitor. --> See page 11 - 217

11.3.8 Adapter Module

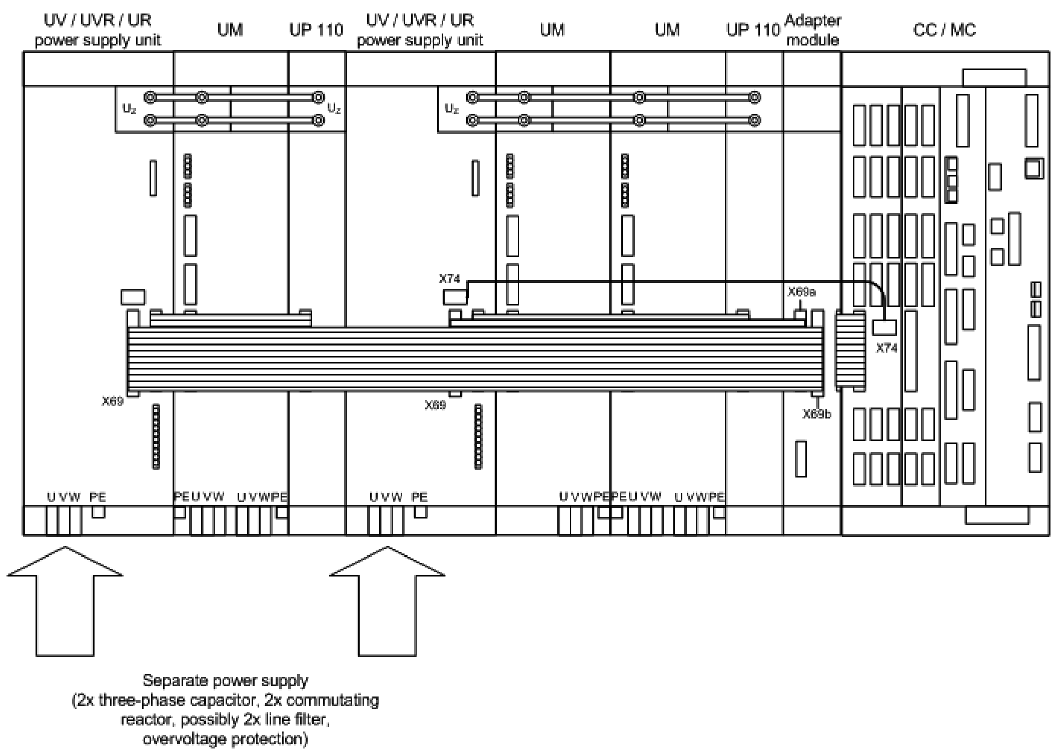
In modular regenerative inverter systems an **additional power supply unit** may become necessary if you are using inverters or motors with a high power demand.
The adapter module makes it possible to connect this power supply unit to the present inverter system.
In this way one power supply unit can, 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

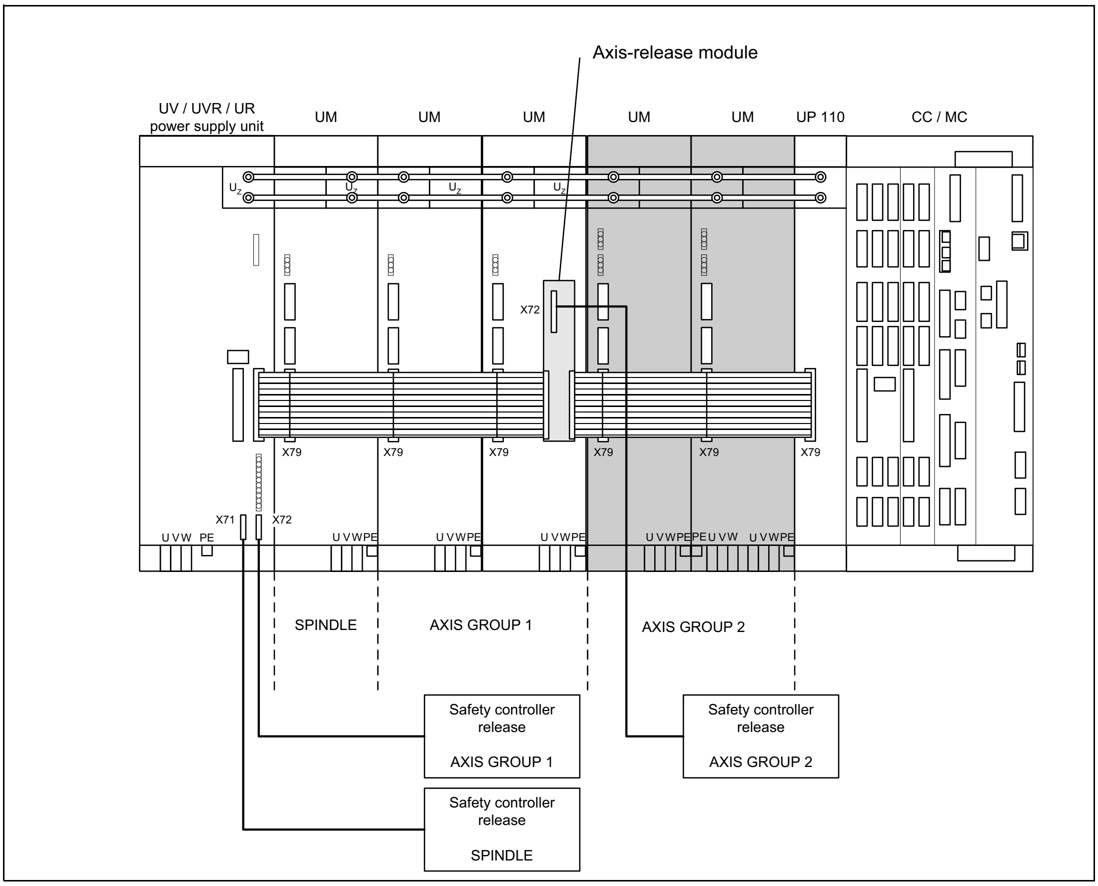
Application example



11.3.9 Axis-Release 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. This line is interrupted through the axis-enabling module so that all the power modules connected to the axis-enabling module are switched off. All other power modules are switched off via X72 of the UV(R) 1x0(D).

Application example



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).
A further 40-line ribbon cable connects the axis-enabling module with the power modules to be switched off via the axis-enabling module.

11.3.10 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 F

11.4 HEIDENHAIN interface cards for the SIMODRIVE system

11.4.1 Assembly

To operate an LE 4xx M or a CC 42x with the SIMODRIVE 611 D inverter system in **single-row** configuration you need the following components:

- UV 105 B (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 4xx M or a CC 42x with the SIMODRIVE 611D inverter system in **double-row** configuration you need the following components:

- UV 105 B (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

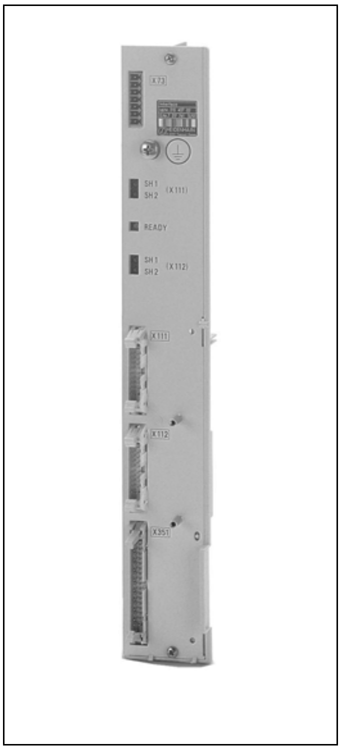
11.4.2 Expansion Boards

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
- Metallically insulated or not metallically insulated

See "Important Notes on the Use of HEIDENHAIN Expansion Boards in the SIMODRIVE System" on page 3 - 17.



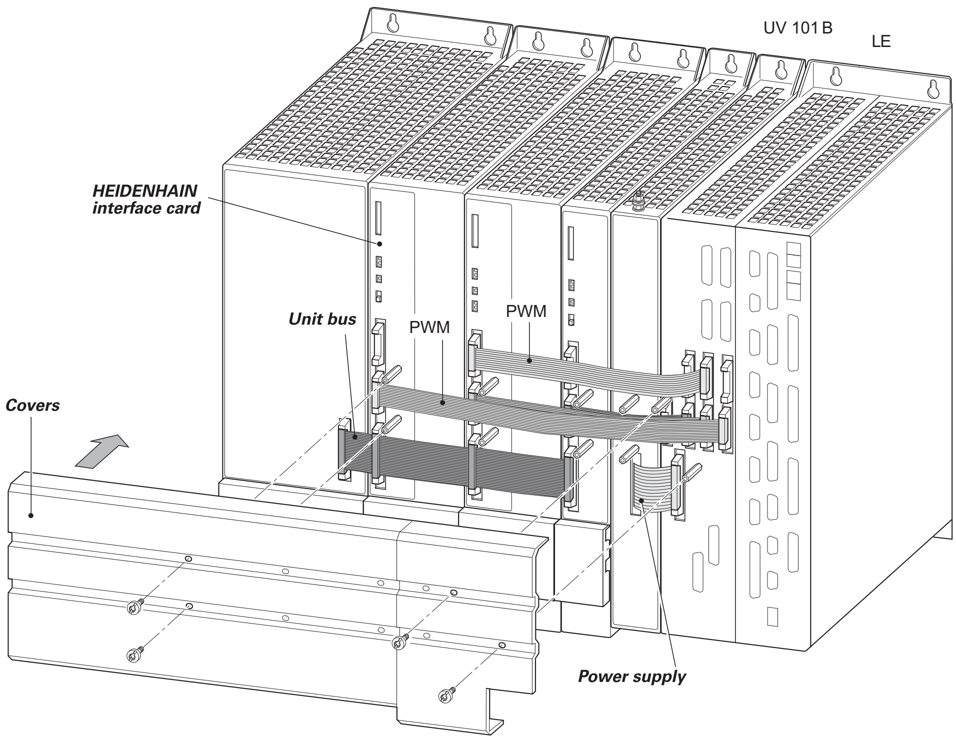
11.5 Power Supply Unit

11.5.1 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

Application example

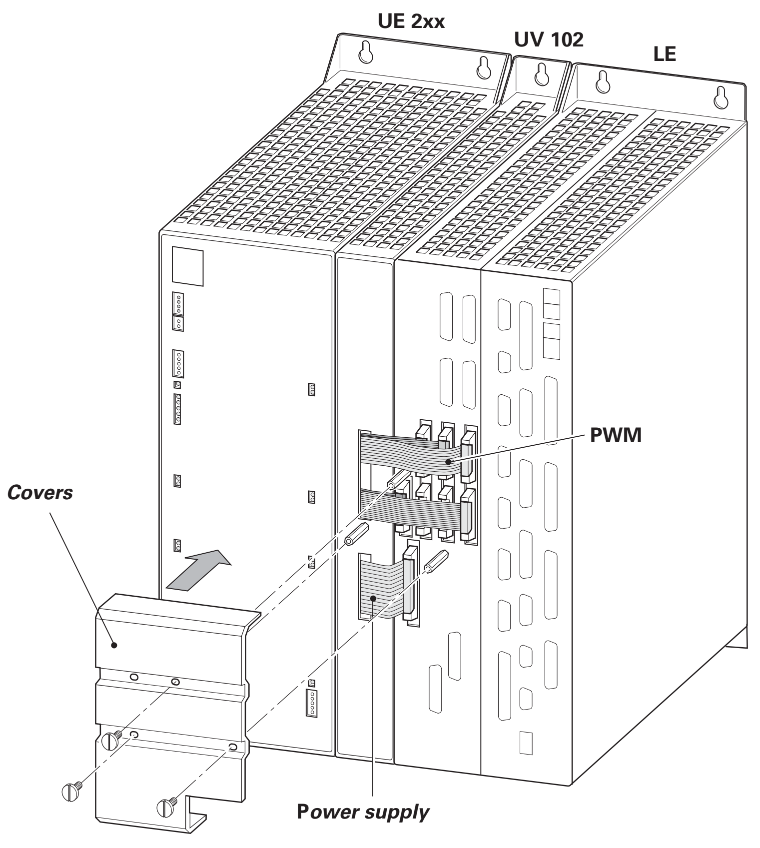


11.5.2 UV 102 Power Supply Unit

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

Application example



11.5.3 UV 105 Power Supply Unit

The power supply for the main computer and controller unit—and therefore also for the connected encoders—is usually covered by the compact inverter or the power supply unit of the modular inverter systems. 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. The UV 105 power supply unit is used for this purpose.

The UV 105 is connected to the control via a ribbon cable and a 5-V terminal.

UV 105

11.5.4 UV 105 B Power Supply Unit

The UV 105 B was designed solely for the use on HEIDENHAIN controls in connection with non-HEIDENHAIN inverter systems.

The phases U/V and the dc-link voltage ± 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

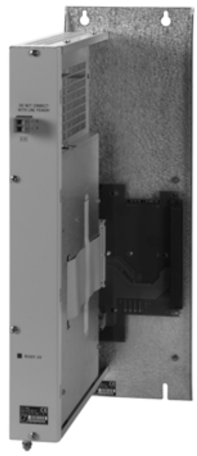
11.5.5 UV 106 B Power Supply Unit

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 power necessary for operation.

The **UV 106B** is being introduced as a replacement for the **UV 106**.

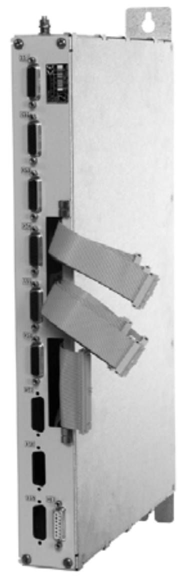


UV 106B

11.5.6 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.

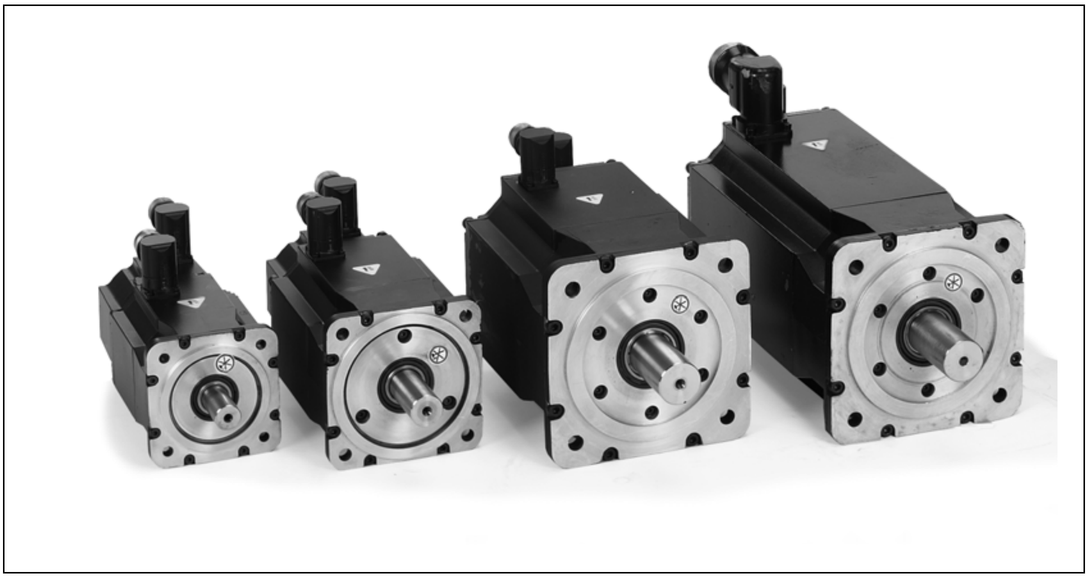
The UV 111 B power supply unit provides the LE 430 M/9 axes with power during operation with the SIMODRIVE 611 D inverter system in multiple-row configuration.



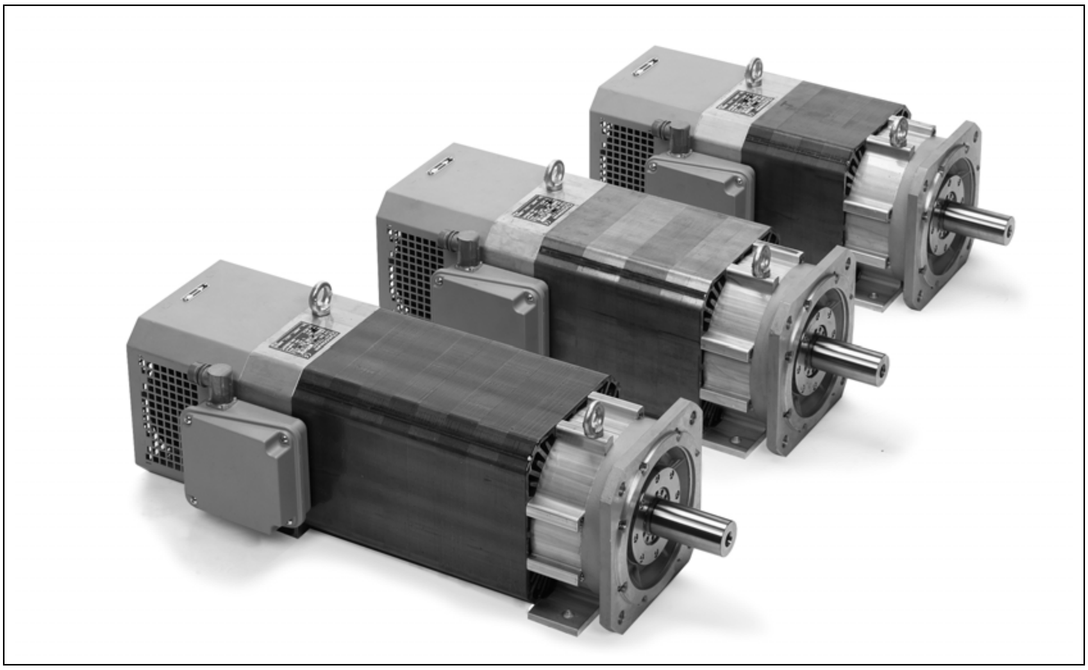
UV 111A

11.6 HEIDENHAIN Motors

There exists a wide variety of HEIDENHAIN **synchronous motors**.



There 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 - 328.

You will find a description of the functionality of the HEIDENHAIN motors in the Appendix. –> See "HEIDENHAIN Motors" on page 15 - 351.

12 Connector Designation and Layout

12.1 Important Note

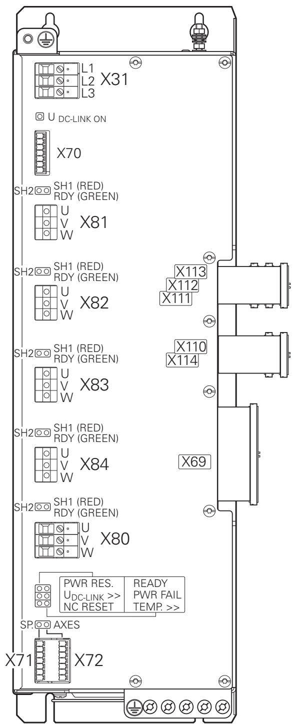
DANGER

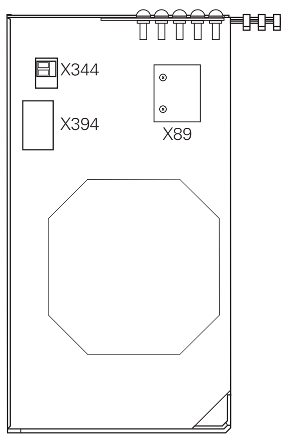
Do not engage or disengage any connecting elements while the unit is under power!
See “Safety Precautions” on page 1 - 7.!

12.2 Compact Inverters

12.2.1 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)

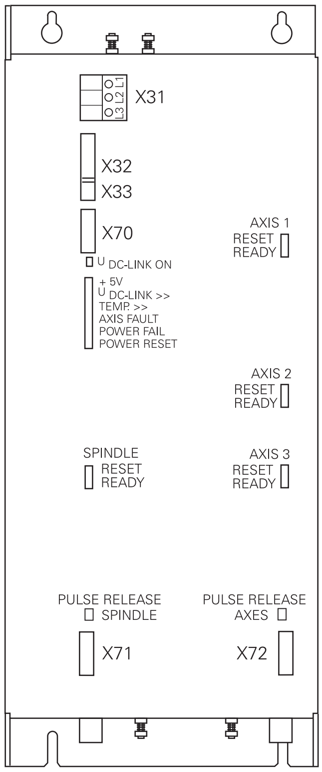
X71 Safety relay for spindle
X72 Safety relay for axes

X344 24-V input for motor brake output

X394 24-V brake outputs

⏚ Equipment ground

UE 210

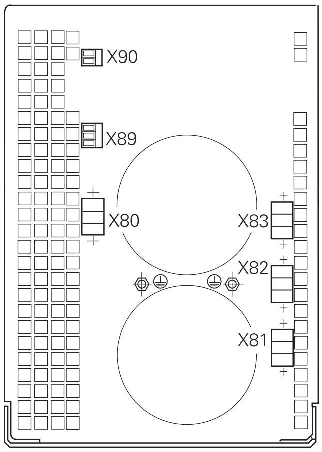


X31 Power supply for inverter

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

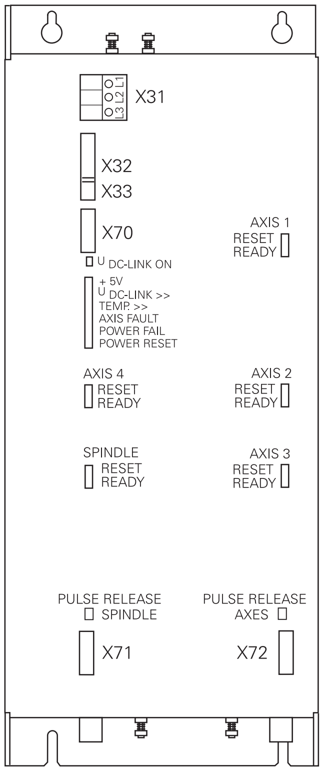
X89 Braking resistor

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

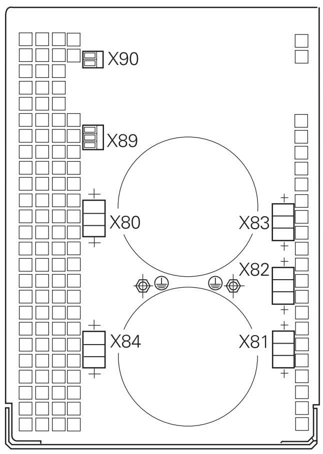


X31 Power supply for inverter

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

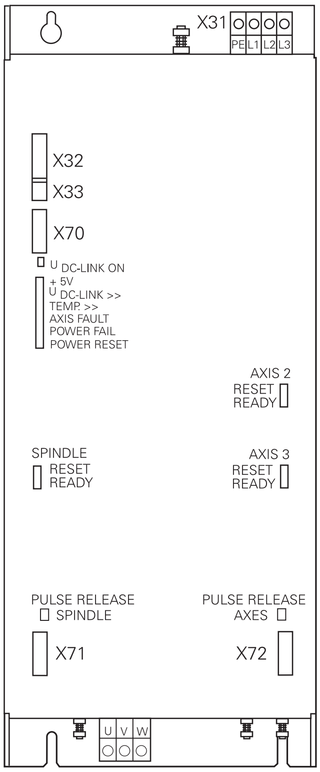
X80 Motor connection for spindle (19 A)
X83 Motor connection for axis 3 (7.5 A)

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



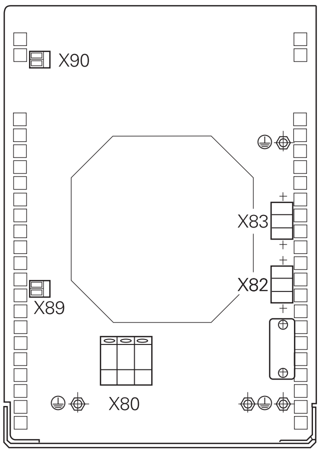
X31 Power supply for inverter

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

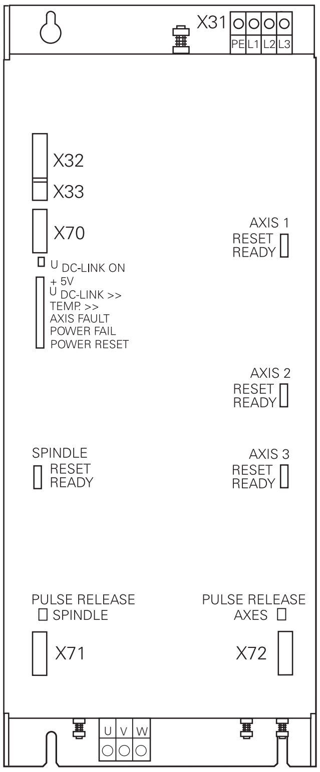
X83 Motor connection for axis 3 (7.5 A)

X82 Motor connection for axis 2 (7.5 A)
X89 Braking resistor

X80 Motor connection for spindle (31 A)

⏚ Equipment ground

UE 240



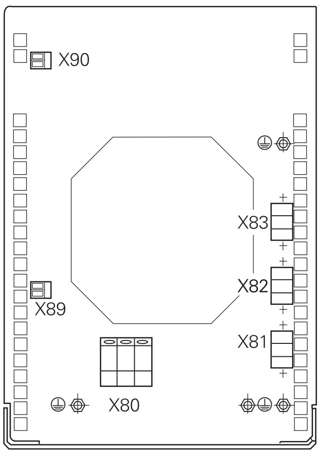
X31 Power supply for inverter

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

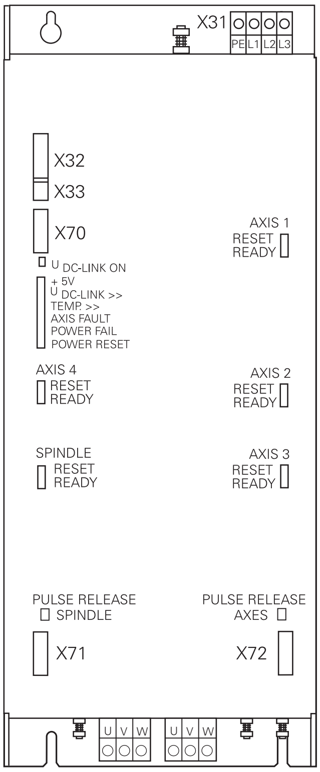
X83 Motor connection for axis 3 (7.5 A)

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

UE 242



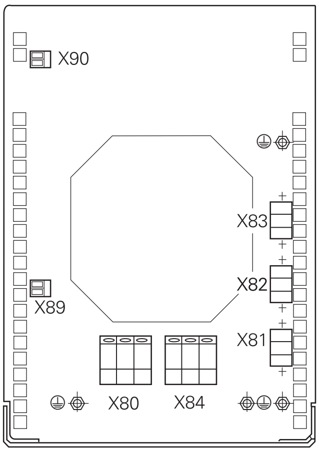
X31 Power supply for inverter

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



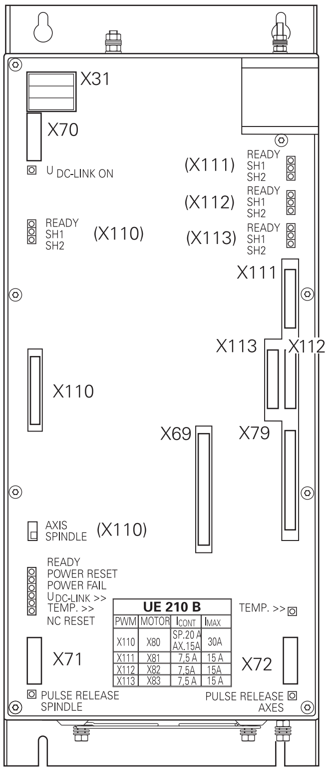
X90 24-V output

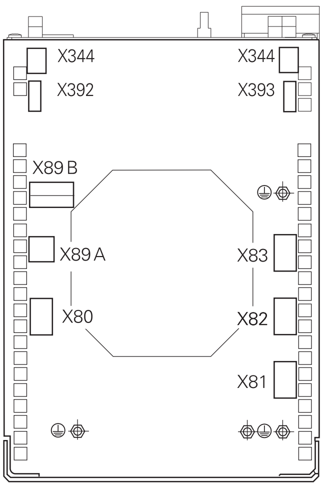
X83 Motor connection for axis 3 (7.5 A)
X82 Motor connection for axis 2 (7.5 A)
X89 Braking resistor

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

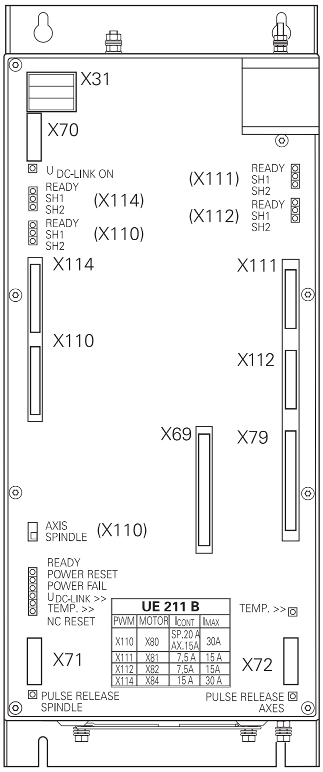
X344 24-V supply for motor holding brake
X392 Motor holding brake (X110)
X393 Motor holding brake (X111 to X113)

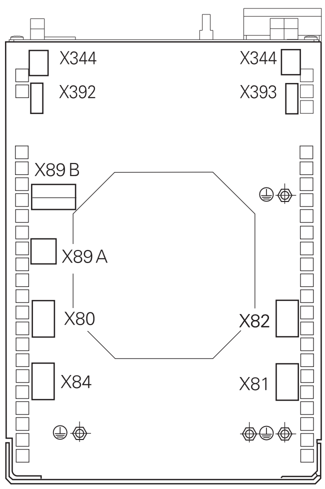
X89B Internal braking resistor
X89A External braking resistor
PW 21x or PW 1x0(B)

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

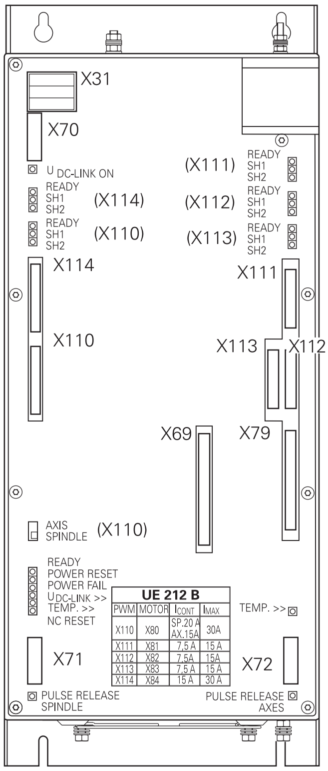
X344 24-V supply for motor holding brake
X392 Motor holding brake (X110, X114)
X393 Motor holding brake (X111, X113)

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

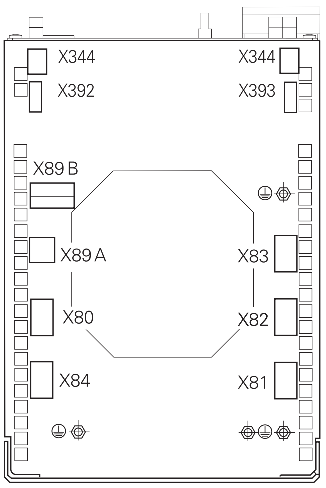
X70 Main contactor

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



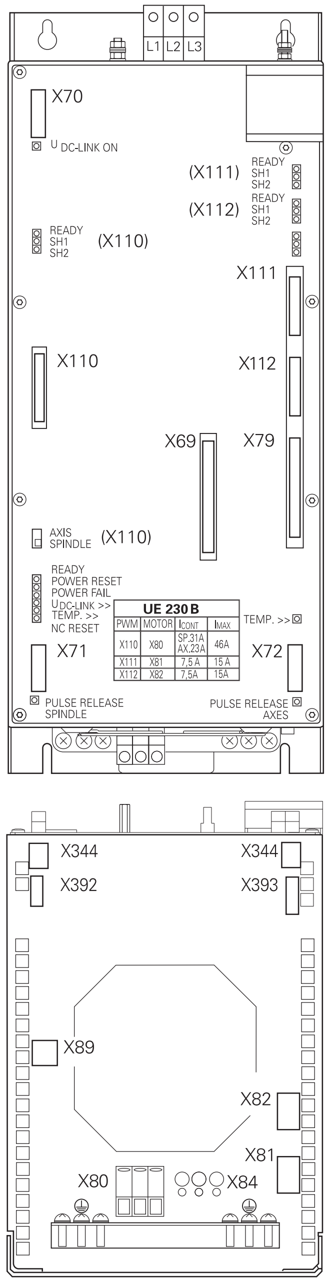
X344 24-V supply for motor holding brake
X392 Motor holding brake (X110, X114)
X393 Motor holding brake (X111 to X113)

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)

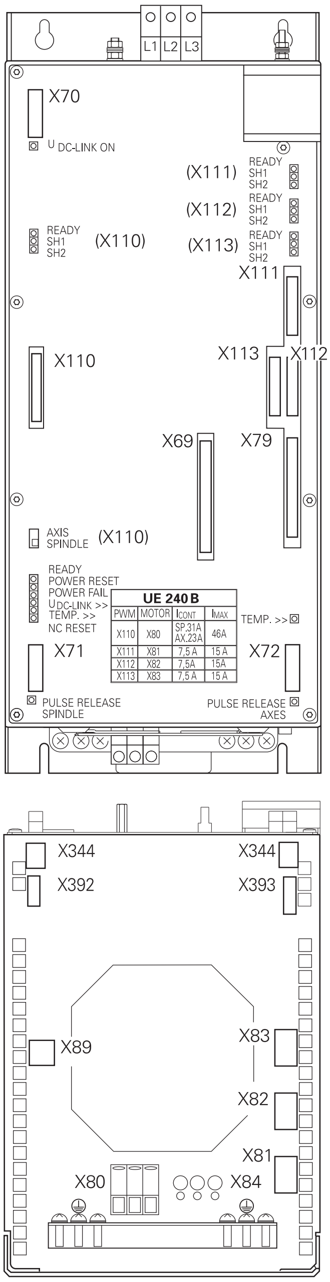
X89 Braking resistor

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)

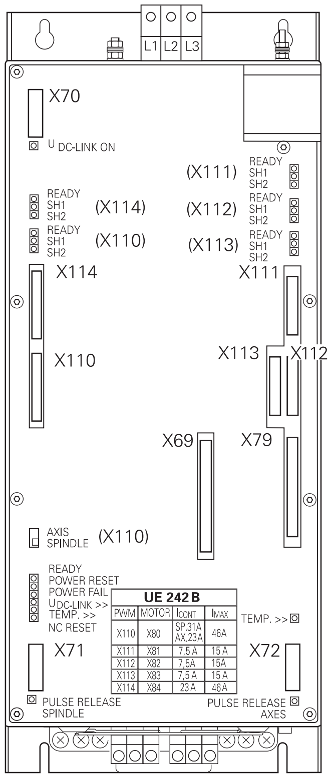
X89 Braking resistor
X83 Motor connection for axis 3 (7.5 A)

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

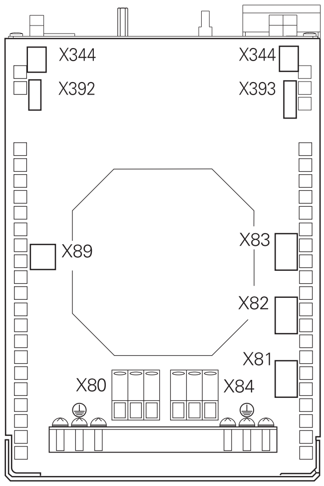
UE 242 B



X31	Power supply for inverter
X70	Main contactor
X110 to X114	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

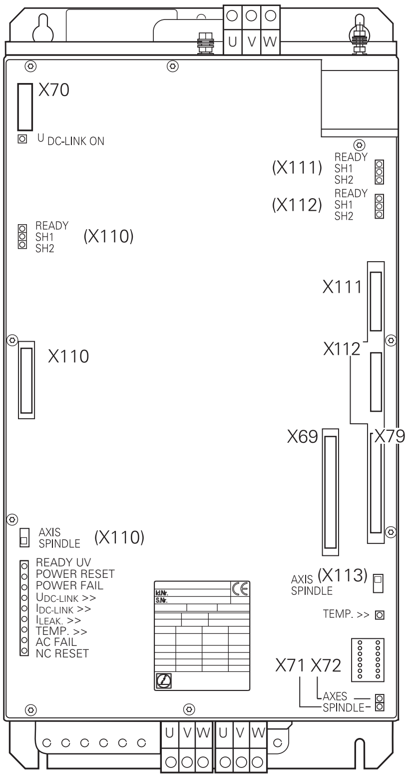
Sliding switch:
AXIS: X110 is used as axis
SPINDLE: X110 is used as spindle

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

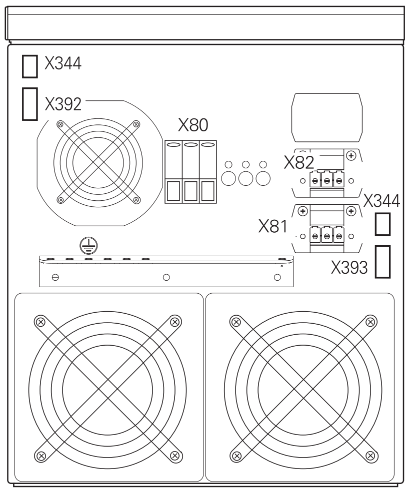
X70 Main contactor

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



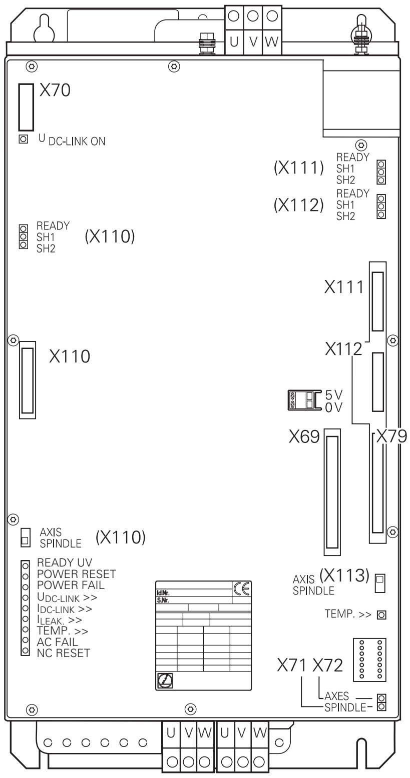
X344 24-V supply for motor holding brake
X392 Motor holding brake (X110)

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)

UR 230 D



X31 Power supply for inverter

X70 Main contactor

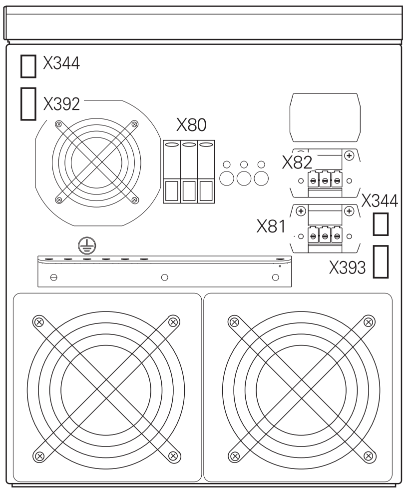
X110 to
X112 PWM connection for axes/spindle

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

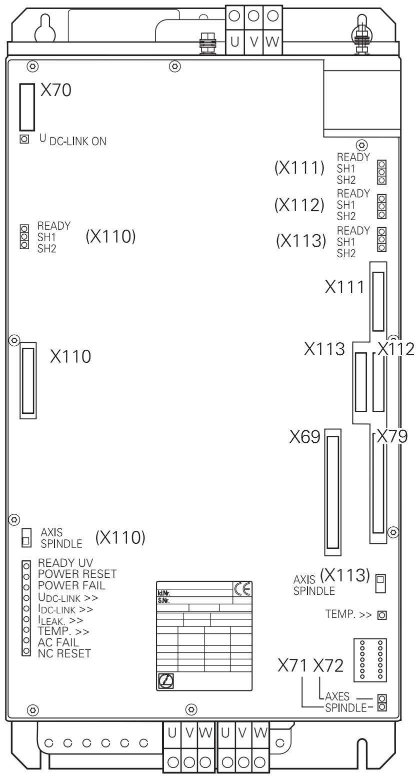


X344 24-V supply for motor holding brake
X392 Motor holding brake (X110)

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)



X31 Power supply for inverter

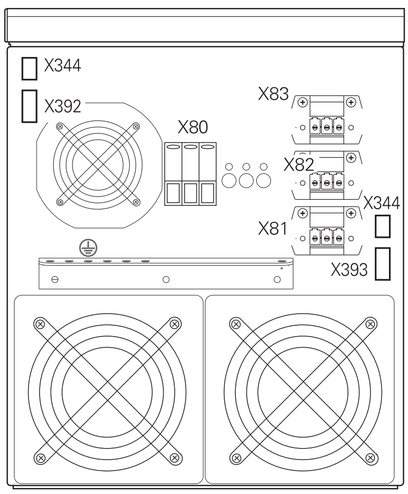
X70 Main contactor

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

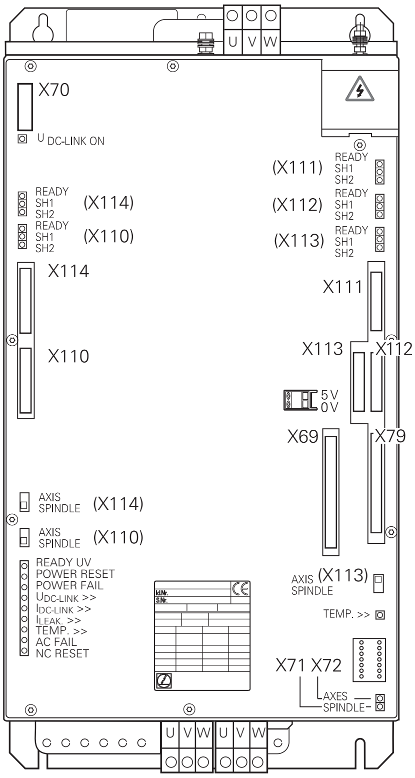


X344 24-V supply for motor holding brake
X392 Motor holding brake (X110)
X83 Motor connection for axis 3 (7.5 A)
X80 Motor connection for spindle (35 A)
X82 Motor connection for axis 2 (7.5 A)
X81 Motor connection for axis 1 (7.5 A)

⏚ Equipment ground

X393 Motor holding brake (X111 to X113)

UR 240 D



X31 Power supply for inverter

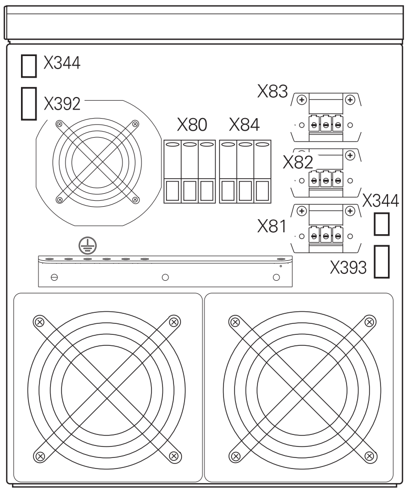
X70 Main contactor

X110 to
X113 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

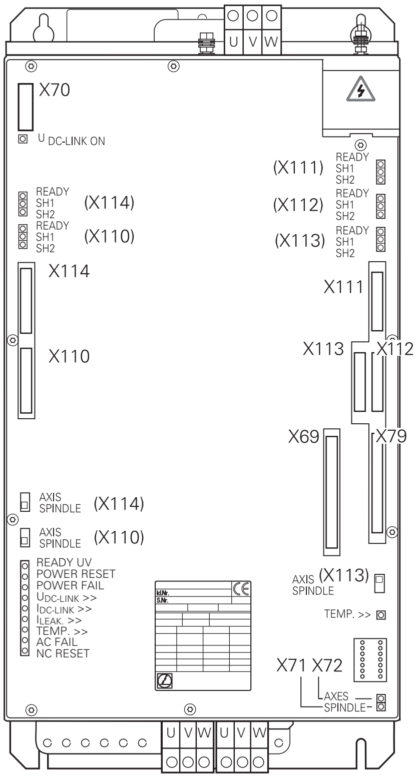
X71 Safety relay for spindle
X72 Safety relay for axes



X344 24-V supply for motor holding brake
X392 Motor holding brake (X110)
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

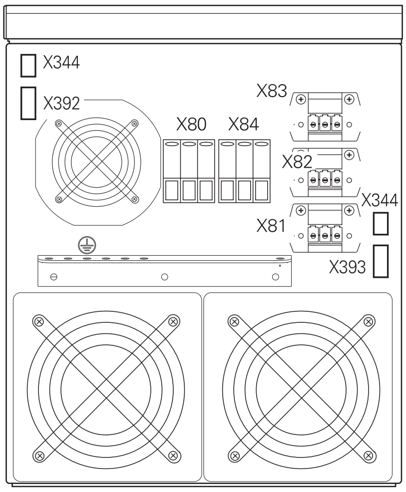
X393 Motor holding brake (X111 to X113)



X31	Power supply for inverter
X70	Main contactor
X110 to X114	PWM connection for axes/spindle
X69	Power supply for control
X79	Unit bus

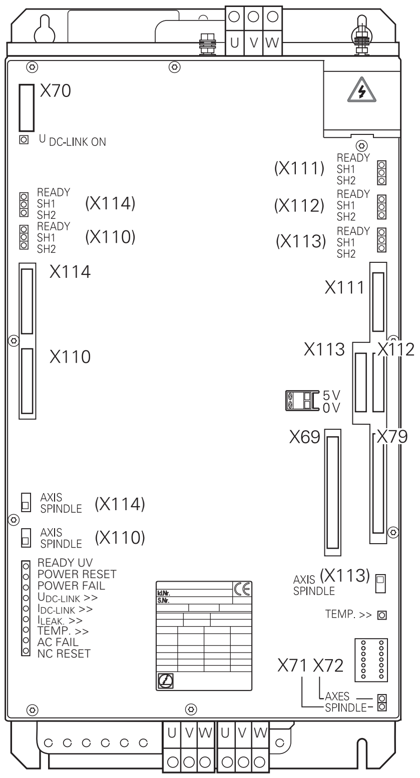
Sliding switch:
AXIS: X110, X113 or X114 is used as axis
SPINDLE: X110, X113 or X114 is used as spindle

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)

UR 242 D



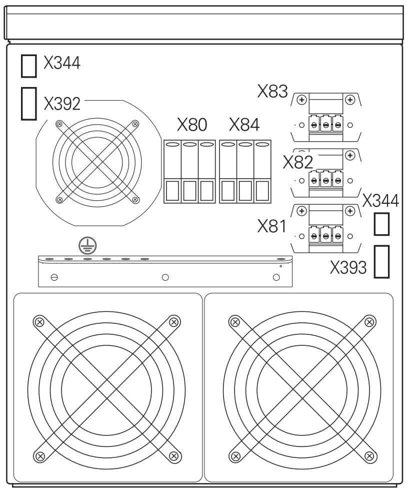
X31 Power supply for inverter

X70 Main contactor

X110 to
X114 PWM connection for axes/spindle
X74 5 V power supply

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)

12.2.2 Pin Layout on the Compact Inverter

X31: Supply voltage

Terminals	UE 110, UE 112
Operation with 400V~	
L1	400 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
	Cable/single conductor (HTwire): 6 mm^2 (AWG 10) Single conductor H07 V2-K: 4 mm^2 (AWG 10) Line fuse: 25 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 - 7 lbs/in)
Operation with 480V~	
L1	480 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
	Cable/single conductor (HTwire): 6 mm^2 (AWG 10) Single conductor H07 V2-K: 4 mm^2 (AWG 10) Line fuse: 25 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 - 7 lbs/in)

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 (HTwire): Wire cross section: 6 mm^2 (AWG 10) Line fuse: 35 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)	Cable/single conductor (HTwire): Wire cross section: 10 mm^2 (AWG 6) Line fuse: 50 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)
Tightening torque for connecting terminals:	0.7 Nm (6.5 – 7 lbs/in)	2.0 – 2.3 Nm (18 – 20.5 lbs/in)

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.

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 (HTwire): 6 mm^2 (AWG 10) Single conductor H07 V2-K: 4 mm^2 (AWG 10) Line fuse: 35 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)	Cable/single conductor (HTwire): 10 mm^2 (AWG 6) Single conductor H07 V2-K: 6 mm^2 (AWG 10) Line fuse: 50 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)
Tightening torque for connecting terminals	0.7 Nm (6.5 – 7 lbs/in)	2.0 – 2.3 Nm (18 – 20.5 lbs/in)

Power Supply	UR 2xx(D)
L1	400 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
PE	
	Cable/single conductor (HTwire): 10 mm^2 (AWG 6) Single conductor H07 V2-K: 6 mm^2 (AWG 10) Line fuse: 35 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)
Tightening torque for connecting terminals:	0.7 Nm (6.5 - 7 lbs/in)

Note

The cables between the UR 2xx 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 unit

Connection:

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

Connection:

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

Connection:

50-pin ribbon-cable connector	Assignment
1a bis 5b	+5 V
6a bis 7b	+12 V
8a	+5 V (low-volt. separation)
8b	0 V (low-volt. 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-cable 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 IEC 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 Basic Circuit Diagram for your control.

Connecting terminals X70 to X72	Assignment for UE 2xx
1	+24 V output (maximum 250 mA)
2	24 V input for U_Z ON, axis ON, spindle ON
3	Do not assign
4[a]	Normally closed contact 1
5[a]	Normally closed contact 2

a. maximum 125 V

Connecting terminals X70 to X72	Assignment for UE 1xx, UE 2xxB and UR 2xx(D)
1	+24 V output (maximum 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. maximum 125 V

Caution

A recovery diode is required in the proximity of inductive loads, e.g., relay or contact coils.

X74:
Additional 5V power supply

Connection:

Connecting terminal X74	Assignment
+	+5 V (load capacity 20 A)
–	0 V

X79:
Unit bus

Connection:

40-pin ribbon-cable connecotor	Assignment	
1a bis 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 bis 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 (axes enable)	
15b bis 16b	0 V	
17a und 17b	-15 V	
18a und 18b	+15 V	
19a bis 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

Connection:

Terminals	Assignment
U	Motor connection U
V	Motor connection V
W	Motor connection W

Motor connections	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	RB2	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	Bridge
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

Caution

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

Connection:

Connecting terminal X90	Assignment
+	+24 V (PLC)
–	0 V

X110 to X114: PWM connection to control

Connection:

20-pin ribbon-cable connector	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	$+I_{\text{Actl 1}}$
6b	$-I_{\text{Actl 1}}$
7a	0 V (analog)
7b	$+I_{\text{Actl 2}}$
8a	$-I_{\text{Actl 2}}$
8b	0 V (analog)
9a	Do not assign
9b	$\overline{\text{BRK}}$
10a	$\overline{\text{ERR}}$
10b	RDY

DANGER

The interface complies with the requirements of IEC 61800-5-1 for “low voltage electrical separation.”

X344: 24-V supply for motor holding brake

Connection:

Connecting terminals 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

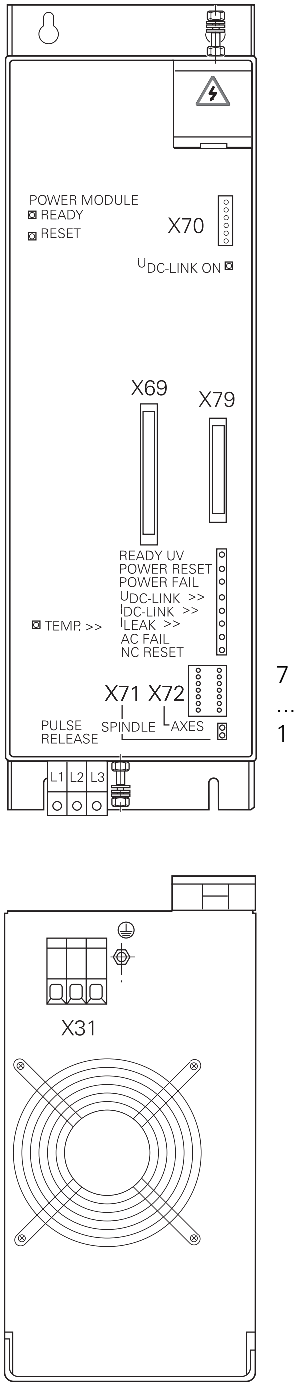
Maximum current I_{max} for controlling the holding brakes via X394:

Compact Inverters	I_{max} (X394)
UE 110	1.5 A
UE 112	1.5 A

12.3 Power supply units

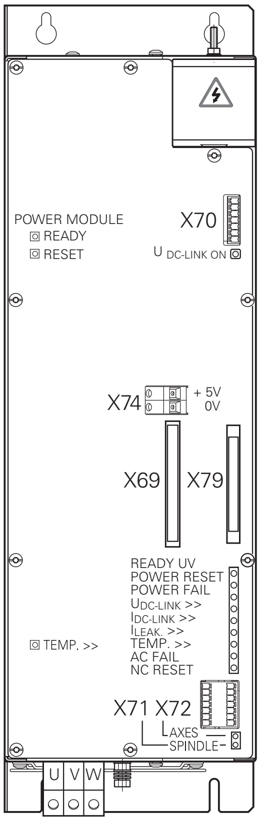
12.3.1 Designation and Position of Connections

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

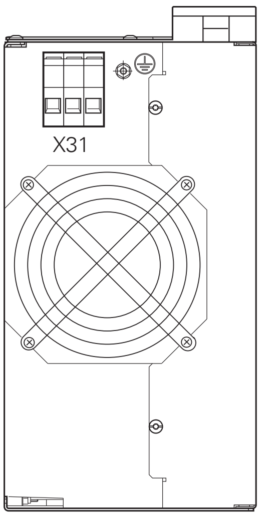


X70 Main contactor

X74 5-V power supply

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

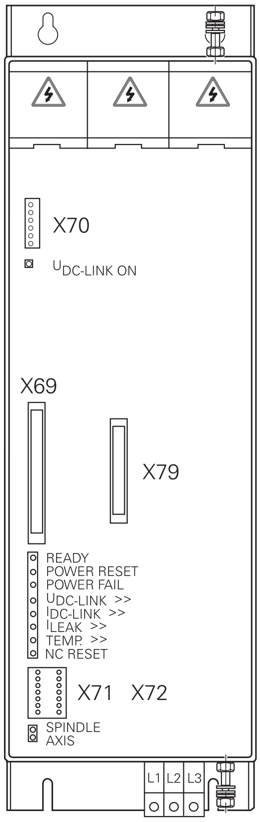
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

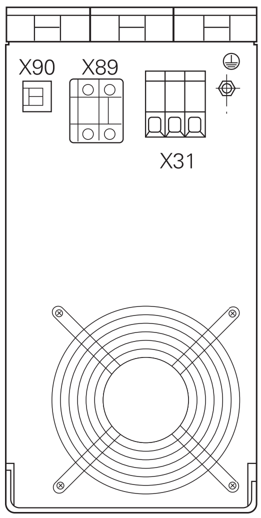
UV 130



X70 Main contactor

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

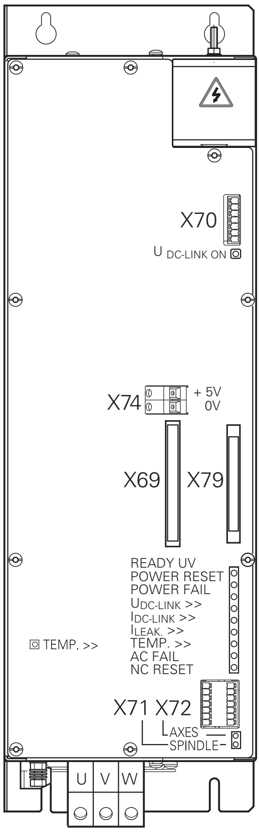
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)
X89 Braking resistor
X90 24-V output

⏚ Equipment ground

UV 130 D

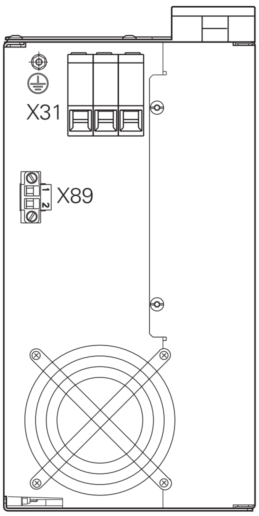


X70 Main contactor

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 the axes (pulse disable for all axes)

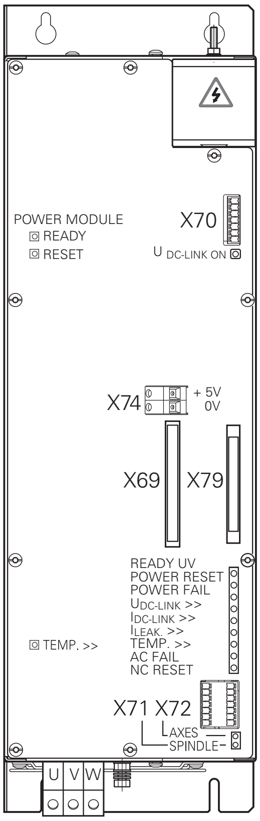


X31 Supply voltage for inverter (3 x 400 V ±10 %)

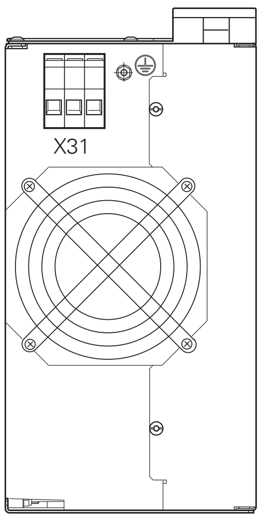
⏚ Equipment ground

X89 Braking resistor

UVR 130 D

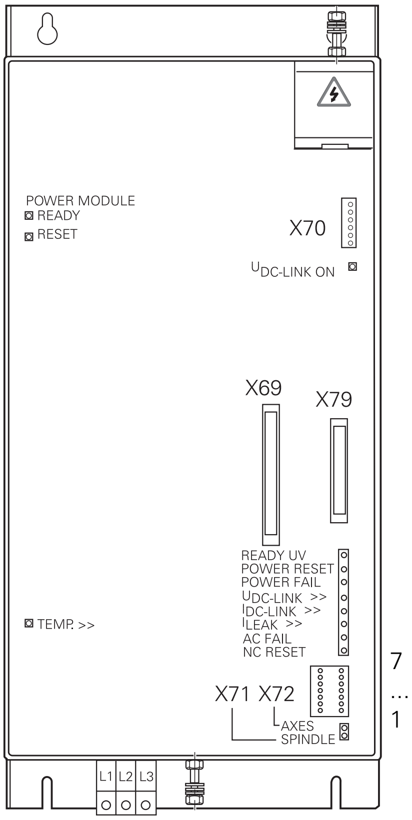


X70	Main contactor
X74	5-V power supply
X69	Power supply for the control (in double for lengths over 0.5 m)
X79	Unit bus
X71	Safety relay for spindle (pulse disable for the spindle)
X72	Safety relay for the axes (pulse disable for all axes)



X31	Supply voltage for inverter (3 x 400 V ±10 %)
⏚	Equipment ground

UV 140



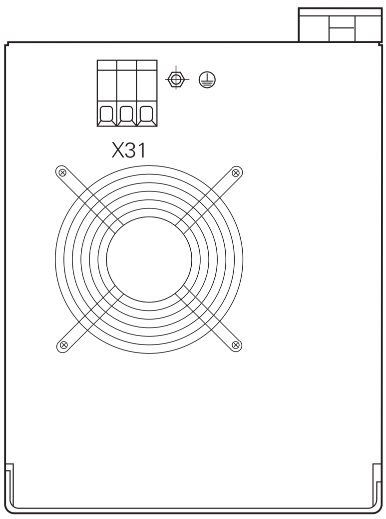
X70 Main contactor

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)

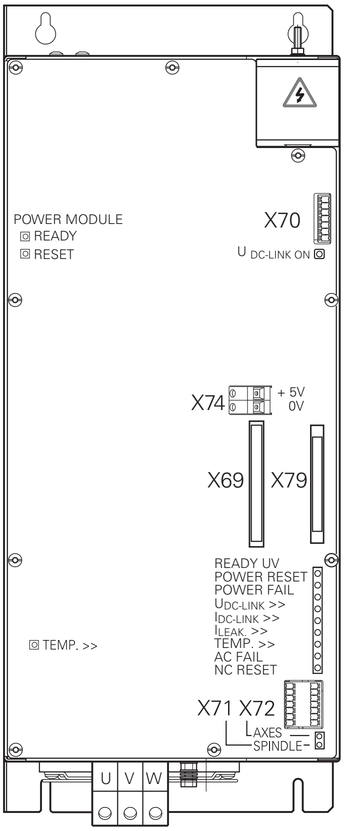
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 140 D

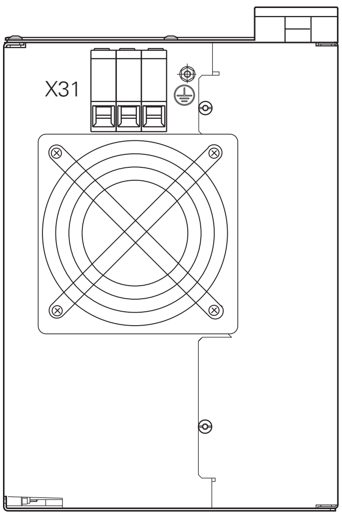


X70 Main contactor

X74 5-V power supply

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

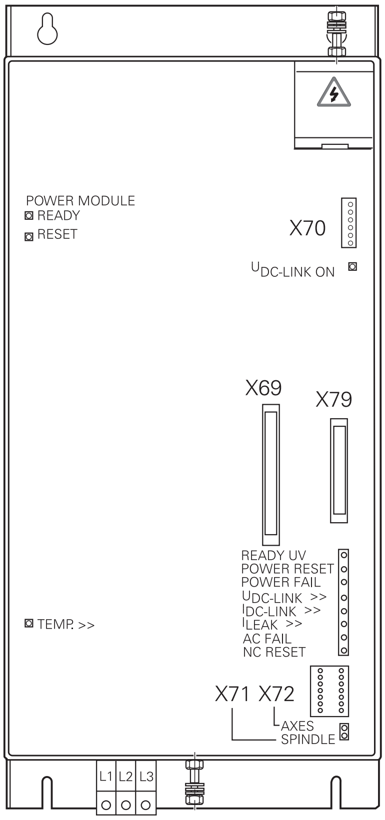
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UV 150



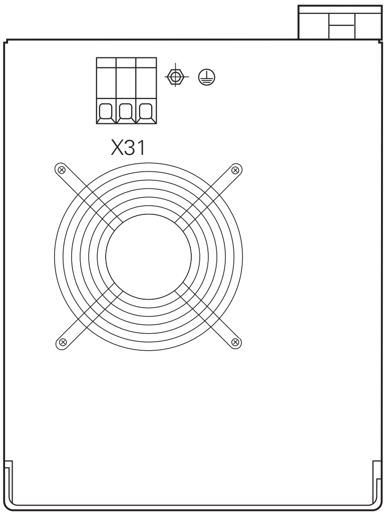
X70 Main contactor

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)

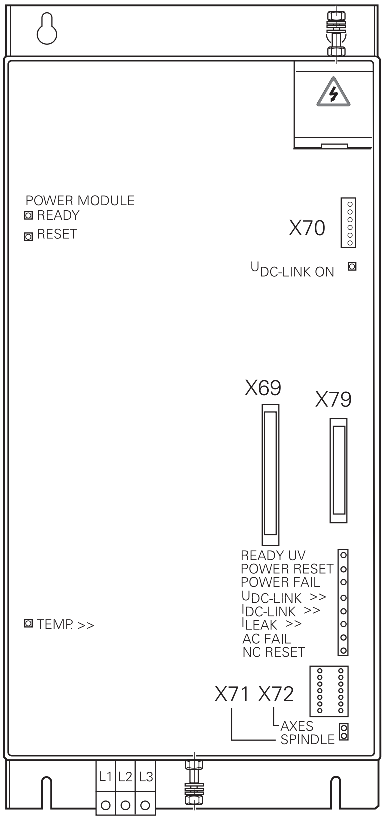
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 150



X70 Main contactor

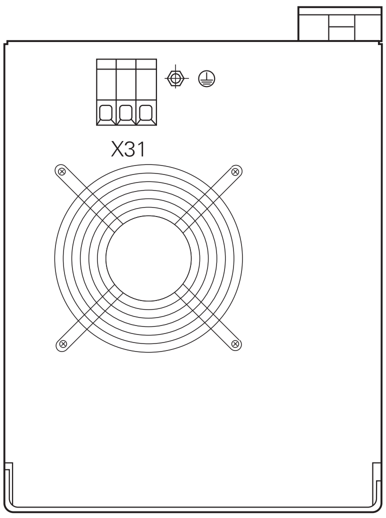
X74 +5-V and 0-V supply

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)

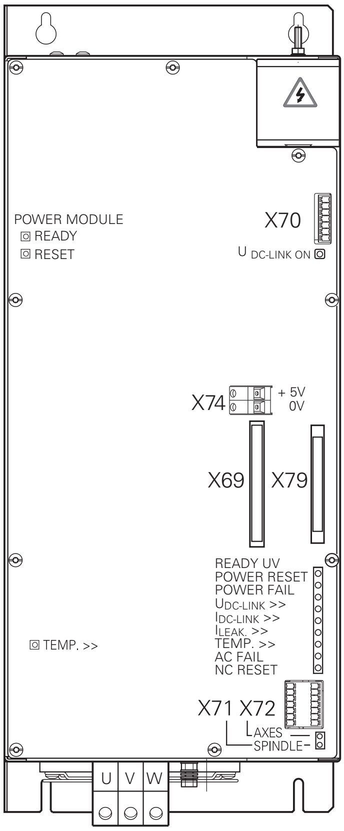
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 150 D

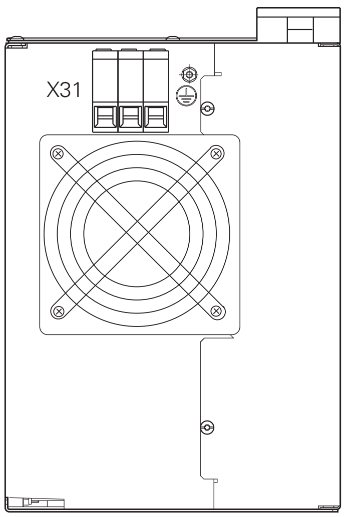


X70 Main contactor

X74 +5-V and 0-V supply

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

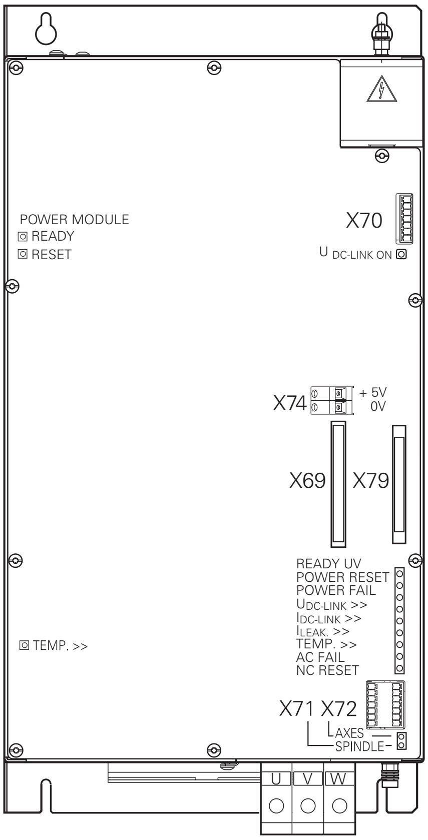
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 160 D

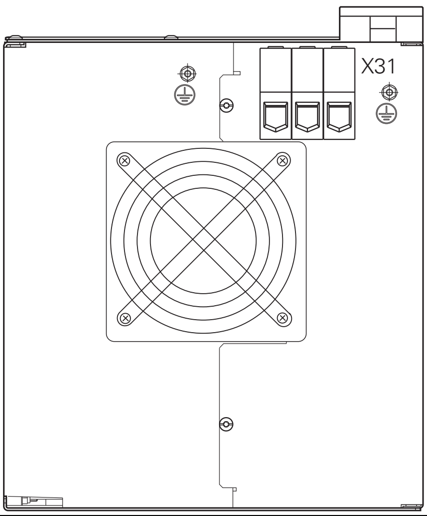


X70 Main contactor

X74 +5-V and 0-V supply

X69 Power supply for the control
(in double for lengths over 0.5 m)
X79 Unit bus

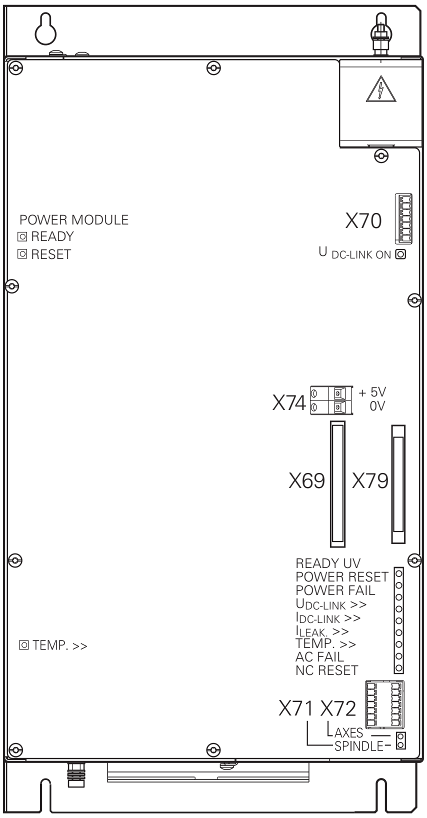
X71 Safety relay for spindle (pulse disable for the spindle)
X72 Safety relay for the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

UVR 160 DW



X70 Main contactor

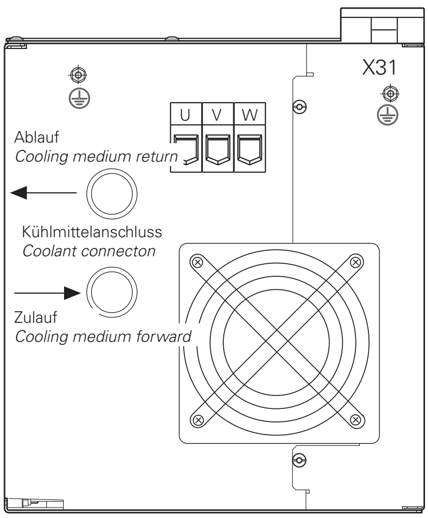
X74 +5-V and 0-V supply

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 the axes (pulse disable for all axes)



X31 Supply voltage for inverter (3 x 400 V ±10 %)

⏚ Equipment ground

12.3.2 Pin Layout on the Power Supply Units

X31: Supply voltage

Terminals	UV 130(D)
L1	400 V~ ± 10 % 50 Hz to 60 Hz
L2	
L3	
	Cable/single conductor (HTwire): Wire cross section: 16 mm^2 (AWG 5) Line fuse: 63 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)
Tightening torque for connecting terminals:	4 – 4.5 Nm (35 – 40 lbs/in)

☞ **Note**

IEC 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.

Power Supply	
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) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6) Tightening torque for connecting terminals: 2.0 – 2.3 Nm (18 – 20.5 lbs/in) **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) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6) Tightening torque for connecting terminals: 2.0 – 2.3 Nm (18 – 20.5 lbs/in) **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) Siemens Sitor type Grounding terminal: ≥ 16 mm^2 (AWG 4) Tightening torque for connecting terminals: 4.0 – 4.5 Nm (35 – 40 lbs/in) **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) Siemens Sitor type Grounding terminal: ≥ 16 mm^2 (AWG 4) Tightening torque for connecting terminals: 4.0 – 4.5 Nm (35 – 40 lbs/in) **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) Siemens Sitor type Grounding terminal: ≥ 25 mm^2 (AWG 4) Tightening torque for connecting terminals: 4.0 – 4.5 Nm (35 – 40 lbs/in)

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 - 249.

X70:
Main contactor

Connection:

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

Caution

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

Connection:

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

Caution

A recovery diode is required in the proximity of inductive loads, e.g. relay or contactor coils.

X74:
Additonal 5-V supply

Connection:

Connecting terminal X74	Assignment
+	+5 V (load capacity 20 A)
–	0 V

X79:
Unit bus

Connections: See “X79: Unit bus” on page 12 - 251.

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

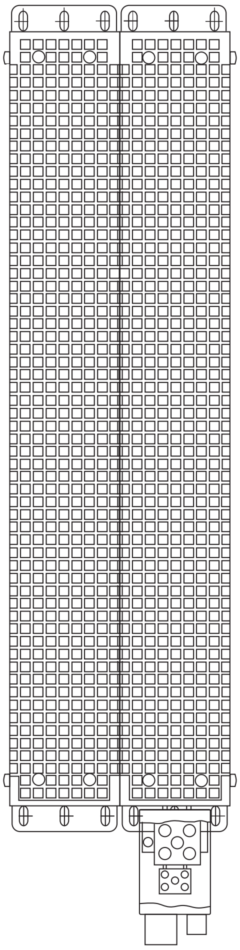
Connection:

Connecting terminal X90	Assignment
+	+24 V (PLC)
–	0 V

12.4 Braking Resistors and Braking Resistor Module

12.4.1 Designation and Position of Connections

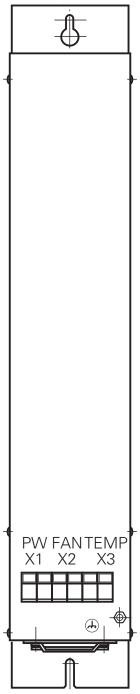
PW 21x



RB1, RB2 Power supply unit

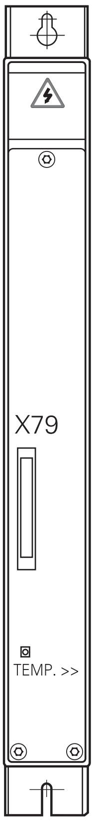
T1, T2 Temperature switch

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

12.4.2 Pin Layout of Braking Resistor or Braking Resistor Module

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		Not assign	do not assign
3	Switch to $-U_Z$	do not assign	RB2	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	Bridge
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

Caution

The internal and an external braking resistor must **not** be operated in parallel!

Pin layout 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 $-U_Z$	RB2	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.
Connection:

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)

Connection:

Connecting terminal X2	Assignment
+	+24 V (PLC)
–	0 V

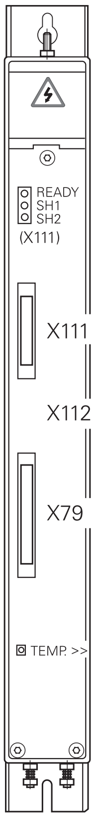
X79:
Unit bus

Connections: See “X79: Unit bus” on page 12 - 251.

12.5 Power Modules

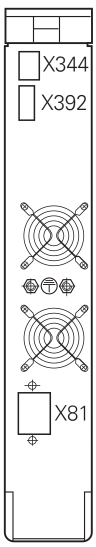
12.5.1 Designation and Position of Connections

UM 111



X111 PWM, axis

X79 Unit bus



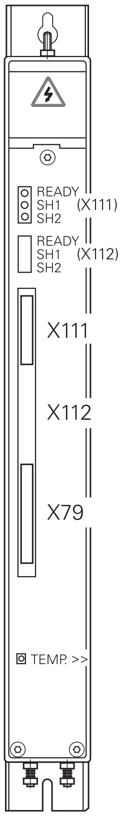
X344 24-V supply for motor holding brake (available as of version 325000-02)

X392 Motor holding brake (available as of version 325000-02)

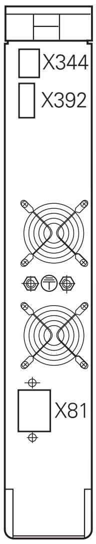
⏚ Equipment ground

X81 Motor connection for axis

UM 111 D

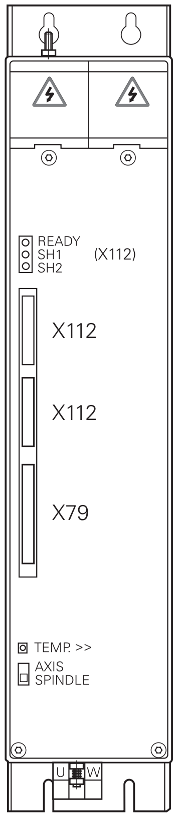


X111	PWM, axis
X79	Unit bus



X344	24-V supply for motor holding brake
X392	Motor holding brake
⏚	Equipment ground
X81	Motor connection for axis

UM 111 B

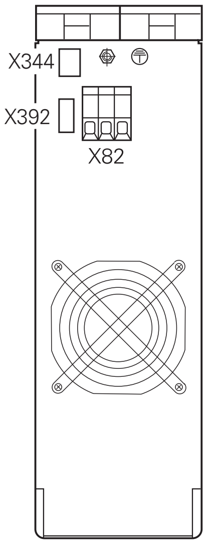


X112 PWM, axis / spindle

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



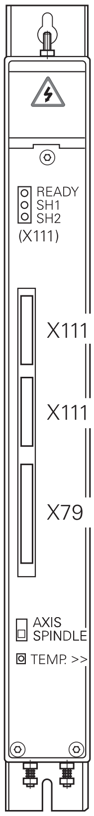
X344 24-V supply for motor holding brake
(available as of version 336 948-03)

X392 Motor holding brake
(available as of version 336 948-03)

X82 Motor connection for axis / spindle

⏚ Equipment ground

UM 111 BD

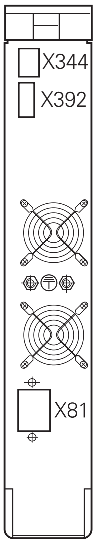


X111 PWM, axis / spindle

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

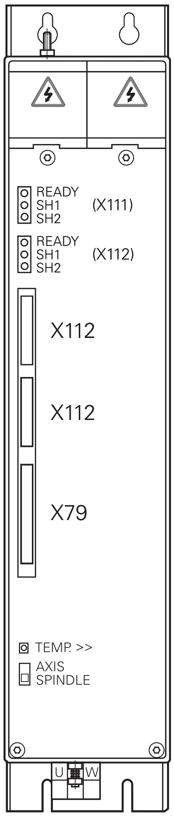


X344 24-V supply for motor holding brake
X392 Motor holding brake

⏚ Equipment ground

X81 Motor connection for axis / spindle

UM 112

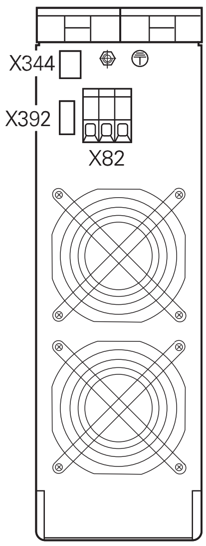


X112 PWM, axis / spindle

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



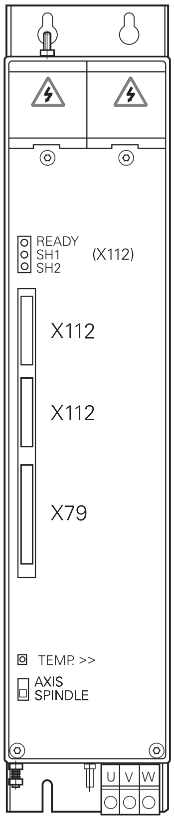
X344 24-V supply for motor holding brake
(available as of version 325 001-02)

X392 Motor holding brake
(available as of version 325 001-02)

X82 Motor connection for axis / spindle

Equipment ground

UM 112 D

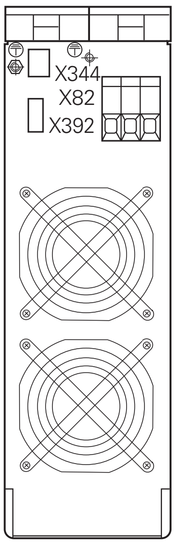


X112 PWM, axis / spindle

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

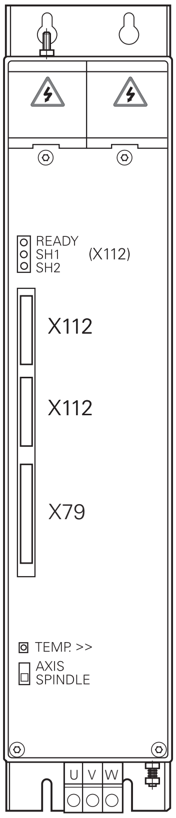


X344 24-V supply for motor holding brake
X392 Motor holding brake

X81 Motor connection for axis / spindle

⏚ Equipment ground

UM 113

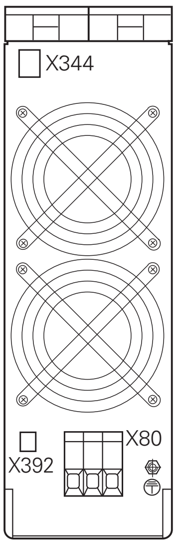


X112 PWM, axis/spindle

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



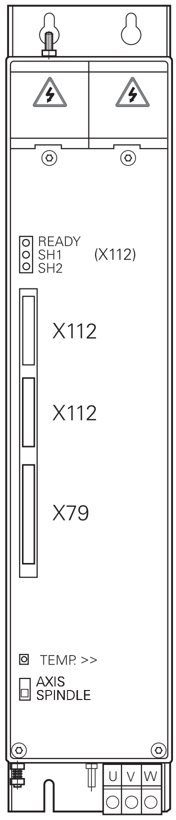
X344 24-V supply for motor holding brake
(available as of version 325002-02)

X392 Motor holding brake
(available as of version 325002-02)

X80 Motor connection for axis / spindle

⏚ Equipment ground

UM 113 D

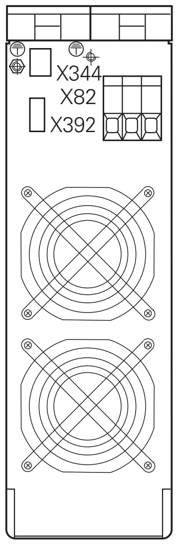


X112 PWM, axis/spindle

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



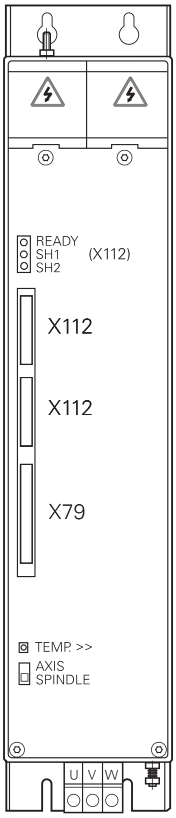
X344 24-V supply for motor holding brake

X392 Motor holding brake

X81 Motor connection for axis / spindle

⏚ Equipment ground

UM 114

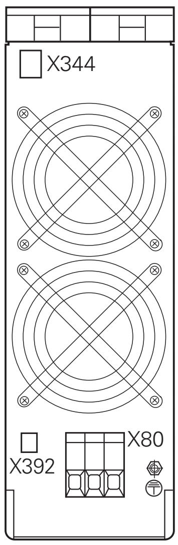


X112 PWM, axis/spindle

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



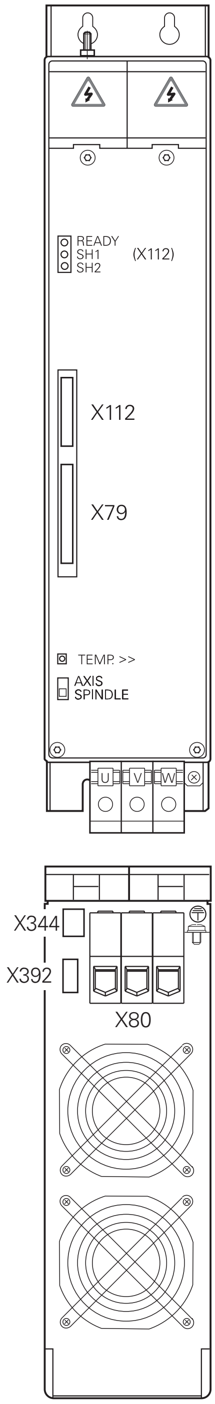
X344 24-V supply for motor holding brake
(available as of version 325005-02)

X392 Motor holding brake
(available as of version 325005-02)

X80 Motor connection for axis / spindle

Equipment ground

UM 114 D



X112 PWM, axis / spindle

X79 Unit bus

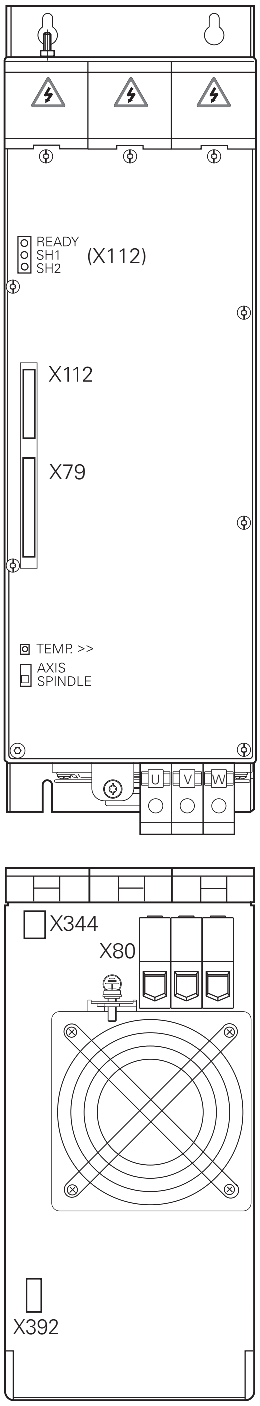
Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

X344 24-V supply for motor holding brake

X80 Motor connection for axis / spindle

⏚ Equipment ground

UM 115



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

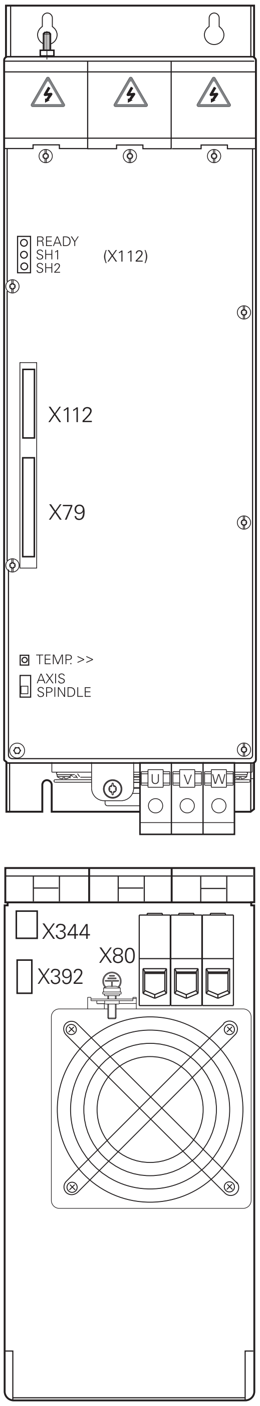
X344 24-V supply for motor holding brake

X80 Motor connection for axis / spindle

⏚ Equipment ground

X392 Motor holding brake

UM 115 D



X112 PWM, axis / spindle

X79 Unit bus

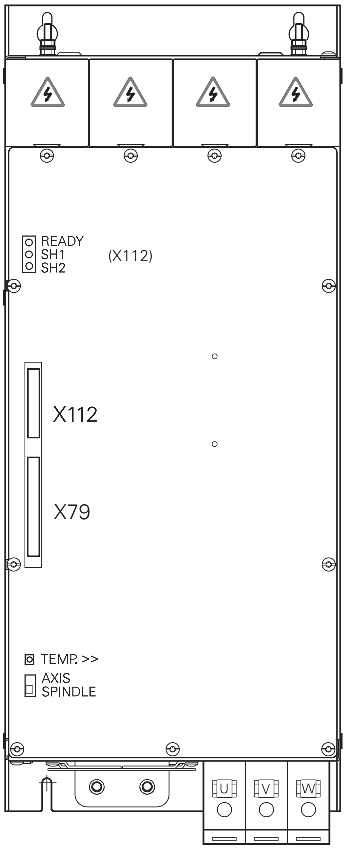
Sliding switch:
AXIS: Axis module
Enabling through X72 of the power supply unit
SPINDLE: Spindle module
Enabling through X71 of the power supply unit

X344 24-V supply for motor holding brake

X392 Motor holding brake

X80 Motor connection for axis / spindle

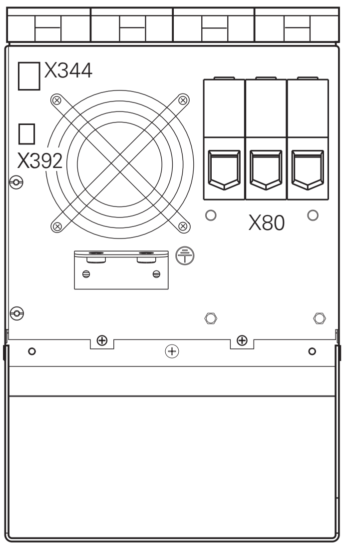
⏚ Equipment ground



X112 PWM, axis / spindle

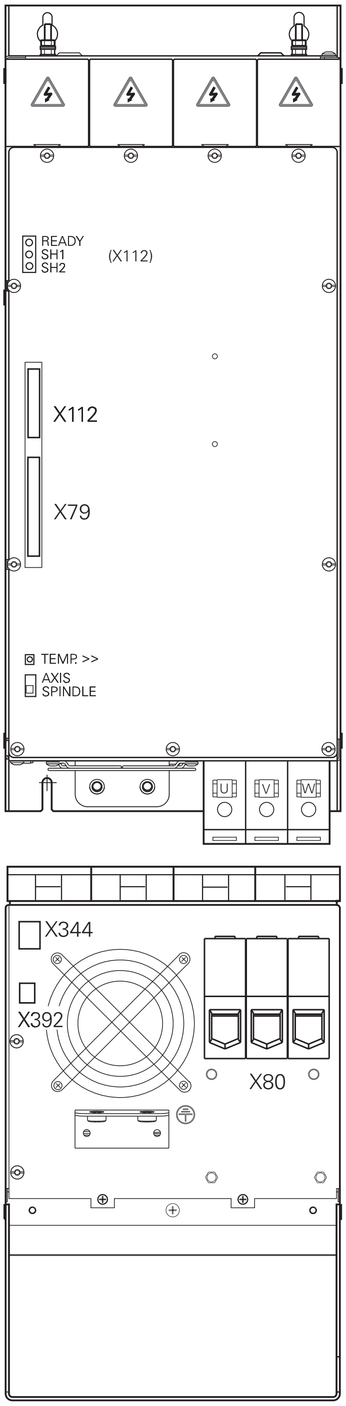
X79 Unit bus

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 116 DW



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

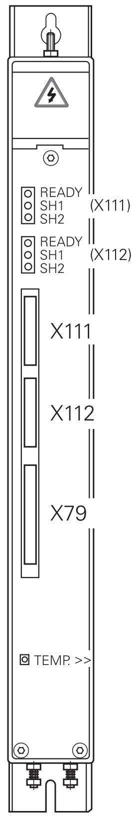
X344 24-V supply for motor holding brake

X392 Motor holding brake

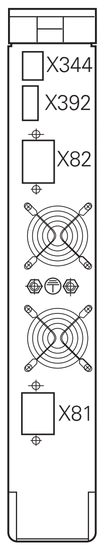
X80 Motor connection for axis / spindle

⏚ Equipment ground

UM 121

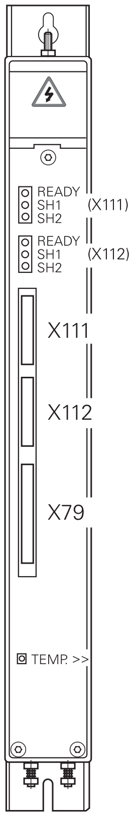


X111	PWM, axis 1
X112	PWM, axis 2
X79	Unit bus

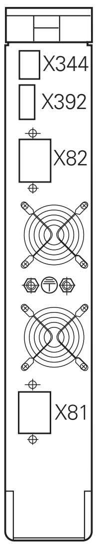


X344	24-V supply for motor holding brake (available as of version 325003-02)
X392	Motor holding brake (available as of version 325003-02)
X82	Motor connection for axis 2 (X112)
⏚	Equipment ground
X81	Motor connection for axis 1 (X111)

UM 121 D

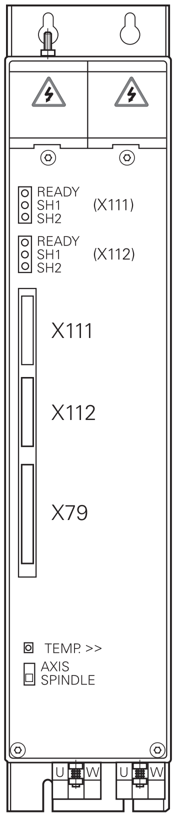


X111	PWM, axis 1
X112	PWM, axis 2
X79	Unit bus



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)

UM 121 B



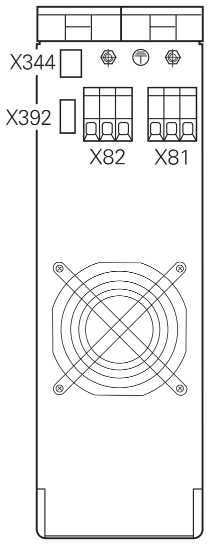
X111 PWM, axis 1

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

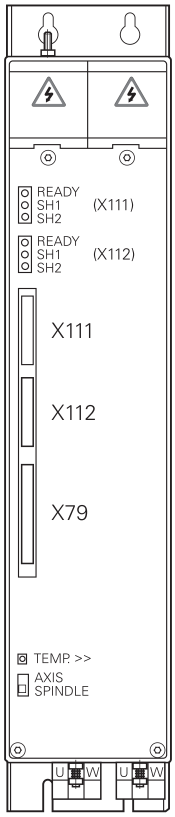


X344 24-V supply for motor holding brake
(available as of version 336948-03)
X392 Motor holding brake
(available as of version 336948-03)

X82 Motor connection for axis 2 / spindle (X112)
X81 Motor connection for axis 1 (X111);

⏚ Equipment ground

UM 121 BD

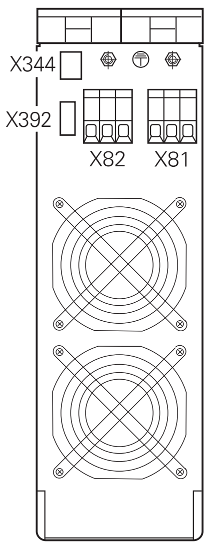


X111 PWM, axis 1

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



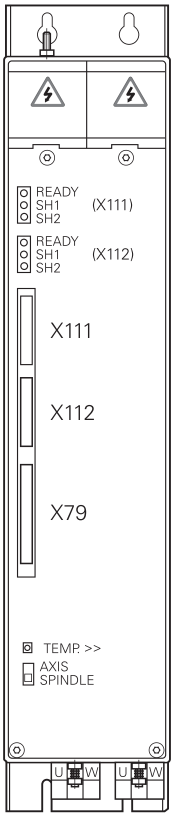
X344 24-V supply for motor holding brake

X392 Motor holding brake

X82 Motor connection for axis 2 / spindle (X112)
X81 Motor connection for axis 1 (X111);

⏚ Equipment ground

UM 122

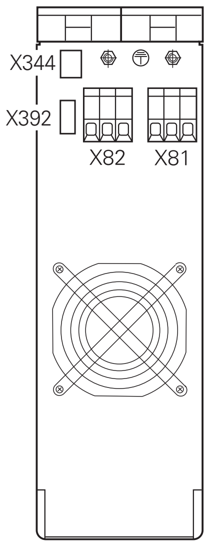


X111 PWM, axis 1

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

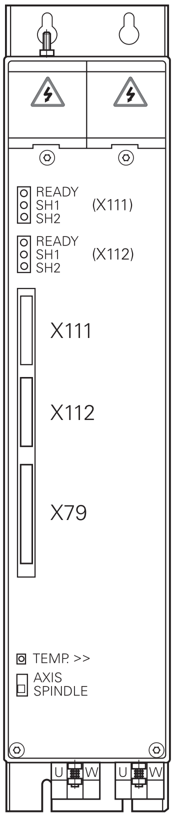


X344 24-V supply for motor holding brake
(available as of version 325004-02)
X392 Motor holding brake
(available as of version 325004-02)

X82 Motor connection for axis 2 / spindle (X112)
X81 Motor connection for axis 1 (X111)

Equipment ground

UM 122 D



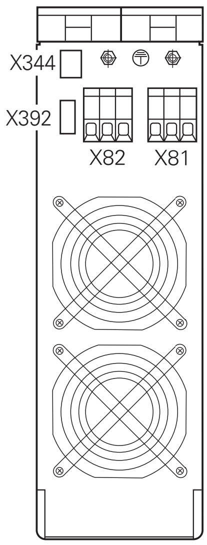
X111 PWM, axis 1

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

12.5.2 Pin Layout on the Power Supply Units

X79:
Unit bus

Connections: See “X79: Unit bus” on page 12 - 251.

X81:
X82 Axis/spindle motor
X82:
X82 Axis/spindle motor

Connection:

Terminals X81, X82	Assignment
U	Motor connection U
V	Motor connection V
W	Motor connection W

X111, X112:
PWM Connection to the Control

Connection:

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 the requirements of IEC 61800-5-1 for “low voltage electrical separation.”

X344:
24-V supply for motor holding brake

Connection:

Connecting terminals 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

4-pin connection:

Connecting terminals X392	Assignment
1	Holding brake (X112)
2	0 V (X112)
3	Holding brake (X111)
4	0 V (X111)

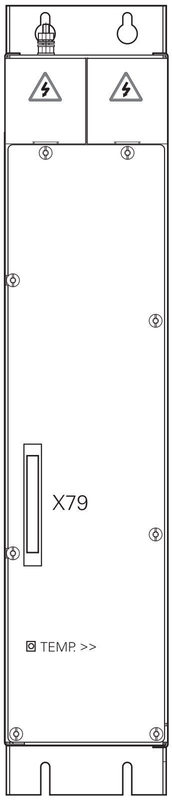
Maximum current I_{max} for controlling the holding brakes via X392:

Power module	I_{max}
UM 11x(B)(D)	3.0 A
UM 12x(B)(D)	2.0 A

12.6 DC-Link Filter

12.6.1 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

12.6.2 Pin Layout on the DC-Link Filter

X79:
Unit bus
(only ZKF 130)

Connections: See “X79: Unit bus” on page 12 - 251.

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.

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

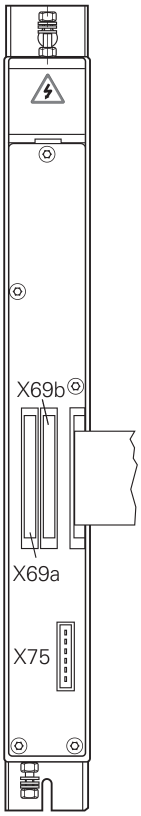
The dc-link is conncected via the conductor bars (for HEIDENHAIN inverters systems).

Caution

A ZKF dc-link filter is not permitted for non-HEIDENHAIN inverters!

12.7 Adapter Module

12.7.1 Designation and Position of Connections



X69a – X69b Ribbon cable	Supply bus from the power supply units to X69 on the control
X75	Service connector (exclusively for service purposes)

12.7.2 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-pin ribbon-cable 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_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-pin ribbon-cable connector	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 the requirements of IEC 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-pin ribbon-cable connector	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-pin ribbon-cable connector	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 the requirements of IEC 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 - 249.

X75: Service connector

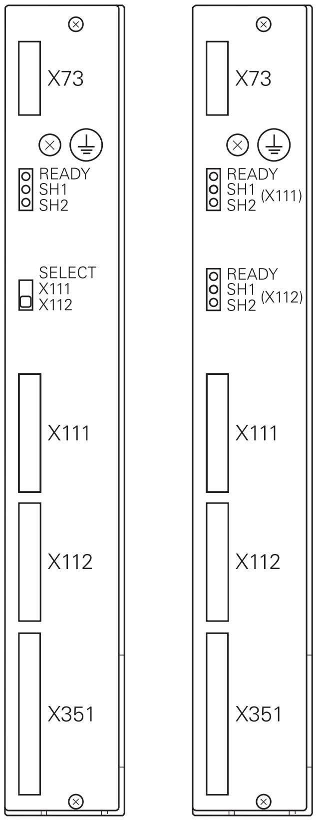
Caution

X75 must not be assigned. It is only for service purposes.

12.8 HEIDENHAIN Expansion Boards for the SIMODRIVE System

12.8.1 Designation and Position of Connections

Expansion boards
Ribbon cable



1-axis version

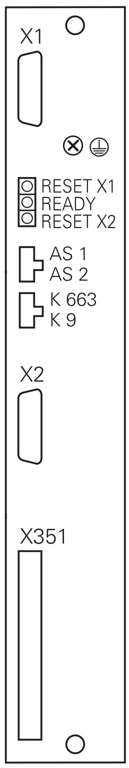
2-axis version

X73	Enabling connector
⏚	Grounding conductor (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 (low-voltage separation)



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

12.8.2 Pin Layout on the Interface Cards

X73: Enabling connector

Connection:

Connecting 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

Caution

A recovery diode is required in the proximity of inductive loads, e.g. relay or contactor coils.

X111, X112: PWM connection to the control

Connection:

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	Ready

X1, X2:
PWM connection

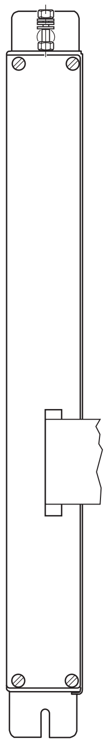
Connection:

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	ext. shield

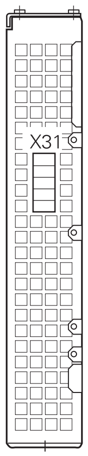
12.9 UV 101 B Power Supply Unit

12.9.1 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

12.9.2 Error Diagnosis on UV 101 B

X31: Supply voltage

Supply voltage: 400 V ± 10%

Connection:

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 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 - 7 lbs/in) **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).

Caution

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 - 249.

U_Z:
Power supply of the UV 101 B with U_Z

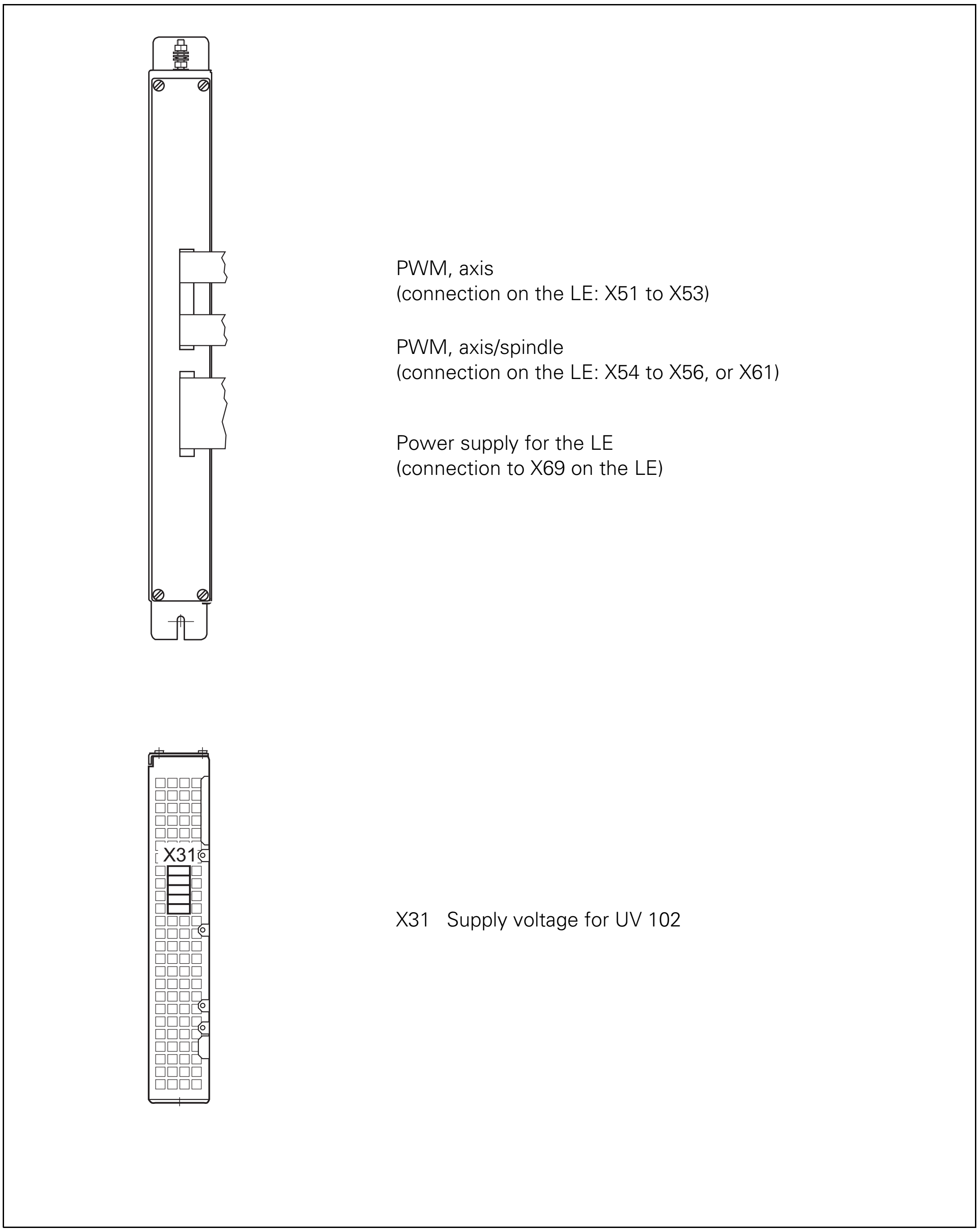
Since the power to the UV 101 B is supplied through the dc-link, the voltage fed into the dc-link by the motors that are still running can be used during line voltage failures. The UV 101 B uses this voltage to maintain the power supply to the control until the non-HEIDENHAIN inverter system has been shut down properly by the control.

Terminals	Assignment
$-U_Z$	DC-link power –
$+U_Z$	DC-link voltage +

12.10 UV 102 Power Supply Unit

12.10.1 Designation and Position of Connections

Only for LE 426 M when used with UE 2xx compact inverter.



12.10.2 Pin Layout on the UV 102

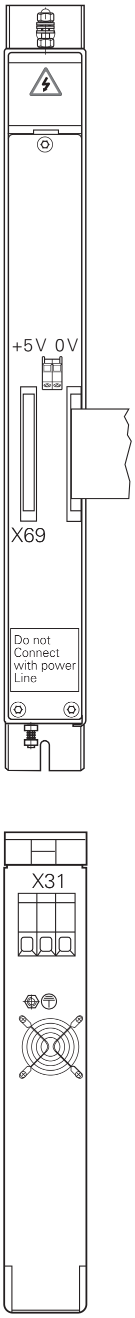
X31: Supply voltage

Connection:

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 power –
$+U_Z$	DC-link voltage +
	Cable/single conductor (HTwire): Wire cross section: 1.5 mm^2 (AWG 16) Line fuse: 6.3 A (gR) Siemens Sitor type Grounding terminal: ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 - 7 lbs/in)

12.11 UV 105 Power Supply Unit

12.11.1 Designation and Position of Connections



Conductor bar	Power supply via dc-link voltage Uz
X74	5-V power supply for control
Ribbon cable supply	Transmission of status signal and power for the control
X 69	Status signals from UV 1x0 or UE 2xxB
X31	400-V power supply
⏚	Equipment ground

12.11.2 Pin Layout on the UV 105

X31: Supply voltage

Supply voltage: 400 V ± 10%

Connection:

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) 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. **Grounding terminal:** ≥ 10 mm^2 (AWG 6)
	Tightening torque for connecting terminals: 0.7 Nm (6.5 - 7 lbs/in)

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 IEC 61800-5-1 or protective insulation as per VDE 0550).

Caution

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 UV105, 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 - 249.

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. Nr. 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

Connection:

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.

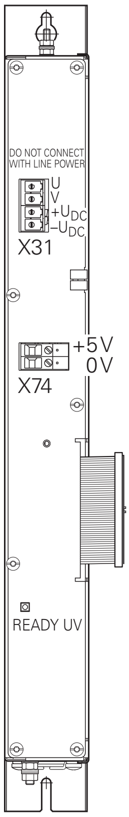
Terminals	Assignment
$-U_Z$	DC-link voltage –
$+U_Z$	DC-link voltage +

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).

12.12 UV 105 B Power Supply Unit

12.12.1 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)	

12.12.2 Error Diagnosis on UV 105 B

X31: Supply voltage

Supply voltage: 400 V ± 10%

Connection:

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) 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 - 7 lbs/in) **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).

Caution

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

> **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!

Connections: See "X69: NC supply voltage and control signals" on page 12 - 249.

X74:
5-V power supply

Connection:

Wire color of 5-V connection	5-V terminal on CC 42x
black	0 V
red	+5 V

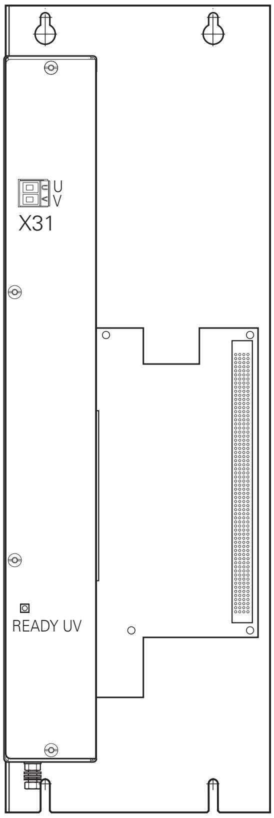
U_Z:
Power supply of the UV 105B with U_Z

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 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.

Terminals	Assignment
$-U_Z$	DC-link voltage –
$+U_Z$	DC-link voltage +

12.13 UV 106 B Power Supply Unit

12.13.1 Designation and Position of Connections



X31	U/V	400-V supply voltage
Green LED		Operational status indicator
⏚		Equipment ground (YL/GN)

12.13.2 Error Diagnosis on UV 106 B

X31: Supply voltage for UV 106B

Supply voltage: 400 V ± 10%

Connection:

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
	Connecting leads Wire cross section: 1.5 mm^2 (AWG 16)
Tightening torque: for the connecting terminals 0.7 Nm (6.5 - 7 lbs/in) **Grounding terminal:** ≥ 10 mm^2 (AWG 6) **Strain relief:** Ensure that the connecting cables are not subject to excessive strain	

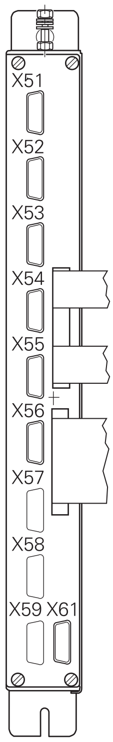
Power connection

12.14 Error Diagnosis on the UV 111A, UV 111B

12.14.1 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.

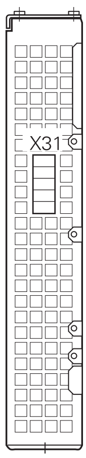


X51 to X56/X59 — **PWM connection for axis UV 111A/UV 111B**

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

12.14.2 Pin layout on the UV 111A, UV 111B

X31: Supply voltage

Supply voltage: 400 V ± 10%

Connection:

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 - 7 lbs/in) **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).

Caution

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 A or UV 111 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 111!

Connections: See “X69: NC supply voltage and control signals” on page 12 - 249.

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 - 326.

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 an **imprint** 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" have 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 readout 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.

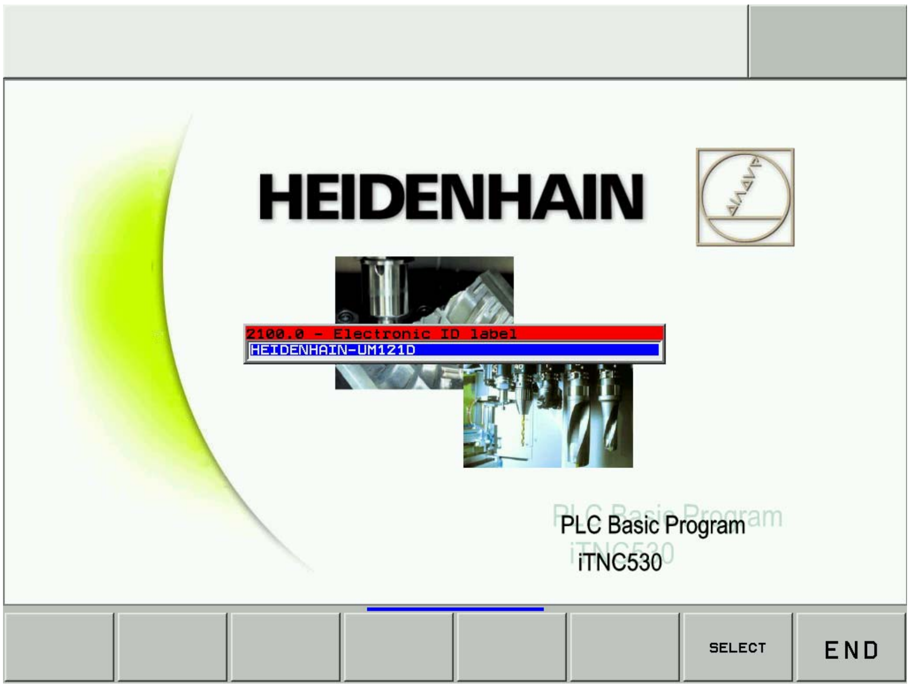
Wrong assignments are recognized!

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 labels before.

Caution

In the event of the following wrong assignments are not recognized:
- 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:

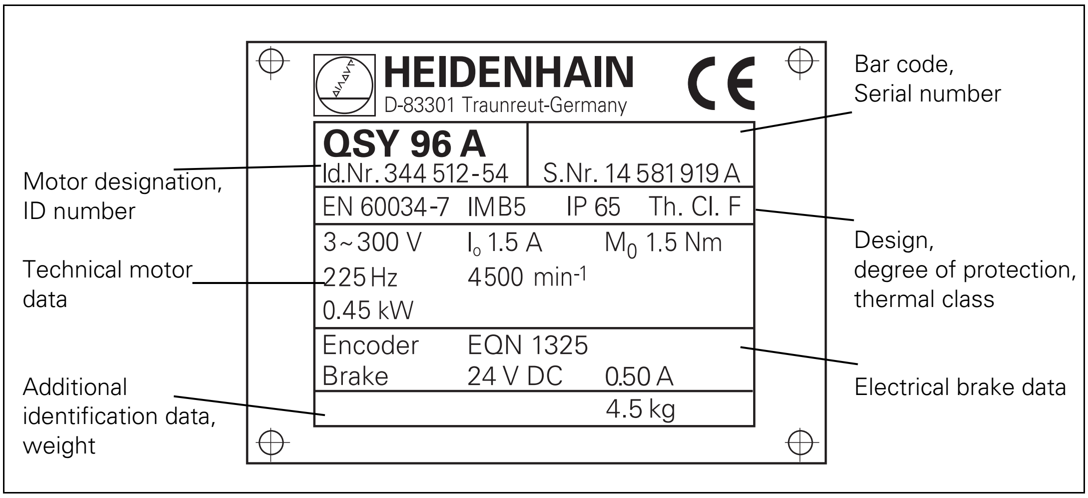


13.3 ID Label for Motors

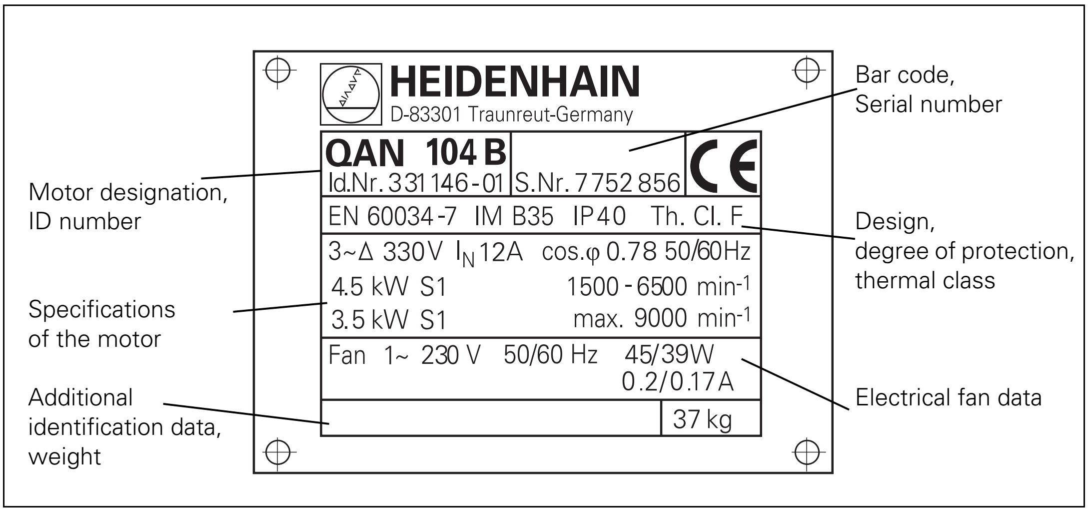
Note

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 Motor

Current motors with EnDat interface have electronic ID labels.

Following data is stored in the electronic ID labels for motors:

- Device
- Model
- Serial number
- ID number
- 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 recognized!

If an ID label message is displayed on the screen when the control is rebooted:

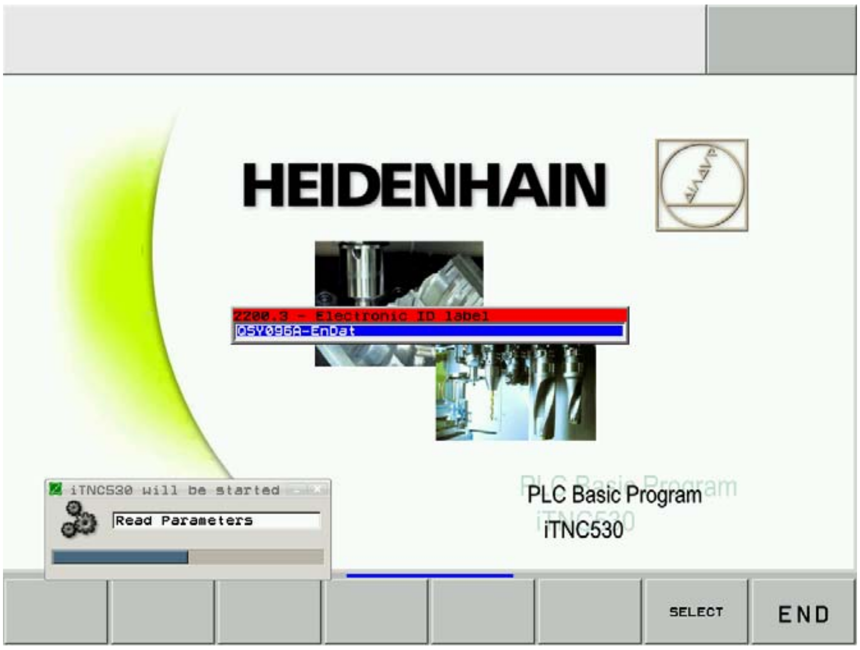
- The connected unit does not correspond to the active MP list (e.g., the mounted replacement unit is not exactly the same).
- The active MP list does not correspond to the connected unit (e.g., if a backup was restored before, that does not fit exactly to the machine).
- You have exchanged the rotary encoder inputs or PWM outputs for troubleshooting, without deactivating the evaluation of the electronic ID labels before.

Caution

In the event of the following wrong assignments are not recognized:

- 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 Interface Cards

The label for the HEIDENHAIN interface card 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 have electronic ID labels** at present.

In most cases the respective **ID label sticker** is located **on the housing** of the devices where it is clearly visible.

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 1 of this manual. --> see “Safety Precautions” on page 1 – 7

Caution

The following inspection, measuring and testing equipment is **only** intended **for a test run** on machines!

Caution

When using the test adapter or the universal measuring adapter, encoder cables, for example, are no longer shielded continuously.

When using grounded measuring equipment (e.g., oscilloscope with power connection), always the socket of the machine's electrical cabinet should be used for power supply. Compensating currents caused by different earth potentials can thus be avoided!

For measuring voltages, the contact should first be established with 0 V and only then the contact with the voltage to be measured!

Caution

Always observe the **operating instructions** of the corresponding units PWM 9, and IK 215!

14.2 Voltage Test Unit

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 induces a test charge to 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

Do not use a multimeter to measure whether the unit 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 measuring device 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 inspected (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 test 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.

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 – 91).

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 cable) without contact.

Current probes are available as accessories for multimeters or as independent units.

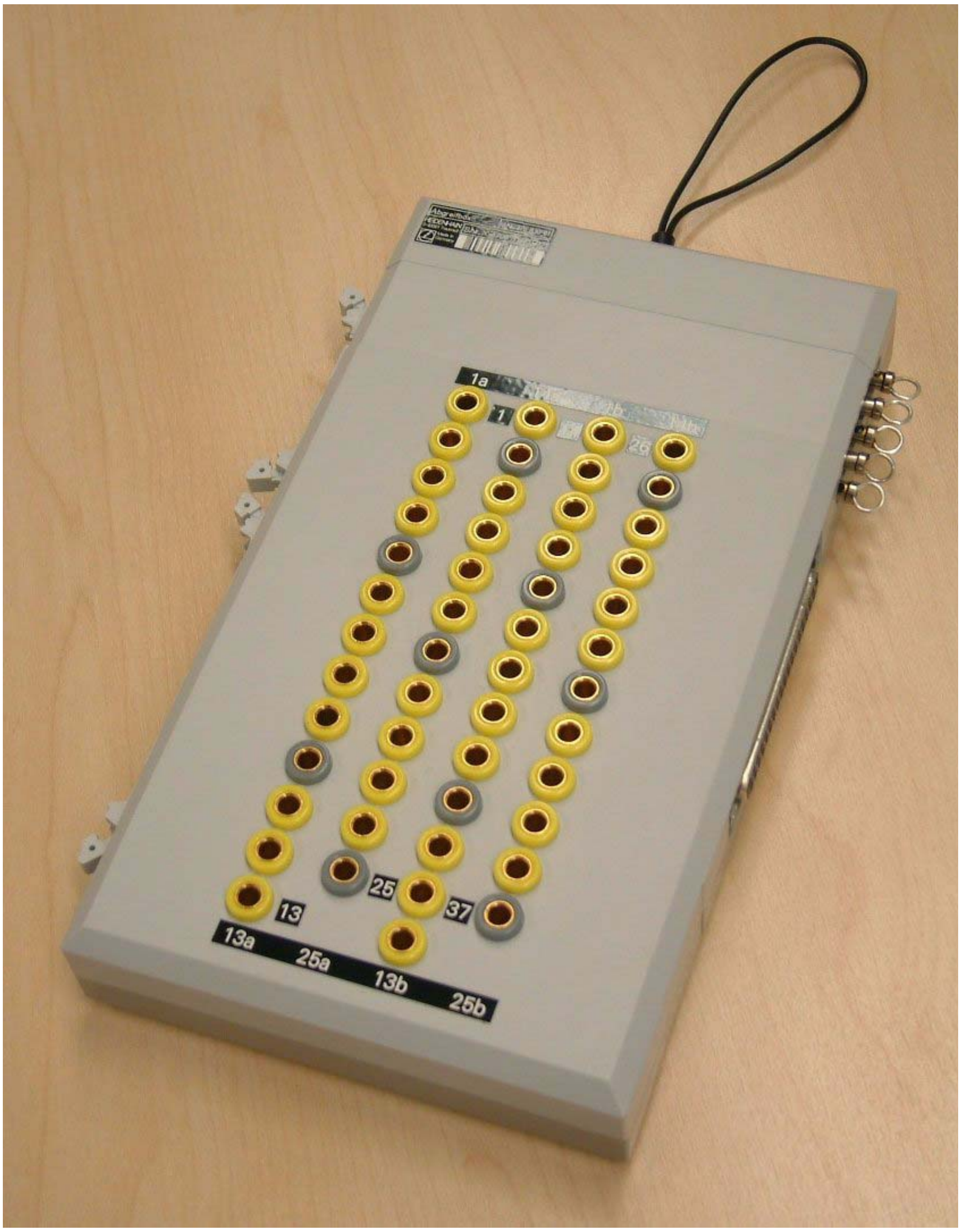
DANGER

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

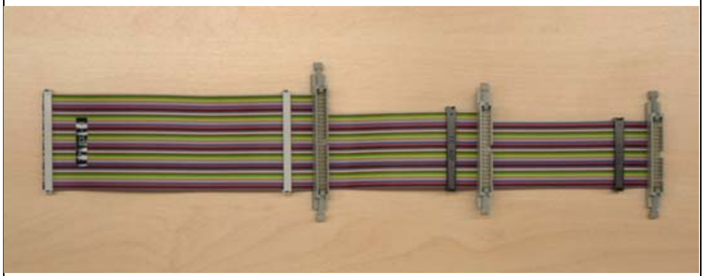
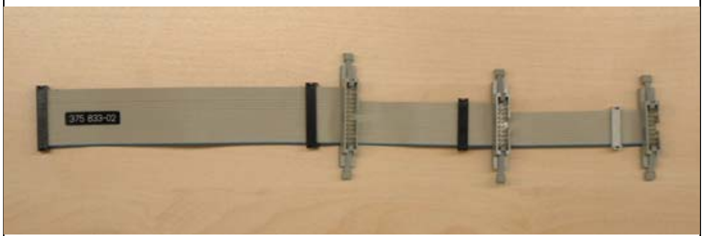
The test adapter ...

- Currently has the ID 375830-01.
- Is the successor of the "Universal measuring adapter" (see “Universal Measuring Adapter” on page 14 – 339) and is fully compatible.
- 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.



Adapter cable to the test adapter

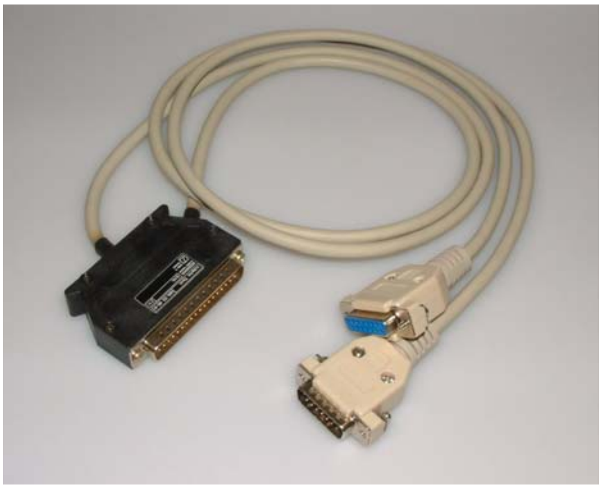
Each ribbon cable and D-sub connector requires its own adapter cable.

	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 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 Universal Measuring Adapter

The universal measuring adapter …

- Currently has the ID 255480-01.
- Is the predecessor of the test adapter.
- **Cannot be connected to a ribbon-cable connector**!
- Functions the same as the test adapter.
- The required D-Sub adapter cables are listed in the test adapter section (see "Test Adapter" on page 14 – 335).

14.8 PWM 9 Encoder Diagnostic Set

General

- 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".
- 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).
- It can also measure the signal amplitude 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!).

Note

With the predecessor unit PWM 8 it is also possible to inspect motor encoders.
Be sure to comply with the operating instructions. If you have any more questions, contact a HEIDENHAIN service agency!

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 measuring system
- 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 board TTL, HTL) via 3 BNC sockets (e.g. on an oscilloscope).

The most important functions of the PWT MODE:

Graphic bar display of the

- Signal amplitude
- Signal quality
- Width of reference signal
- Position of reference signal

Note

Each **PWM 9** is delivered with detailed **operating instructions**.
It also includes the cables and adapters that are required for the wiring.
These operating instructions are available on the Internet in German and in other languages.
They can be downloaded from www.heidenhain.de/Services and Documentation/...
During our **training courses on encoders** 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 effectively.
Contact HEIDENHAIN Traunreut or your regional agency.

14.9 PWT 18 Test Unit

General

- The **PWT** test unit was designed as mounting aid for scanning heads.
  However, it is also possible to check **signals (A track, B track, reference mark) of a motor encoder**!
- 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).
- It can also measure the signal amplitude 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 PWT it is possible to display the …

- Signal amplitude
- Signal quality
- Position of the reference mark
- Width of the reference mark

Note

Each **PWT** is delivered with **operating instructions**.
These operating instructions are available on the Internet in German and in other languages.
They can be downloaded from www.heidenhain.de/Services and Documentation/...
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.

14.10 IK 215 Adjusting and Testing Package

- Current ID number 547858-01.
- The IK 215 is an adapter board for PCs for inspecting and testing absolute HEIDENHAIN encoders with EnDat or SSI interface.
- Parameters (e.g. datum shift) and the electronic ID label can be read and written via the EnDat interface.

Note

Each **IK 215 Adjusting and Testing Package** is delivered with detailed **operating instructions**.
These instructions are also available on the Internet in German and English.
They can be downloaded from www.heidenhain.de/Services and Documentation/...
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 effectively.
Contact HEIDENHAIN Traunreut or your regional agency.

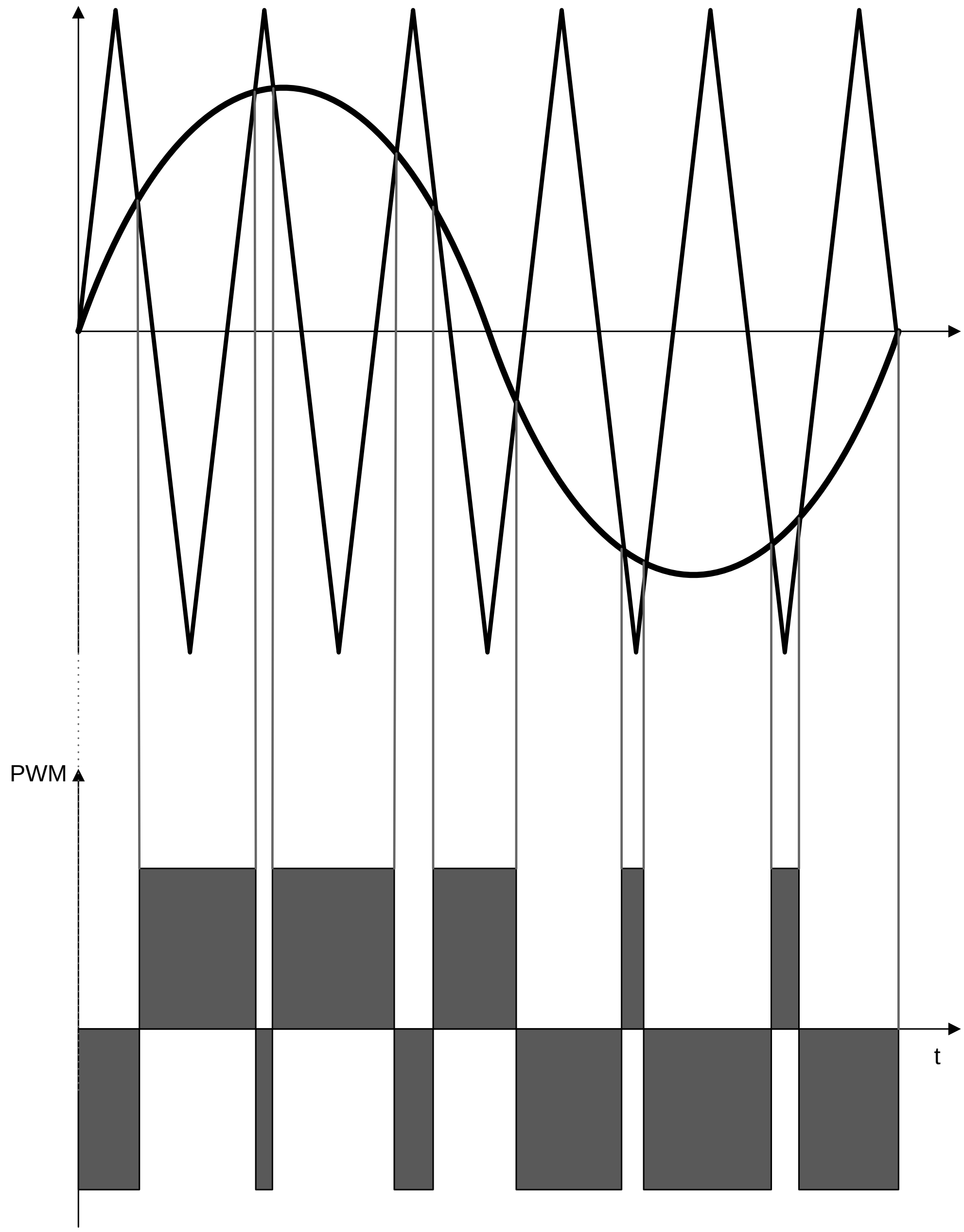
15 Annex: Functional Principles

15.1 PWM Signals

Digital axes and spindles are driven with PWM signals.

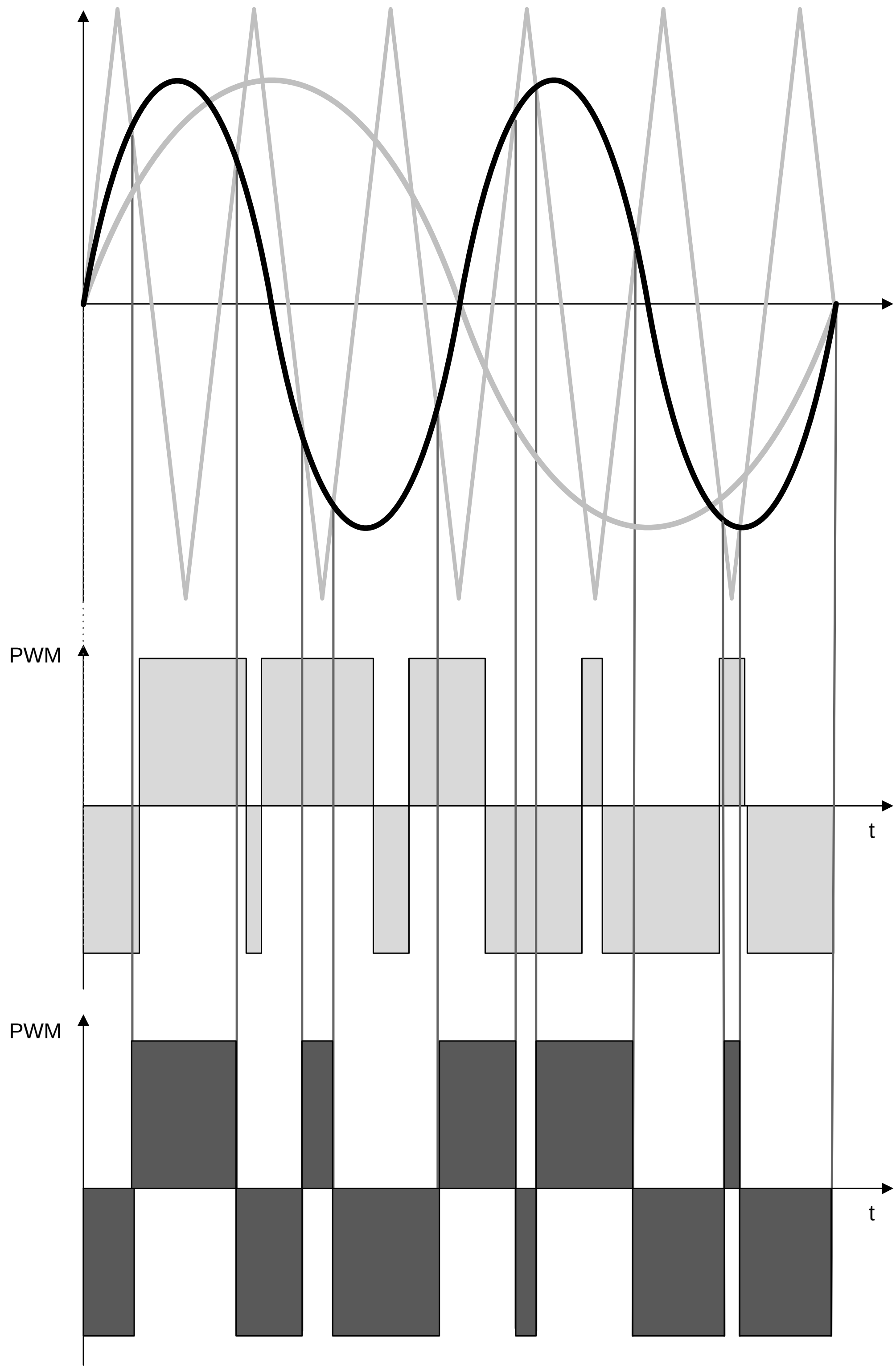
PWM is the abbreviation **"Pulse Width Modulation"**. The information (speed, torque) for the output stages is converted into a pulse and pause ratio.

The PWM signal is generated in the HEIDENHAIN control and is transferred to the inverter via PWM interfaces.

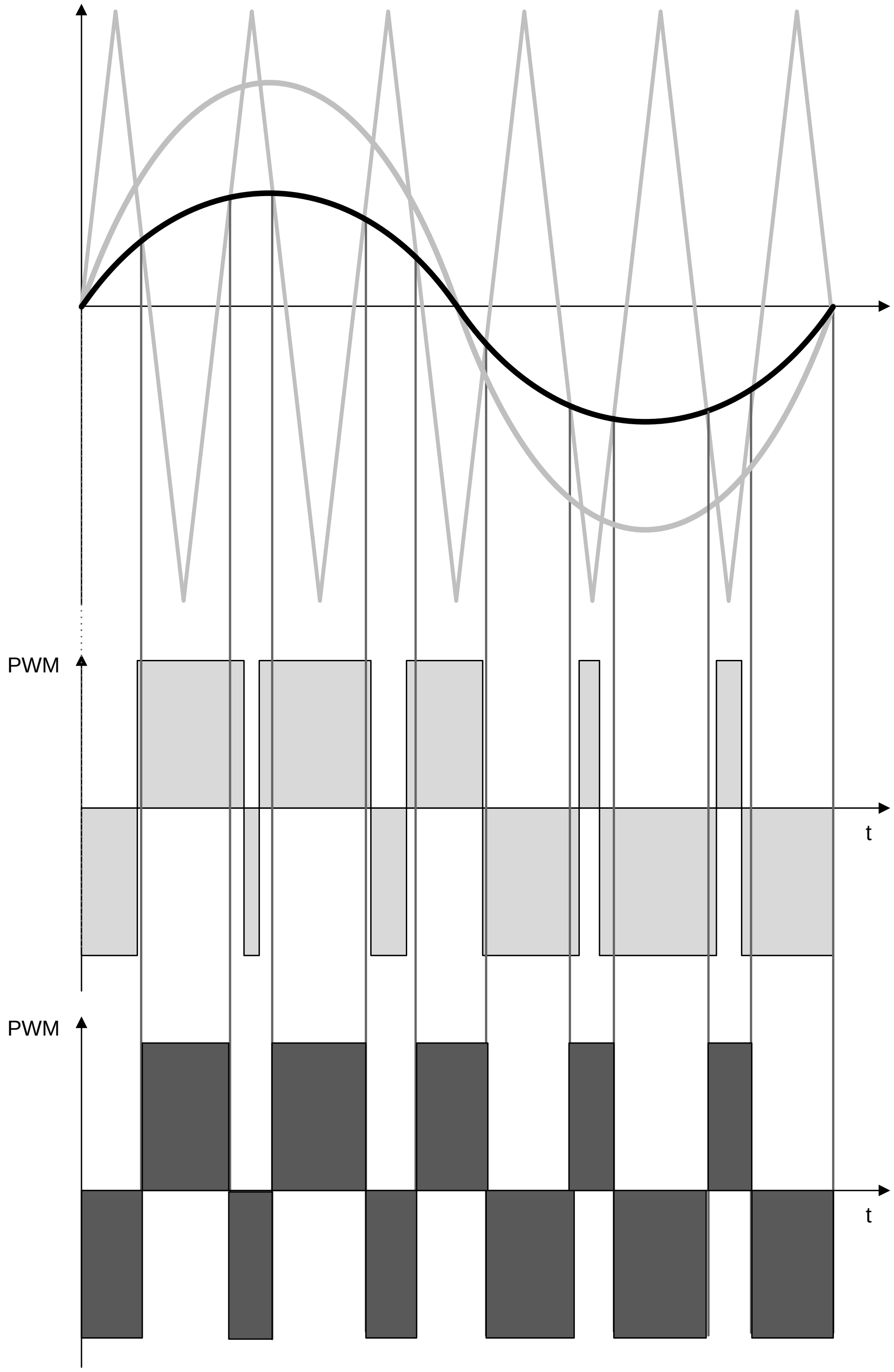


The output signal of the current controller is compared to a delta voltage (e.g., 5 kHz fixed frequency) to create the PWM signal. At each interface of the current controller signal and the delta voltage there is a switchover from pulse to pause.

"Scanning" a signal with higher frequency (higher motor speed) effects a more frequent change of pulses and pauses.



"Scanning" a signal with a lower amplitude (low motor torque) results in a smaller difference between pulses and pauses.



An infinite low or missing signal 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 and compact inverter systems**.

A modular inverter system consists of a power supply unit (UV, UVR) and mostly of several power modules (UM).

A compact inverter (UE, UR) constists of the power supply unit and the axes or spindle output stages in one unit.

HEIDENHAIN also distinguishes between **regenerative and non-regenerative inverter systems.**

The regenerative inverters include all UR, UV 120, UV 140 and all UVR.
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 V**.

The non-regenerative inverters include all UE, UV 130 and UV 130 D.
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 V**.

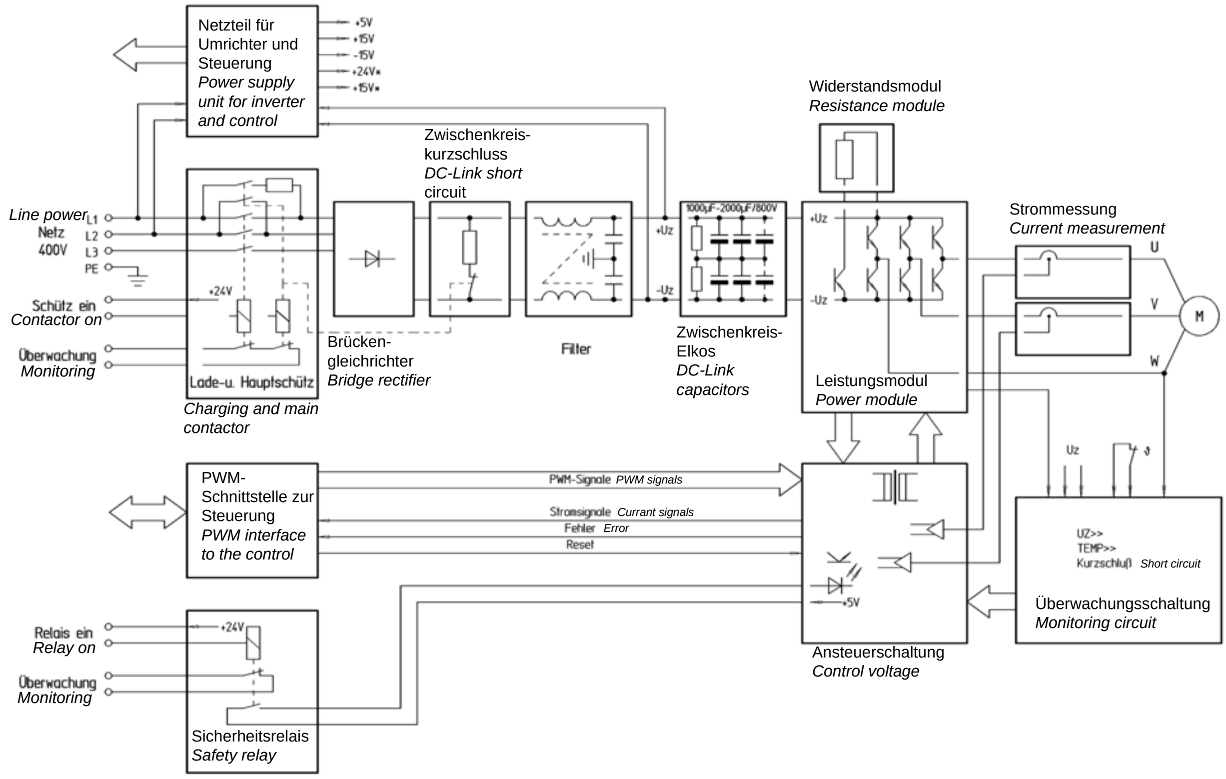
The current or speed controller has not to be set on HEIDENHAIN inverters (this is made in the HEIDENHAIN control).
Their function is **to power the motors** and thus the machine!

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 a inverter.

Current inverters with the designation "D" have an **electronic ID label**. --> see “Electronic ID Label for Inverters” on page 326.

Block diagram



The inverter is connected to a 400 V three-phase line power. The fuses are located outside 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 U_Z) 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 U_{eff} = 400 Vac.

Infeed / regenerative module

In regenerative inverters from HEIDENHAIN, the dc-link voltage U_z 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 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

These potential dividers consist of resistors connected in series to ground.

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 insulation of the gate drivers is realized via optocouplers.

Safety relay The supply voltage of the opto couplers 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, lead to the outside.

EMC Observe the following measures in order 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 current capacitor
- DC-link filter
- Voltage protection module
- Adapter module
- Axis-release module
- Braking resistor module

... in chapter “Overview of Components” on page 203

15.3 HEIDENHAIN Motors

15.3.1 Introduction

HEIDENHAIN offers **three-phase ac motors** for the control of digital axes and spindles (PWM signals).
This includes synchronous motors (QSY), asynchronous motors (QAN), linear motors and 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 Motor” on page 329.

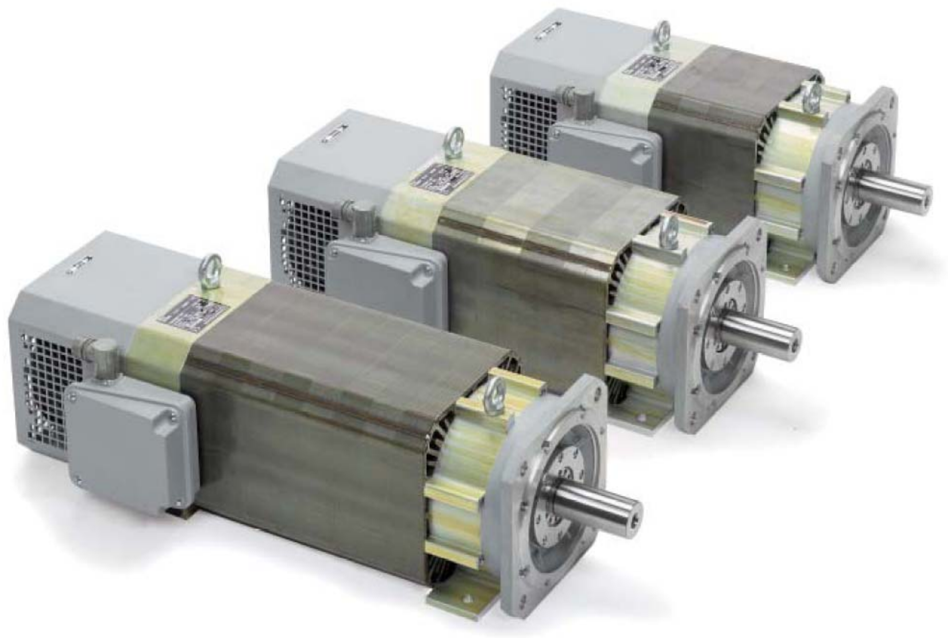
At least one **temperature sensor** is integrated in each motor.
The **temperature signal** is transmitted **to the control via the signal cable**.

Many axis motors are equipped with a **brake**.
The control lines for the brake are 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).



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**.

Spindle 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 linears 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 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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The **HEIDENHAIN Helpline** in Traunreut consist of qualified, multi-lingual specialists who support you in solving your problems.

Especially if you need **technical support** the HEIDENHAIN Helpline team can provide detailed advice and information on measuring systsems, controls as well as NC and PLC programming.

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