BAUMÜLLER

CURRENT CONVERTER
BKD 6 / ... 2000

Technical Description and
Operating Instructions

E	5.96200.01

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Edition: 6 February 1997

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BEFORE CARRYING OUT COMMISSIONING, READ AND OBSERVE THE OPERATING INSTRUCTIONS AND SAFETY INFORMATION

This document contains the information necessary to correctly use the products it describes. It is intended for specially trained, technically qualified personnel who are well-versed in all warnings and maintenance activities. The equipment is manufactured using state-of-the-art technology and is safe in operation. It can safely be installed and commissioned and functions without problems if you follow the safety information.

You must not carry out commissioning until you have established that the machine into which this component is to be installed complies with EU machine guidelines.

The publishing of this document invalidates all earlier editions of descriptions and operating instructions of the corresponding product. Within the scope of further-development of our products, Baumüller GmbH reserve the right to change their technical data and handling.

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Country of Origin: Germany

Date of Manufacture: Determined from the device's serial number

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ABBREVIATIONS

ASF	Amature contactor enable
BSA	Reference voltage, analog
GRE	Rectifier final position
I_{Aact}	Armature actual current value
I_F	Field current
I_{Fmax}	Maximum field current (rated current)
I_{Fmin}	Minimum field current
I_{Fspec}	Field current specified value
I_{spec}	Armature specified current value
$IxR_{operation}$	IxR compensation in operation
IxR_{creep}	IxR compensation in creep
M24	24-V reference potential
MTL	Medium time lag (fuse)
n = 0	RPM = 0
n_{act}	Speed actual value
n_{max}	Maximum speed
n_{min}	Minimum speed
n_{SG}	Creep speed
n_{spec}	Speed specified value
PE	Protective earth
R_A	Armature resistance
RF	Controller enable
U_A	Armature voltage
WRE	Inverter final position
X	Terminal strip

1 SAFETY INSTRUCTIONS

Preliminary Remarks

During operation, the principles on which the power converter and the motor work lead to leakage currents to earth that are dissipated via the specified protective earths and may result in a current-operated e.l.c.b. on the input side blowing prematurely.
In the case of a short-circuit to frame or to ground a direct proportion may arise in the leakage current that makes triggering a higher-level current-operated e.l.c.b. either more difficult or totally impossible.
This means that connecting the power converter to the mains supply using only the current-operated e.l.c.b. is prohibited (preliminary standard EN 50178/VDE 0160/11.94, Sections 5.2.11 and 5.3.2.1)

When in use, the equipment is protected from being touched directly by installing the power converters in commercially available control cabinets whose degrees of protection meet the minimum requirements of provisional standard EN 50178/VDE 0160/11.94, Section 5.2.4.

Sheets of plastic covering the control electronics, the power unit and the equipment connection provide additional protection against accidental contact.

At routine testing of the equipment, we carried out a high-voltage test in accordance with DIN VDE 0160.

The most important factors for protecting people are the DIN/VDE protective measures and safety regulations.

(DIN VDE 0106 Part 100, Accident Prevention Regulation VBG4 "Electrical Systems and Equipment").

If there are no protective earth connections on the equipment or the motor, personal injuries and/or considerable damage to property are inevitable.

General Information

This document contains the information necessary to correctly use the products it describes. It is intended for specially trained, technically qualified personnel who are well-versed in all warnings and maintenance activities. The equipment is manufactured using state-of-the-art technology and is safe in operation. It can safely be installed and commissioned and functions without problems if the safety instructions in the operator's manual are always followed.

WARNING

When operating electrical equipment, some parts of the equipment always carry dangerous voltages.
Ignoring these safety instructions and warnings may result in serious personal injury and/or damage to property
Only qualified personnel who are familiar with the safety information, assembly operation and maintenance instructions may carry out work on this equipment.

Danger Information

On the one hand, the information below is for your own personal safety and on the other to prevent damage to the described products or to other connected equipment.

In the context of the operating instructions and the information on the products themselves, the terms used have the following meanings:

DANGER

This means that death, severe personal injury or damage to property will occur unless appropriate safety measures are taken.

WARNING

This means that death, severe personal injury or damage to property may occur unless appropriate safety measures are taken.

NOTE

This draws your attention to important information about the product, handling of the product or to a particular section of the documentation.

Qualified Personnel

In the context of the safety-specific information in this document or on the products themselves, qualified personnel are considered to be people who are familiar with setting up, assembling, commissioning and operating the product and who have qualifications appropriate to their activities:

Trained or instructed or authorized to commission, ground and mark circuits and equipment in accordance with recognized safety standards.

Trained or instructed in accordance with recognized safety standards in the care and use of appropriate safety equipment.

Appropriate Use

WARNING

You may only use the equipment/system for the purposes specified in the operating instructions and in conjunction with the third-party equipment and components recommended or authorized by BAUMÜLLER NÜRNBERG GmbH.

For safety reasons, you must not change or add components on/to the equipment/system.

The machine minder must report immediately any changes that occur which adversely affect the safety of the equipment/system.

2 TECHNICAL DATA

2.1 General

BAUMOTRONIC current converters of equipment range BKD 6, series 2000 are line-commutated series current converters with fully controlled alternating current three-phase bridge circuit (B6C) for one direction of current.

These current converters are suitable above all for supplying speed-controlled direct current drives in a power range of 12 kW to 600 kW.

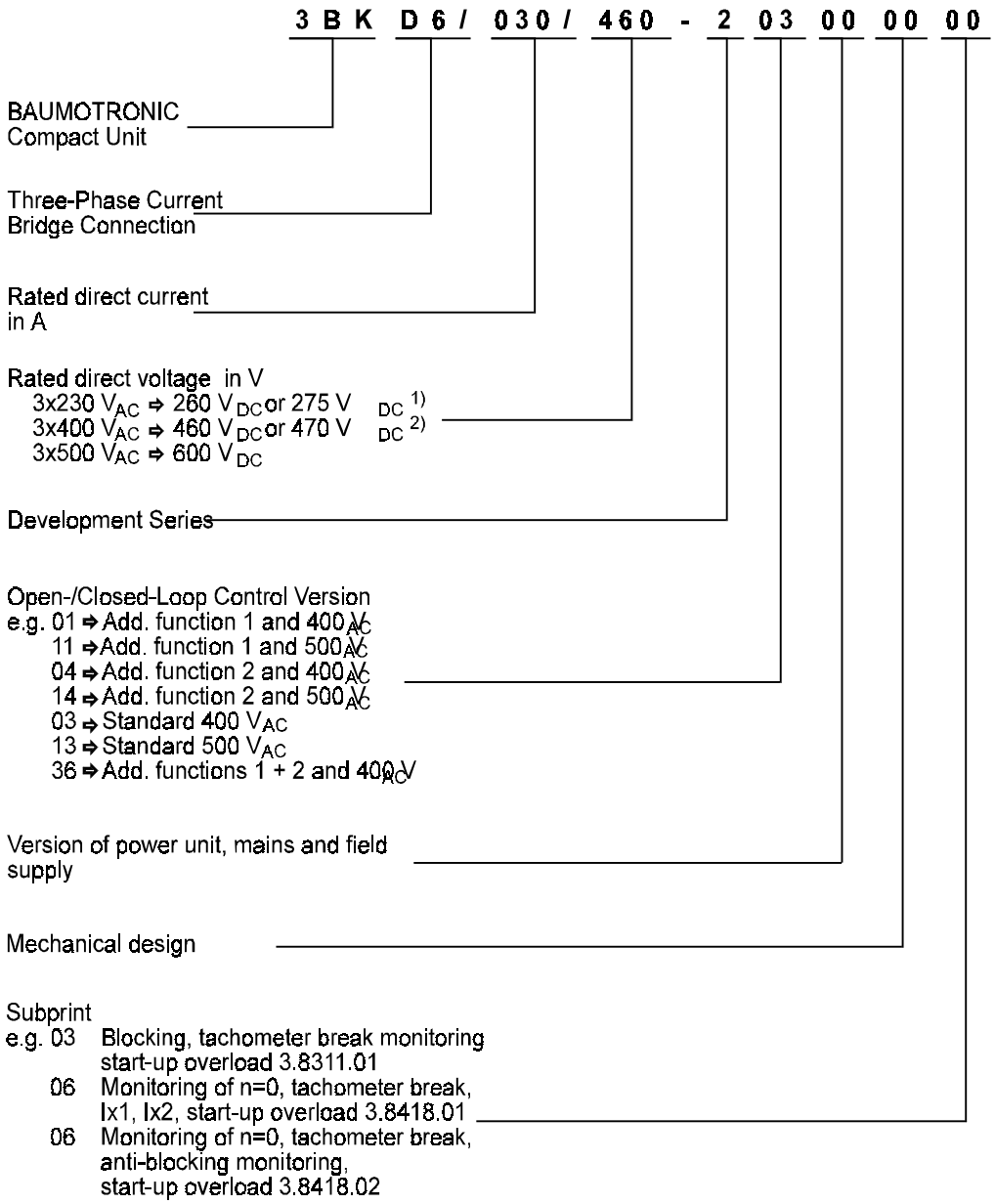
The combination of power unit and control unit in one casing yields a space-saving, easy-to-mount current converter unit, i.e. a compact current converter.

The closed-loop and open-loop control unit is fitted to a swivelling lid board which is accessible from the front. All the other main components are accessible even when mounted after the lid board was swiveled away.

The standard closed-loop and open-loop control units are identical for all unit sizes of this equipment range.

Additional modules allow you to add closed-loop and open-loop control functions matched to the technological requirements of the application in question.

2.2 Type Code



1. 260 V_{DC} at the original mains voltage of 220 V (10% or with a mains voltage of 230 V +6%, -15%).

   275 V since the increase of the mains voltage according to DIN IEC 38/05.87.
   The voltage of 260 V indicated on the rating plate remains unchanged even after the increase of the mains voltage in order to ensure uniform type designation.

2. 460 V_{DC} with the original mains voltage of 380 V (10% or with a mains voltage of 400 V +6%, -15%).

   470 V according to DIN 40030/09.93 since the increase of the mains voltage according to DIN IEC 38/05.87. The voltage of 460 V indicated on the rating plate remains unchanged even after the increase of the mains voltage in order to ensure uniform type designation.

2.3 Power Converters

	BKD6 / ... / 260 - 2000	BKD6 / ... / 460 - 2000	BKD6 / ... / 600 - 2000
Connection voltage [2)]	3 x 230 V_{AC}	3 x 400 V_{AC}	3 x 500 V_{AC}
Permissible mains voltage tolerance	±10%		
Mains frequency	50 Hz or 60 Hz ±2%		
Mains type (refer to 5.2 b)		TN or TT network with grounded star point	
Nominal direct voltage acc. to DIN 40030/09.93	275 V_{DC}	470 V_{DC}	600 V_{DC}
Rated DC currents size I	30 A 40 A 60 A 100 A 150 A 200 A		
Rated DC currents size II	250 A 300 A 380 A 480 A		
Rated DC currents size III	600 A 800 A 1000 A		
Speed control range	1: 100 (with direct voltage tachometer generator) 1: 70 (with alternating voltage tachometer generator) 1: 20 (with armature voltage control)		
Stat. control deviation (without tachometer generator errors and related to nominal speed)	0.6% (with tachometer generator control) 5% (with armature voltage control) These quantities are corrected even when occurring simultaneously: 100% load change ±10% mains voltage change ±10% temperature change		
Operating temperature range (refer to 5.2 d) At temperatures up to 55 °C At H > 1000 m above sea level	with self-ventilation: 30 A and 40 A unit: 0...45° C with force-ventilation: from 60 A unit on: 0...35° C Reduction of rated DC current by 1% per °C Reduction of rated DC current by 10% per 1000 m		
Specified speed voltage	+10 V at n_{max}		
Storage and transport temperature (see 5.2 d)	-30° ... +70° C		
Moisture class according to DIN 40040	F		
Climate class acc. to EN 60721 (refer to 5.2 d)	3K3		
Protect. system to EN60529 or DIN VDE0470-1	IP 00		
Dimensions	refer to 4.1, Dimensions		
Weights	refer to 4.2, Weight		
Type of unit (refer to 5.2 a)	Built-in power converter The casing into which the unit is fitted must ensure protection against direct contact.		
Insulation, clearances and creep distances (refer to 5.2 f)	Dimensioning acc. to provisional standard EN 50178/ VDE 0160/ 11.94: • Soiling grade 2 • Overvoltage category III at mains connection • Insulation material of class IIIa • Basic insulation		

Electromagnetic Compatibility	
Provisional standard EN 61800- 3 (IEC 22G/21/ CDV/ 11.95) (refer to 3.2.7 Standard-ization Information)	EMC product standard, including special inspection procedures for electrical drives **Noise immunity according to Paragraph 5:** • Noise immunity to low-frequency conducted interferences – IEC 1000-2-2 for public low-voltage networks – EN 61000-2-4/ IEC 1000-2-4, Class 3 for industrial low-voltage networks – EN 60146-1-1/ IEC 146-1-1, Paragraph 2.5: Requirements of Line-Commutated Convert-ers • Noise immunity to high-frequency interference for application in public as well as in industrial environments – IEC 1000-4-2/ IEC 801-2: ESD· – Provisional standard EN 61800-3, Section. 5.3.3: EMF; (“Walkie Talkie Test” WTT) – EC 1000-4-4/ IEC 801-4: Burst – IEC 1000-4-5/ IEC 801-5: Surge **Interference emissions according to Section 6:** • Low-frequency conducted interference – Commutation notches Limitation of the commutation depth at the mains connection by using line reactors – Mains harmonics To analyze the generation of harmonics, take into account the guideline in Paragraph B2 • High-frequency interference – Conducted interference Public networks in residential areas: Limit values for medium drives (I > 25 A); if necessary, use mains filter [1)] Non-public networks in industrial areas: the standard does not specify any limit values; the converter can be used without limitations. – Radiated interference Public networks in residential areas: The converter generally complies with the limit values for medium drives (I > 25 A) without additional measures being required. Non-public networks in industrial areas: The standard does not specify any limit values; the converter can be used without limitations. **Evaluation of distribution channel:** Limited availability according to Paragraphs 3.2 and 6
Generic standards EN 50081- 2/ 04.94 EN 50082- 2/ 11.94	EMC Generic Standard for Interference Emissions Part 2: Industry EMC Generic Standard for Noise Immunity Part 2: Industry (applicable for electrical drives in part only)
Basic Standards: EN 55011/ 07.92 IEC 1000-4-2/ IEC 801-2/ 05.94 IEC 1000-4-4/ IEC 801-4/ 10.94 IEC 1000-4-5/ IEC 801-5/ 02.92 EN 61000-2-4/ IEC 1000-2-4/ 05.95	Radio interference suppression of electrical resources and systems (emitted interference) Class A: if necessary, use a mains filter [1)] EMC; Noise immunity to discharge of static electricity/ESD EMC; Noise immunity to rapid electrical transients/bursts EMC; Noise immunity to surges EMC; Compatibility level for low-frequency conducted interference in industrial systems

1. The rated DC current is valid for the temperature range stated to a height of installation of 1000 m above sea level (= permanently permissible unit direct current)
2. Refer to 5.6, adaptation of the power converters to different mains voltages
3. Output voltage of the power converters as a function of inverter angle α:

$$U_{di\alpha} = \frac{3 \cdot \sqrt{2}}{\pi} \cdot U_{Mains} \cdot \cos\alpha$$

4. Current converters generate an interference voltage spectrum at the power connections on the input side which generally exceeds the specified limit curve in some areas.

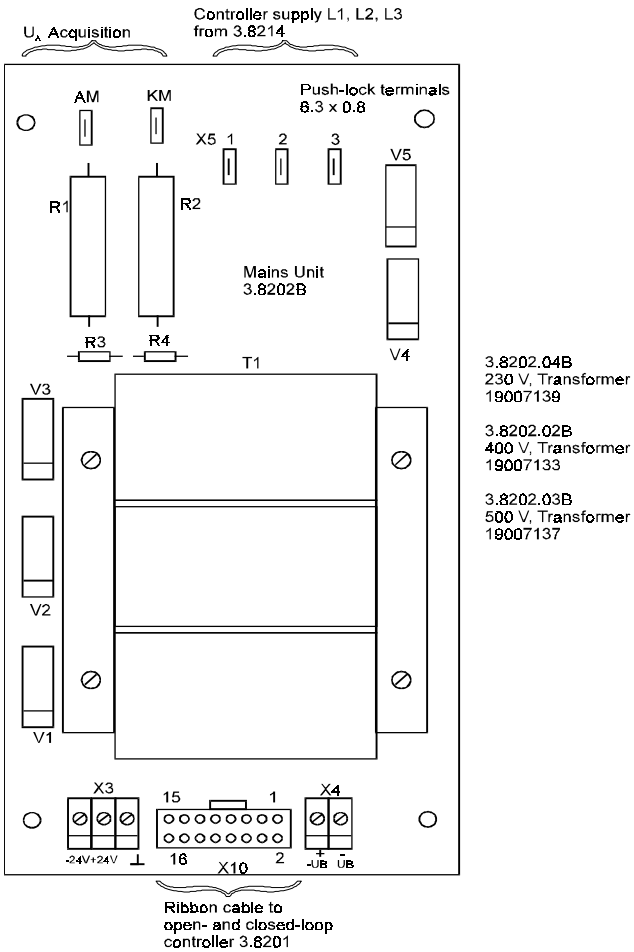
   With applications in which it is only necessary to comply with the limit values at the interface to the public network, the cable attenuation of the connecting line alone may, under some circumstances, provide adequate filtering.

   See also the document entitled “EMC on and with Line-Commutated Converters of Series BKF 12/ ... and BKD 6/...“.

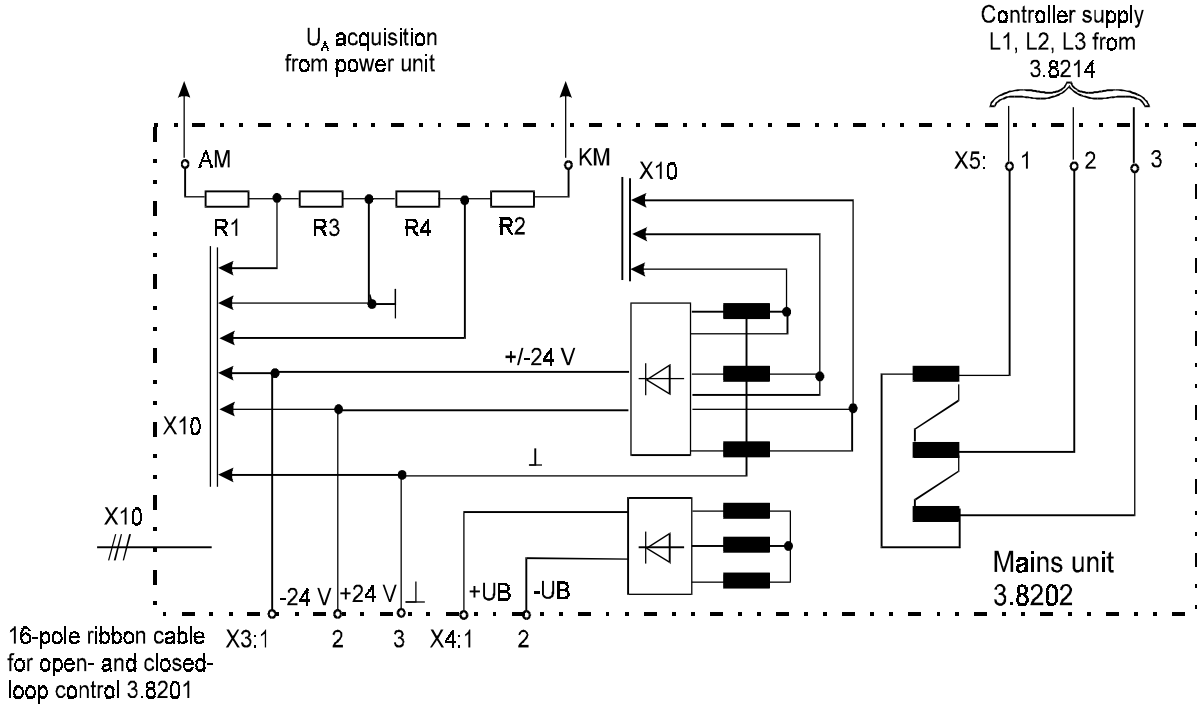
2.4 Power Supply

	BKD6 / ... / 260 - 2000	BKD6 / ... / 460 - 2000	BKD6 / ... / 600 - 2000
Connection voltage	3 x 230 V_{AC}	3 x 400 V_{AC}	3 x 500 V_{AC}
Permissible voltage range	205 V_{AC} ... 275 V_{AC}	345 V_{AC} ... 460 V_{AC}	410 V_{AC} ... 550 V_{AC}
Frequency	50 / 60 Hz		
Power requirement	max. approx. 40 W		
Fuse protection sizes I, II	F1, F2, F3 on printed circuit board 3.8214: 3 x 0.2 A/500 V m		
Fuse protection size III	F701, F702, F703 on printed circuit board 3.8222 3 x 0.2 A/500 V m		
Direct voltages at X3 can be loaded externally with	(24 V; -17% +25% 200 mA		
Relay power supply $+U_B/-U_B$	48 V/40 mA		
Stab. direct voltages can be loaded externally with	±15 V 80 mA (external connection on lid board 3.8201.04, 3.8201.14 or 3.8201.36)		
Stab. specified value voltage (connection to lid board)	10 V ±6% 5 mA		

Construction drawing of printed circuit board:



Schematic circuit diagram



2.5 Field Supply

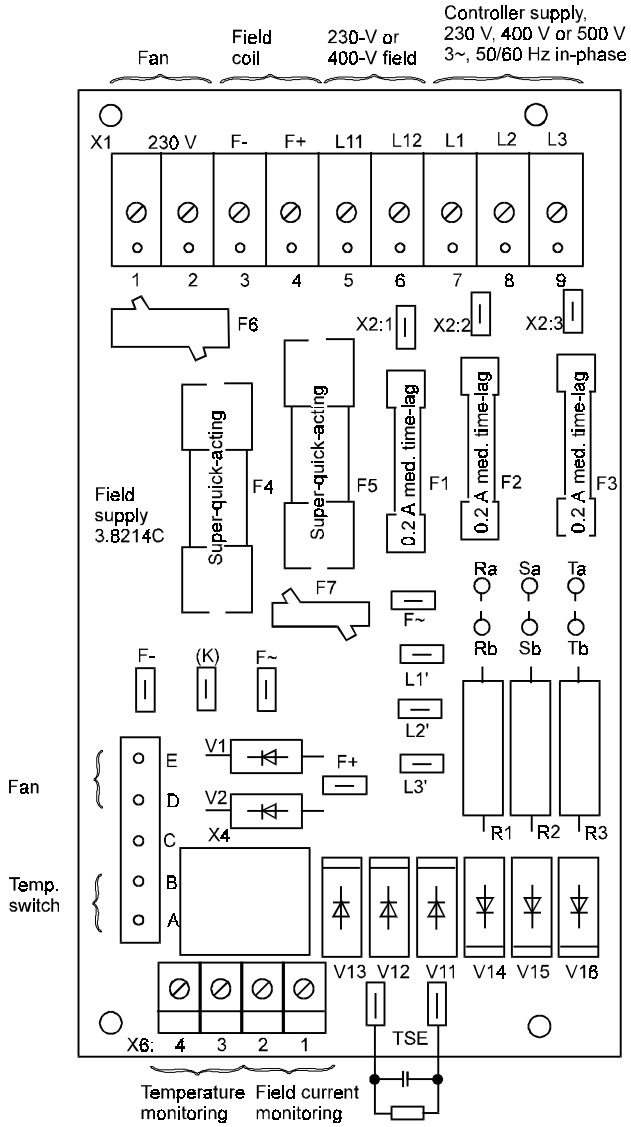
A total of three field supply units are available:

- Uncontrolled field
  Contained in units of sizes I and II, but not in unit size III
- Constant field supply
  Used in unit size III
- Field weakening control unit
  Installed outside the power converter in the control cabinet, if required.

2.5.1 Uncontrolled Field

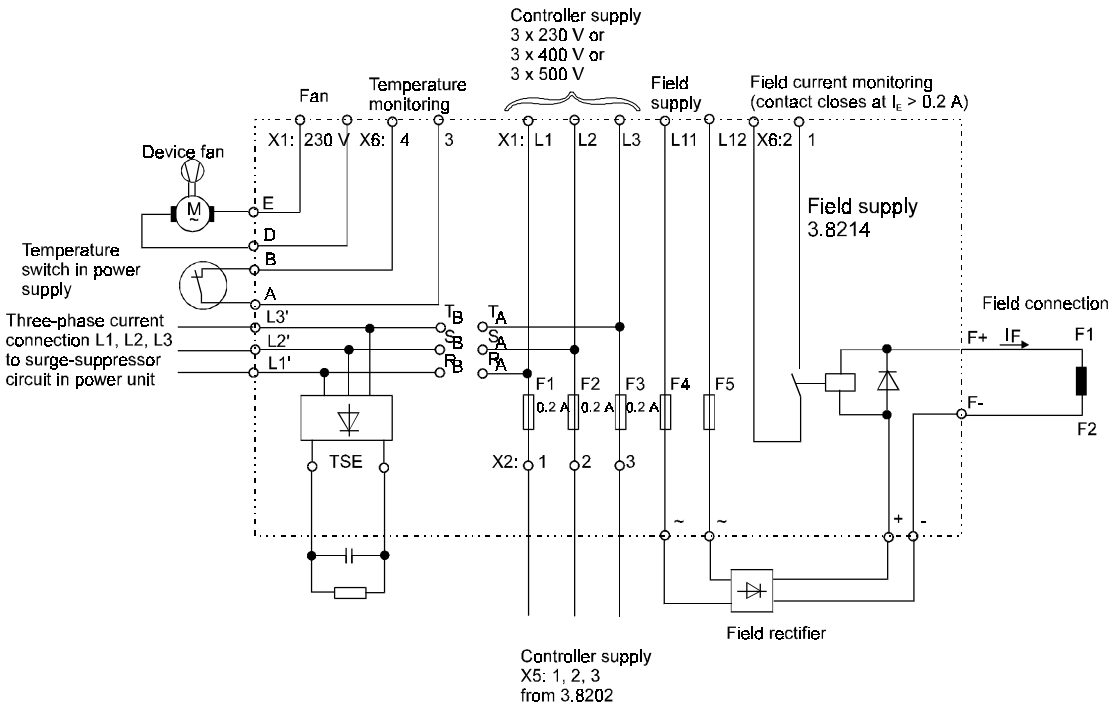
	BKD6 / ... / 260 - 2000	BKD6 / ... / 460 - 2000	BKD6 / ... / 600 - 2000
Field voltage U_F	depends on supply voltage $U_F \leq 0.9 * U_{netz}$ U_{netz} U_F 230 V ≤ 205 V 400 V ≤ 360 V 290 V ≤ 260 V 500 V ≤ 450 V		
Adaptation of field voltage	if required, with field adjusting resistor or field transformer		
Rated DC currents Size I Size II	 5 A or 8 A 8 A		
Fuse protection	Semiconductor fuses are contained in the unit F4, F5 on board 3.8214: 5 A nominal current:8 A/600 V URB 8 A nominal current:16 A/600 V URB		
Components fitted	generally in unit sizes I and II, not in size III		
Field failure protection	Relay Contact load max. 230 V/1 A		

Construction drawing of printed circuit board



	3.8214C01	3.8214C02
max. field current	5 A	8 A
Field rectifier	SKB15/16	SBK 30/16
Diodes V1, V2	CSR 5/120	SKKE 15/08 (V1 + V2 not fitted)
Semiconductor fuse F3 and F4	8 A/600 V/ 10 x 38 mm (600CPURB10.8) A060URB008 T13	16 A/600 V/ 10 x 38 mm (600CPURB10.16) A060URB016 T13
Miniature fuses F1, F2 and F3	0.2 A/500 V / m 5 x 30 mm	0.2 A/500 V / m 5 x 30 mm

Schematic circuit diagram



2.5.2 Field Controller: Boards 3.8316/17

Constant field supply

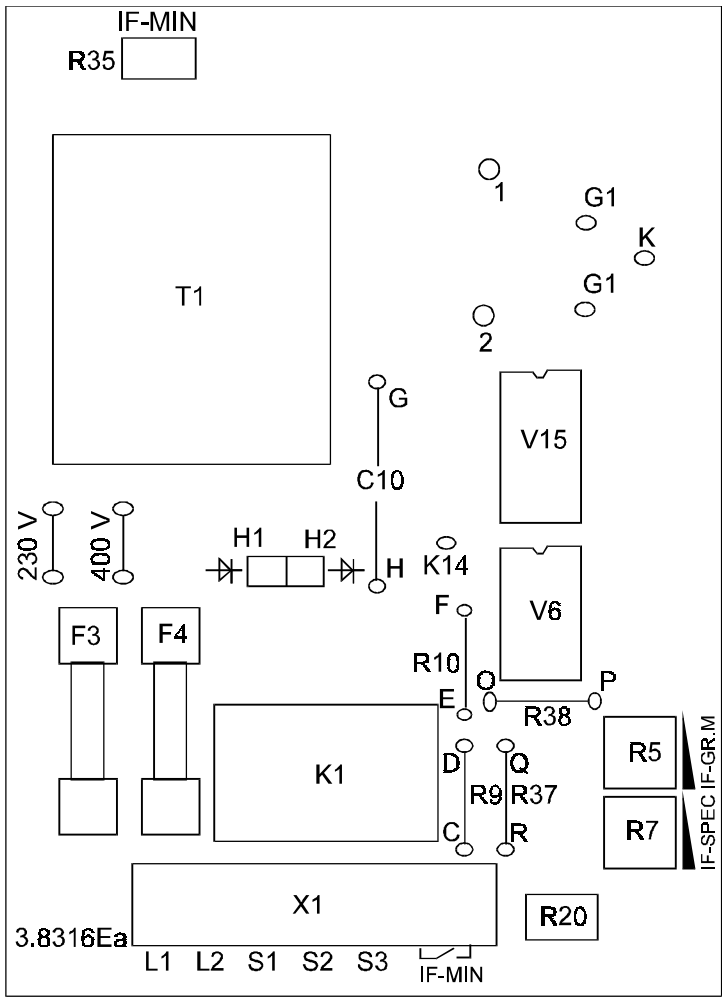
	BKD6 / ... / 260 - 2000	BKD6 / ... / 460 - 2000	BKD6 / ... / 600 - 2000
Connection voltages	230 V/400 V to be set on unit via soldering jumper		
Permissible voltage tolerance	±15%		
Nominal direct voltages [1] (field voltages)	180 V_{DC} with U_{Netz} = 230 V_{AC} 310 V_{DC} with U_{Netz} = 400 V_{AC}		
Rated DC currents I_{Fmax}	2 A 6 A 12 A	can be set with R7	
Reduction of field current to I_{Fmin}	Contact I_{Fmin} closed Minimum field current can be set with R35		
Field failure protection	Relay Contact load max. 230 V/1 A Switching threshold can be set with R5		
Fuse protection Control Power	The fuses are integrated in the unit F3, F4: 0.2 A/500 V m F1, F2: Semiconductor fuses 8 A or 16 A/600 V URB		
Components fitted	in unit size III		
Accessories	For line commutation reactor(s), refer to line reactors		

1. Output voltage of the field controller as a function of the angle α:

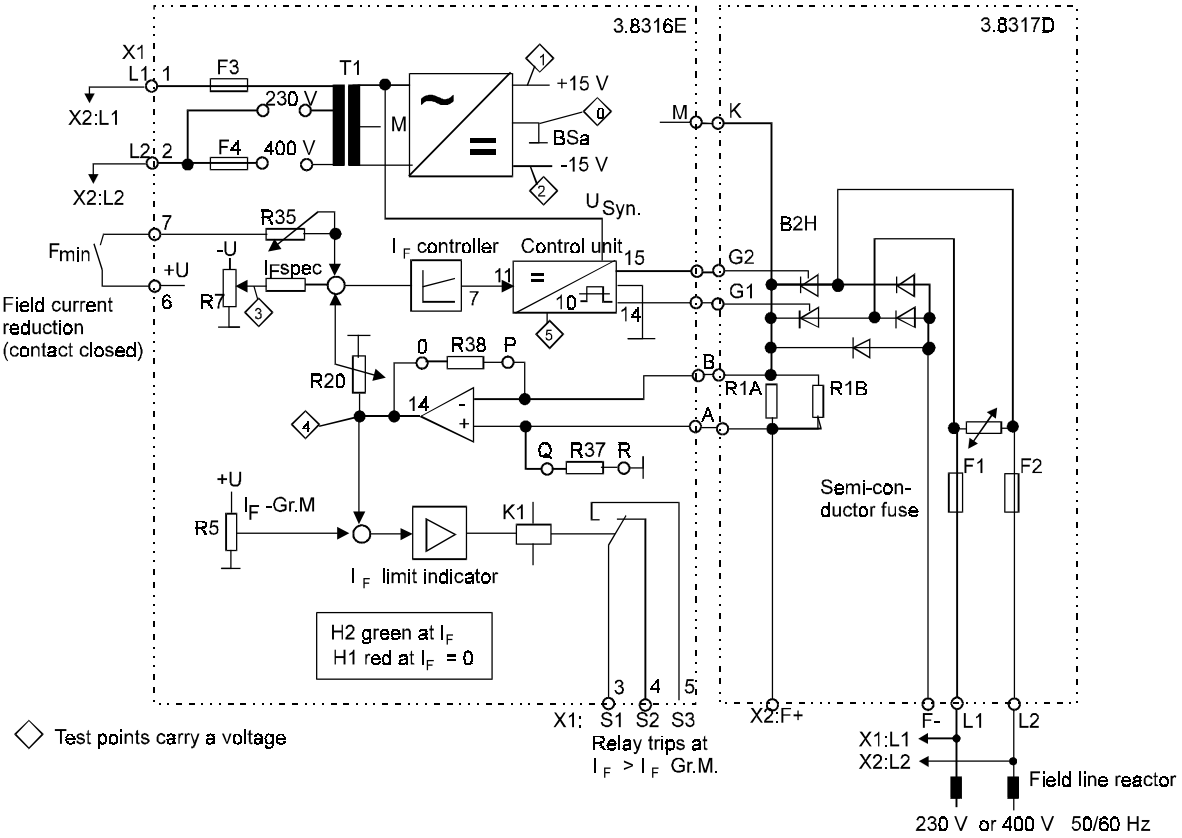
$$U_{di\alpha} = \frac{3 \cdot \sqrt{2}}{\pi} \cdot U_{mains} \cdot \frac{1 + \cos\alpha}{2}$$

α = 5 ... 175°

Construction drawing of printed circuit board



Function diagram



Potentiometer setting:

R7: I_{max} (max. field current)

R35: I_{min} (min. field current) e.g. for zero speed field with contact X1:6-7 closed

R5: I_F monitoring

2.5.3 Field Weakening Control Unit BZF4: Board 3.8106

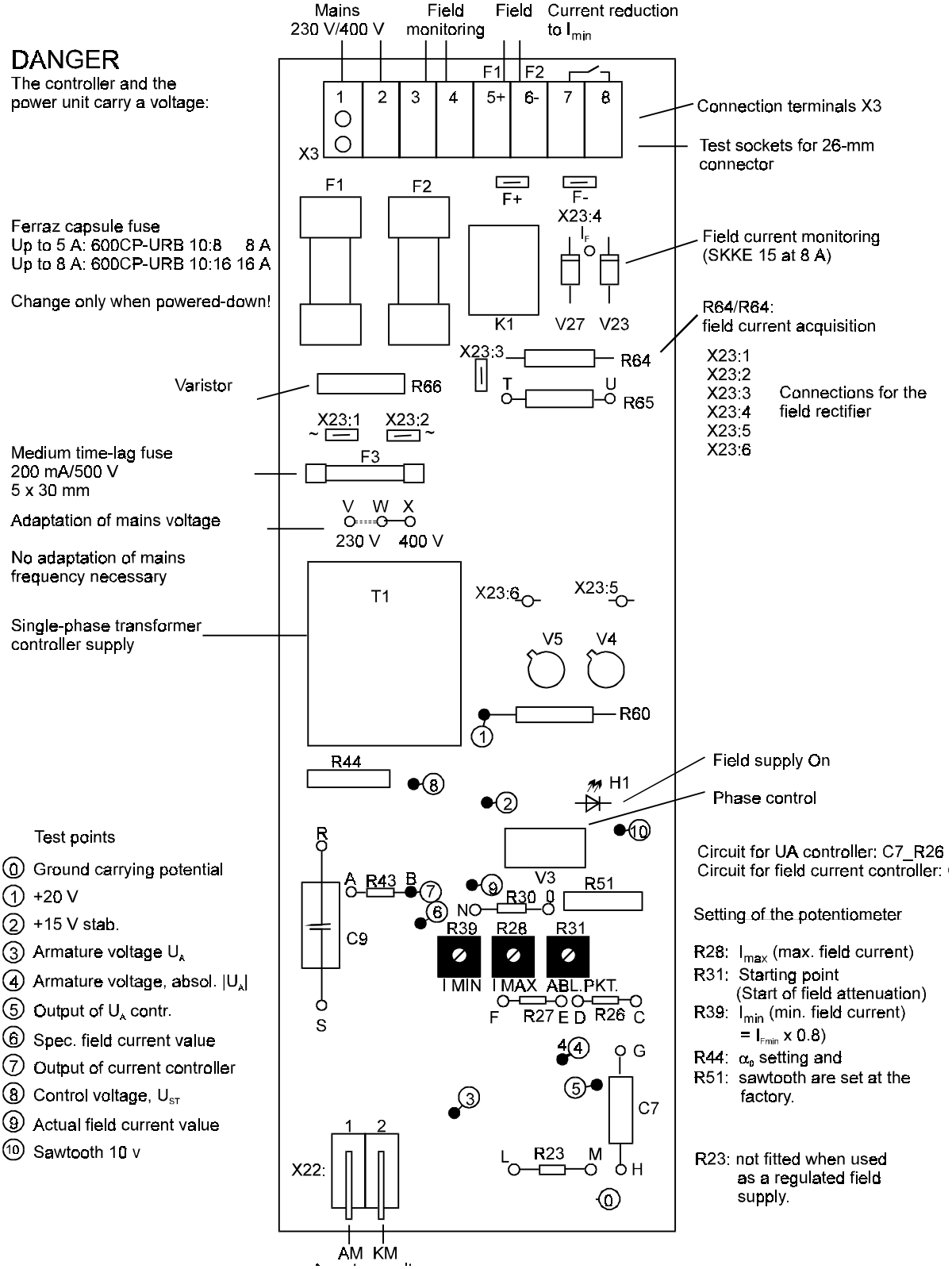
	BKD6 / ... / 260 - 2000	BKD6 / ... / 460 - 2000	BKD6 / ... / 600 - 2000
Connection voltages	230 V/400 V to be set on unit via soldering jumper		
Permissible voltage tolerance	+10%/-15%		
Nominal direct voltages [1)] (field voltages)	180 V_{DC} with U_{Netz} = 230 V_{AC} 310 V_{DC} with U_{Netz} = 400 V_{AC}		
Rated DC currents I_{Fmax}	5 A can be set with R28 8 A		
Reduction of field current to I_{Fmin}	Contact X3:7-8 closed Minimum field current can be set with R39		
Field failure protection	Relay Contact load max. 230 V/1 A Switching threshold: 0.2 A firm		
EMF cross-over point	340 V_{DC} ... 440 V_{DC} Can be set with R31		
Fuse protection Control Power	The fuses are integrated in the unit F3: 0.2 A/500 V m F1, F2: Semiconductor fuses 8 A or 16 A/600 V URB		
Components fitted	Can be fitted optionally: If required, install outside the power converter		
Accessories	For line commutation reactor(s) refer to line reactors		

1. Output voltage of field controller as a function of the delay angle α:

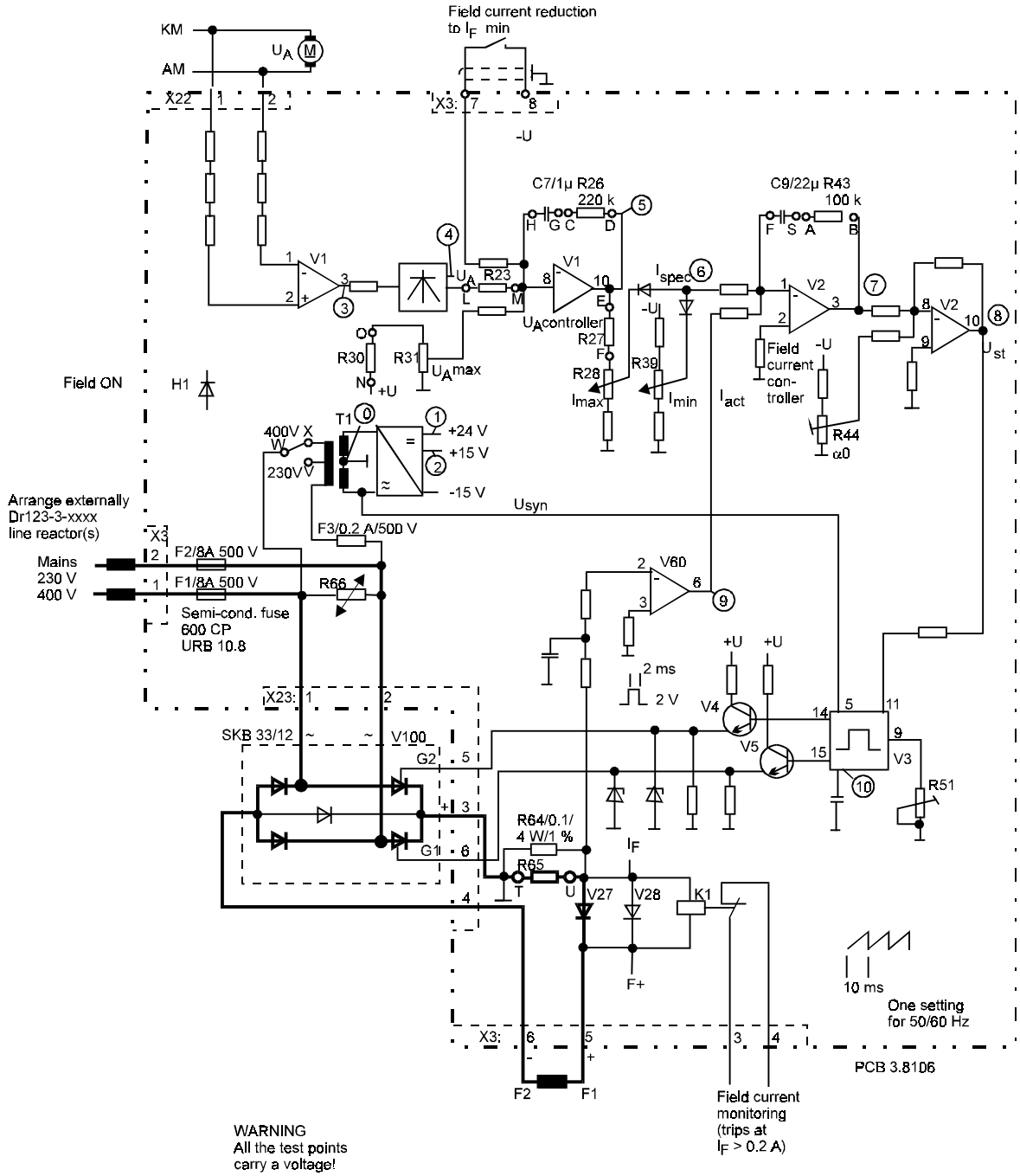
$$U_{di\alpha} = \frac{3 \cdot \sqrt{2}}{\pi} \cdot U_{Netz} \cdot \frac{1 + \cos\alpha}{2}$$

α = 5 ... 175 °

Construction drawing of printed circuit board

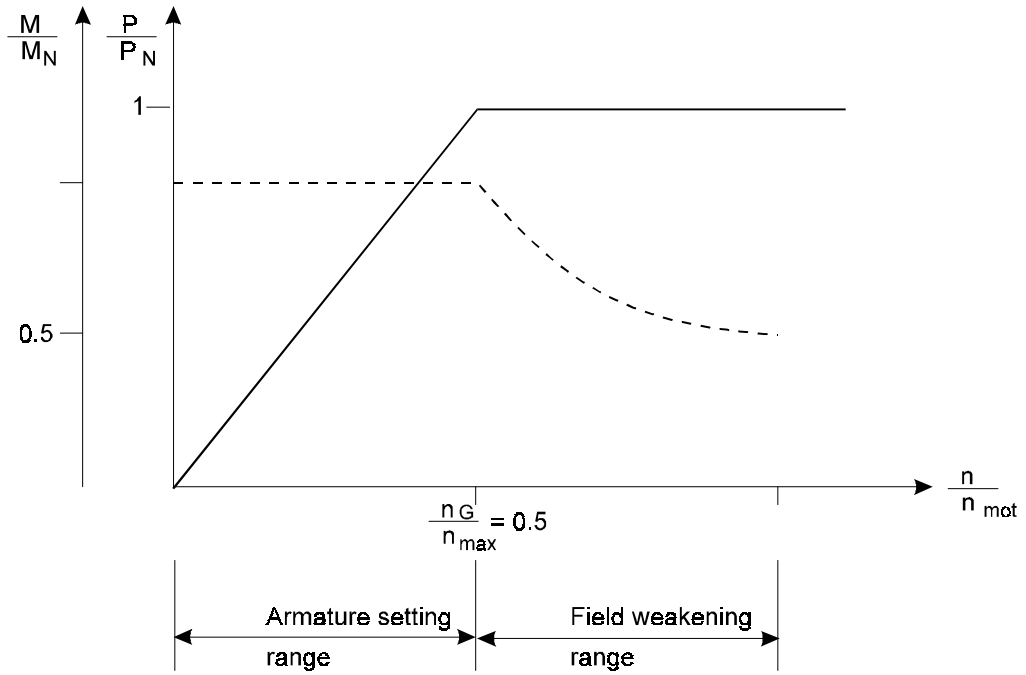


Function diagram



Field weakening control unit BZF4 is mainly used in drives which require high torque in the lower speed range and can be operated with reduced torque at high speeds.

This makes it possible to achieve cost-effective adaptation of the drives to specific machines.



In the lower speed range, the armature adjusting range, the drive can be operated starting from n = 0 RPM with the maximum torque up to base speed n_G. In this range, the available motor power increases proportional to the speed.

With base speed n_G the nominal values of the drive are attained (P_{nom} and U_{Anom} with M_{nom} and I_{Enom}). To this operating point, the rated-load field current I_{Enom} acts on the motor. It is set with R 28 ($I_{max.}$).

Above the base speed, the field weakening range follows in which the maximum drive power cannot be increased any more, as there are no more voltage reserves. Therefore, the field weakening range is often described as the constant-power operating range.

To be able to operate the drive at speeds exceeding the base speed, the field current must be reduced.

The consequence is that with increasing speed the attainable torque decreases.

(P = const. = M x ω). As can be seen from the diagram above, with a field weakening range of $\frac{n_G}{n_{max}} = 0,5$ at maximum speed, only half the nominal torque is available.

Intermediate values can be determined with the equation $n = \frac{M_{nom}}{M} \cdot n_G$.

The reduction in field current is triggered by the armature voltage controller which presets the specified field current for the field current controller. If, for example, due to a speed increase the armature voltage exceeds the preset nominal value, the armature voltage controller reduces the specified field current until the nominal armature voltage is reached again.

The nominal armature voltage is set using potentiometer R 31 ($U_{A\,max}$).

2.6 Power Unit

	BKD6 / ... / 260 - 2000	BKD6 / ... / 460 - 2000	BKD6 / ... / 600 - 2000
Connection voltages	3 x 230 V_{AC}	3 x 460 V_{AC}	3 x 500 V_{AC}
Thyristors Sizes I, II: Module thyristor Size III: Disk-type thyristor	SKKT ../12 SKT ../12		SKKT ../16 SKT ../16
Permissible mains voltage tolerance [1)]	±10%		
Mains frequency	50 Hz or 60 Hz ±2%		
Fans 60 A - 150 A 200 A - 300 A 380 A and 480 A 600 A - 1000 A	230 V_{AC}/0.20 A at 50 Hz 230 V_{AC}/0.50 A at 50 Hz 230 V_{AC}/0.85 A at 50 Hz 3 x 400 V_{AC}/0.22 A at 50 Hz 3 x 400 V_{AC}/0.27 A at 60 Hz		
Current converters Size I Size II Size III	50 A/70 mA order no. 19007313 120 A/70 mA order no. 19007314 250 A/70 mA order no. 19007304 400 A/70 mA order no. 19007300 720 A/70 mA order no. 19007338		

1. See 5.6, Adaptation of the Units to Different Connection Voltages.

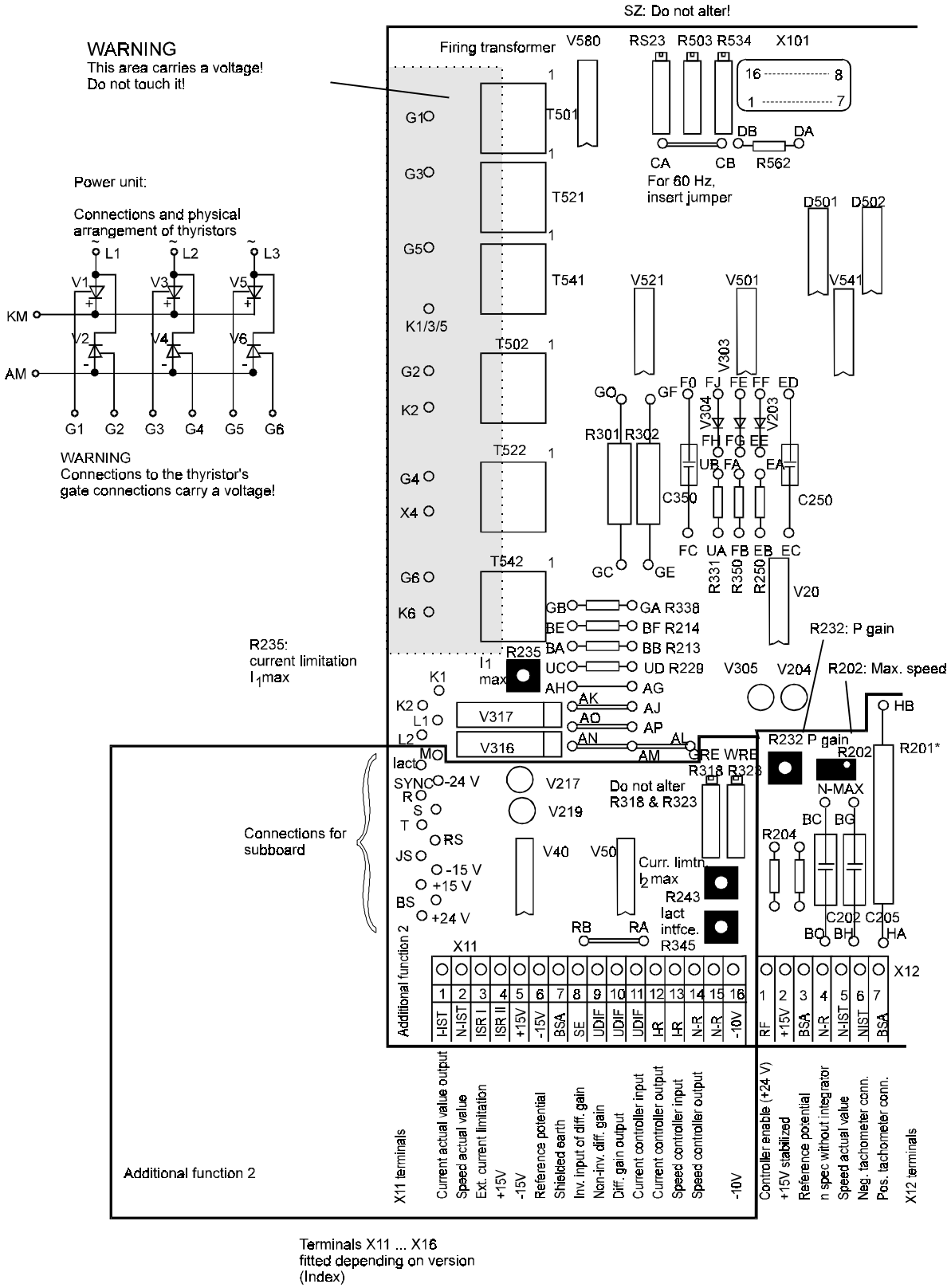
2.7 Closed-Loop and Open-Loop Control: Board 3.8201

For closed-loop and open-loop control, there are a total of four versions all located on one board:

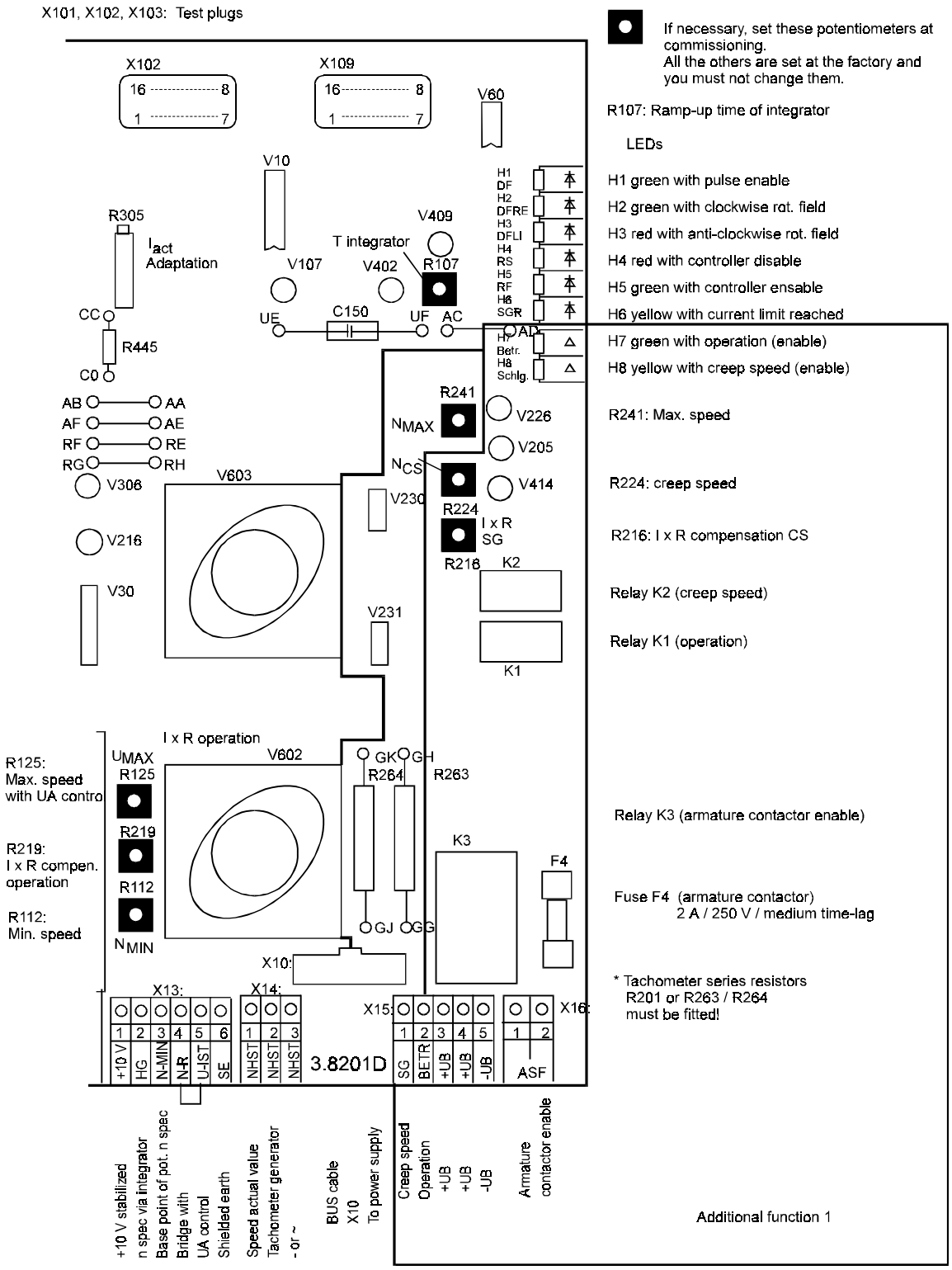
- Standard closed-loop and open-loop control
- Standard version with additional function 1 upgrade
- Standard version with additional function 2 upgrade
- Standard version with additional functions 1 and 2 upgrade

Construction drawing of printed circuit board 3.8201 for all function variants

Left-hand side of board



Right-hand side of board



2.7.1 Standard Version of Closed-Loop and Open-Loop Control

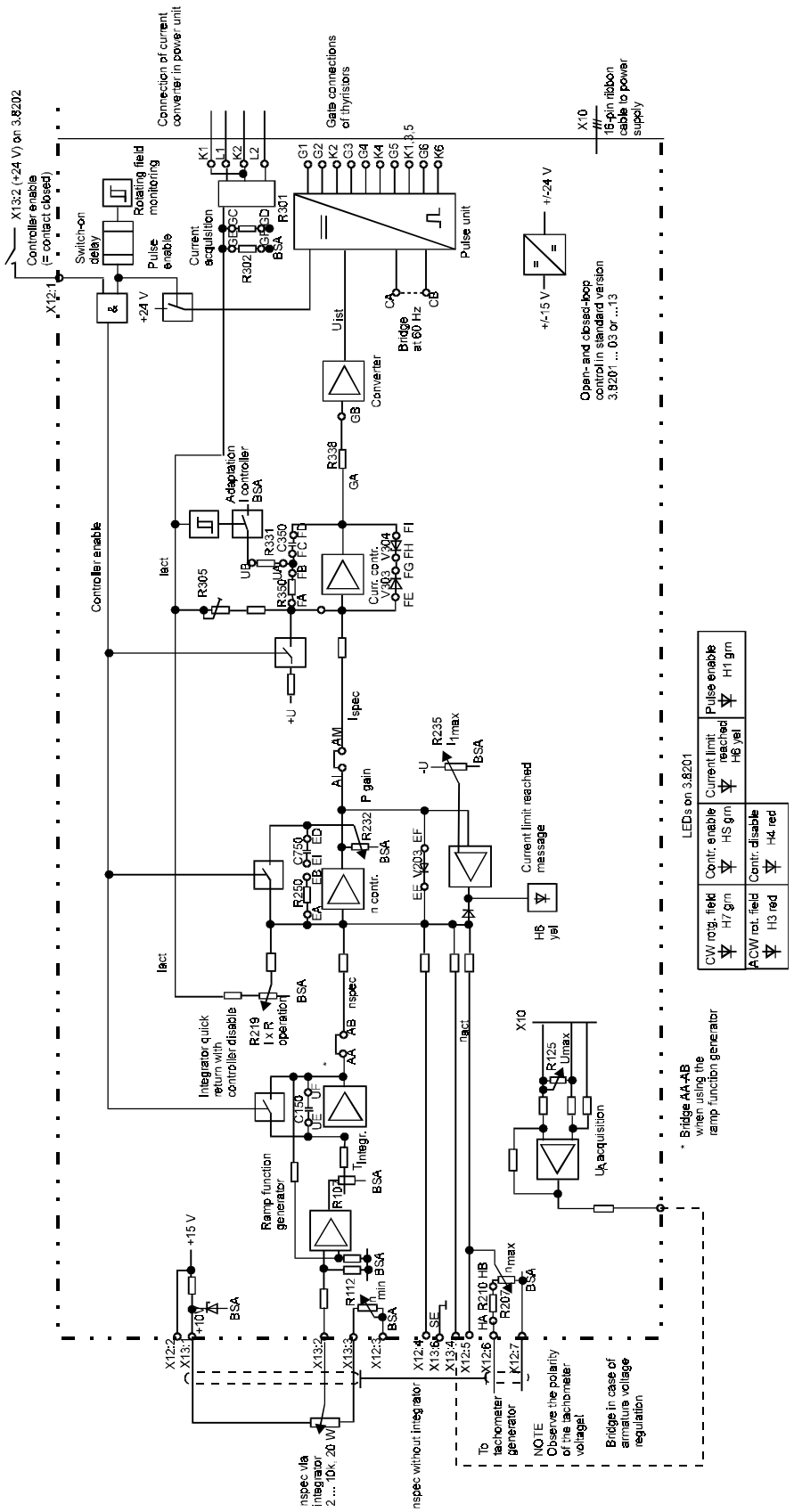
Boards 3.8201.03 and 3.8201.13

Speed controller with lower-level current controller as well as open-loop control unit on one board.

Main characteristics:

- Switch-on logic
- Rotating field monitoring
- 50/60 Hz adaptation
- Start-up integrator
- Potentiometers for:
  – Ramp-up time, min. and max. speeds
  – P gain
  – Current limitation
- LEDs for:
  – Pulse enabling
  – Anti-clockwise/clockwise rotating fields
  – Current limit reached
- Test plug
- U_A recording virtually potential-free

Function description



In the closed-loop and open-loop control units, the desired nominal speed value is converted to trigger pulses with variable trigger angles, taking into account the maximum speed and maximum current values. A speed specified value of 0 V yields an output voltage of 0 V by shifting the trigger pulses to the right within one sinusoidal half wave; the maximum specified value of +10 V yields (pulses to the left) an output voltage of 470 V (600 V) and thus maximum speed.

The nominal speed value is preset with an external nominal value potentiometer and acts either via a start-up integrator (terminal X13:2) or directly on the speed controller (terminal X12:4). It reduces step-changes in the specified value setting. The integration time can be set with potentiometer R107: $T_{Int.}$ in a range from 1.3 to 25 seconds (C150 = 3.3 µF). The minimum speed of the drive is adjusted on potentiometer R112: n_{min}.

Setting range:

$n_{min} \leq 0.16\ n_{max}$
for R112 = 1 kΩ
and R n_{spec} = 5 kΩ

With **tachometer closed-loop control,** the voltage of a tachometer generator that is attached torsionally rigid to the motor shaft is fed to the speed controller as the actual speed value n_{act}; with armature voltage control, the system feeds the terminal voltage of the motor (U_A) recorded in a high-resistance range via a differential amplifier.

Tachometer control is used when a large speed setting range as well as high accuracy are required. It is important that the tachometer generator voltage exceeding the voltage level of the specified speed value by a multiple (e.g.: $U_{TG}=n_{max}$ x 20 V/1000 1/min.) is accurately adjusted via actual value series resistor R201 and potentiometer R202 (n_{max}):

Max. tacho generator voltage U_{TG}	30-50 V	50-80 V	80-120 V	120-200 V
R 20/2 W/TK 25	10 kΩ	22 kΩ	39 kΩ	68 kΩ

With less stringent requirements, an alternating current tachometer generator fulfils the same function as the direct current tachometer described above; here the actual value is routed via a rectifier.

Armature voltage control:

With constant flow, the motor speed is directly proportional to the difference between the armature voltage and the armature voltage drop. Compensation for the voltage drop is via R119. The control range and the control accuracy are reduced by a factor of five.

The maximum speed is set with potentiometer R125 (U_{Amax}).

In stationary condition, the specified speed value (MP X103/12) and the actual speed value (MP X103/13) have the same values but opposite polarities.

Speed controller

The PI type speed controller compares the specified speed value with the actual speed adapted to the closed-loop control. The difference between the two signals is amplified by the controller and fed to the current controller as the specified current value (0...-10) (MP X102:11).
The sensitivity of the speed controller is set with potentiometer R 232 (proportional gain).

Current controller

The speed controller sets the specified current value for the lower-level current control loop. Using potentiometer R235: I_{max}, you can set the output voltage of the speed controller, i.e. the specified current via active limitation in the range 0...-10 V. The rated DC current is attained at the right-hand stop of R235. The response of the current limiting device is shown by LED H6: SGR.

The **actual current value** is acquired by two power converters on the alternating current side and rectified. Burdens R301, R302 and trimming potentiometer R305 and right-hand stop of R235 set the actual current value to the rated DC current (MP X101/8). The setting of R 305 must not be changed any more!

The current controller is an adaptive type PI controller: In the event of pulsating current, the amplification of the current controller is increased:

R331 = 4.7 kΩ (standard component fitting)
MP101/7: I controller adaptation signal

The converter adapts the current controller output voltage $U_{controller}$ (MP: X101/1) to the signal level required in the pulse unit. The converter output signal (X101/3) is designated as control voltage U_{st}, which sets the pulse position and thus the power converter output voltage:

U_{st} = 5 V- 0,5 * $U_{controller}$ valid for R 338 = 27.4 kΩ

For sizes I and II, **optimization,** i.e. adaptation of the PI action of both controllers, is not normally required with the following standard component configuration:

R250 = 560 kΩ

C250 = 1 µF

R350 = 18 kΩ

C350 = 0.68 µF

Open-loop control unit

The diagram below shows functioning of voltage modification by shifting the trigger pulses. It represents motor operation with non-pulsating current for an inverter angle of a = 30° el.

Starting from the diametric mains voltages, the three synchronous voltages are formed with transformer T1 with star-delta connection. The synchronous voltages are then offset by 60° el relative to the mains voltages.

Synchronous voltages:

L1:X101/4
L2:X101/6
L3:X101/5

Depending on the voltage zero passages of the three synchronous voltages, the three control circuits (V501, V521, V541) generate three sawtooth voltages.

Sawtooth voltages:

L1:X101/2
L2:X101/9
L3:X102/8

The control circuits compare these sawtooth voltages with the control voltage U_{st} (X101/3).

If the voltages are identical, one pulse each is generated for activating a thyristor.

With decreasing control voltage U_{st} = +10 V...±0 V, the activating pulses are electrically displaced relative to the mains voltage by between 180° and 0° el. The zero degree position corresponds to the maximum speed.

With three-phase bridge circuits, it is necessary to provide a second trigger pulse to each of the six thyristors (pulsating current operation).

The required electrical isolation between the power unit and the control unit is ensured by the firing transformers which are supplied with chopped firing pulses by a transistor array on the primary side. The firing pulses can be measured on the primary side (refer to the diagram). Correct assignment to synchronous voltage must be ensured.

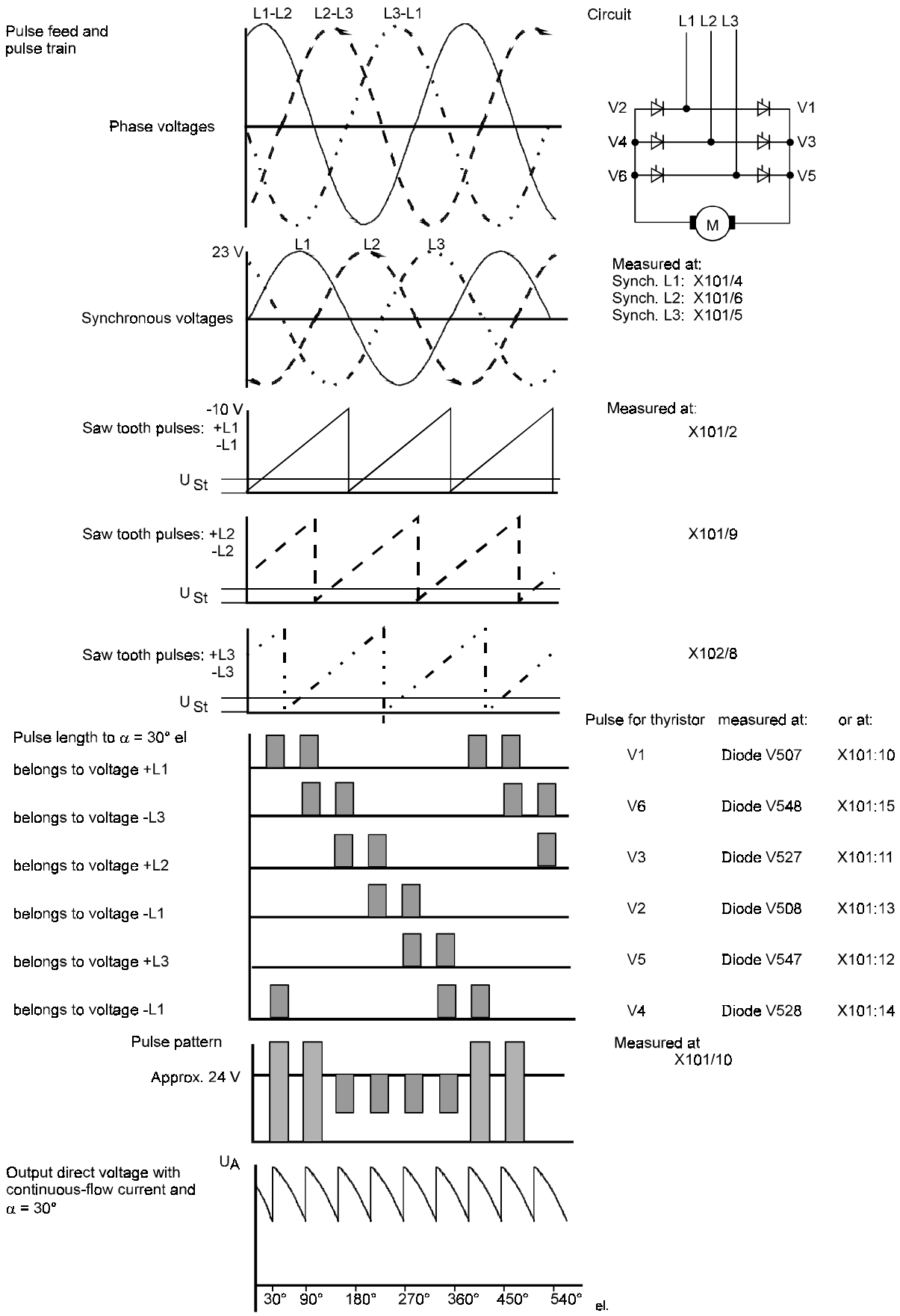
WARNING

Via connections G1 to G6 and K1 to K6, the secondary side of the firing transformers is connected to the thyristor gate connections and thus directly to the mains.

The trigger pulses shown in the pulse representation consist of 10 kHz needle pulses. The burst is 0.5 ms wide. The important pulses are the ones that exceed the +24 V curve.

Adaptation to mains frequency

The sawtooth voltage rises from 0 V to 10 V within 10 ms (at 50 Hz). This voltage must be kept to with a tolerance of 0.2%. Therefore, at 50 Hz (t=8.3 ms), adaptation to the slope of the sawtooth is necessary. Soldering jumper CA-CB, which is soldered??? at 60 Hz, acts on all three phase-angle controls (TCA 785).


Pulse feed and pulse train
L1-L2
L2-L3
L3-L1
Phase voltages
Circuit
L1 L2 L3
V2
V1
V4
V3
V6
V5
M
23 V
L1
L2
L3
Synchronous voltages
Measured at:
Synch. L1: X101/4
Synch. L2: X101/6
Synch. L3: X101/5
-10 V
Saw tooth pulses: +L1
-L1
U St
Measured at:
X101/2
Saw tooth pulses: +L2
-L2
U St
X101/9
Saw tooth pulses: +L3
-L3
U St
X102/8
Pulse length to α = 30° el
belongs to voltage +L1
belongs to voltage -L3
belongs to voltage +L2
belongs to voltage -L1
belongs to voltage +L3
belongs to voltage -L1
Pulse for thyristor
measured at:
or at:
V1
Diode V507
X101:10
V6
Diode V548
X101:15
V3
Diode V527
X101:11
V2
Diode V508
X101:13
V5
Diode V547
X101:12
V4
Diode V528
X101:14
Pulse pattern
Approx. 24 V
Measured at
X101/10
Output direct voltage with continuous-flow current and α = 30°
UA
30°
90°
180°
270°
360°
450°
540°
el.

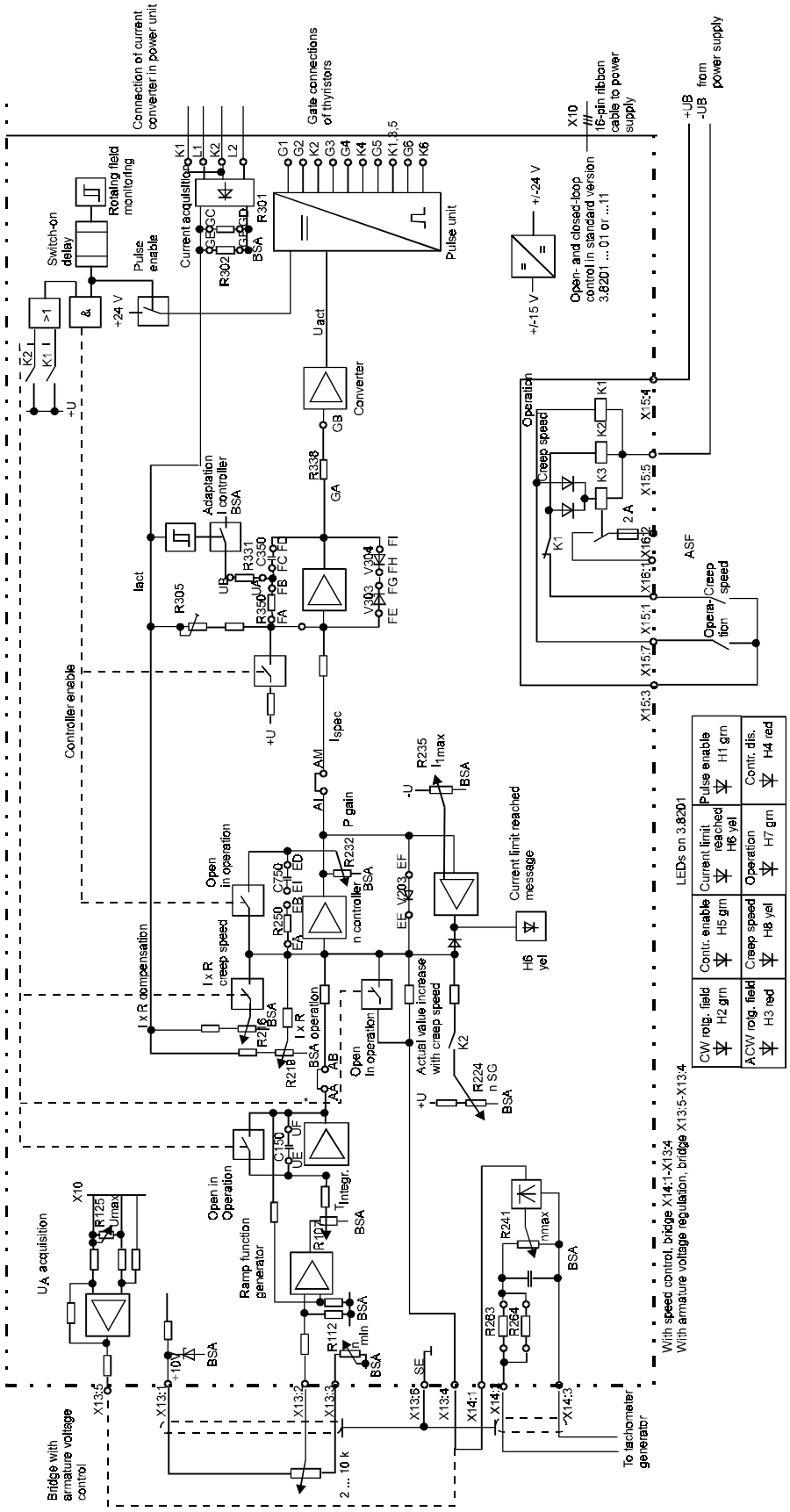
2.7.2 Standard Version with Additional Function 1 Upgrade

Boards 3.8201.01 and 3.8201.11

Main features:

- Machine control unit with operation and creep mode
- Armature contactor enable
- Potentiometers for
  I x R compensation
  Creep feed speed
  Max. speed
- Connection of direct and alternating voltage transformers

Function description



Two operating modes are possible:

- Creep feed
- Operation

The operating mode is set by external control contacts activating either relay K1 or K2.

Selecting the operating mode switches over the speed control loop such that it meets the respective requirements.

In “operation”, the specified speed value is set by an external specified value potentiometer and the start-up integrator so that in this mode the controllers as well as the start-up integrator are enabled.

A minimum speed, which can be set internally by means of a potentiometer, enables exact speed default for the inching mode of the equipment.

In “creep mode”, the specified speed value set internally with potentiometer R 224: N_{SG} is fed directly to the speed controller. To ensure undelayed start-up of the drive even at very low creep speeds, the gain of the speed controller is increased by means of V226 (switch-over of actual speed).

In addition, the start-up integrator is inhibited and I x R compensation set as the default for creep mode.

I x R compensation is required in armature voltage-controlled operation and can be set by means of potentiometer R216: I x R SG.

The two operating modes are indicated by LEDs H7: BETR (“operation“) and H8: (“creep mode“). Controller enabling depends on the selected operating mode. With the controller enabled, H5: RF lights up, with the controller inhibited H4: RS.

In a similar way to the basic version, tachometer control and armature voltage control are possible, but in this case the speed recording unit is fitted with a rectifier that allows connection of direct or alternating current tachometer generators.

The tachometer generator voltage is adapted to the maximum specified speed value by means of R263/ R264 and potentiometer R 241 (maximum speed).

Depending on the tachometer voltage $U_{TG} = \frac{U_{max}}{1000} \cdot \frac{20V}{1000RPM}$ the following series resistors are needed

Tachometer voltage	from ...14 V	21 V	26 V	32 V	39 V	44 V	50 V	57 V	65 V	76 V
UTG (V)	to ...21 V	26 V	32 V	39 V	44 V	50 V	57 V	65 V	76 V	89 V
R 263	1.5 k	3.9 k	6.8 k	10 k	12 k	15 k	18 k	22 k	27 k	33 k
R 264	1,5 k	3.9 k	6.8 k	10 k	12 k	15 k	18 k	22 k	27 k	33 k

Tachometer voltage	from	89 V	103 V	115 V	125 V	135 V	150 V	165 V	180 V	195 V
UTG (V)	to	103 V	115 V	125 V	135 V	150 V	165 V	180 V	195 V	210 V
R 263		39 k	47 k	47 k	56 k	56 k	68 k	68 k	82 k	82 k
R 264		39 k	47 k	56 k	56 k	68 k	68 k	82 k	82 k	100 k

Resistors 2 W/10%

A potential-free output contact is available at terminals X 16:1 and 2, which is opened with a delay of approximately 250 ms after specification of the controller inhibit (opening of the external operation or creep mode contact). This contact can be used for delayed enabling of armature contactor switch-over.

The description given for the version without additional functions fully applies to the function of the ramp function generator and the speed and current controller with converter. This version can be used at 50 Hz and 60 Hz without switching-over.

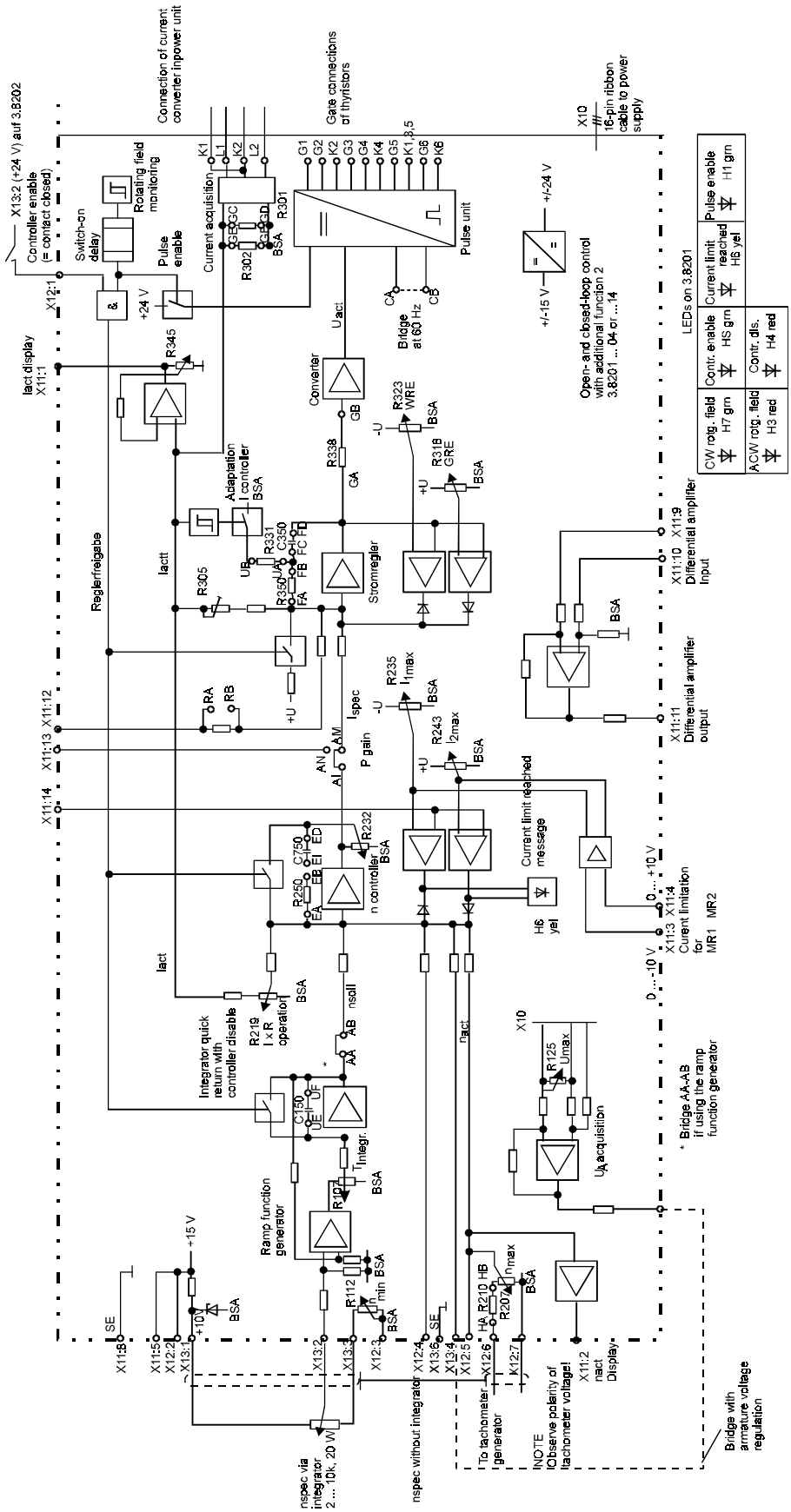
2.7.3 Standard Version with Additional Function 2 Upgrade

Boards 3.8201.04 and 3.8201.14

Main features:

- Outputs for speed and armature voltage displays
- Free differential amplifier
- External current limiting
- Armature circuit switch-over with additional logic (BZU)
- ±15 V stabilized
- Option of speed controller and current controller intervention
- Connections for subboard

Function description



- **Uncoupled output of speed and current nominal values**

  For external signal processing such as the display of actual values or monitoring circuits, the speed and current actual values are routed uncoupled to terminal block X11 (a_{act} to X11:2 and I_{act} to X 11:1).

  The actual current value is routed to the outside by an impedance converter with adjustable gain (potentiometer R345) so that the output signal can be normalized to +10 V, for example.

  Speed output cannot be adjusted, since it is assumed that the nominal drive speed and the maximum specified voltage of +10 V were matched to each other. Thus, at maximum speed, -10 V are present at terminal X11:2.

- **Freely usable differential amplifier**

  The differential amplifier can be used for uncoupling and/or inverting signals. One possible application is potential-free specification of the specified speed. The amplifier inputs are routed to terminals X11:9 and X11:10 and the output is connected to X11:11.

- **Expansion option to four-quadrant operation**

  Apart from this, the additional function allows you to use the equipment for multi-quadrant operation with armature or field switch-over. The relevant interfaces for connecting the switch-over logic BZU, which must be fitted externally, are located on terminal block X11.

  These are terminals X11:15 (additional speed controller input), X11:14 (speed controller output). X11:13 and X11:12 (current controller inputs). Furthermore, soldering jumper AL-AM must be opened and jumpers AM-AN and RA-RB fitted.

  Limiting of the positive speed controller output voltage for direction of current I2 is active in a similar way to current limit I1 and can be set by means of a potentiometer (R 243).

- **Freely usable controller inputs and outputs**

  Due to the option of expanding to multi-quadrant operation, there are two controller inputs in the additional function that can be used for other purposes if the BZU is not active:

  X11/5: additional speed controller input

  X11/12: additional current controller input

  Furthermore, it is possible to split the signal path between the speed controller and the current controller so that an additional functional module, like dynamic current limiting, can be included in the control loop. The attachment for fixing a subboard like this with customer-specific additional functions is on the lid board.

  To uncouple the current controller specified value input from the speed controller, you only need to remove soldering jumper AL-AM. For the external additional functions, the speed controller output on terminal X11:14 is available. Two terminals are available for the specified current value: on the one hand X11:12 with an input evaluation of the current controller that can be programmed via soldered taps RA and RB or terminal X 11:13 on the other hand. For the latter option, however, soldering jumper AM-AN must be fitted.

- **Externally adjustable current limiting for both directions of current**

  In the factory, the power converters were preset such that the rated current is attained at maximum speed controller output voltage. Active speed controller limiting is fully opened, i.e. the sliders of potentiometers R235: I_{1max} for direction of current 1 and R 243: I_{2max} for direction of current 2 are all the way to the right (R243 in the case of multi-quadrant operation of the unit only!) and set the limits of the speed controller output to ±10V. In the case of single-quadrant operation, potentiometer R243: I_{2max} is all the way to the left for control reasons and the controller output thus operates in the range 0...-10 V.

Due to external current limiting, it is now possible to reduce the maximum speed controller output voltage – and with this the unit and motor current – regardless of the current limit set internally.

With internal current limiting open, applying a negative voltage of 0...-10 V to terminal X11:3 can limit the negative speed controller output voltage (direction of current I1) to this reference value.

The same applies in the case of multi-quadrant operation for direction of current I2: In this case, a positive voltage of 0...+10 V must be applied to terminal X11:4.

- **Rectifier and inverter limits**

  In additional function 2, the pulse limits are fixed by means of potentiometers in operation. Once they have been correctly set, you must not change them any more!

Rectifier end position	R318:α = 15° el	(1-quadrant operation)
	R318:α = 30° el	(4-quadrant operation)
Inverter end position	R323: α = 125° el	(1-quadrant operation)
	R323: α = 150° el	(4-quadrant operation)

- **Stabilized direct voltages for supply of external modules**

  Terminal block X 11 is provided with stabilized direct voltages of ±15 V and -10 V which can be used to supply externally fitted modules.

  Permissible maximum load of the supply voltages:

  -10 V (terminal X11:16) can be loaded with 5 mA
  +15 V (terminal X11:5) can be loaded with 80 mA
  -15 V (terminal X11:6) can be loaded with 80 mA

  ±24 V unstabilized and 48 V (relay supply) are available at terminals X 3 and X 4 on the power supply. Permissible load: 200 mA and 50 mA, respectively.

- **Soldered taps at left-hand edge of board**

  The row of soldered taps offers you additional options for intervention in the control electronics of the lid board. In conjunction with the signals routed to terminal block X 11, you can implement a wide range of user-specific additional functions, such as monitoring units or additional control functions.

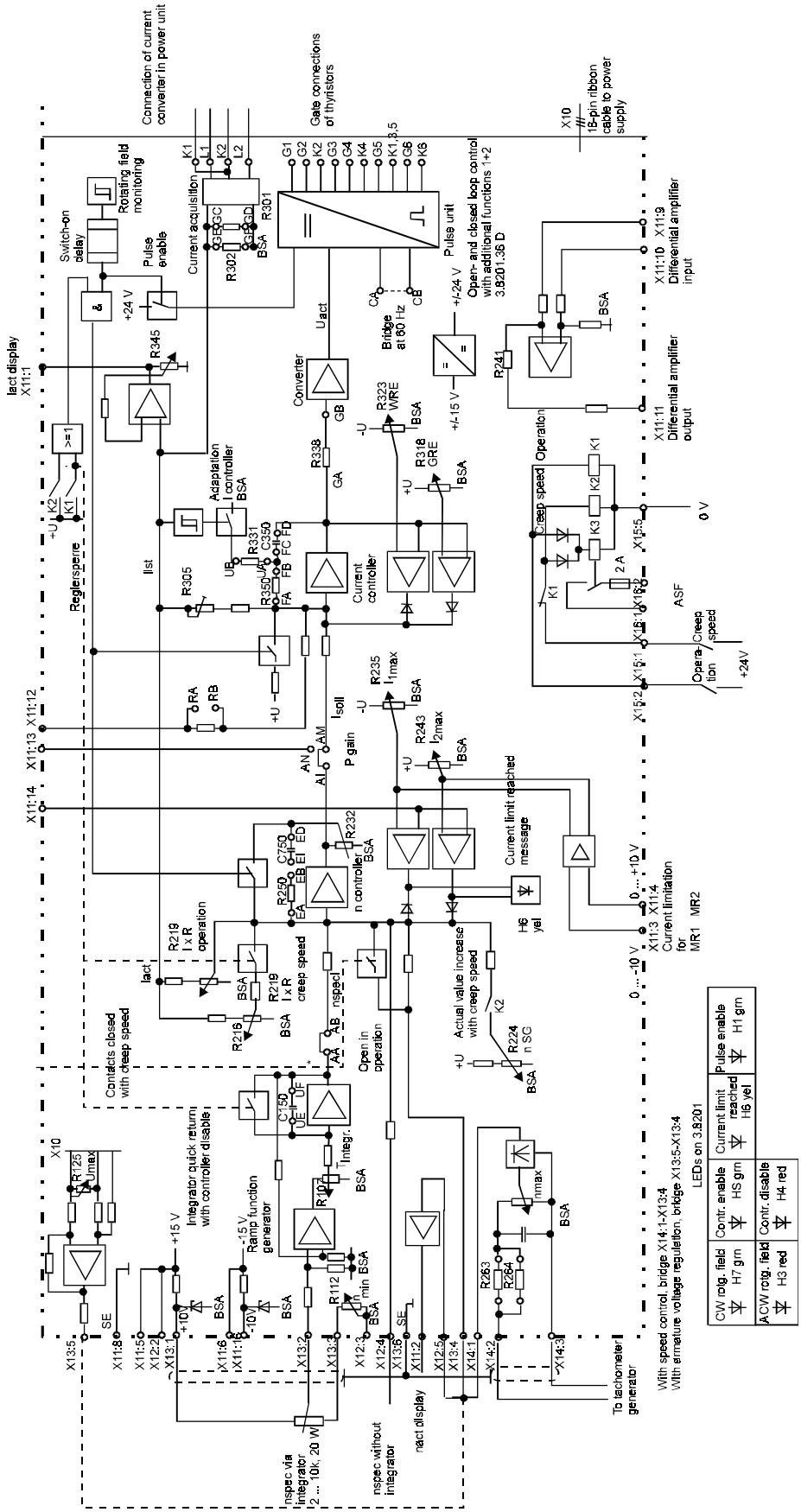
2.7.4 Standard Version with Additional Functions 1 and 2 Upgrade

Board 3.8201.36

Main features:

- Outputs for speed and armature voltage displays
- Free differential amplifier
- External current limiting
- Armature circuit switch-over with additional logic (BZUu)
- ±15 V stabilized
- Intervention options in speed controller and current controller
- Connections for subboard
- Machine control with operation and creep mode
- Armature contactor enable
- Potentiometers for
  – I x R compensation
  – Creep feed speed
  – Max. speed
- Connection of direct or alternating voltage transformers

Function description



This version is a combination of the standard version and additional functions 1 and 2.

Please note:

For **controller enable,** a direct voltage of 24 V must be applied either to X15:2 (operation) or to X15:1 (creep mode). It activates relays K1 and K3 or K2 and K3. Current consumption is approximately 90 mA.

In a similar way to the basic version, tachometer control and armature voltage control are possible, but here the speed recording unit is fitted with a rectifier that allows connection of direct or alternating current tachometer generators.

The tachometer generator voltage is adapted to the maximum specified speed value by means of R263/ R264 and potentiometer R 241 (maximum speed).

Depending on the tachometer voltage $U_{TG} = \frac{U_{max}}{1000} \cdot \frac{20V}{1000RPM}$ the following series resistors are needed:

Tachometer voltage	from ...14 V	21 V	26 V	32 V	39 V	44 V	50 V	57 V	65 V	76 V
UTG (V)	to ...21 V	26 V	32 V	39 V	44 V	50 V	57 V	65 V	76 V	89 V
R 263	1.5 k	3.9 k	6.8 k	10 k	12 k	15 k	18 k	22 k	27 k	33 k
R 264	1,5 k	3.9 k	6.8 k	10 k	12 k	15 k	18 k	22 k	27 k	33 k

Tachometer voltage	from	89 V	103 V	115 V	125 V	135 V	150 V	165 V	180 V	195 V
UTG (V)	to	103 V	115 V	125 V	135 V	150 V	165 V	180 V	195 V	210 V
R 263		39 k	47 k	47 k	56 k	56 k	68 k	68 k	82 k	82 k
R 264		39 k	47 k	56 k	56 k	68 k	68 k	82 k	82 k	100 k

2.8 Additional Modules

For monitoring the speed, armature current and tachometer generator, optional subboards are available which are permanently connected to the closed-loop and open-loop control units. The connections required for power supply are only possible in conjunction with versions 3.8201.04, ...14 or ...36 of the closed-loop and open-loop control units

Function	Subboard 3.8311	Subboard 3.8418.01	Subboard 3.8418.02	Subboard 3.8336.01
Start-up overload	×	×	×	
Tachometer break monitoring	×	×	×	
Blocking monitoring	×			
Armature current monitoring $I > I_{X1}$		×	×	
Armature current monitoring $I > I_{X2}$		×		
Speed $n \neq 0$		×	×	
Speed $n = 0$			×	×
Creep speed n_{CS}				×
Operating speed $n_{oper.}$				×

In general, monitoring is not linked to controller enable, i.e. it must be processed externally in the control unit.

Power is supplied from the closed-loop and open-loop control units via wire bridges.

Function description

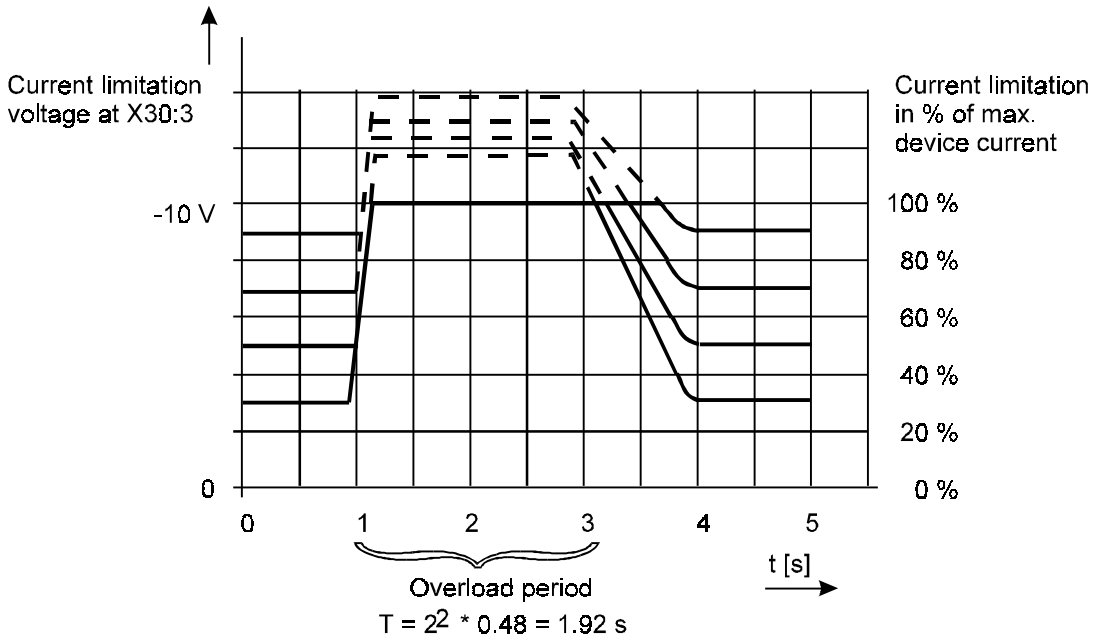
- **Start-up overload**

  Start-up overload triggers closing of a contact between X20:1 and 2 and thus an increase in the armature current limit for a limited period of time.

  The motor manufacturer presets the overload as well as the time . This allows start-up under conditions of overload. At the end of the preset time, the armature current drops within one second to the value permissible for permanent operation which is set by means of potentiometer R 37.

  Whereas the motor can be subjected to short-term overload, this is normally not possible for the power converter. This unit must therefore be designed for higher current values. the overload current corresponds to the unit's rated DC current determined by the burden resistance.

  The time is set by means of S 10.



Overload curve

Potentiometer R 37 presets the current limit before and after the overload situation. The curves for limiting to 90, 70, 50 and 30% are shown (100% correspond to the unit's maximum rated DC current). In the example shown, switch 3 on S 10 was switched. This yields $T = \Sigma T_N = 2^2 * R * C = 4 * 0.48\ s = 1.92\ s$.

Tachometer break monitoring

The normalized armature voltage is used for a comparison to monitor the tachometer generator function. If no actual speed value is indicated in this comparison, tachometer break is signalled.

Blocking monitoring

ANDing signals n = 0 and $I_A = I_{max}$ results in the signal "drive blocked" with a certain delay (R66).

Armature current monitoring $I > I_x$

Threshold I_X can be modified in the range of 55% to 100% of the unit's maximum rated DC current by means of potentiometer R71 or R79. While the start-up overload is activated, message display is suppressed.

Speed n ≠ 0 (3.8418)

The relay picks up as soon as the tachometer generator voltage U_{TG} exceeds a threshold that is preset using R48.

Setting range: -0.5 V...-6.5 V.

Speed n ≠ 0 (3.8336)

Relay K2 picks up as soon as the voltage of the actual speed n_{act} exceeds a threshold preset by means of R7.

Setting range: n_{act} = 0.1 V...0.4 V (neg.)

Creep feed speed n_{SG}

Relay K1 picks up as soon as the actual speed n_{act} exceeds a threshold preset by means of R19.

Setting range: n_{act} = 0.75 V ... 3.75 V (neg.)

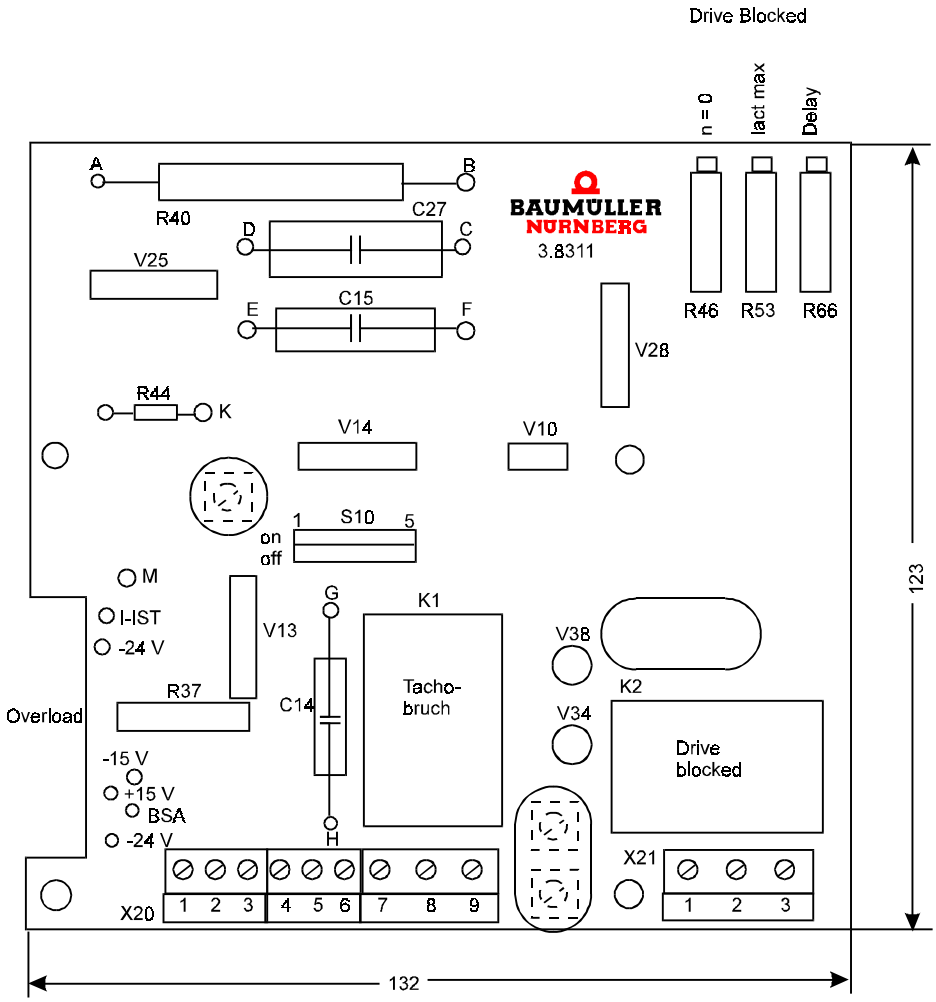
Operating speed n_{Betr}

Relay K3 picks up as soon as the actual speed n_{act} exceeds a threshold preset by means of R 10.

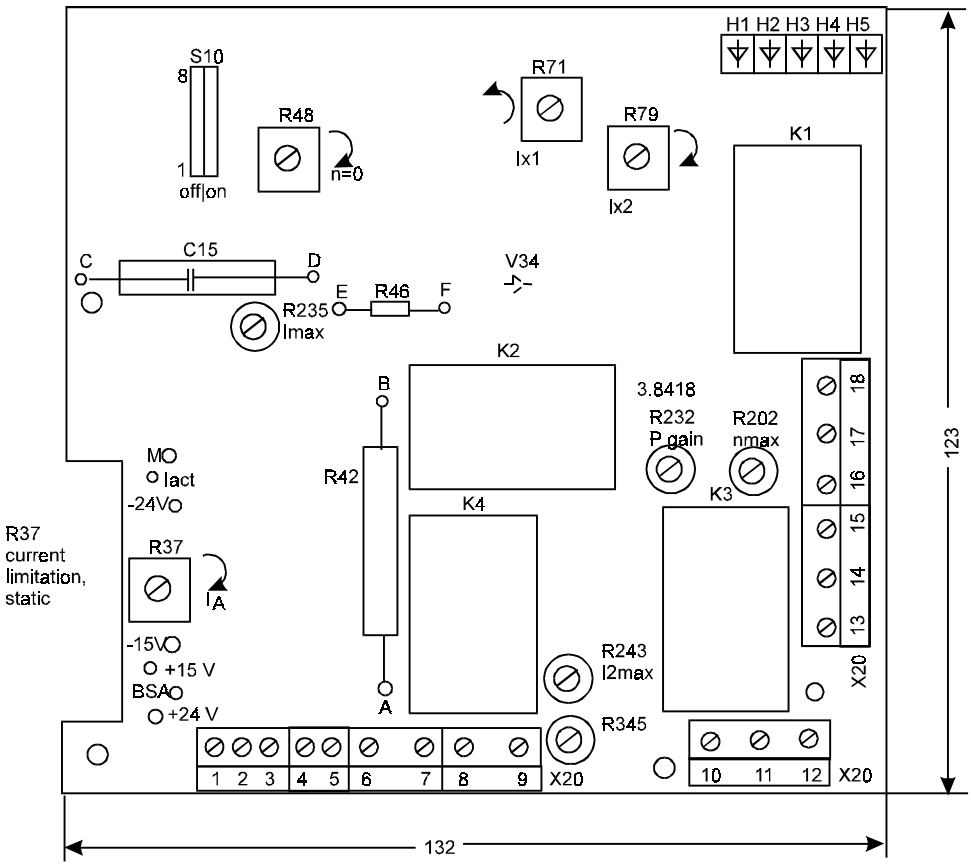
Setting range: n_{act} = 3.5 V ... 6.5 V (neg.)

Construction drawings

Monitoring module 3.8311..



Monitoring module 3.8418..



H1: $I_A \geq I_{X1}$

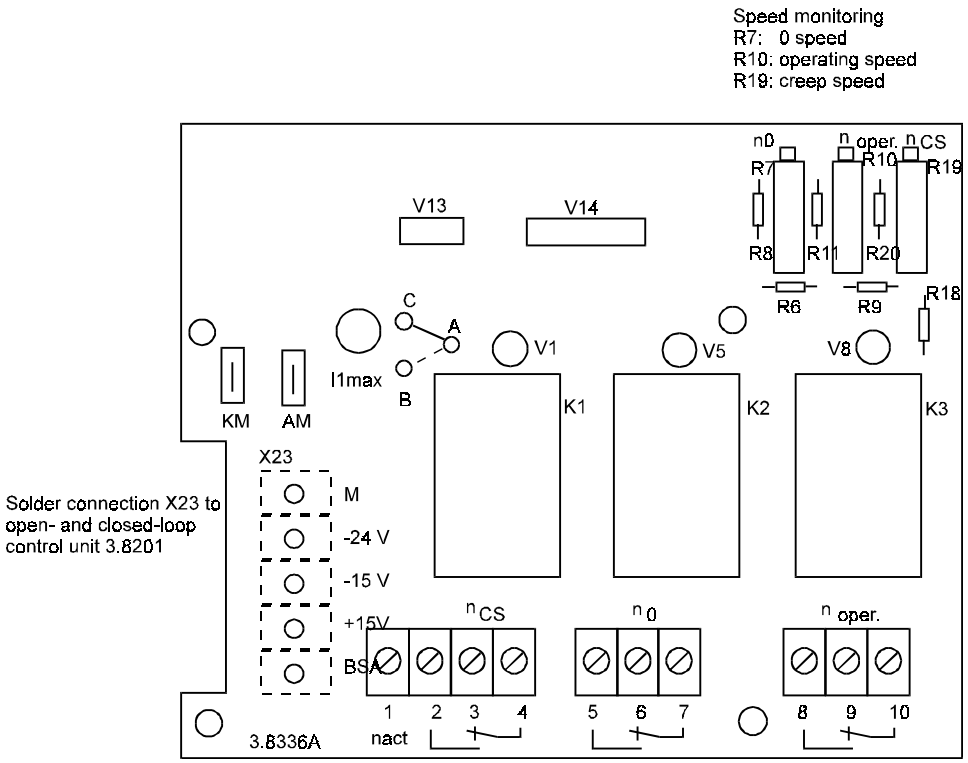
H2: $I_A \geq I_{X1}$

H3: Tachometer OK

H4: Speed $n \neq 0$

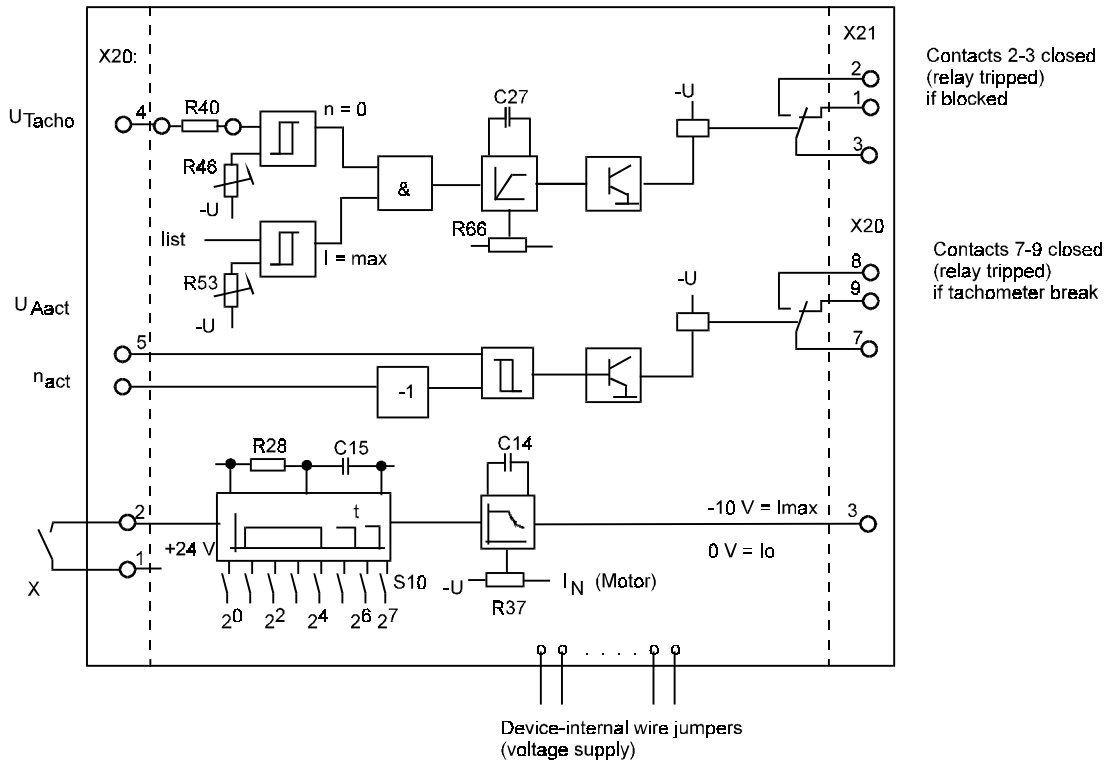
H5: Overload time

Module 3.8336

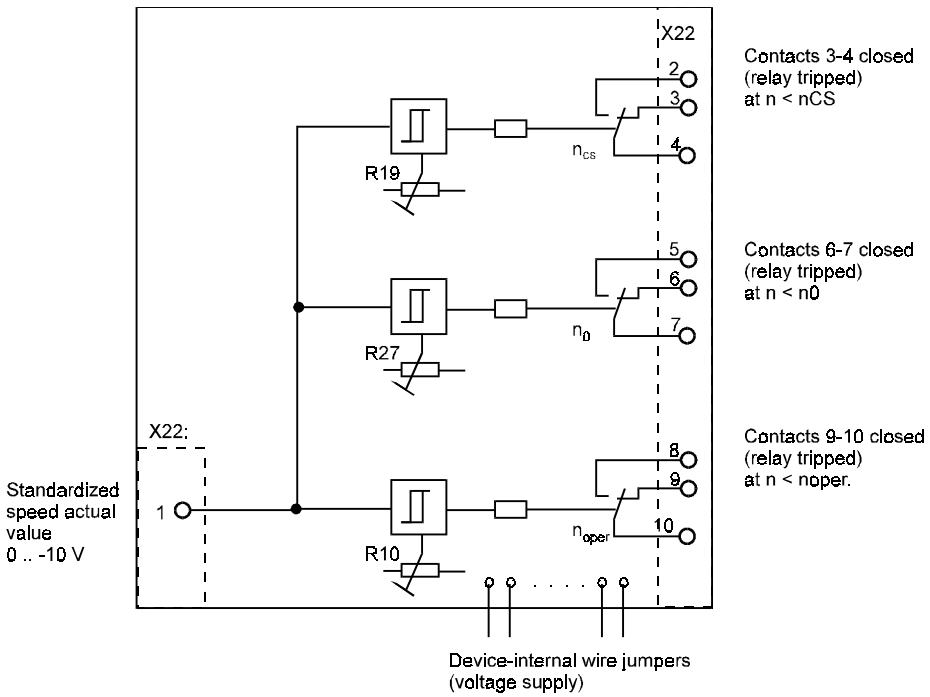


Schematic circuit diagrams

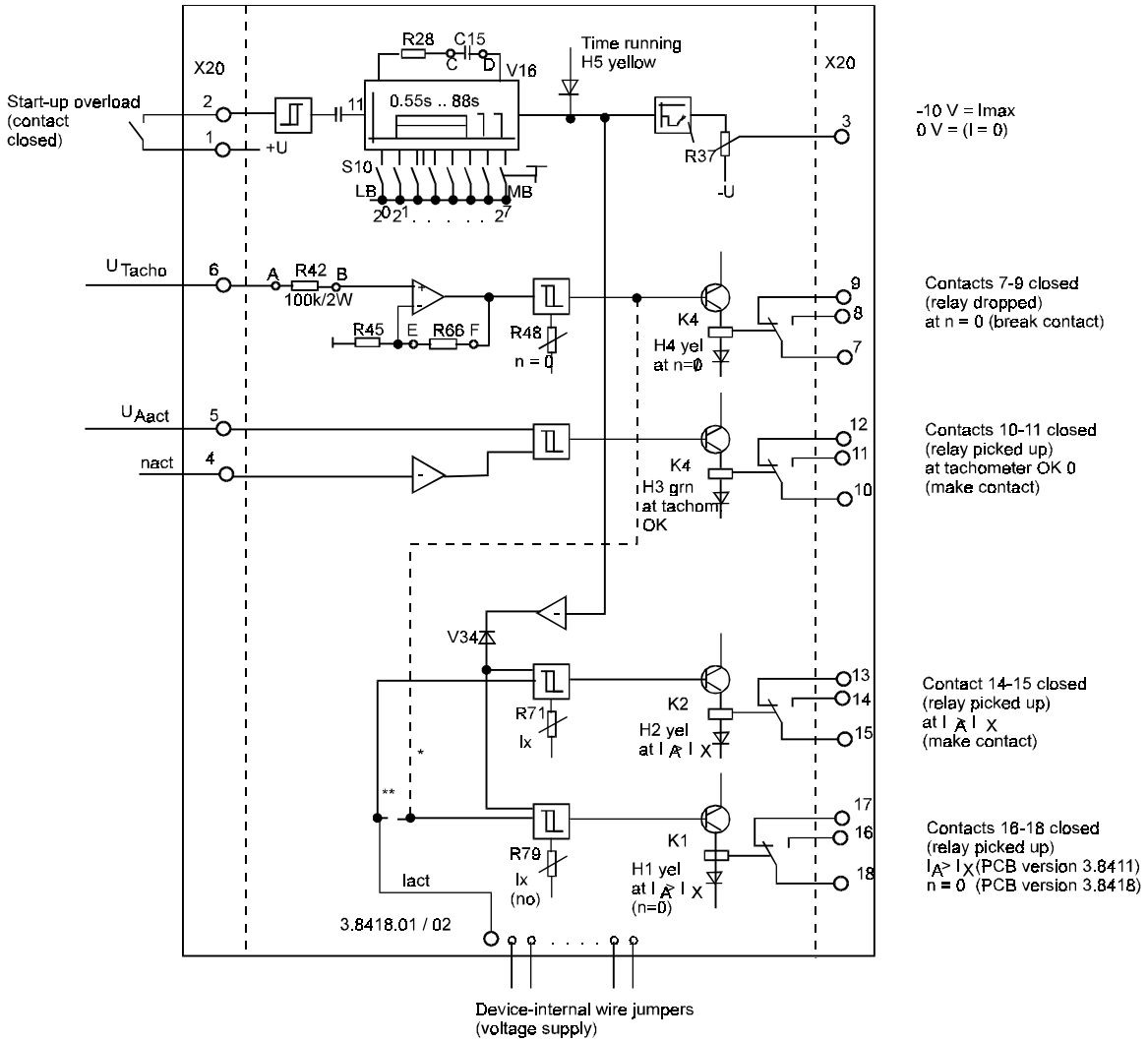
Additional board “Blocking and tachometer break monitoring, start-up overload” 3.8311



Additional board “Speed monitoring” 3.8336



Additional board 3.8418



* This connection with version 3.8418.02 only instead of connection to I_{act}

** This connection not in version 3.8418.02

- Subboard 3.8418.01 with functions:
  - Start-up overload
  - Speed 0
  - Tachometer break monitoring
  - Current monitoring (2 x)
- Subboard 3.8418.02 with functions:
  - Start-up overload
  - Speed 0 (2 x)
  - Tachometer break monitoring
  - Current monitoring

2.9 Power Loss of Power Converter, Line Reactor, Fuses

In rated operation of the equipment, the following power losses occur when the additional components listed in the chapter entitled Installation (line reactor, semiconductor fuses) are fitted:

Power losses in watts (W)				
	Power converter*	Line reactor	Fuses	Total
BKD6/ 30/460	120	50	30	200
BKD6/ 40/460	130	50	35	215
BKD6/ 60/460	200	55	45	300
BKD6/ 100/460	330	90	55	475
BKD6/ 150/460	450	105	75	630
BKD6/ 200/460	525	120	135	780
BKD6/ 250/460	800	150	180	1130
BKD6/ 300/460	1000	170	200	1370
BKD6/ 380/460	1300	190	255	1745
BKD6/ 480/460	1450	250	280	1980
BKD6/ 600/460	1600	300	330	2230
BKD6/ 800/460	2000	350	420	2770
BKD6/1000/460	2600	400	600	3600

* The power converter power loss includes the losses of the power unit for armature and field supply as well as for operating voltage supply.

3 TRANSPORTATION, UNPACKING

The units are packed at the factory in accordance with the order.

You should avoid jolting or dropping the package in transit, e.g. when putting the unit down.

You can start assembly after unpacking the equipment and checking that it is complete and undamaged .

The equipment is packed in cardboard, corrugated sheeting and/or wooden packaging that you should dispose of in accordance with local regulations.

Report any damage that has occurred in transit immediately.

DANGER

If the unit was damaged in transit, a qualified person must check, repair and test it before it may be connected.

Ignoring this information can result in death, serious personal injury or considerable damage to property.

4 ASSEMBLY

WARNING

You are responsible for mounting the described equipment, the motor, the transformer and any other equipment in accordance with appropriate safety regulations (e.g. EN, DIN, VDE); equally you must ensure that all other relevant national or local regulations are met with regard to cable ratings and protection, grounding, disconnectors, overcurrent protection, etc.

During operation, the unit is protected from direct contact such that it is suitable for use in enclosed electrical premises (DIN VDE 0558 Part 1/07.87, Section 5.4.3.2, provisional standard EN 50178/VDE 0160/ 11.94, Sections 5.2.6, 5.2.7).

4.1 Dimensions

The main difference in the structure of the different-sized power converters is the components that are included in the power unit.

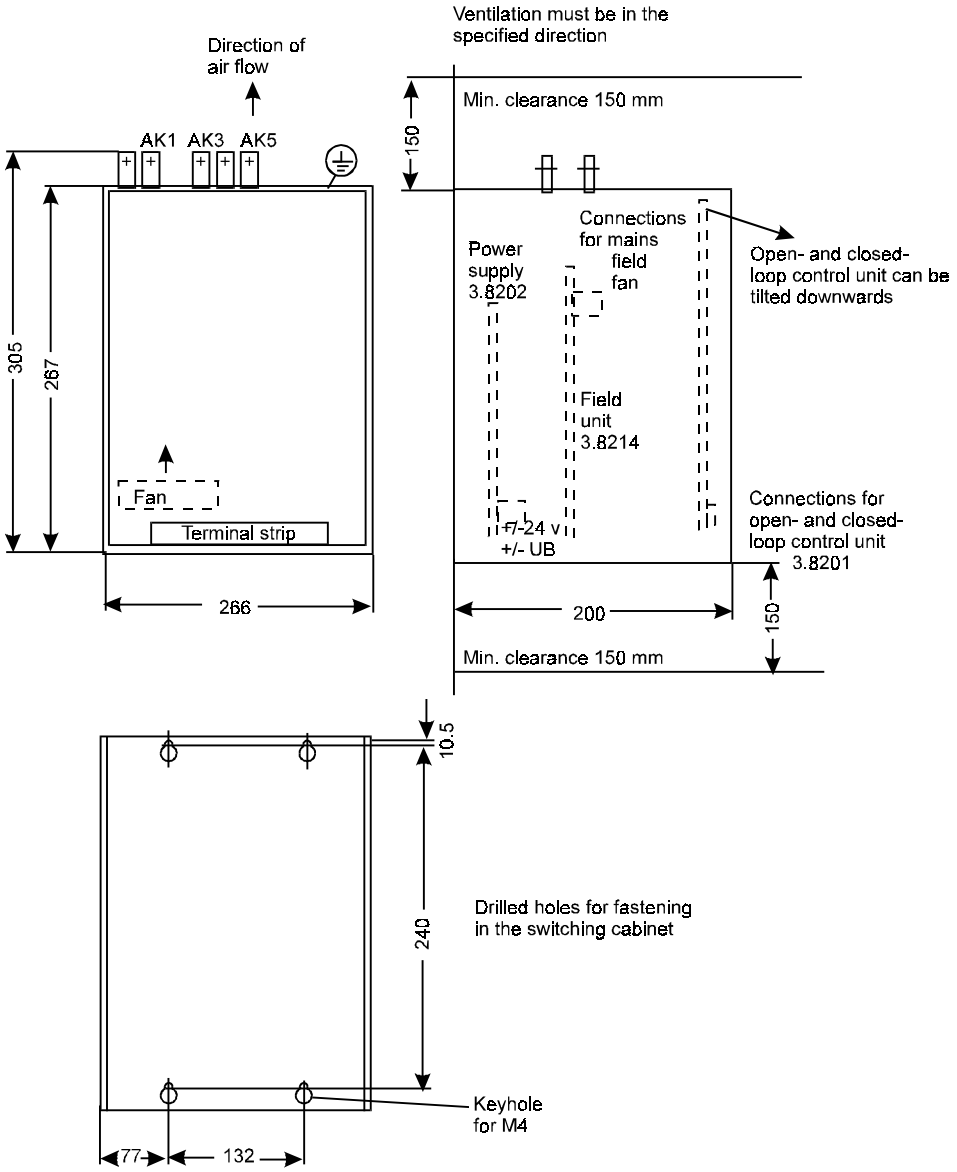
In units of sizes I and II, the power unit consists of electrically insulated thyristor modules on a potential-free cooling element. The power unit is protected with three semiconductor fuses in the three-phase current line.

Units of size III are fitted with disk-type thyristors because of the higher current and the connections of the three-phase current bridge are routed separately to the outside. A total of six branch fuses must be provided for the thyristors. They can be located in a fuse-carrier specially designed for this purpose.

For outline and schematic circuit diagrams, refer to section 4.1.3 on page 60.

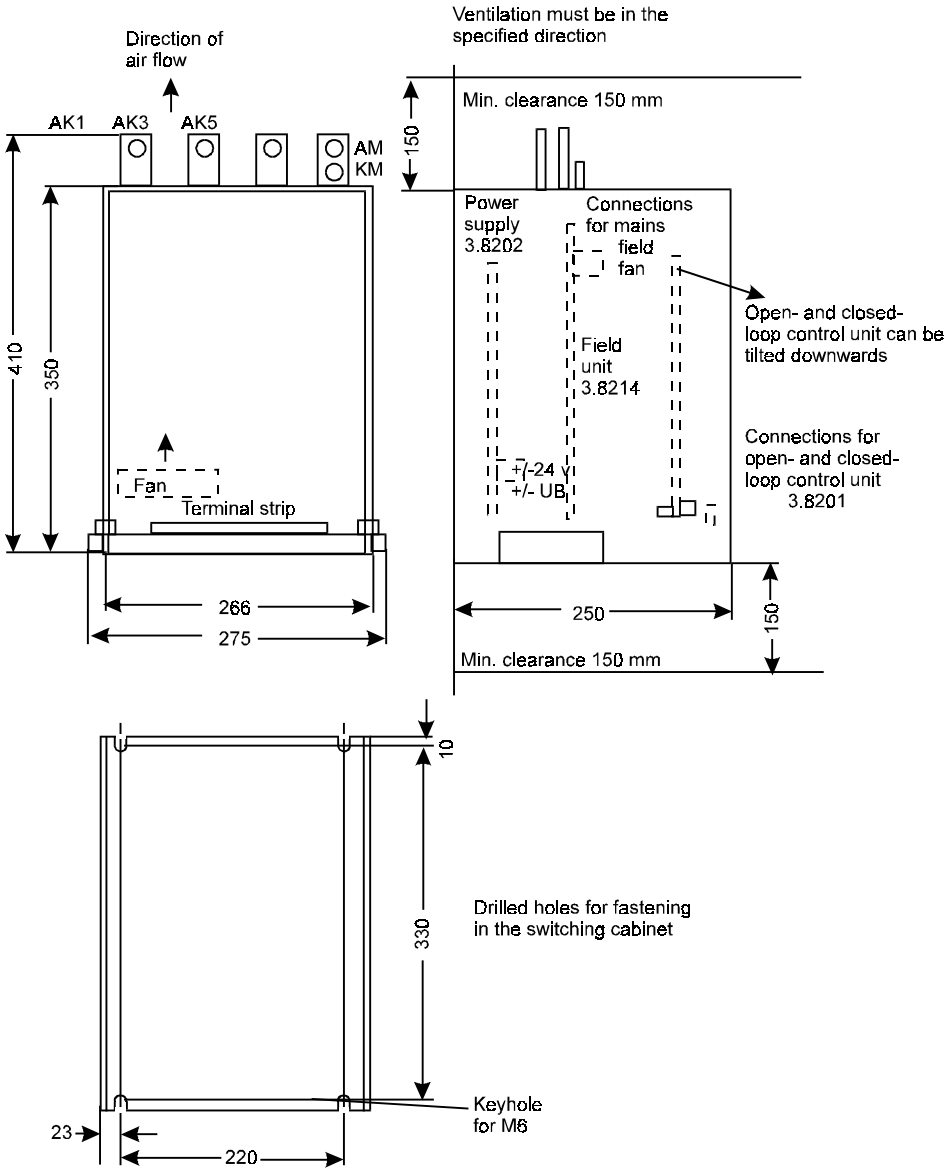
When mounting in the control cabinet, the fuse-carrier should best be located directly above the power converter so that the fuses can be cooled by the unit's fan and cabling can be as short and simple as possible.

4.1.1 BKD6, Series 2000 Size I (30 A - 200 A)

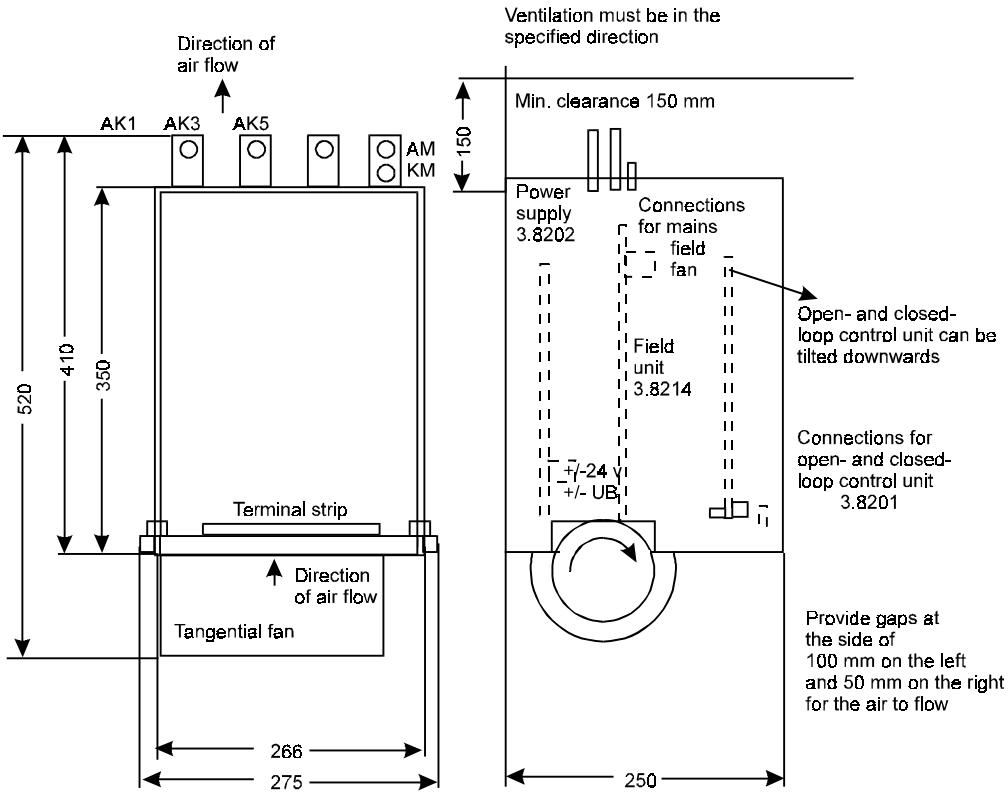


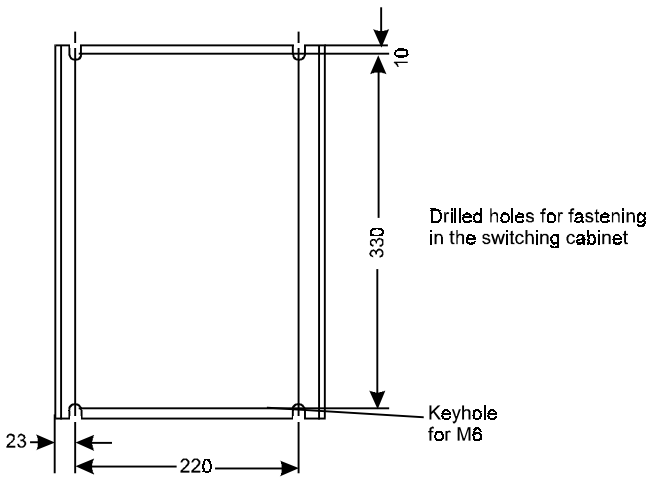
4.1.2 BKD6, Series 2000 Size II (250 A - 480 A)

- Rated DC current 250 A - 300 A



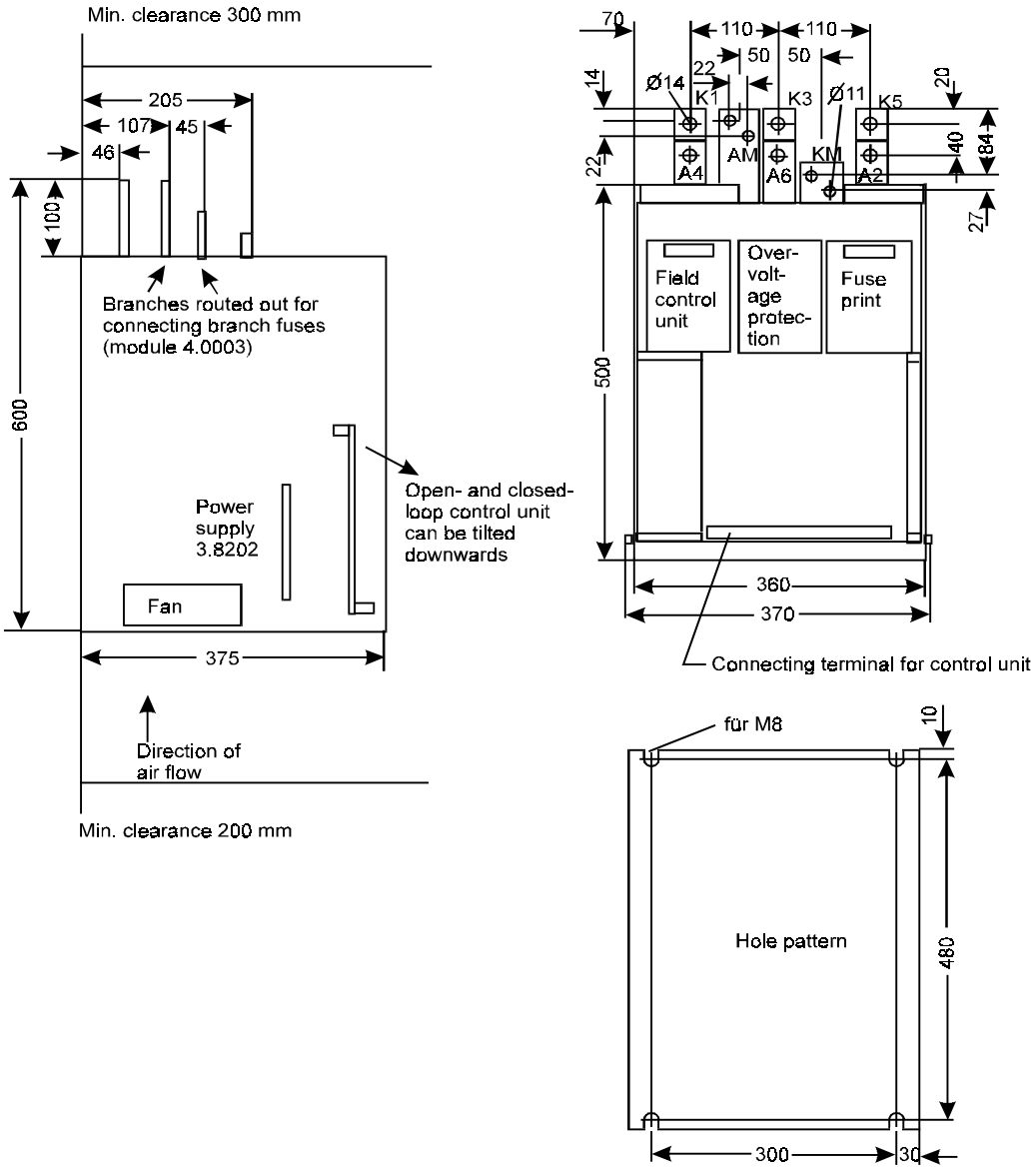
- Rated DC current 380 A - 480 A





4.1.3 BKD6, Series 2000 Size III (600 A - 1000 A)

- Power converter without fuse module

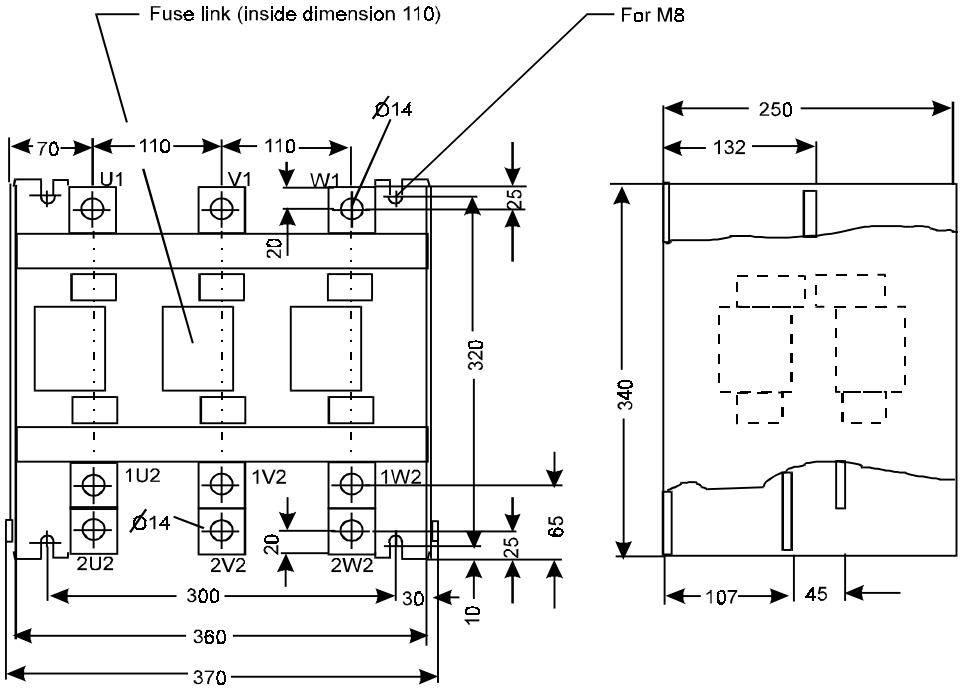


Dimensions without fuse module,

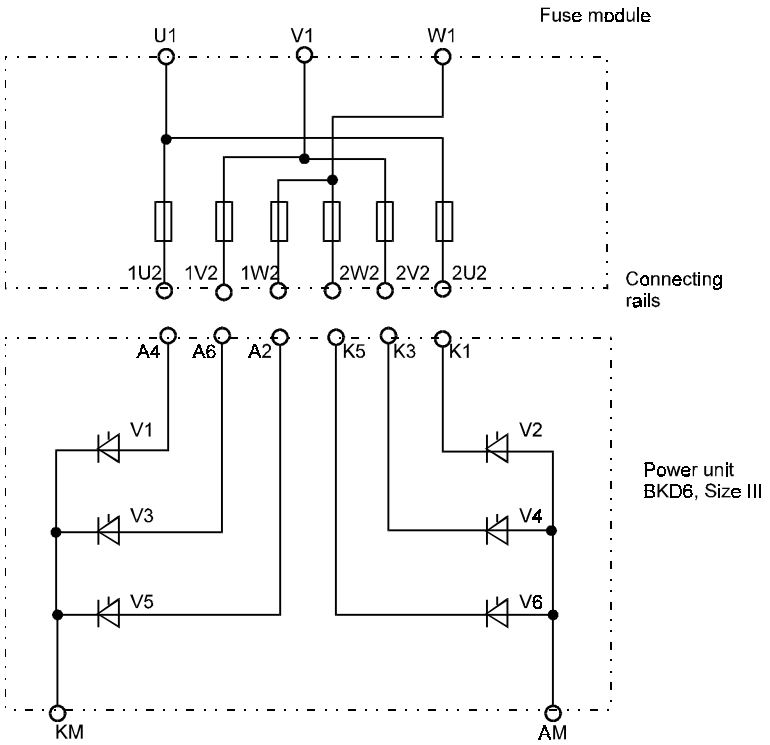
mounting holes 300 x 480 mm, diameter 8 mm

Fuse module

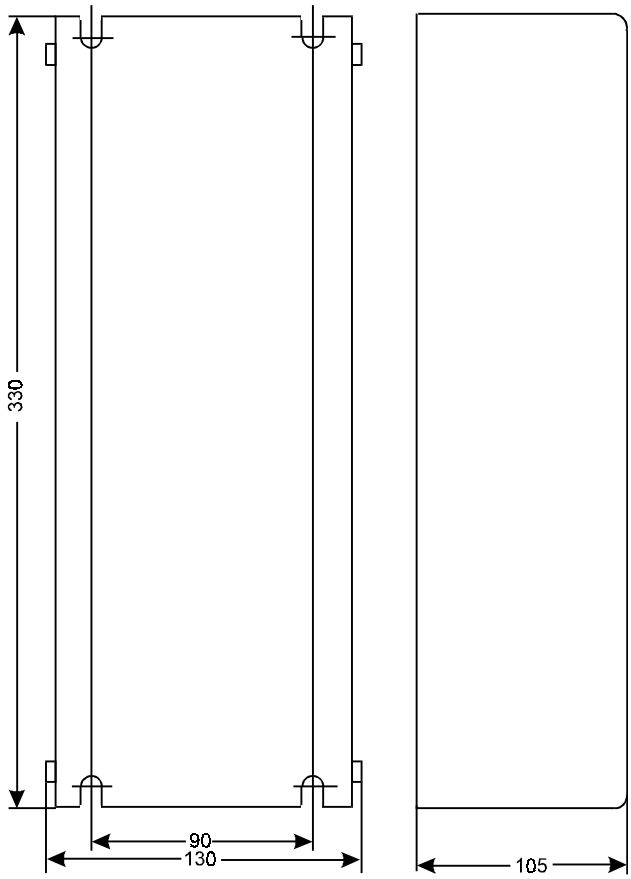
Outline diagram



Schematic circuit diagram



4.1.4 Field Weakening Control Unit BZF4 as an Additional Unit



4.2 Weight

BKD, series 2000	Size I	30 - 40 A	10 kg
		60 - 200 A	11 kg
BKD, series 2000	Size II	250 - 300 A	19 kg
		380 - 480 A	22 kg
		600 - 1000 A	40 kg

4.3 Assembly Information

WARNING

Personal injury or damage to property can be caused by lifting the equipment incorrectly. The unit may only be lifted by qualified personnel using appropriate equipment.

- You must install the units in a closed control cabinet.
- On mounting, ensure that no force is applied to the busbars.

WARNING

It is vital to carry out the ventilation measures listed below. Ignoring these measures may lead to the equipment overheating.

- Current converters are designed to be mounted vertically.
  If you want to mount the unit in another position, ask for more information at the factory.
- The equipment must be ventilated from the bottom to the top.
- Ensure that the flow of air is not obstructed.
- The clearance above and below the units must be at least
  150 mm for unit size I
  150 mm for unit size II with a rated DC current of 250 A and 300 A
  150 mm above and 100 mm beside tangential fans

  for unit size II with a rated DC current of 380 A and 480 A

  300 mm above and 200 mm below for unit size III

  Ignoring these measures may lead to the equipment overheating
- Temperature of coolant 50 mm below the unit:

  Power unit

  30-A and 40-A power converters (self-ventilated): up to 45° C
  All other units (force-ventilated): up to 35° C

  At relatively high temperatures (up to a maximum of 55° C), the unit's rated DC current must be reduced by 1% per degree Centigrade.
- Do not mount any additional sources of heat above or below the equipment.
- Avoid soiling grades 3 and 4 according to provisional standard EN 50178/VDE 0160/11.94, Section 5.2.15.2.
- Make the PE connection to the central grounding point as short as possible.

5 INSTALLATION

5.1 Danger Information

WARNING

This equipment carries a dangerously high voltage and, depending on the version, may have dangerous rotating parts (fans). Ignoring the safety and warning information may result in death, severe personal injury or damage to property.

You are responsible for mounting the power converter, the motor, the commutating reactor and any other equipment in accordance with appropriate safety regulations (e.g. DIN, VDE); equally, you must ensure that all other relevant national and local regulations are met with regard to cable ratings and protection, grounding, disconnectors, overcurrent protection, etc.

The most important factors for protecting people are the DIN/VDE protective measures and safety regulations. If there are no protective earth connections on the equipment, commutating reactor or the motor, personal injuries are inevitable, since the surfaces may carry dangerously high voltages.

The power converter's power cables are energized!

The mains unit and the field connector of the power converter carry a dangerous voltage even when the main contactor has dropped.

During operation, the principles on which the power converter and the motor work lead to leakage currents to earth that are dissipated via the specified protective earths and may result in a current-operated e.l.c.b on the input side blowing prematurely.

In the case of a short-circuit to frame or to ground, a direct proportion may arise in the leakage current that makes triggering a higher level current-operated e.l.c.b either more difficult or totally impossible.

Make the PE connection in accordance with DIN EN 60204/VDE 0113 Part 1/06.93; Section 8.2.2 taking into account provisional standard EN 50178/ VDE 0160/11.94, Sections 5.3.2.1 and 8.3.4.4.
You may only use variable speed drives in applications corresponding to applicable VDE regulations.

Speed monitoring systems in the equipment must not just be complemented by a stand-alone monitoring system on the motor. You can implement this control of the RPM speed, which is independent of the controller, by means of inductive, optical or torque-dependent encoders. Refer to the appropriate motor's operating and maintenance instructions.

Be particularly careful before touching the drive shaft directly or indirectly with your hands. This is only allowed when the system is deenergized and the drive is stationary.

Safety devices must never be deactivated.

According to applicable regulations (EN 60204 Part 1 and VDE 0113 Part 1/06.93), stopping the drive by means of a controller inhibit or by opening the trigger commands for Creep mode, Positioning in creep mode, Inching and Operation do not, on their own, represent a safe stop condition. A disturbance in the power converter's control electronics can lead to accidental starting of the motor.

5.2 Standardization Information

1. The power converters are built-in units in the sense of provisional standard EN 50178/ VDE 0160/ 11.94, Section 5.2.6 and DIN VDE 0558 Part 1/07.87, Section 5.4.3.2.1. They are intended for installation in commercially available control cabinets whose degrees of protection meet the minimum requirements of provisional standard EN 50178/VDE 0160/11.94, Section 5.2.4 (IP 2X, possibly IP4X according to EN 60529/5.1).

   Plastic covers on the equipment provide additional protection against accidental contact during commissioning and in the case of casual use of the control elements located close to the equipment (DIN VDE 0106 Part 100, Accident Prevention Regulation VBG4 “Electrical Systems and Equipment”).

   If you intend to set up the equipment in closed electrical workshops according to provisional standard EN 50178/VDE 0160/11.94, Section 5.2.7 and DIN VDE 0558 Part 1/07.87, Section 5.4.3.2.2, you must implement additional measures to ensure compliance with the requirements of provisional standard EN 50178/VDE 0160/11.94, Section 5.2.4.

2. Power converters are intended for permanent mains connection to conventional TN and TT systems according to DIN VDE 0100 Part 410/11.83 with a diametric voltage of up to 3 x 500 V_{eff}.

   Connection to a system with an insulated neutral point (IT system) is only possible under special circumstances. If necessary, enquire at the factory.

   During operation, the principles on which the power converter and the motor work lead to leakage currents to earth that are dissipated via the specified protective earths and may result in a current-operated e.l.c.b. on the input side blowing prematurely. In the case of a short-circuit to frame or to ground a direct proportion may arise in the leakage current that makes triggering a higher-level current-operated e.l.c.b. either more difficult or totally impossible. This means that connecting the power converter to the mains supply using only the current-operated e.l.c.b. is prohibited (provisional standard EN 50178/VDE 0160/11.94, Sections 5.2.11 and 5.3.2.1).

3. With regard to climatic conditions, the equipment conforms to category 3K3 for sheltered locations according to provisional standard EN 50178/VDE 0160/11.94, Section 6.1, Table 7, LIne 3 or Table 1 of EN 60721-3-1,2,3,4, respectively, taking into account Remarks 1 and 3 of provisional standard EN 50178/ VDE 0160/11.94, Section 6.1. The actual operating temperature range is higher and is in the range 0...+55° C. The information in Table 7 (Lines 5 and 6) of provisional standard EN 50178/ VDE 0160/11.94, Section 6.1 also applies to storage and transportation The storage and transportation temperature of the equipment varies from this information in as much as it may be between -30...+70 °C (refer to Power Converter’s Technical Data).

4. The units are in protection class IP 00 according to EN 60529 (DIN VDE 0470-1).

5. The units are equipment in protection class I corresponding to IEC 536/3 and DIN VDE 0106 Part 1 (provisional standard EN 50178/VDE 0160/11.94, Section 5.2.9).

   Equipment of protection class I is equipment whose protection against dangerous shock currents is not limited to basic insulation which also has additional safety devices. This additional protection is provided by connecting the casing and other parts to the protective earth such that if the basic insulation fails no voltage can remain. With these power converters, the entire insulation is carried out according to provisional standard EN 50178/VDE 0160/11.94, Section 5.2.9.1, at least to basic insulation standard. This also applies to the insulation between the individual circuits.

   The power converter’s control terminals are designed for connection of FELV circuits that must be protected from direct and indirect contact. The rated insulation voltage is 300 V_{eff}, i.e. you can use normal plastic-insulated control lines.

   You may not connect SELV and PELV circuits without taking special measures.

At measurement of the creepage distances and clearances, the following criteria were taken into account:

– Soiling grade 2 according to provisional standard EN 50178/VDE 0160/11.94, Section 5.2.15.2, Table 2, Line 3: Normally, only non-conducting pollutants are produced. When the equipment is out of service, brief conductivity can occur due to condensation.

– Overvoltage category III according to IEC 664-1, Table 1 for the air clearances of mains circuits to their environment according to provisional standard EN 50178/VDE 0160/11.94, Section 5.2.16.1. The rated insulation voltage of the mains circuits for TN and TT systems according to DIN VDE 0100 Part 410/11.83 with a diametric voltage of 3 x 500 V.

– Insulation material IIIa for the creepage distances according to provisional standard EN 50178/ VDE 0160/11.94, Section 5.2.17.

6. Series 2000 line-commutated power converters are short-circuit-proof in the sense of provisional standard EN 50178/VDE 0160/11.94, Section 6.3.4, assuming that you use the protective semiconductor fuses specified in this technical description to protect the thyristors.

7. Provisional product standard EN 61800-3 for electric drives contains EMC requirements for electric drives that can be connected to low voltage networks of up to 1000 V_{eff}.

   The limits specified here with regard to electromagnetic interference immunity and emitted interference depend on the drive's place of use: A differentiation is made between operation in residential and in industrial areas or whether the equipment's mains connection is to a public low-voltage network or to an industrial one.

   The standard takes precedence over all the requirements of generic standards.
   If you install an electric drive in another device for which a special EMC product standard exists, you must use this device's EMC product standard.

   With regard to electromagnetic interference immunity, the converters fulfil the set requirements without additional measures needing to be taken – this applies to a public environment as well as an industrial one (provisional standard EN 61800-3, Section 5).

   To limit commutation notches according to provisional standard EN 61800-3, Section 6.1.1, you must connect line reactors on the converters' input sides.

   The depth of the commutation notches in the mains voltage depends on the ratio of the line reactor's reactance to the reactance of the supplying main: The higher the line reactor's reactance relative to the mains reactance is, the lower the voltage dips that occur at the connection point to the mains supply.

   The line reactors listed in chapter 5.5 of this document are rated with a relatively low short-circuit voltage of 4% (on the 50Hz mains). At the connection point to the mains, this results in a commutation notch of 20% if we assume a power ratio of 1% between the fundamental apparent power of the converter and the short-circuit power of the mains (provisional standard EN 50178/ VDE 0160).

   Due to their physical way of functioning, line-commutated converters generate harmonics in the line current that correspond to provisional standard EN 61800-3, Section 6.1.2.

   You can ask about these current harmonics at the factory (the line impedance at the drive's place of use, the intended current converter and the data of the motor and the line reactor are needed to calculate them) or consult the separate document entitled "EMC on and with Line-Commutated Converters of Series BKF 12/... and BKD 6/....".
   You should take into account the guideline in provisional standard EN 61800-3, Section B2 to rate the generation of harmonics. This applies above all to the superposition of harmonics from different sources.
   Interference emission limits in the high-frequency range were defined on the principle that limit values must be stricter the higher the probability of a disturbance.

Up to now, no limits have been specified for the use of drives in non-public networks in industry, since electrical drives can generally be run with no filtering measures without disturbing or affecting the function of other electrical equipment or devices. Apart from this, filtering measures for damping interference emissions reduce the effectiveness of drives and increase the volume of the casing and the costs (see Section 6.3, and in particular 6.3.2 of the EMC product standard).

For information and limit values for connecting the converter to a public low-voltage network, refer to section 6.3.1. In this connection, we should emphasize that with line lengths of more than two metres between the motor and the converter, you should use shielded cables.

5.3 Terminal Diagrams

The lid board housing the entire open-loop and closed-loop control electronics is the same size for all unit sizes. There are, however, differences in electrical layout due to the fact that additional functions can be provided.

Technology-specific additional boards, which can optionally be fitted as a subboard to the lid board, add to the scope of application of these units.

The power unit is identical for all unit sizes and versions, adaptation to different mains voltages is carried out by fitting different line transformers.

The power unit of unit sizes I and II is made up of thyristor modules.

Size III units are fitted with disk-type thyristors; in addition, the lines of the three-phase current bridge are routed separately to the outside.

Size III units are fitted as standard with a field controller instead of the uncontrolled field supply as well as with electronic fuse monitoring.

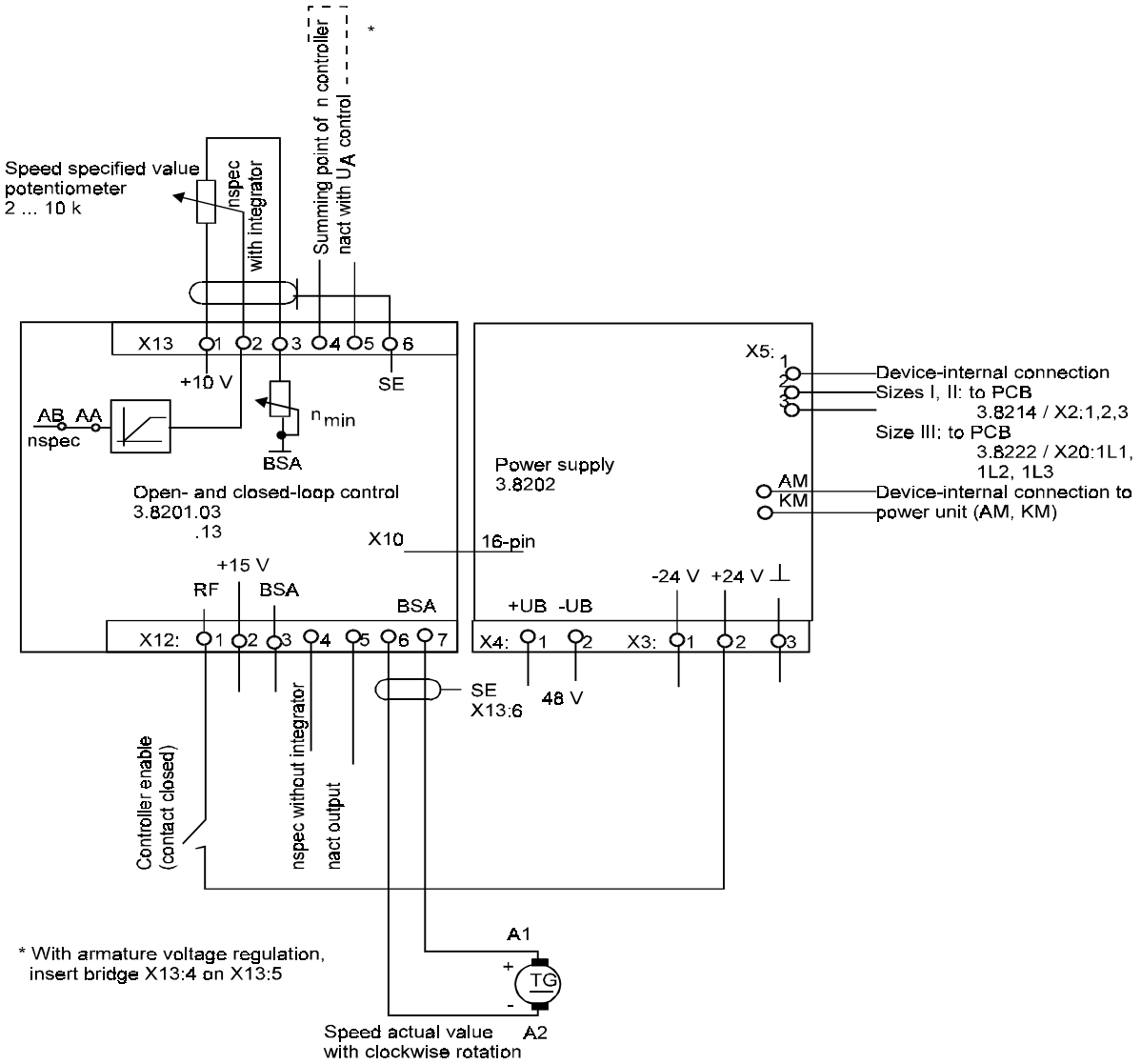
For the reasons mentioned above, the connection diagrams of the different unit versions listed in below are divided up into

- Connection diagrams for the different controller versions
- Connection diagrams for the different additional modules
- Connection diagrams for both power unit versions (sizes I and II /size III)

5.3.1 Connection of Controller Board

Standard versions of open-loop and closed-loop control units

BKD6/30 ... 1000 A/460 - 203 (400 V_{AC} unit)
BKD6/30 ... 1000 A/600 - 213 (500 V_{AC} unit)



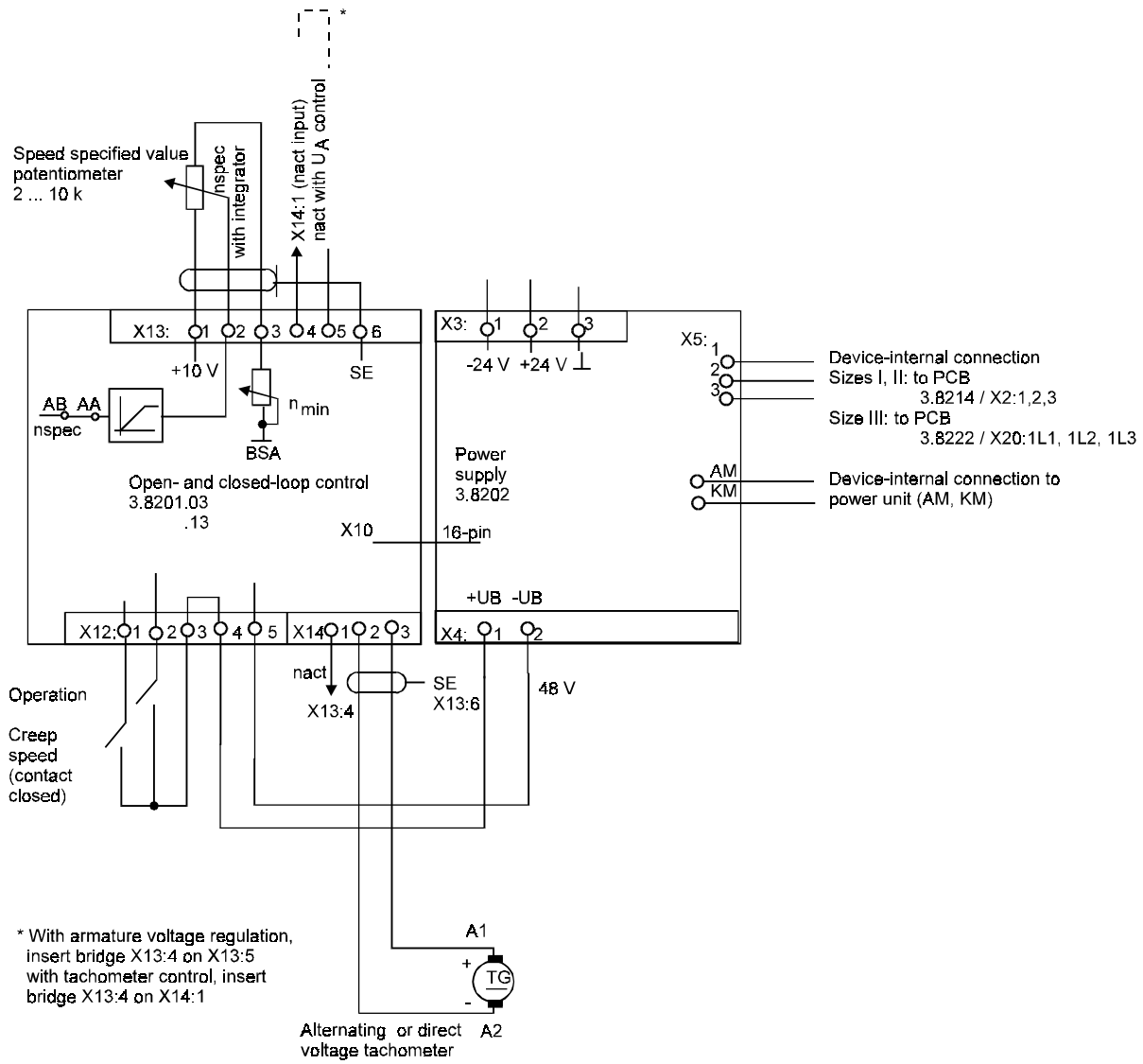
BSA: Reference potential, analog
SE: Shielded earth
Test plugs: X101, X102, X103 (for BZD)

LEDs:

H1	green	with pulse enable (IF)
H2	green	with clockwise rotating field (DF RE)
H3	red	with anti-clockwise rotating field (DFLI)
H4	red	with controller inhibit (RS)
H5	green	with controller enable (RF)
H6	yellow	with current limit reached (SG)

Open-loop and closed-loop control units with additional function 1

BKD6/30 ... 1000 A/460 - 201 (400 V_{AC} unit)
BKD6/30 ... 1000 A/600 - 211 (500 V_{AC} unit)

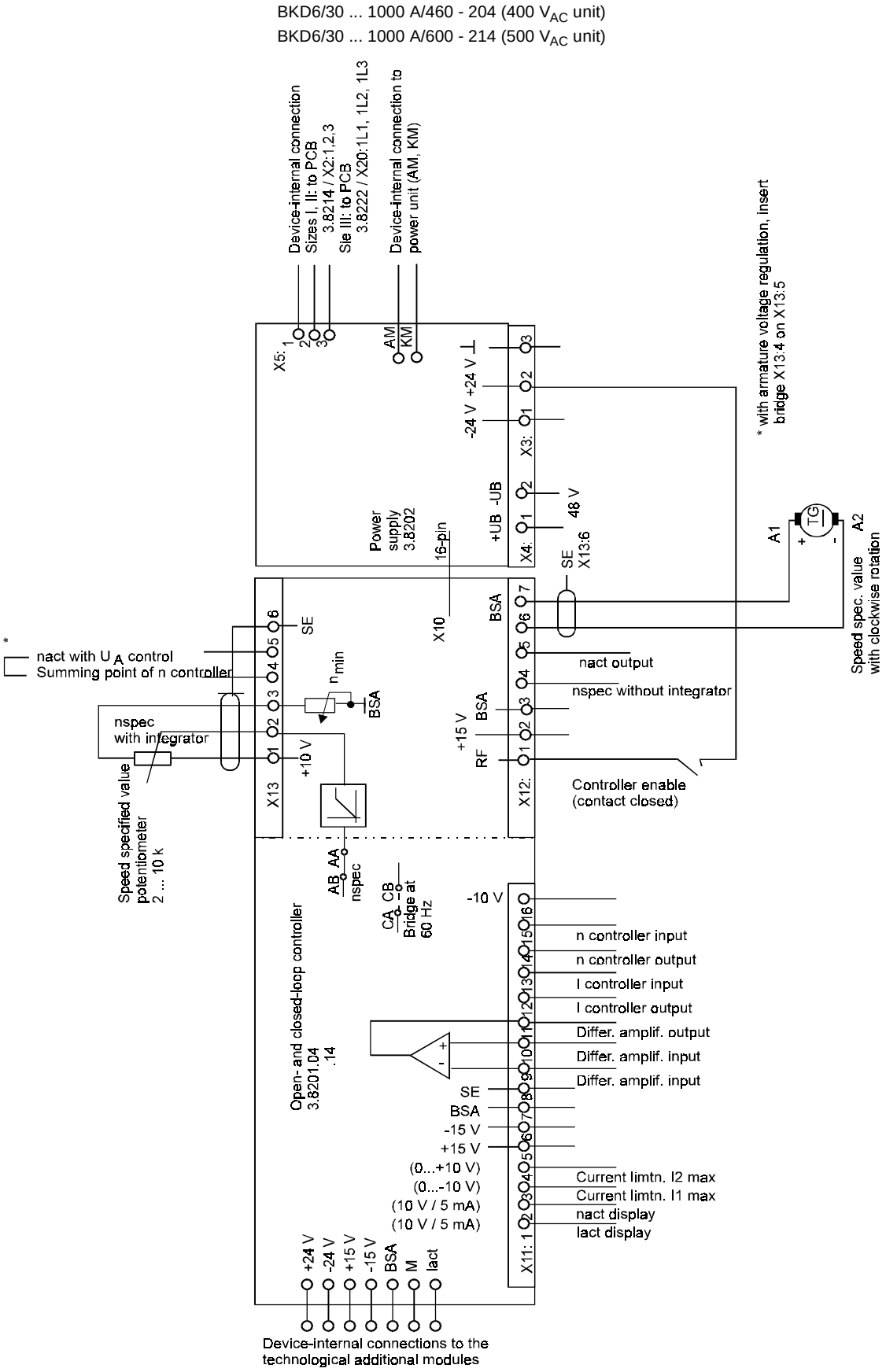


BSA: Reference potential, analog
SE: Shielded earth
Test plugs: X101, X102, X103 (for BZD)

LEDs:

H1	green	with pulse enable (IF)
H2	green	with clockwise rotating field (DF RE)
H3	red	with anti-clockwise rotating field (DF LI)
H4	red	with controller inhibit (RS)
H5	green	with controller enable (RF)
H6	yellow	with current limit reached (SG)
H7	green	with operation (Betr.)
H8	yellow	with creep mode (Schlg.)

Open-loop and closed loop control units with additional function 2



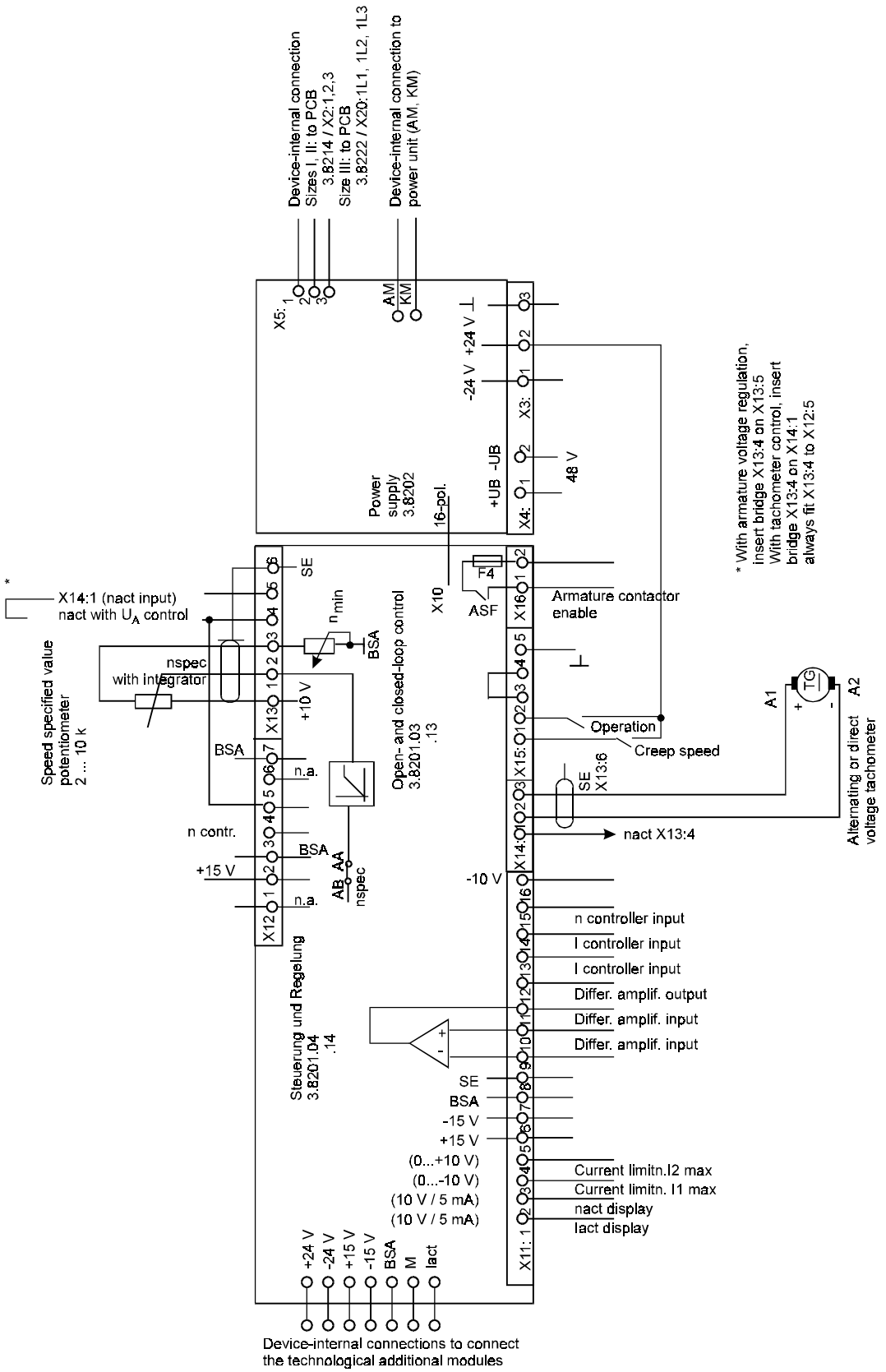
BSA: Reference potential, analog
SE: Shielded earth
Test plugs: X101, X102, X103 (for BZD)

LEDs:

H1	green	with pulse enable (IF)
H2	green	with clockwise rotating field (DF RE)
H3	red	with anti-clockwise rotating field (DF LR)
H4	red	with controller inhibit (RS)
H5	green	with controller enable (RF)
H6	yellow	with current limit reached (SG)

Open-loop and closed-loop control units with additional functions 1 and 2

BKD6/30 ... 1000 A/460 - 236 (400 V_{AC} unit)
BKD6/30 ... 1000 A/600 - 236 (500 V_{AC} unit)



BSA: Reference potential, analog
SE: Shielded earth
Test plugs: X101, X102, X103 (for BZD)

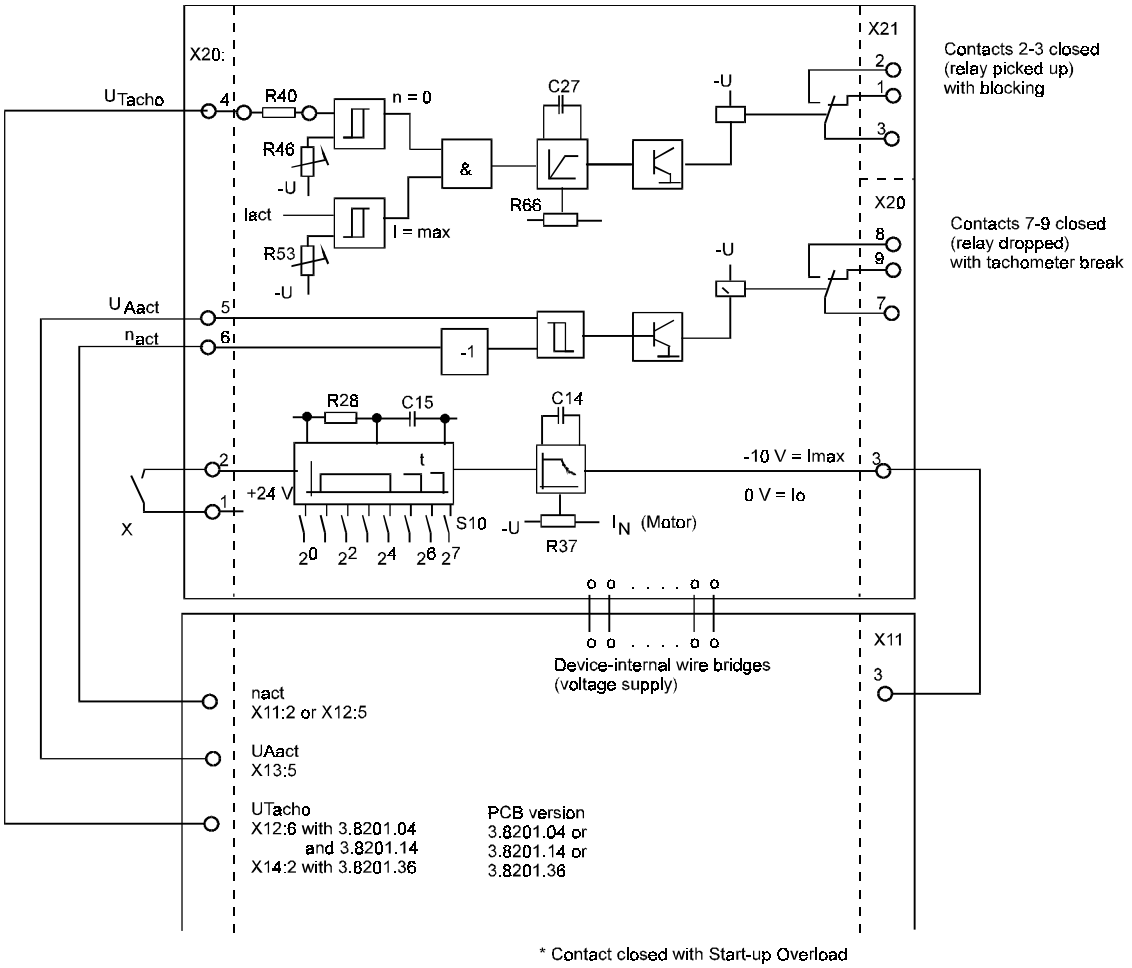
LEDs:

H1	green	with pulse enable (IF)
H2	green	with clockwise rotating field (DF RE)
H3	red	with anti-clockwise rotating field (DF LI)
H4	red	with controller inhibit (RS)
H5	green	with controller enable (RF)
H6	yellow	with current limit reached (SGR)
H7	green	with operation (Betr.)
H8	yellow	with creep mode (Schlg.)

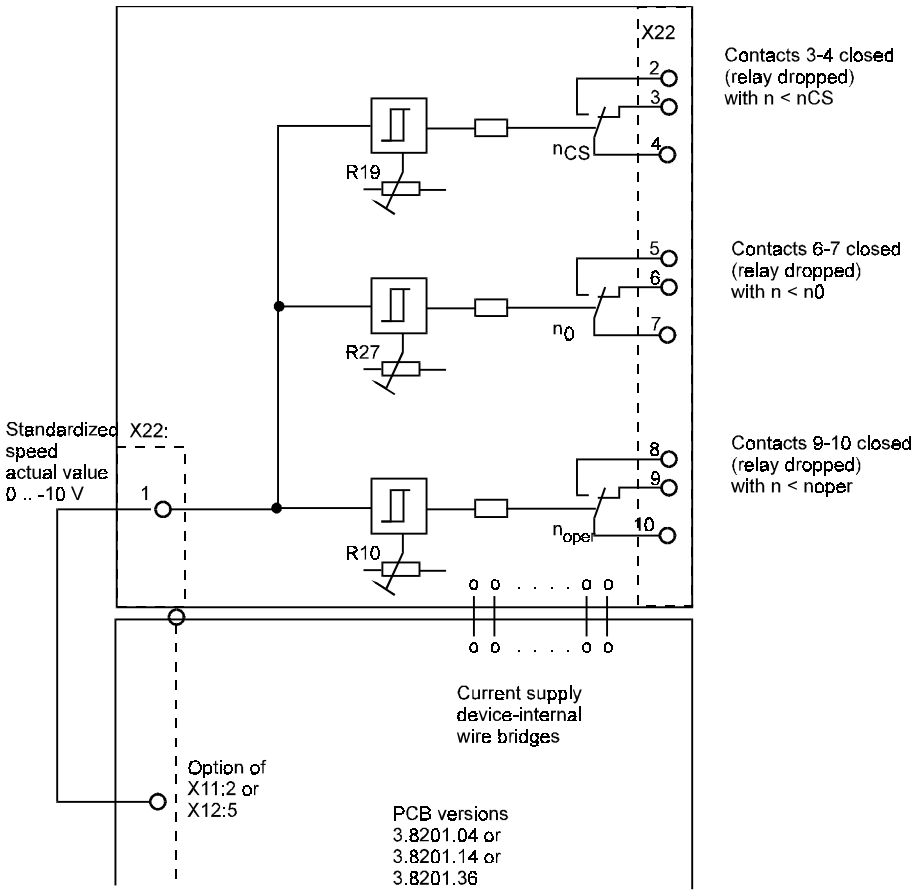
5.3.2 Connecting Additional Modules

Subboards are available for monitoring different functions. They are usually permanently connected to the closed-loop and open-loop control units. The connections required for power supply are only possible in conjunction with versions 3.8201.04, .14 or .36 of the lid board.

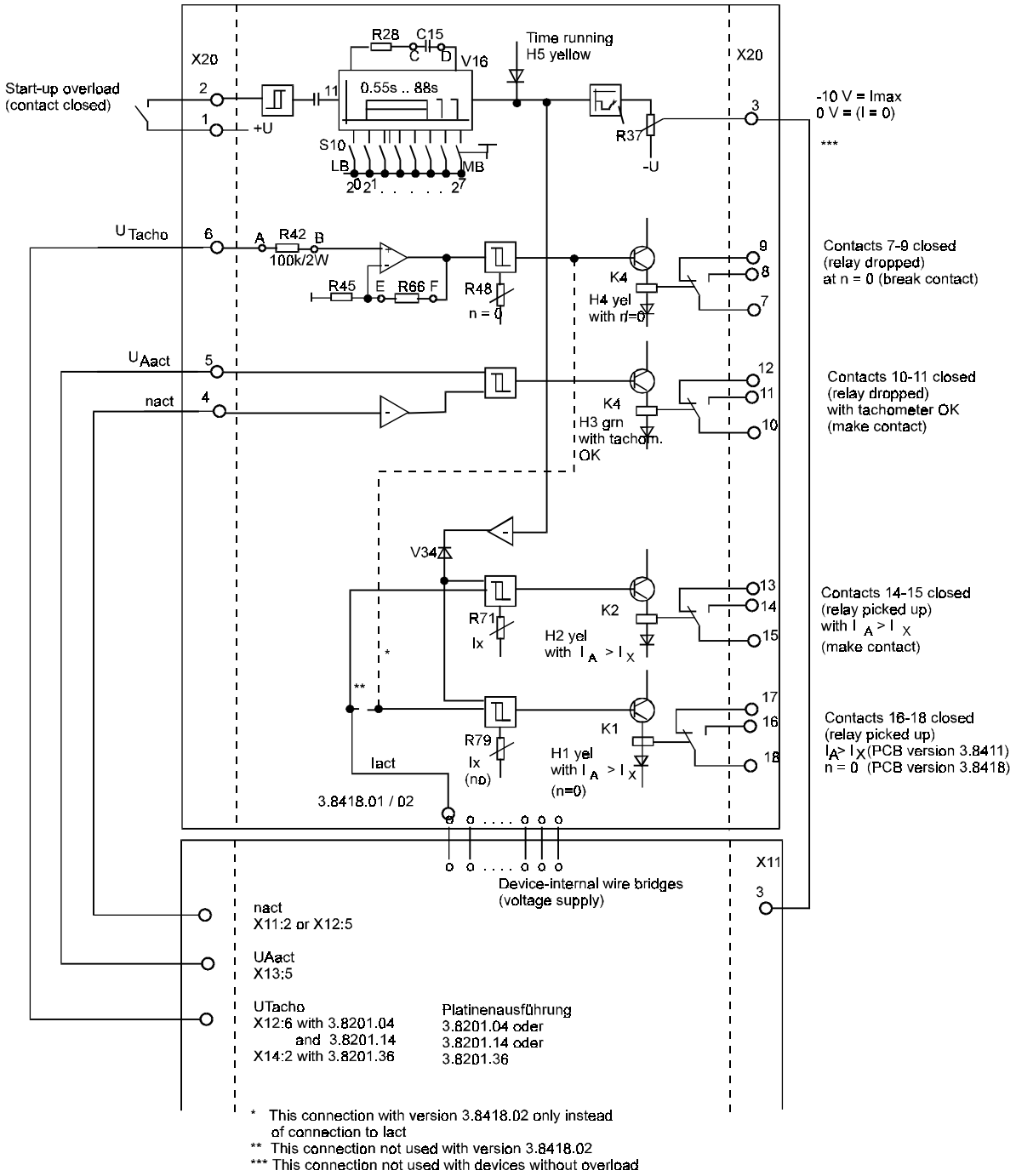
Additional board “Lock and tachometer break monitoring, start-up overload” 3.8311



Additional board “Speed monitoring” 3.8336

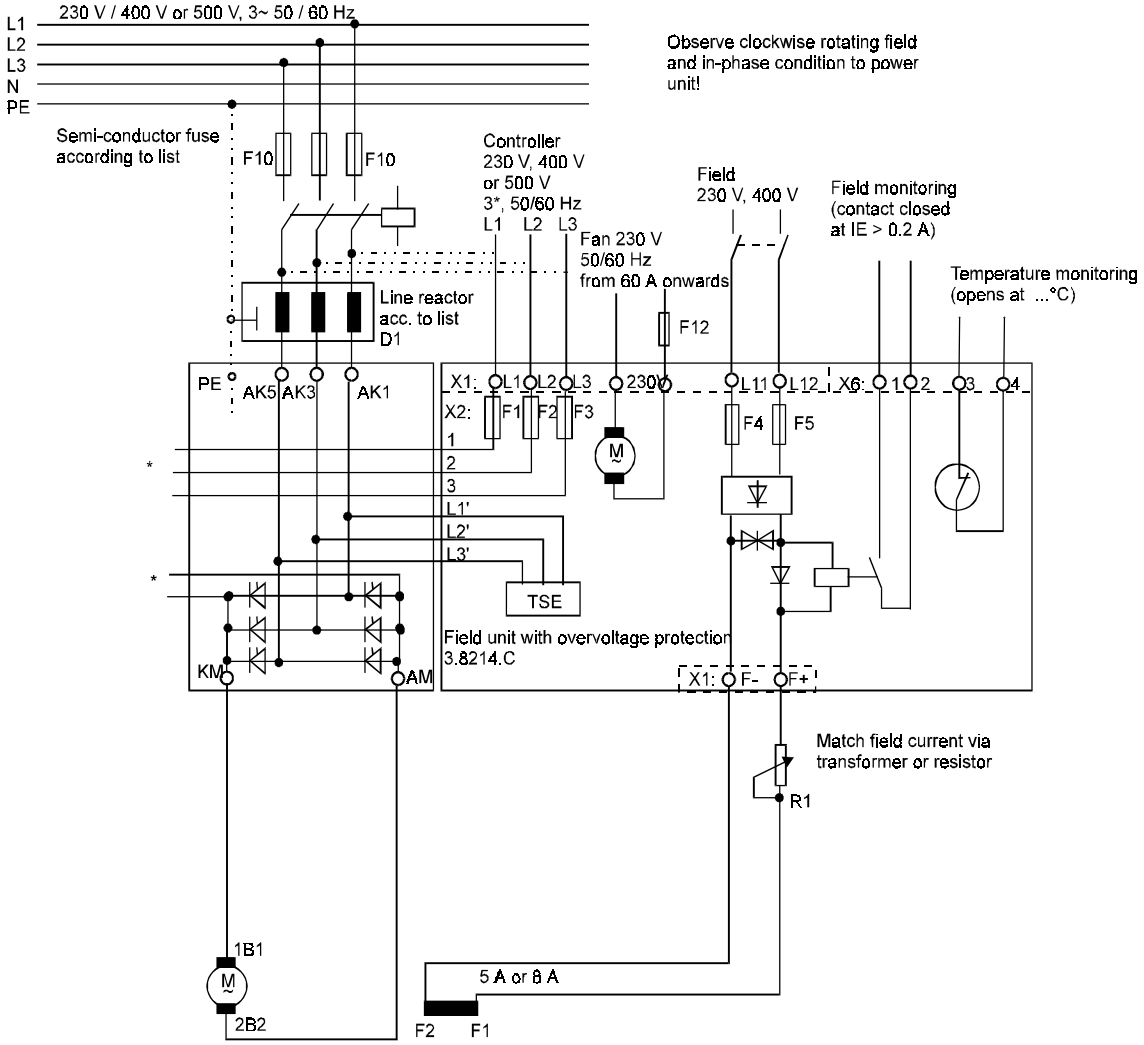


Additional board 3.8418



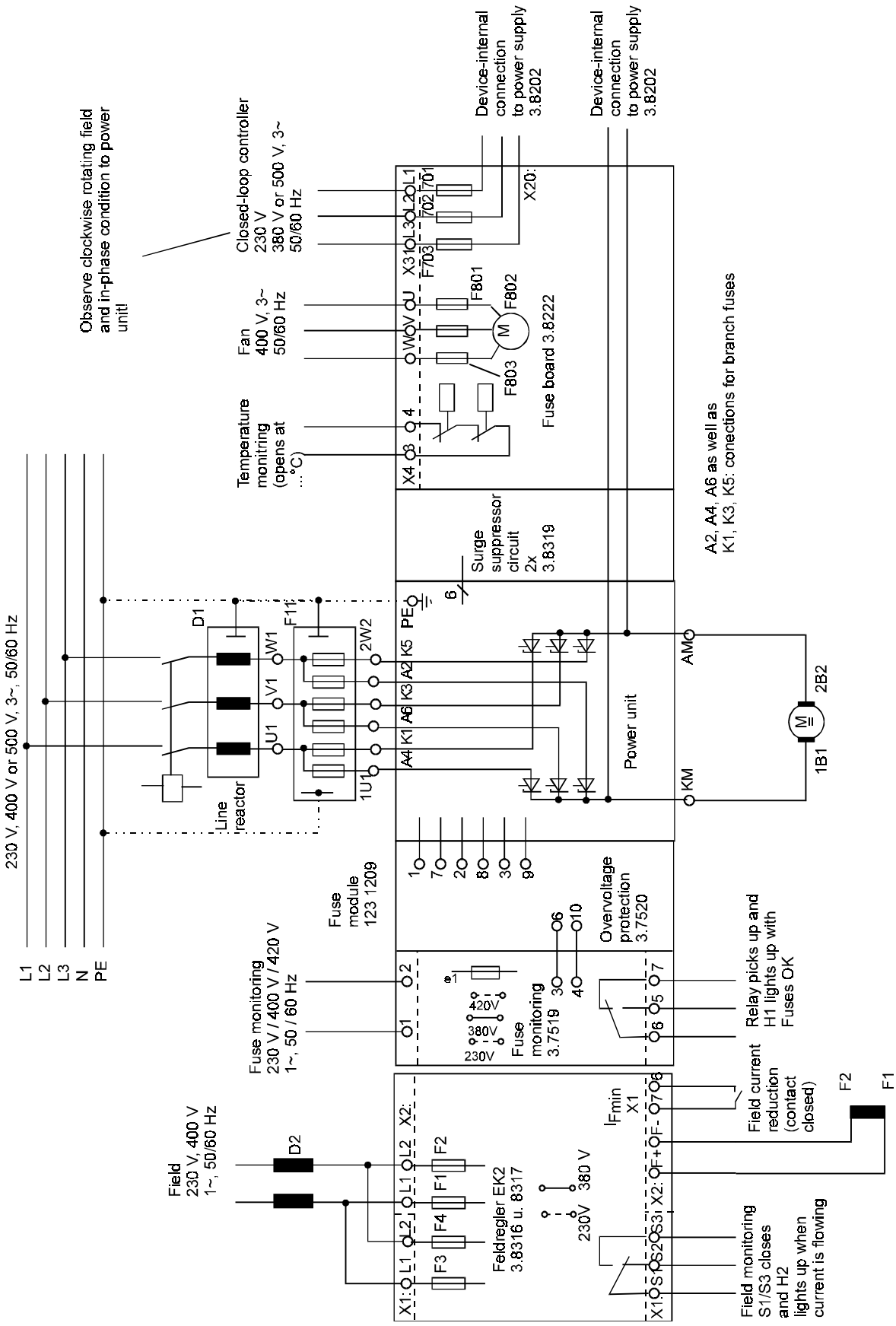
5.3.3 Connection of Power Unit

Connection of power unit for sizes I and II (30 - 480 A)



* Device-internal connections to power supply 3.8202

Connection of power unit for size III (600 - 1000 A)



5.3.4 Information on the Terminal Diagrams

NOTE

Monitoring functions on the additional boards are not linked device-internally to controller enable and must therefore be processed in the external controller.

For safety reasons, monitoring of the drive speed is recommended independently of the control unit, e.g. by means of inductive, optical or centrifugal encoders

X1 on board 3.8214	Terminal block on field unit of sizes I and II	Board terminal, terminal cross-section 0.2 .. 4 mm
X1 on board 3.8316	Terminal block on field unit of size III	Board terminal, terminal cross-section 0.14 .. 2.5 mm
X2 on board 3.8317	Terminal block on field unit of size III	Board terminal, terminal cross-section 0.2 .. 4 mm
X3 on board 3.8202	Terminal block on power supply 3.8202	Board terminal, terminal cross-section 0.14 .. 2.5 mm
X4 on board 3.8202	Terminal block on power supply 3.8202	Board terminal, terminal cross-section 0.14 .. 2.5 mm
X6 on board 3.8214	Terminal block on field unit of sizes I and II	Board terminal, terminal cross-section 0.14 .. 2.5 mm
X4 on board 3.8222	Terminal block on fuse board 3.8222 of size III	Board terminal, terminal cross-section 0.2 .. 4 mm
X31 on board 3.8222	Terminal block on fuse board 3.8222 of size III	Board terminal, terminal cross-section 0.2 .. 4 mm
Connections 1 to 7 on board 3.7519	Terminal block on fuse monitoring unit of size III	Board terminal, terminal cross-section 0.2 .. 4 mm
X11 ... X16 on board 3.8201	Terminal block on controller board	Board terminal, terminal cross-section 0.14 .. 2.5 mm
X20 ... X22	Terminal block on additional boards	Board terminal, terminal cross-section 0.14 .. 2.5 mm
L1, L2, L3	Connection cables	Cross-section according to DIN EN 60204 Part 1/VDE 0113 Part 1/06.93, Sections 14 and 15, Appendix C or VDE 0298/Part 4
1B1, 2B2 F1, F2	Motor connections	Cross-section according to DIN EN 60204 Part 1/VDE 0113 Part 1/06.93, Sections 14 and 15, Appendix C or VDE 0298/Part 4 Connection 1B1 positive in case of clockwise rotating motor shaft
PE	Protective earth connection	Cross-section according to DIN EN 60204 Part 1/VDE 0113 Part 1/06.93, Sections 8.2.2, taking into account provisional standard EN50178/VDE 0160/11.94, Sections 5.3.2.1 and 8.3.4.4 Connection screw Size I: M8 x 20 Size II M10 x 25 Size III: M12 x 40
AK1, AK3, AK5	Power terminals of power converters of sizes I and II	For cross-sections of cables, refer to L1, L2, L3 Connection screws: Size I: M8 Size II M10

A2, A4, A6 K1, K3, K5	Power terminals of the power converter of size III	For cross-sections of cables, refer to L1, L2, L3 Connection screws M12
AM, KM	Armature circuit motor connection	KM is positive relative to AM Connection screw Size I: M8 Size II M10 Size III: 2 x M10
D1	Three-phase current line reactor	For recommendations, refer to chapter 5.5, Line Reactors reduces the reaction of the power converter to the supply mains and protects the thyristors against inadmissible rates of current rise
D2	Field line reactor	For recommendations refer to chapter 5.5, Line Reactors one reactor for 230 V_{AC} connection two reactors for 400 V_{AC} connection Only required as standard for units of size III.
F1, F2 on board 3.8317	Fuses of field controller of size III	Depends on field current 8A or 16 A/600 V URB for the field controller power unit
F3, F4 on board 3.8316	Fuses of field controller of size III	0.2 A/500 V m for the operating voltage supply of the field current control unit
e1 on board 3.7519	Fuse of fuse monitoring of size III	0.2 A/250 V m
F1, F2, F3 on board 3.8214	Fuses on field unit of sizes I and II	3 x 0.2 A/500 V m Pre-fuse for the unit's operating voltage supply
F4, F5 on board 3.8214	Fuses on field unit of sizes I and II	8 A/600 V URB for fuse protection of the field rectifier
F10	Phase fuse for power unit of sizes I and II	Refer to chapter 5.4, Semiconductor Fuses
F11	Phase fuse for power unit of size III	Refer to chapter 5.4, Semiconductor Fuses
F12	Fuse protection of unit fan of sizes I and II	Fan data: Size. I: 30 A & 40 A: without ventilation 60 A - 150 A: 0.2 A/230 V 200 A: 0.5 A/230 V Size. II: 250 A & 300 A: 0.5 A/230 V 380 A & 480 A: 0.85 A/230 V
F801, F802, F803 on printed circuit board 3.8222 of size III	Fuse protection of unit fan	Fan data: 3 x 0.22 A/400 V
F701, F702, F703 on printed circuit board 3.8222 of size III	Pre-fuse for operating voltage supply of the unit	3 x 0.2 A/500 V m
R1	Field adjusting resistor	If the required field voltage of the motor deviates from the supply voltage provided by the power converter, adaptation can, in most cases, be made with a field adjusting resistor. In the case of major deviations, we recommend connecting a field transformer on the input side of the field rectifier. If necessary, use field weakening control unit BZF4 which can also control the field current in units of sizes I and II.

5.4 Semiconductor Fuses

NOTE

If you use fuses that are different from the ones listed, reliable protection of the power unit cannot be guaranteed!

For thyristor protection, semiconductor fuses with super-quick-acting shutdown characteristics must be connected in the three-phase current supply line.

5.4.1 Unit Sizes I and II

Connection voltage: 3 x 400V_{AC} or 3 x 500V_{AC}

For fuse protection, three phase fuses are required.

1. Made by SIEMENS

Power converter	Phase current (A_{eff})	Rated DC current (A)	Phase fuse Type	Nominal current/ Nominal voltage	Size	Order No. 1900...
BKD6/ 030/...-2...	24.5 A	30 A	5 SD4 80	30 A/ 500 V	E 27	-----
			3 NE4 101	32 A/ 1000V	0, DIN 43620	8528
			3 NE8 003	35 A/ 660 V	00, DIN 43620	8566
BKD6/ 040/...-2...	32.8 A	40 A	5 SD4 60	50 A/ 500 V	E 33	-----
			3 NE4 102	40 A/ 1000 V	0, DIN 43620	8553
			3 NE8 017	50 A/ 660 V	00, DIN 43620	8567
BKD6/ 060/...-2...	49.2 A	60 A	3 NE4 117	50 A/ 1000 V	0, DIN 43620	8529
			3NE8 018	63 A/ 660 V	00, DIN 43620	8575
BKD6/ 100/...-2...	82 A	100 A	3 NE4 121	100 A/ 1000 V	0, DIN 43620	8526
			3 NE8 021	100 A/ 660 V	00, DIN 43620	8573
BKD6/ 150/...-2...	123 A	150 A	3 NE4 122	125 A/ 1000 V	0, DIN 43620	8532
			3 NE4 124	160 A/ 1000 V	0, DIN 43620	8545
			3 NE8 022	125 A/ 660 V	00, DIN 43620	8576
			3 NE8 024	160 A/ 660 V	00, DIN 43620	8700
BKD6/ 200/...-2...	164 A	200 A	3 NE3 225	200 A/ 1000 V	1, Ins. dim. 110 mm	-----
			3 NE4 327-0B	250 A/ 800 V	2, Ins. dim. 110 mm	8619
			3 NC8 425-3	200 A/ 660 V	3, Ins. dim. 110 mm	-----
BKD6/ 250/...-2...	205 A	250 A	3 NE3 227	250 A/ 1000 V	1, Ins. dim. 110 mm	8626
			3 NE3 230-0B	315 A/1000 V	1, Ins. dim. 110 mm	8620
			3 NE4 327-0B	250 A/ 800 V	2, Ins. dim. 110 mm	8619
			3 NC8 427-3	250 A/ 660 V	3, Ins. dim. 110 mm	8568
BKD6/ 300/...-2...	246 A	300 A	3 NE3 230-0B	315 A/ 1000 V	1, Ins. dim. 110 mm	8620
			3 NE3 231	350 A/ 1000 V	1, Ins. dim. 110 mm	8621
			3 NE4 330-0B	315 A/ 800 V	2, Ins. dim. 110 mm	-----
			3 NC8 431-3	350 A/ 660 V	3, Ins. dim. 110 mm	8548
BKD6/ 380/...-2...	312 A	380 A	3 NE3 231	350 A/ 1000 V	1, Ins. dim. 110 mm	8621
			3 NE3 232-0B	400 A/ 1000 V	1, Ins. dim. 110 mm	8627
			3 NC8 431-3	350 A/ 660 V	3, Ins. dim. 110 mm	8548
BKD6/ 480/...-2...	394 A	480 A	3 NE3 233	450 A/ 1000 V	1, Ins. dim. 110 mm	8622
			3 NE4 333-0B	450 A/ 800 V	1, Ins. dim. 110 mm	8571
			3 NE4 334-0B	500 A/ 800 V	2, Ins. dim. 110 mm	8574

2. Made by: SIBA

Power converter	Phase current (A_{eff})	Rated DC current (A)	Phase fuse			
			Type	Nominal current/ Nominal voltage	Size	Order No. 1900...
BKD6/ 030/...-2...	24.5 A	30 A	2038404/32 2020920/35	32 A/ 1000 V 35 A/ 660 V	0, DIN 43620 00, DIN 43620	8528 -----
BKD6/ 040/...-2...	32.8 A	40 A	2038404/40 2020920/50	40 A/ 1000 V 50 A/ 660 V	0, DIN 43620 00, DIN 43620	----- -----
BKD6/ 060/...-2...	49.2 A	60 A	2038404/50 2020920/63	50 A/ 1000 V 63 A/ 660 V	0, DIN 43620 00, DIN 43620	8529 -----
BKD6/ 100/...-2...	82 A	100 A	2038404/100 2020920/100	100 A/ 1000 V 100 A/ 660 V	0, DIN 43620 00, DIN 43620	8526 -----
BKD6/ 150/...-2...	123 A	150 A	2038404/160 2020920/160	160 A/ 1000 V 160 A/ 660 V	0, DIN 43620 00, DIN 43620	8545 -----
BKD6/ 200/...-2...	164 A	200 A	2031524/200	200 A/ 1000 V	1, Ins. dim. 110 mm	-----
BKD6/ 250/...-2...	205 A	250 A	2031524/250	250 A/ 1000 V	1, Ins. dim. 110 mm	-----
BKD6/ 300/...-2...	246 A	300 A	2031524/315	315 A/ 1000 V	1, Ins. dim. 110 mm	-----
BKD6/ 380/...-2...	312 A	380 A	2031524/350	350 A/ 1000 V	1, Ins. dim. 110 mm	-----
BKD6/ 480/...-2...	394 A	480 A	2031524/450	450 A/ 1000 V	1, Ins. dim. 110 mm	-----

5.4.2 Unit Size III

Connection voltage: 3 x 400V_{AC} or 3 x 500V_{AC}

For fuse protection, six arm-circuit fuses are required.

1. Made by SIEMENS

Power converter	Phase current/Current of an arm (A_{eff})	Rated DC current (A)	Arm-circuit fuse			
			Type	Nominal current/ Nominal voltage	Size	Order No. 1900...
BKD6/ 600/...-2...	492 A/ 348 A	600 A	3 NE4 333-0B 3 NE3 232-0B	450 A/ 800 V 400 A/ 1000 V	2, Ins. dim. 110 mm 1, Ins. dim. 110 mm	8571 8627
BKD6/ 800/...-2...	656 A/ 464 A	800 A	3 NE4 334-0B 3 NE3 334-0B	500 A/ 800 V 500 A/ 1000 V	2, Ins. dim. 110 mm 2, Ins. dim. 110 mm	8574 8623
BKD6/ 1000/...-2...	820 A/ 580 A	1000 A	3 NE4 337 3 NE3 336	710 A/ 800 V 630 A/ 1000 V	2, Ins. dim. 110 mm 2, Ins. dim. 110 mm	8572 8625

2. Made by SIBA

Power converter	Phase current/Current of an arm (A_{eff})	Rated DC current (A)	Arm-circuit fuse			
			Type	Nominal current/ Nominal voltage	Size	Order No. 1900...
BKD6/ 600/...-2...	492 A/ 348 A	600 A	2031624/400	400 A/ 1000 V	2, Ins. dim. 110 mm	-----
BKD6/ 800/...-2...	656 A/ 464 A	800 A	2031624/500	500 A/ 1000 V	2, Ins. dim. 110 mm	-----
BKD6/ 1000/...-2...	820 A/ 580 A	1000 A	2031624/630	630 A/ 1000 V	2, Ins. dim. 110 mm	-----

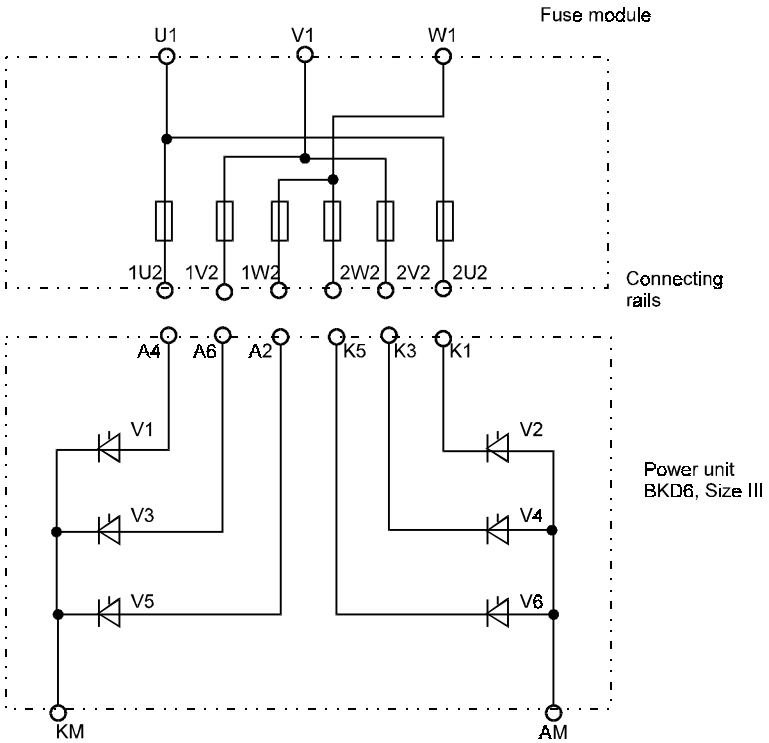
Power units of size III differ from sizes I or II due to their construction with individually fuse-protected disk-type thyristors.

The different arms of the three-phase current bridge, to which a total of six arm-circuit fuses can be connected, are routed separately to the outside. These fuses can be located in a fuse-carrier designed specifically for this purpose.

If mounted in the control cabinet, the fuse-carrier should best be located directly above the power converter so that the fuses can be cooled by the unit's fan and the cabling can be as short and simple as possible.

When arm-circuit fuses are used, phase fuses are no longer required.

Fuse module		Prod. No.
600 A:	fitted with fuses 3 NE4 333/ 450 A	32.89001
800 A:	fitted with fuses 3 NE4 334/ 500 A	32.89002
1000 A:	fitted with fuses 3 NE4 337/ 710 A	32.89003
Fuse module without fuses		32.89000/ 110120



Schematic circuit diagram of fuse module and power unit of size III

5.5 Line Reactors

A line reactor must be fitted between the power converter and the mains (provisional standard EN 50178/ VDE 0160).
The line reactor protects the thyristors against unacceptable rates of current rise and reduces feedback of the power converters to the supply mains.

- Three-phase current line reactors for connection voltage 400 V; U_N = 400 V 50/60 Hz, T_A = 55 °C, U_K = 4%/4.8% with flat termination, IP00

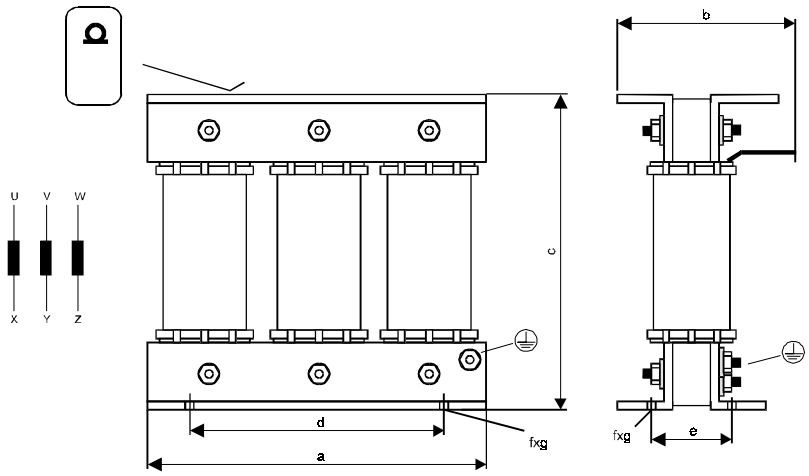
Reactor DR3-40-4	Rated DC current A	a mm	b mm	c mm	d mm	e mm	f x g mm	Flat termination diam. mm x mm	Out-line dia-gram	Weight kg	Losses W	Works number 1900 ..
- 0035	35	150	105	130	113	65	5.8 x 11	diam. 7	A1	6.0	45	- 7466
- 0040	40	150	105	130	113	65	5.8 x 11	diam. 7	A1	6.0	50	- 7467
- 0050	50	150	105	130	113	65	5.8 x 11	diam. 7	A1	6.0	55	- 7468
- 0080	80	180	130	158	136	75	7 x 14	Terminals 35 mm	A2	9.8	65	- 7822
- 0100	100	225	125	200	176	73	7 x 13	diam. 9	A1	12.7	90	- 7471
- 0120	120	225	125	200	176	71	7 x 13	diam. 9	A1	13.0	100	- 7472
- 0160	160	240	165	210	220	120	9 x 14	25 x 4/diam. 11	A1	19.0	105	- 7473
- 0200	200	310	170	255	280	106	11 x 18	25 x 4/diam. 11	A1	28.0	120	- 7474
- 0300	300	310	220	260	280	131	11 x 18	40 x 4/diam. 14	A1	50.0	170	- 7475
- 0400	400	310	220	260	280	131	11 x 18	40 x 4/diam. 14	A1	50.0	180	- 7476
- 0500	500	420	260	260	380	161	11 x 18	40 x 8/diam. 14	A1	70.0	185	- 7477
- 0600	600	420	260	260	380	161	11 x 18	40 x 8/diam. 14	A1	70.0	300	- 7478
- 0750	750	520	230	400	470	120	11 x 18	50 x 10/2x diam. 14	A3	110.0	350	- 7479
- 1050	1050	520	240	405	470	150	11 x 18	50 x 10/2x diam. 14	A3	130.0	400	- 7480

- Three-phase current line reactors for connection voltage 500 V; U_N = 420 V ... 500 V, 50/60 Hz, T_A = 55 ° C max., U_K = 4%/4.8% with flat termination, IP00

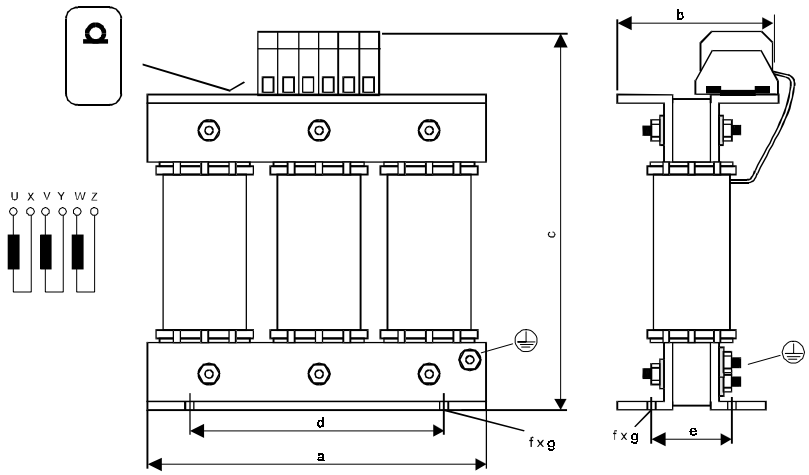
Reactor DR3-50-4	Rated DC current A	a mm	b mm	c mm	d mm	e mm	f x g mm	Flat termination diam. mm x mm	Out-line dia-gram	Weight kg	Losses W	Works number 1900 ..
- 0030	30	150	105	130	113	65	5.8 x 11	diam. 7	A1	6.1	30	- 7481
- 0050	50	180	130	155	136	75	7 x 14	diam. 7	A1	9.8	50	- 7482
- 0070	70	230	125	200	176	70	7 x 14	diam. 9	A1	13.0	65	- 7483
- 0100	100	230	125	200	176	70	7 x 13	diam. 9	A1	13.5	85	- 7484
- 0120	120	240	140	210	200	80	8.5	25 x 3/diam. 9	A1	16.8	95	- 7485
- 0150	150	240	160	210	200	100	8.5	25 x 3/diam. 11	A1	20.5	95	- 7486
- 0200	200	270	170	230	200	102	10 x 18	30 x 4/diam. 11	A1	27.5	135	- 7487
- 0300	300	300	210	265	240	125	9 x 14	30 x 5/diam. 14	A1	47.5	170	- 7488
- 0400	400	360	230	315	300	150	9 x 14	40 x 5/diam. 14	A1	73.0	225	- 7489
- 0600	600	470	240	370	320	155	9 x 14	40 x 8/diam. 14	A1	95.0	315	- 7490
- 0800	800	520	240	410	470	150	9 x 14	50 x 10/2xdiam. 14	A3	110.0	365	- 7491
- 1000	1000	480	300	420	360	170	14 x 19	50 x 10/2xdiam. 14	A3	140.0	445	- 7492

Dimensional drawings and connection diagrams

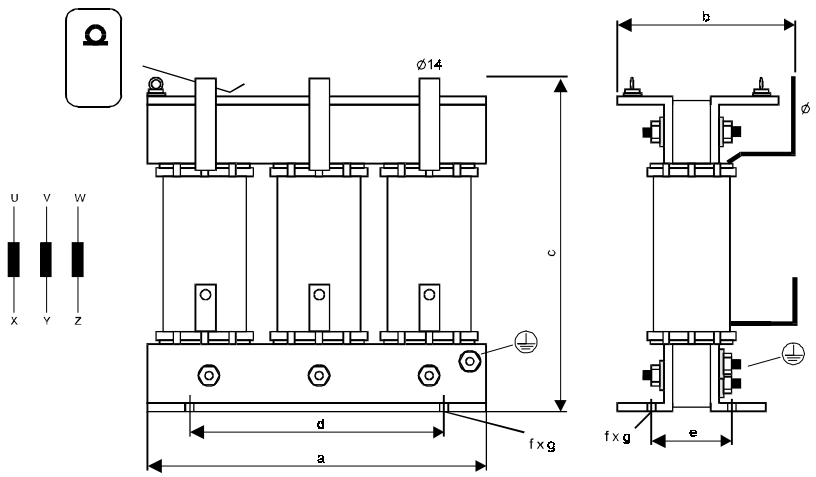
Dimensional drawing and connection diagram A1



Dimensional drawing and connection diagram A2



Dimensional drawing and connection diagram A3

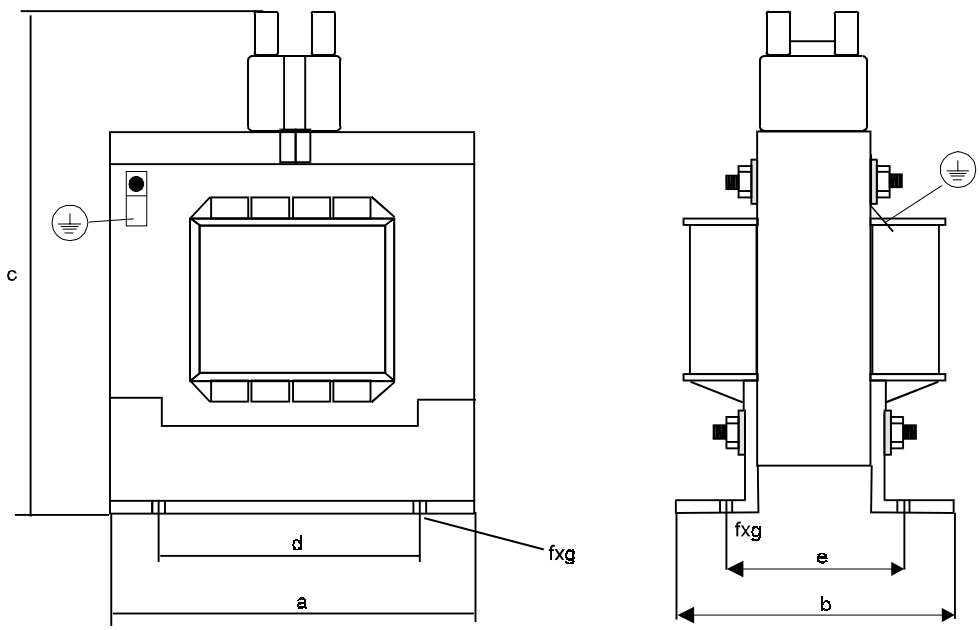


- Single-phase line reactor for connection voltage 230 V, 400 V or 500 V
  U_N = 230 V 50/60 Hz, U_K = 3%, T_A = 55° C, IP00,
  The line reactors are required for unit size III for mains connection of field controllers EK02 (Boards 3.8316 and 3.8317) or with separate field weakening control unit BZF4

  With 230 V_{AC} connection: use one reactor
  With 400 V_{AC} or 500 V_{AC} connection: one reactor per line

Reactor DR1-23-3	Rated DC current A	a mm	b mm	c mm	d mm	e mm	f x g mm	Weight kg	Losses W	Works number 1900 ..
0003	3	56	47	72	44	34.5	7 x 3.5	0.4	6	- 7460
0008	8	67	55	81	55	41	6 x 4.5	0.75	8	- 7461
0015	15	85	64	97	64	49	9 x 4.8	1.65		- 7462
0025	25	96	80	112	84	64	11 x 5.8	2.3		- 7463

Dimensional drawing of field line reactor



5.6 Adaptation of the Units to Different Connection Voltages

<table>
<tr><td></td><td></td><td colspan="10">Alternating connection voltage U_{mains} in V_{eff}</td><td colspan="2">Mains frequency</td></tr>
<tr><td></td><td>Power consumption</td><td>220V (10%</td><td>230V +6% -15V</td><td>230V (10%</td><td>380V (10%</td><td>400V +6% -15V</td><td>400V (10%</td><td>415V +6% -15V</td><td>415V (10%</td><td>460V (10%</td><td>500V (10%</td><td>50 Hz</td><td>60 Hz</td></tr>
<tr><td>Nominal direct voltage U_{1nom} of the power unit [1)]</td><td>$U_{netz}*I_A*$ 1.41 [VA]</td><td>260 V</td><td>260 V</td><td>275 V</td><td>460 V</td><td>460 V</td><td>480 V</td><td>480 V</td><td>500 V</td><td>550 V</td><td>600 V</td><td colspan="2">No adaptation required</td></tr>
<tr><td>Field supply:
(a) or (b) or (c)</td><td colspan="13"></td></tr>
<tr><td>a) Uncontrolled field 3.8214
(sizes I and II)</td><td>$U_{Netz}*I_E$ [VA]</td><td colspan="10">No adaptation required with $U_E=0.9*U_{Netz}$; with $U_E<0.9*$ U_{netz} adaptation via field adjusting resistor or field transformer; if required, use field weakening control unit</td><td colspan="2">No adaptation required</td></tr>
<tr><td rowspan="2">b) Field controller 3.8316/17 $U_{Enom}=$
Size. III</td><td>$U_{Netz}*I_E$ [VA]</td><td>170 V</td><td>170 V</td><td>180 V</td><td>300 V</td><td>300 V</td><td>310 V</td><td>310 V</td><td>320 V</td><td colspan="2">310 V</td><td colspan="2" rowspan="2">No adaptation required</td></tr>
<tr><td></td><td colspan="3">No adaptation required bridge 220 V</td><td colspan="3">No adaptation required bridge 380 V</td><td colspan="3">Adaptation via autotransformer; bridge 380 V</td></tr>
<tr><td rowspan="2">c) Field weakening control unit BZF4 $U_{Enom}=$
3.8106
(Option)</td><td>$U_{Netz}*I_E$ [VA]</td><td>170 V</td><td>170 V</td><td>180 V</td><td>310 V</td><td>310 V</td><td>310 V</td><td>310 V</td><td colspan="4">310 V</td><td colspan="2" rowspan="2">No adaptation required</td></tr>
<tr><td></td><td colspan="3">No adaptation required bridge V-W: 220 V</td><td colspan="4">No adaptation required bridge W-X: 380 V</td><td colspan="3">Adaptation via autotransformer; bridge W-X 380 V</td></tr>
<tr><td>Fan for</td><td colspan="13"></td></tr>
<tr><td>60 A - 150 A unit</td><td>230 V/0.2 A</td><td colspan="3">No adaptation required</td><td colspan="7">Adaptation via autotransformer</td><td colspan="2">No adaptation required</td></tr>
<tr><td>200 A- 300 A</td><td>230 V/0.5 A</td><td colspan="3">No adaptation required</td><td colspan="7">Adaptation via autotransformer</td><td colspan="2">No adaptation required</td></tr>
<tr><td>380 A - 480 A</td><td>230 V/ 0.85 A</td><td colspan="3">No adaptation required</td><td colspan="7">Adaptation via autotransformer</td><td colspan="2">No adaptation required</td></tr>
<tr><td>600 A - 1000 A</td><td>3 x 400 V/ 0.22 A</td><td colspan="3">Adaptation via autotransformer</td><td colspan="4">No adaptation required</td><td colspan="3">Adaptation via autotransformer</td><td colspan="2">No adaptation required</td></tr>
<tr><td>Power unit</td><td></td><td colspan="6">400 V power unit</td><td colspan="4">500 V power unit</td><td colspan="2">No adaptation.</td></tr>
<tr><td>Power supply</td><td>max. 40 VA</td><td colspan="4">230 V power supply</td><td colspan="5">400 V power supply</td><td colspan="2">500 V power supply</td><td colspan="2"></td></tr>
<tr><td>Closed-loop and open-loop control unit</td><td colspan="13"></td></tr>
<tr><td>a) In standard version. 3.8201.03 or .13</td><td></td><td colspan="11">No adaptation required</td><td>Bridge C-A not fitted</td><td>Bridge C-A fitted</td></tr>
<tr><td>b) With additional function 2 3.8201.04 or .14</td><td></td><td colspan="11">No adaptation required</td><td>Bridge C-A not fitted</td><td>Bridge C-A fitted</td></tr>
<tr><td>c) With additional functions 1+2 3.8201.36</td><td></td><td colspan="11">No adaptation required</td><td>Bridge C-A not fitted</td><td>Bridge C-A fitted</td></tr>
<tr><td>d) With additional function 1 3.8201.01 or .11</td><td></td><td colspan="11">No adaptation required</td><td colspan="2">No adaptation required</td></tr>
</table>

1. Maximum permissible values referred to the lower tolerance level

5.7 Configuration Guidelines

Three-phase current line reactors

According to provisional standard EN 50178/VDE 0160, a commutation reactor must be used to reduce feedback to the mains.

The relative short-circuit voltage of the three-phase current line reactors is 4% at a mains frequency of 50 Hz and 4.8% at 60 Hz, relative to a nominal mains voltage of $400V_{AC}$ and $500V_{AC}$, respectively, and the specified rated DC current.

The rated DC currents stated in the Tables in chapter 5.5 are relative to the direct current side of the current converter.

Usually, the line reactors are dimensioned according to the nominal current (S1) of the motor.

Single-phase current line reactors for field supply

For standard units, field line reactors are required only for unit size III (600A - 1000A) in the mains supply line of the field controller.

The relative short-circuit voltage of the line reactors is 3%/ 3.6% (50 Hz/60 Hz).

The single-phase line reactors listed in chapter 5.5 are dimensioned for an operating voltage of $230V_{AC}$.

This means:

- For $U_{mains} = 230V_{AC}$ use one reactor.
- For $U_{mains} = 400V_{AC}$ use two reactors (one reactor for each supply line).

Semiconductor fuses

For protection of the thyristors, semiconductor fuses with super-quick-acting shutdown characteristics must be fitted in the three-phase current supply line.

Suitable semiconductor fuses are shown in the Tables in Section 5.4.

NOTE

If you use fuses that are different from the ones listed, reliable protection of the power unit cannot be guaranteed!

At configuration, you must checked whether the specified semiconductor fuses can simultaneously protect the lines. If this is not the case, additional measures are needed for line protection.

Line selection

Mains connection lines and motor connection:

Cross-section according to DIN EN 60204 Part1/VDE 0113 Part1/06.93, Sections 14 and 15, Appendix C, or VDE 0298 Part 4.

Connection of protective conductor:
Cross-section according to DIN EN 60204 Part1/VDE 0113 Part1/06.93, Section 8.2.2, taking into account provisional standard EN 50178/VDE 0160/11.94, Sections 5.3.2.1 and 8.3.4.4.

Unit fan

Fan ratings:

Unit:	60A - 150A	200A - 300A	380A - 480A	600A - 1000A
Fan:	19007503	19007510	19007523	19007526
Ratings:	230V/ 0,2A	230V/ 0,5A	230V/ 0,85A	3 x 400V/ 0.22A (Fuses 0.63A m/500V are contained in the unit)

Field current adaptation and field current setting

- Unit sizes I and II (30A - 480A):

  These production units are equipped with an uncontrolled field supply (board 3.8214).

  No adaptation is needed if the rated field voltage $U_{E\ Nenn}$ of the motor fulfils the following condition: $U_{E\ nom} \leq 0.9 \times U_{mains}$.

  If the required field voltage of the motor deviates from the supply voltage provided by the power converter, adaptation can in most cases made by means of a field adjusting resistor.

  The required resistance can be determined as follows:

$$R = \frac{U_{ES} - U_{EM}}{I_E}$$

  Where U_{ES} = current converter excitation voltage (take into account mains voltage tolerance)
  U_{EM} = motor excitation voltage

$$P_R = I_E^2 \cdot R$$

  R=field adjusting resistance
  I_E=excitation current
  P_R=power loss

  Round up the calculated resistance to the next standardized value.

  In the event of a very large deviation, we recommend connecting a field transformer in series with the field rectifier for adaptation purposes.

Autotransformers with tapping points at 400V - 379V - 358V -and 336V are available.

Rated currents and works number of the transformers:

3 A (internal identifier 19007151)
6 A (internal identifier 19007152)
10 A (internal identifier 19007141)

If other transformers are required, the ratio can be determined as follows:

$$u = \frac{U_{mains}}{U_{EM} \cdot 1,11}$$

For special applications, we recommend using field weakening control unit BZF4 (wired as a constant field). The unit must be connected externally to the power converter.

- Unit size III:
  With these units, the field controller is fitted as standard (boards 3.8316 and 3.8317).
  The required field current is set with a potentiometer.
- Drives with field weakening:
  This application requires the use of field weakening control unit BZF4, which has its own casing and must be fitted externally to the power converter.

Switching-on and switching-off

You do not need to apply the supply voltage to the power unit and operating voltage supply in any particular order when **switching-on** the unit if the controller is reliably inhibited.

The controller must not be enabled until after the power unit has been connected to the mains!

As a rule, you connect the power unit and the operating voltage supply at the same time to the mains; and after this you start the drive separately by means of the command controller enable.

When **switching-off,** you must only separate the power unit from the mains when it is deenergized.

This must be done as follows:

First inhibit the controller and then switch off the mains contactor with a delay of at least 50 ms (in most cases, the contactor drop-off time lag is sufficient).

Adaptation of the tachometer generator voltage to the control unit

Adaptation depends on the components fitted to controller board 3.8201. ...

Standard version open-loop and closed-loop control: boards 3.8201.03 and 3.8201.13
Open-loop and closed-loop control with additional function 2: boards 3.8201.04 and 3.8201.14
Open-loop and closed-loop control with additional functions 1 + 2: board 3.8201.36

Max. tachometer generator voltage U_{TG}	30-50 V	50-80 V	80-120 V	120-200 V
R 20/2 W/TK 25	10 kΩ	22 kΩ	39 kΩ	68 kΩ

Open-loop and closed-loop control with additional function 1: boards 3.8201.01 and 3.8201.11

Tachometer voltage	from ...14 V	21 V	26 V	32 V	39 V	44 V	50 V	57 V	65 V	76 V
UTG (V)	to ...21 V	26 V	32 V	39 V	44 V	50 V	57 V	65 V	76 V	89 V
R 263	1.5 k	3.9 k	6.8 k	10 k	12 k	15 k	18 k	22 k	27 k	33 k
R 264	1,5 k	3.9 k	6.8 k	10 k	12 k	15 k	18 k	22 k	27 k	33 k

Tachometer voltage	from	89V	103V	115V	125V	135V	150V	165V	180V	195V
UTG (V)	to	103V	115V	125V	135V	150V	165V	180V	195V	210V
R 263		39 k	47 k	47 k	56 k	56 k	68 k	68 k	82 k	82 k
R 264		39 k	47 k	56 k	56 k	68 k	68 k	82 k	82 k	100 k

5.8 Information for EMC-Appropriate Machine and System Installation

One of the conditions for correct functioning of an automation system is that the electrical resources that comprise the complete system should not, during operation, mutually influence their functions in an impermissible way or be disturbed by external electromagnetic effects.

In general, this can be achieved by observing and complying with EMC criteria.

EMC is the abbreviation of Electromagnetic Compatibility, which is defined in the standards as follows:

“Electromagnetic Compatibility describes the ability of a piece of electrical equipment to function satisfactorily in its electromagnetic environment without influencing this environment – in which other equipment is also located – in an impermissible way.”

To achieve EMC-appropriate installation, you should always bear in mind the configuration information listed below.

Due to the fact that drives are operated in widely differing electromagnetic environments and are mutually affected by a wide range of different components such as controllers, measuring systems, switched inductivities, etc. whose interference emissions and noise immunity can vary widely, you should consider the measures suggested here as a list of guide values that does not claim to be complete.

These guide values are adequate if drives are used in normal industrial surroundings and the other system components have suitable levels of noise immunity.

In surroundings that are very harsh from an electromagnetic point of view, further selective measures may prove to be necessary, e.g. additional interference suppression of individual system components or other measures listed in the separate description entitled “EMC on and with Line-Commutated Converters of Series BKF12/... and BKD6/...”.

General

- You must wire switched inductivities, e.g. relays, contactors, solenoid valves, etc. with spark-quenching combinations or overvoltage-limiting components (RC combinations, varistors or diodes, for example), directly on the coil.
- Components that are sensitive to disturbances, e.g. µPs, bus systems, etc. should be physically separated from potential sources of interference such as transformers, reactors or power electronics resources, for example.
  There must be a distance between the current converter and other potentially susceptible equipment of at least 20 cm.

Frame-grounding/Earthing

- You should connect together all the metal parts of the switching cabinet over a wide area and with good conductivity.
  It is advisable to use metallic bare mounting plates, preferably with a galvanized surface.
  If it is not possible to use a broad reference plate, you should mount the main equipotential busbar directly next to the converter, since this device usually generates the greatest potential jumps compared with the other components in the switching cabinet.
- Before making the ground connections, remove insulating layers such as varnish, adhesive, etc. from the contact points. It is also advisable to use DIN 6798 serrated lock washers that bite into the material to be contacted when you tighten them and cut through any protective (oxide) layers that may still be present.

Corrosion is dependent on the difference in potential of the metal parts that touch one another and on the conductivity of electrolytes in the contact area. To prevent electrochemical corrosion, choose the metal parts that are to be connected on the basis of the electrical displacement series and protect the contact points – particularly in the case of aggressive air pollution – by a layer of grease from penetration by damp and electrolytes.

Cabling

- Route cables as close as possible to the reference potential to keep the effective antenna height as low as possible. Avoid outdoor cabling.
- To avoid ground loops, you should run connectors and screens directly across the frame ground.
- Lay power cables physically separate from the control and signal lines. To avoid interference by near-field influences, keep them at least 20 cm apart.
- Lines of different EMC categories should only cross at an angle of 90°.
- Avoid reserve loops on overlong cables.
- Connect reserve lines at both ends to the switching cabinet's ground (this has an additional screening effect!)
- You should twist the unshielded lines of a current circuit to prevent asymmetric electromagnetic effects.
- Choosing cables and lines for wiring the converter:
  – Analog signal lines (particularly speed specified value lines, the line to the analog tachometer) must be twisted pairs.
  – In normal industrial applications with usual levels of electromagnetic interference you may use unshielded cables for digital control lines for triggering the controller (controller enable, pulse enable, etc.); however, the lines should be twisted to reduce asymmetric interference effects.
  – With BAUMÜLLER line-commutated converters of types BKD ... and BKF ..., you may use unshielded cables; however, when laying the cables you should try to keep the control and signal lines at least 20 cm apart to avoid interference by near-field influences (see above).
  – If you use EMC filters to help to suppress conducted disturbances, you must also lay the power cables of different EMC categories (mains lines before the filter mains and motor lines after the filter) physically separate from one another (try to keep them at least 20 cm apart).
  – This measure is intended to prevent unnecessary line links canceling out the effect of the filter. If necessary, use separating panels or similar.
- When routing cables (motor lines, tachometer generator, etc.) outside the switching cabinet, run them as close as possible to the frame ground system. If necessary, use metal cable rack profiles that have a good conductive connection to the frame ground system (effective antenna height, screen effect).

Screening

- Connect the screens of analog signal lines to frame ground on one side to prevent low-frequency couplings.

  Exceptions:

  – Multiple screen connections are possible in the switching cabinet (e.g. at the entrance to the cabinet and on the converter) if there is good equipotential bonding by means of the metal mounting plate.
  – With relatively long lines (about 70 m and above), the second end of the screen must be connected capacitively.
  – The capacitor guide value is 100 nF. To prevent resonance phenomena, you can, in addition, provide an RC element in-parallel to the capacitor where C = 100 nF and R = 100 W.
  – Instead of the capacitive line terminator, you can also use double-screened cables with two separate screens. The external screen must be connected at both ends to reduce high-frequency influences; the internal screen only needs to be connected on one end.

- Connect the screens of digital signal lines at both ends to frame ground.
  This is conditional on good equipotential bonding between all parts of the system so that the screen current cannot take on inadmissibly high values. If necessary, you must lay an equipotential bonding conductor with an adequate cross-section (EN60204 Part 1/ VDE0160 Part 1) parallel to the screen. With relatively long lines, it is advisable to have several screen contacts. Otherwise, the exceptions for screened analog lines apply in this case too.

- The screen connection point does not necessarily have to be at the end of the cable screen; it can, for example, also be mounted close to the converter. However, you must route the braided screen on to the end of the cable.

- With cable screens that are to be grounded at one end, you should prefer to connect the end at which there is a lower impedance of the signal lines to ground.

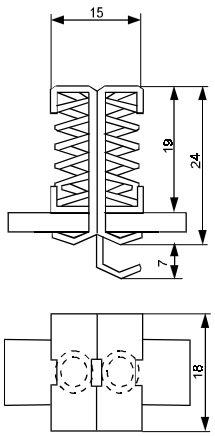
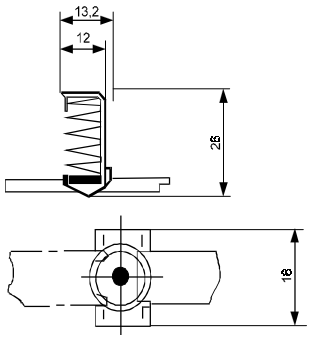
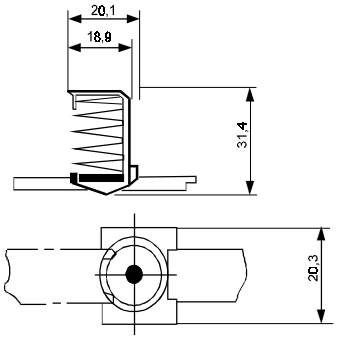
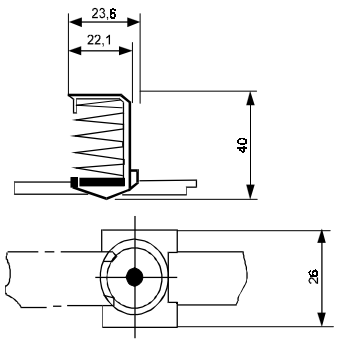
- Make the screen connections low-impedance and over a wide area. The lowest impedances can be achieved with wide area all-round contact. For this, you can use the cable clips mounted on the converter as well as the screen clips (see below) that are available as accessories.
  You should always prefer to carry out grounding by means of screen clips to cable plaits. As result, cable tails that are only three centimeters long (1 cm of wire = 10nH) reduce the screening effect in the case of disturbances in the megahertz range by up to 30 dB!

  Electric circuits of different voltages and/or frequencies should not be routed in a common cable!

  If the current converters are the main sources of interference in the switching cabinet and no other screen suppression values are needed, you can use normal commercially available steel switching cabinets, i.e no special RF-proof EMC cabinets are needed.

  It is advisable to use bare metallic mounting plates and to additionally ground screened lines at entry to the switching cabinet.

Shield terminals for grounding

	Cable Diameter (mm)	Product No.
	2 x 2 - 6 mm	226752
	3 - 8 mm	226741
	4 - 13.5 mm	226745
	10 - 20 mm	226749
	Larger cross-sections on request	

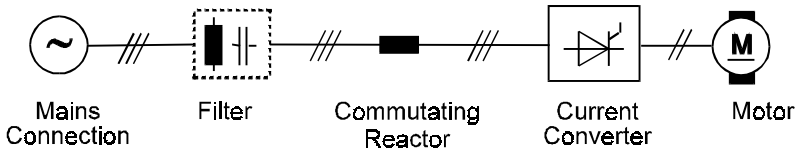
Filtering

- No filters are needed for converters of types BKD/ ... and BKF/ ... to function.
  However, under some circumstances, line-end filters may be needed to cope with certain regulations, e.g. Limit Value Class A1 according to EN 55011)..

NOTE

In the EMC product standard for electrical drives provisional standard EN 61800-3, high-frequency emitted interference in an industrial environment is not limited (see Section 6.3.2 of the EMC product standard).

- For filter rating, refer to the separate description entitled Baumüller Filters for Network Applications.
- You should mount the interference-suppression filter and the converter on the same mounting plate and make a good RF-conductive connection between them.
- Connect the filter casing to ground over a wide area.
- Lay the input and output lines of the filter physically separate from one another.
- To comply with specified limit values, the mains connections of the armature and field current converters (BZF4, EK 02) must always be filtered. Unregulated field supplies, on the other hand, do not need to be filtered, since the interference they emit is generally of a much lower level.
  You must provide a common mains filter for both inputs. If it is feasible, you could also implement a collective interference suppression filter for the entire system or for a relatively large section of it.
- Wire the suppression filter in accordance with the diagram below:

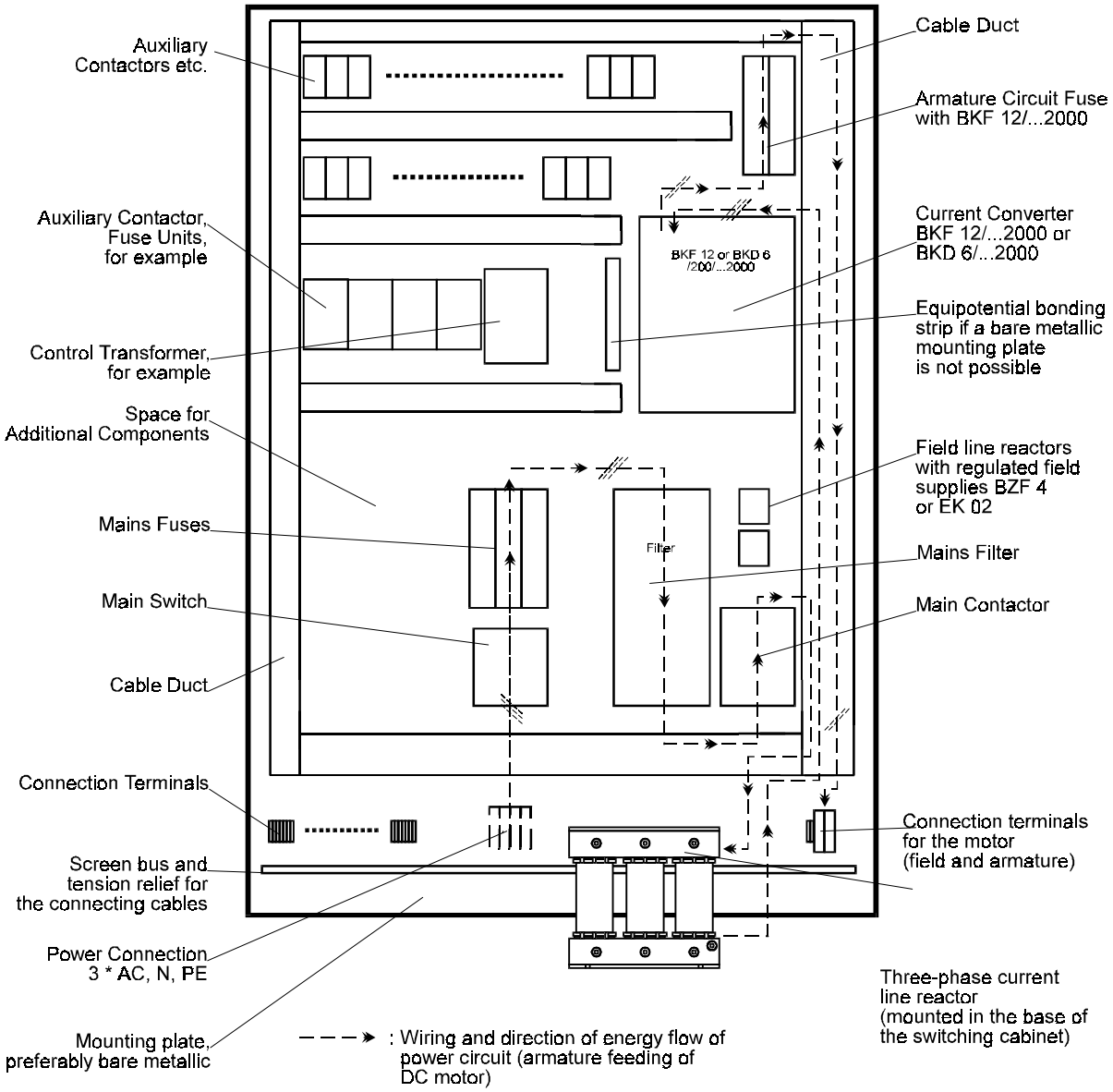


The filter must not be directly connected to the converter – you must always provide a commutating reactor!

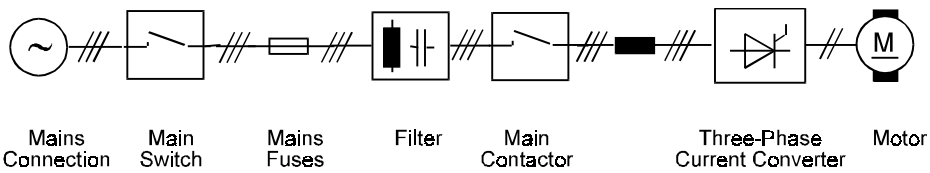
- During operation, the principles on which the filter, the power converter and the motor work lead to capacitive leakage currents to earth that are dissipated via the specified protective earths and may result in a current-operated e.l.c.b on the input side blowing prematurely.
  In this connection, observe the safety information in preliminary standard EN 50178/VDE 0160/ 11.94, Paragraph 5.2.11.2.
- Observe the specifications in preliminary standard EN 61800- 3/12.95, Paragraph D.2 Safety Features with Filtering Measures and Leakage Currents.

Example of switching cabinet structure with 200 A converter and mains filter

Circuit diagram of the power circuit:



Circuit diagram of the power circuit



6 COMMISSIONING

Danger Information

WARNING

This equipment carries a dangerously high voltage and, depending on the version, may have dangerous rotating parts (fans). Ignoring the safety and warning information may result in death, severe personal injury or damage to property.

You are responsible for mounting the power converter, the motor, the commutating reactor and any other equipment in accordance with appropriate safety regulations (e.g. DIN, VDE); equally, you must ensure that all other relevant national and local regulations are met with regard to cable ratings and protection, grounding, disconnecters, overcurrent protection, etc.

The most important factors for protecting people are the DIN/VDE protective measures and safety regulations. If there are no protective earth connections on the equipment, commutating reactor or the motor, personal injuries are inevitable, since the surfaces may carry dangerously high voltages.

The power converter's power cables are energized!

The DC side is not galvanically isolated from the mains!

The mains unit and the field connector of the power converter carry a dangerous voltage even when the main contactor has dropped.

During operation, the principles on which the power converter and the motor work lead to leakage currents to earth that are dissipated via the specified protective earths and may result in a current-operated e.l.c.b on the input side blowing prematurely.

In the case of a short-circuit to frame or to ground, a direct proportion may arise in the leakage current that makes triggering a higher level current-operated e.l.c.b either more difficult or totally impossible.

Make the PE connection in accordance with DIN EN 60204/VDE 0113 Part 1/06.93; Section 8.2.2 taking into account provisional standard EN 50178/ VDE 0160/11.94, Sections 5.3.2.1 and 8.3.4.4.

Before carrying out commissioning, check whether the plastic covers over the power stage connections are in place.

WARNING

You must only reset the converter when the controller is inhibited and the motor is at a standstill.

If an error occurs, the drive is deenergized and then coasts unbraked to a standstill. You should consider this situation particularly with motion and lifting drives.

Faulty drive response

During initial commissioning, faulty or uncontrolled motion of the driven machine elements is always possible. At this stage, you should therefore proceed with particular care.

Before switching on the drive, you must carefully check the functions of all the higher level safety equipment to prevent injury to people.

Take particular care when directly or indirectly touching the drive shaft with your hand. This is only allowed when the shaft is stationary and the power converter is deenergized. Any exposed parts of the machine, such as the shafts, fans, etc., must be covered during operation.

Contact protection in accordance with paragraph 4 Section 4 VBG 4

Protection against direct contact comprises all the measures against danger that can result from touching the active parts of electrical equipment.

You must therefore protect the active parts from being touched by means of insulation, the construction and arrangement of the equipment or permanently mounted guards. The guards in question are standard covers, barriers and procedures that guarantee that people cannot touch active parts that are carrying power.

Switching cabinets must have an emergency off facility to switch off any voltages that could be dangerous. This does not include equipment which, if switched off, would cause an even more dangerous situation. The emergency off releasing element must be arranged in such a way that it can be reached quickly in case of danger. In the case of work that is considerably more dangerous than usual, another person must be present.

The machine minder must ensure that unauthorized people do not work at the machine.

The machine minder must report immediately any changes that occur at the machine which adversely affect safety.

When dismounting safety equipment during commissioning, repair and maintenance work, you must ensure that the machine is taken out of commission in accordance with applicable regulations. You must remount and check safety equipment immediately after completing commissioning, repair and maintenance work.

NOTE

When commissioning using a PC, you must connect the interface cable to the power converter's RS 232 service interface.

For safety reasons, you are advised to only handle this plug with the motor idle and the controller disabled.

Observe electrostatic discharge protection: Before touching the plug, discharge electrostatic energy from your body by touching a grounded conductive object, for example.

6.1 Commissioning Guidelines

6.1.1 Recording of Actual Condition

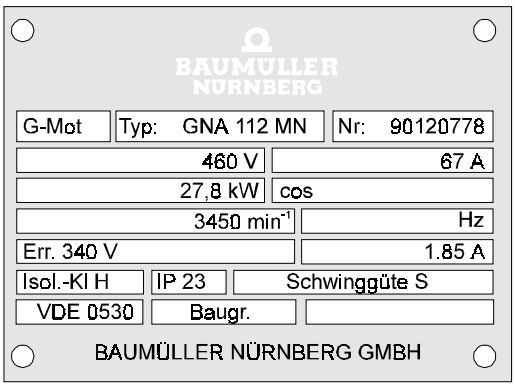
The data on the machine, motor, power converter and additional components must be recorded and entered in the configuration and commissioning record.

- Machine: Type, serial number, customer
- Mains: Connected load, frequency, type of mains (TN or TT mains)
  e.g.: voltage: 3 x 400 V
  rotating field:
  clockwise rotating field
- Power converter: The rating plate is located inside the casing on the left-hand side.
  Sample rating plate

Built-in power converter for rectifying and inverting

Type:	BKD 6/060/460-203000000	
Input:	3 AC 400 V	50/60 Hz
Output:	DC 0 ... 460 V	60 A
Mode:	DB mains: TN or TT	No. 90316556J

- Field supply: Field supply of unit field weakening control unit BZF4,
  field adjusting transformer, field adjusting resistor
- Additional board: Components for monitoring functions fitted?
  e.g. type 3.8311, 3.8336 or 3.8418
- Tachometer resistance: Lid board executions 3.8201.03/.13, 3.8201.04/.14, 3.8201.36
  R201: kΩ/2 W/TK25
  Lid board versions 3.8201.01/.11
  R263: kΩ/2 W/10%
  R264: kΩ/2 W/10%
  For position of lid board, refer to closed-loop and open-loop control data
- Motor data: According to rating plate, e.g.



- Tachometer generatore.g. type GHTS 42
  No.:003319
  Current:max. 10 mA
  Voltage:20 V/100 min^{-1}
- Three-phase current line reactor for armature power converter
- Single-phase line reactor for field power converter (only for unit size III or separate field weakening control unit BZF4)
- Semiconductor fuses

6.1.2 Unit Setting

NOTE

Power converters are subjected to complete function testing by the manufacturer. This testing also covers exact setting of potentiometers and optimization of the controllers. Therefore, the following checks are sufficient at commissioning of the unit.

Before switching-on

- Check the cabling and line cross-sections
- Check the unit connection and protective measures

WARNING

Power unit and mains and motor connections carry electrical potential in operation.

- Check the higher-level safety devices (e.g. emergency stopping device of machine)
- Check the phase coincidence between power supply and power unit
- Hook up the push-button or switch for controller enable and/or operation/creep mode
- Set potentiometer R235/I_{1max} all the way to the left, mark the previous setting

Unit and motor fan

- Switch on the motor and power converter fans, check the direction of rotation

Setting of field supply

WARNING

When you open the current-carrying field circuit, an electric arc may occur which can be life-threatening.

Observe these steps when commissioning the three possible field supply versions:

1. Uncontrolled field: board 3.8214 of unit sizes I and II (30 A - 480 A)

WARNING

In operation the field power unit carries electrical potential!
You must therefore make all settings (e.g. of the field adjusting resistor) only when the unit is deenergized.

- Check that the equipment is deenergized!
- Connect a direct current ammeter to the field circuit
- Switch on the field supply
- Check the field current I_F
  $1.3*I_{fnom}$ as indicated on the motor rating plate with the winding cold. Only carry out setting on the field adjusting resistor or adjusting transformer when the equipment is deenergized.
- Switch off the field supply, restore the initial condition (remove measuring instrument)

2. Field controller of unit size III (600 A - 1000 A)

WARNING

In operation the field power unit carries electrical potential!
You must therefore make all settings (e.g. of the field adjusting resistor) only when the unit is deenergized.

- Check that the equipment is deenergized!
- Connect a direct current ammeter to the field circuit. If function “zero-speed field” is required: connect a push-button switch safe from contact (NO contact) or switch to the terminals on board 3.8316/X1:6,7.
- Switch on the field supply

– Checking/adjusting the field monitoring
  Connection of the field monitoring device is shown by LEDs H1 and H2:
  H2/green lights up with I_F = O.K.
  H1/red lights up with $I_F < I_{Flim}$
  Use potentiometer R7 on board 3.8316 to reduce/increase the field current until the field monitoring device responds.
  If necessary, readjust the switching threshold of the monitoring device with potentiometer R5 on board 3.8316.
– Set the nominal field current I_{fnom} to the value stated on the motor rating plate using potentiometer R7 on board 3.8316.
– Check/set the minimum field current (“zero-speed field”). Press push-button/switch to reduce the field current to I_{fmin}.
  If necessary, set with potentiometer R35 on board 3.8316.
– Switch off field supply, restore initial condition (remove measuring instrument and switches, restore original wiring).

3. Field weakening control unit BZF4

WARNING

In operation the field power unit carries electrical potential!
You must therefore make all settings (e.g. of the field adjusting resistor) only when the unit is deenergized.

– Check that the equipment is deenergized!
– Connect a direct current ammeter to the field circuit, connect a push-button switch safe from contact (NO contact) or switch to terminals 3.8106/X3:7,8.
– Switch on the field supply.
  LED H1/green lights up on the field weakening control unit.
– Checking/setting nominal field current $I_{fnom.}$
  If necessary, set to the value stated on the motor rating plate using potentiometer R28/I_{fmax} on board 3.8106.
– Check/set minimum field current
  Press the push-button/switch to reduce the field current to I_{Fmin}.
  If required, set to 80% of the value stated on the motor rating plate using potentiometer R39/ I_{fmin} on board 3.8106.
– Switch off the field supply
  Check if the field monitoring relay drops. Restore the initial condition (remove measuring instrument, restore original wiring).

Setting of controller board 3.8201

For diagnosis and display of different operating conditions, the following LEDs are available at the right-hand edge of the board :

- H1 (green)/IF: Pulse enable.
  Lights up with clockwise rotating field after the switch-on delay (approx. 250 ms)
- H2 (green)/DFRE: Clockwise rotating field.
  Lights up immediately after application of the supply voltage with clockwise rotating field.
- H3 (red)/DFLI: Anti-clockwise rotating field.
  Lights up immediately with anti-clockwise rotating field. The pulses are inhibited, i.e. LED H1 (green)/ IF must not light up.
- H4 (red)/RS: Controller inhibit.
  Lights up when the controllers and the ramp function generator are inhibited.
- H5 (green)/RF: Controller enable
  Lights up when the controllers are enabled. The LED must light up only when H1 (green)/IF also lights up.
- H6 (yellow)/SGR: Message: “Current limit reached”
  Lights up as soon as the preset current limit is reached or the closed-loop control circuit is interrupted.

Only for equipment with additional functions 1 or 1 + 2:

- H7 (green)/Betr.: Operation.
  Lights up when “operation” is selected (ramp function generator enabled).
- H8 (yellow)/SG:Creep feed.
  Lights up when “creep mode” is selected (creep mode rated value is connected and ramp function generator inhibited).
- Switch on only the controller supply, keep the controller inhibited.
  The following LEDs must light up:
  H1/IF
  H2/DFRE
  H4/RS
  If, however, H3/DFLI and H4/RS light up, there is an anti-clockwise rotating field.
  In this case, the rotating field must be corrected by changing two mains supply lines (switch the mains off first and ensure phase coincidence to the power unit!) and then re-checking.
- Connect the controller supply and power unit with identical phases, keep the controller inhibited. Check phase coincidence by taking a measurement.
- With the controllers inhibited, set the maximum rated speed value and check if +10 V are present at the controller and ramp function generator inputs used. Then reset the rated value to 0 V.
- Connect field; check if potentiometer R235/I_{1max} is all the way to the left.

- At specified speed value n_{spec} = 0 RPM
  enable controller and/or activate operation/creep mode (with additional functions 1 or 1 + 2).
  All the green LEDs must be lit up, as well as LED H6/SGR.

WARNING

This setting/checking is the most critical commissioning operation in the entire unit setting procedure. If the tachometer, field or armature are wrongly polarized, there is a risk of the motor accelerating unchecked up to maximum speed.

In drives with field weakening (BZF4), the motor can run up to inadmissibly high speeds and explode!

- Slowly open potentiometer R235/I_{1max} to the right and check if the drive runs at minimum speed.
  If the drive runs up **straight away, immediately** inhibit the controller/reset potentiometer R235/I_{1max} all the way to the left.
  Recommission the unit carefully, starting from the first step.
  Check in particular the polarity of the armature, field and tachometer connections.
- If the drive can be controlled, check if the direction of rotation is correct.
- If the drive cannot be controlled:
  Check the equipment according to the detailed troubleshooting guide and in particular the current converter using the test point description and the function plan.
- Setting/checking the unit's current limit
  On units preset at the factory, it is generally sufficient to set R235/I_{1max} to the value that was marked at the start of commissioning.
  If the current limit set is to be checked by means of measurements, proceed as follows:
  – Disconnect the drive from the mains.
  – Disconnect the field, if necessary, bridge the field monitoring device, block the motor.
  – Connect a direct current ammeter/current measuring device to the armature circuit.
  – Switch on the equipment, enable the controller and set a low specified speed value; among others, LED H6/SGR must light up.
  – Set the armature current to the required value using potentiometer R235: I_{1max} .

NOTE

The rated DC current must be applied to the non-rotating motor for a very short time, since the collector can otherwise be damaged. Never exceed the rated DC current.

  – Inhibit the controller and switch off the equipment.
  – Restore the initial condition (field, field monitoring device, armature, armature circuit).

Additional setting for drives with field weakening control

Only possible in conjunction with field weakening control unit BZF4 and speed control.

- Switch on the equipment, set the rated speed value to 0 V.
- Enable the controller.
- Continuously increase the speed specified value, checking the armature voltage and motor speed and compare it to the nominal value indicated on the motor rating plate.
- Set the maximum armature voltage with potentiometer R31 on the field weakening control unit BZF4/ board 3.8106.
  If the cross-over point is not reached because the maximum speed has not yet been adjusted, increase the drive speed by slowly turning the n_{max} potentiometer to the right, until the cross-over point is reached. You must keep checking the motor speed!
- Inhibit the controller.

Controller settings depending on the components fitted on controller board 3.8201:

1. Standard version of closed-loop and open-loop control unit
   Boards 3.8201.03/.13

   – Maximum speed with speed control: Left-hand stop with U_A control — Pot. R202/n_{max}
   – Maximum speed with U_A control: Left-hand stop with speed control — Pot. R125/ U_{Amax}
   – IxR compensation with U_A control: Left-hand stop with speed control — Pot. R219/ IxR_{oper}
   – Minimum speed — Pot. R112/n_{min}
   – Ramp-up time integrator — Pot. R107/$T_{integr.}$
   – Proportional gain speed controller — Pot. R232/P_{gain}

2. Closed-loop and open-loop control with additional function 1
   Boards 3.8201.01/.11

   – Maximum speed with speed control: Left-hand stop with U_A control — Pot. R241/n_{max}
   – Maximum speed with U_A control: Left-hand stop with speed control — Pot. R125/ U_{Amax}
   – IxR compensation with U_A control: Left-hand stop with speed control — Pot. R219/ IxR_{oper}
   – Creep speed — Pot. R224/n_{CS}
   – IxR compensation in creep mode with U_A control — Pot. R216/IxR_{CS}
   – Minimum speed — Pot. R112/n_{min}
   – Ramp-up time integrator — Pot. R107/$T_{integr.}$

3. Closed-loop and open-loop control with additional function 2
   Boards 3.8201.04/.14

   – Maximum speed with speed control:
     Left-hand stop with U_A control — Pot. R202/n_{max}
   – Maximum speed with U_A control:
     Left-hand stop with speed control — Pot. R125/ U_{Amax}
   – IxR compensation with U_A control:
     Left-hand stop with speed control — Pot. R219/ $IxR_{oper.}$
   – Minimum speed — Pot. R112/n_{min}
   – Ramp-up time integrator — Pot. R107/$T_{integr.}$
   – Proportional amplification speed controller — Pot. R232/P_{gain}
   – Maximum current I_2
     Always in left-hand stop position — Pot. R243/I_{2max}
   – Actual current value output — Pot. R345/$I_{actadap}$

4. Closed-loop and open-loop control with additional functions 1 + 2
   Board 3.8201.36

   – Maximum speed with speed control:
     Left-hand stop with U_A control — Pot. R202/n_{max}
   – Maximum speed with U_A control:
     Left-hand stop with speed control — Pot. R125/ U_{Amax}
   – IxR compensation with U_A control:
     Left-hand stop with speed control — Pot. R219/ IxR_{oper}
   – Minimum speed — Pot. R112/n_{min}
   – Ramp-up time integrator — Pot. R107/$T_{integr.}$
   – Proportional amplification speed controller — Pot. R232/P_{gain}
   – Creep feed speed — Pot. R224/n_{CS}
   – IxR compensation in creep mode
     with U_A control — Pot. R216/IxR_{CS}

Further checks and settings

- Function of the monitoring board
- Function of the peripheral monitoring devices
- Response of the controller under load

6.2 Controller Optimization

Good dynamic behavior with short reaction times is conditional on exact and play-free mounting of the tachometer generator to the motor.

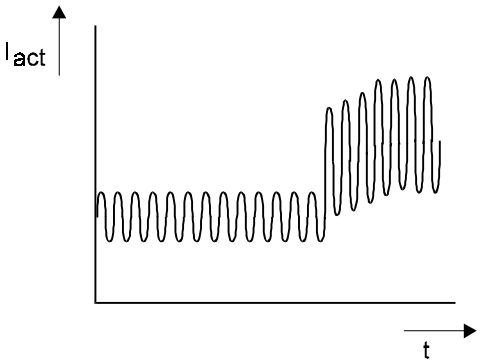
If the control circuit is unstable, first try to correct this by changing the setting of the P gain of the speed controller at medium speeds.

It can be influenced on the lid board at a ratio of 1:6 by means of potentiometer R 232: P-Verst.

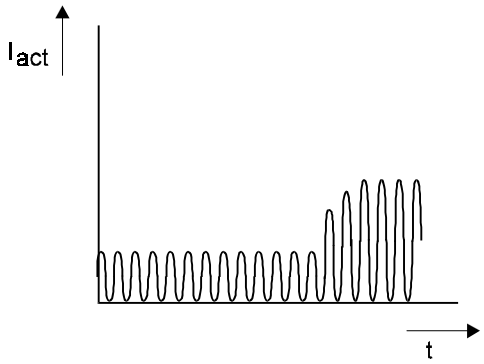
If the control circuit continues to be unstable, new optimization of the controller connections is required.

You can determine these controller connections experimentally using an R-C wiring decade.

Optimization is first carried out on the current controller, then on the speed controller.



Current controller optimization
with continuous flow



Current controller optimization
with intermittent flow

6.2.1 Current Controller Optimization

Standard connection on delivery

R 350 = 18 kΩ

C 350 = 0.68

R 331 = 4.7 kΩ

Integrating time: T_i = 37 ms with continuous current
I_i = 8 ms with intermittent current

Integral-action time: T_N = 12 ms with continuous current
T_N = 3 ms with intermittent current

NOTE

If the current converters are used for feeding Baumüller motors, new optimization of the current converter is not generally necessary.

- Switch off the equipment.
- Disconnect the field supply, bridge field monitoring, if necessary, block the motor.

a) Optimization with continuous current

- Remove current controller connections R 331, C 350 on one side
- Replace R250 with a 56 kΩ resistor, remove C250, set potentiometer R232 (P gain) all the way to the left.
- Bridge soldered tags EC and ED with switch S1 and close the contact, connect switch S2 to the +10 V supply of potentiometer n_{spec} and close the contact.
  If the specified speed is routed via the ramp function generator, the specified value potentiometer slider must be attached directly to the speed controller input (refer to the Figure in Section 6.3.1 c).
- Connect an RC connecting decade in soldered tags FA and FD (refer to the Figure in Section 6.3.1 c). First set the values removed before for R and C.
- Connect oscilloscope to measuring positions X101/8 (actual current value) and X101/16 or to bridge R 301.
- Switch on the equipment, enable the controller.
- Increase the preset specified value (using the external speed specified value potentiometer) until the armature current exceeds the pulsating limit.

- Set short-term step-changes of the specified value by opening switch S1. (Maximum specified current value is set with potentiometer R 235: I_{1max}).

WARNING

Do not exceed permissible zero-speed loading of the motor, since the collector can otherwise be damaged!

The actual current value curve should have the shape shown in the figure in chapter 6.2 (current controller optimization in continuous operation).

In the event of major deviations – especially current overshoots or current peaks of unequal height in stationary condition – the wiring values must be changed. The controller should be inhibited before changing over to other wiring values.

General guidelines for experimentally determining the optimum controller connection:

With increasing negative feedback resistance (R350), the control response time and overshoot increase.

With increasing integral-action time (T_N = R350 x C350!) transient oscillation to the final value lags more and more.

If the integral-action time becomes shorter than the optimum, the control loop tends to show increasing oscillation as the integration time decreases.

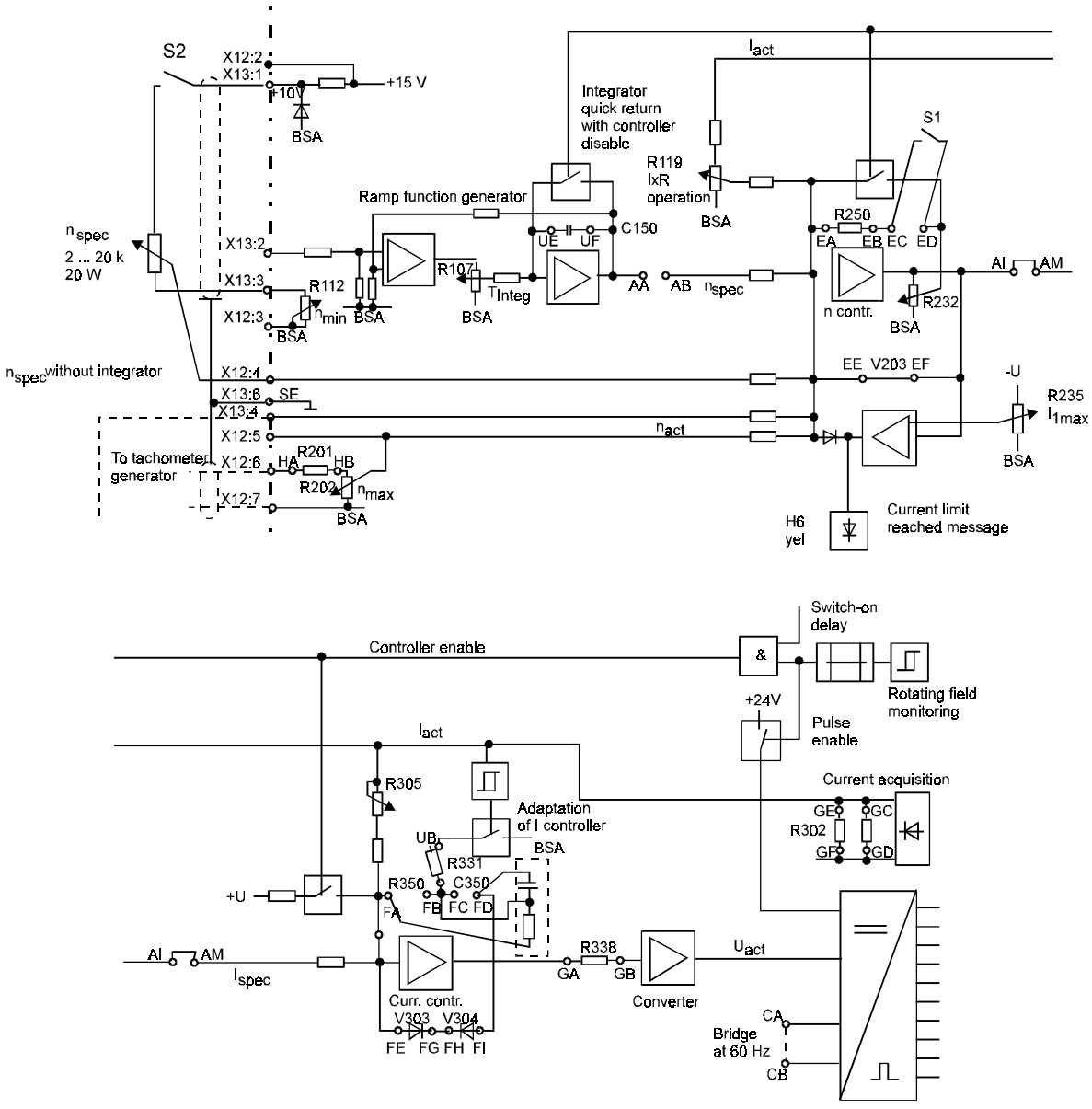
- Solder the determined connection with the unit switched off and again check the transfer function.
- Switch the equipment off.

b) Optimization with intermittent current

- Connect the R decade to terminals UA, UB, set R = 4.7 kΩ.
- Switch on the drive with switches S1 and S2 closed, enable the controller.
- Set the specified value default in such a way that the armature current just reaches the pulsating limit.
- Briefly switch S2 on and off again and observe the actual current value on the oscilloscope. The actual current value curve must be like the one shown in the figure in chapter 6.2 (current converter optimization in intermittent operation).
- Switch off the equipment, remove the R decade and solder the value determined for R 331.

c) Checking the connection at transition from the intermittent to the continuous range

- Switch the unit on with switches S1 and S2 closed and enable the controller. Slightly open the specified value potentiometer such that a small armature current flows in the pulsating area.
- Briefly open switch S1 and observe the actual current value on the oscilloscope. With optimum connection, the current rises as shown in the figure in chapter 6.1.
- Switch the unit off.
- Connect the field, remove the bridge for field monitoring.
- Remove R 250, remove switch S1.
- Check the connection of the speed controller.



6.2.2 Speed Controller Optimization

Standard connection:

R250 = 560 kΩ
C250 = 1.0

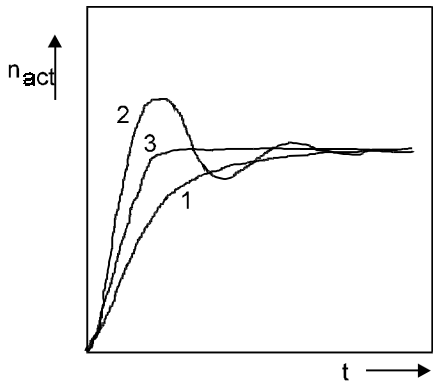
Integration time: T_i = 55 ms

Integral-action time: T_i = 560 ms

The P gain can be modified with potentiometer R232 at a ratio of 1:6.

Switch off the unit and

- Remove C250 on one side (you did this already when the current controller was optimized previously).
- Connect R-C connection decade to soldered tags EA and ED, set potentiometer R 232 in the center position, connect the oscilloscope to the n_{act} input of the speed controller (either X103/13 or X102/1; refer to the internal circuit diagram, and to X109/16 or X101/16).
- Switch on the mains supply, enable the controller.
- Set speed step-changes up to the nominal speed with S2. The transfer behavior of the actual speed value should be similar to the transfer behavior shown in the figure below.
- Switch the equipment off, remove switch S2. Reconnect the specified value potentiometer according to the circuit diagram.



1. R too low, C too high

2. R too high, C too low

3. Optimum control behavior

6.3 Configuration and Commissioning Record

				Modifications:	Date
Machine	Type:			.....	.....
	Internal identifier:			.....	.....
	Customer:			.....	.....
Mains	Voltage/tolerance:			.....	.....
	Rotating field:			.....	.....
Current	Type:			.....	.....
converter	Item No.:			.....	.....
	Input:	Voltage:		.....	.....
	Output:	Voltage:	Current:	.....	.....
	Field:	Current:		.....	.....
	R201:		kΩ/ 2 W/TK25	.....	.....
	or R263, R264:		kΩ/ 2 W/10%	.....	.....
DC	Type:			.....	.....
motor	No.:			.....	.....
	Armature voltage:			.....	.....
	Armature current:			.....	.....
	Power:			.....	.....
	Speed:			.....	.....
	Field voltage:			.....	.....
	Field current:			.....	.....
Speed	Tachometer generator	Type:		.....	.....
recording		Voltage:		.....	.....
Line	Armature:			.....	.....
reactors	Field, if required:			.....	.....
Semicon-	.....			.....	.....
ductor fuse	.....			.....	.....

7 MAINTENANCE

WARNING

The equipment carries a dangerously high voltage and has dangerous rotating parts (fans). Ignoring the safety and warning information may result in death, severe personal injury or damage to property.

You may only carry out maintenance when the unit is deenergized..

Do not begin work on the power stage and the intermediate circuit until you have made sure that the unit is not carrying potential or a voltage (remanent charge).

When dismounting safety devices during commissioning, repair and maintenance work, you must ensure that the machine is taken out of commission exactly as specified. You must remount and check safety equipment immediately after completing commissioning, repair and maintenance work..

After carrying out any work involving intervention in the machine – regardless of whether this involves the motor, the actual value acquisition or the power converter – the owner must carry out acceptance testing and document it chronologically in the machine log. Failure to do this may result in the owner being faced with consequences relating to liability legislation.

Do not start work on the power unit, intermediate circuit until you have made sure that the unit is not carrying potential or a voltage (remanent charge).

In addition, you should observe the danger information in the previous chapters!

Due to technical requirements, individual components in the units can contain dangerous substances.

Use only manufacturer-approved spare parts.

We cannot guarantee the product documentation is completely error-free unless this is expressly indicated in our General Conditions of Business and Delivery.

7.1 Maintenance Information

The units supplied are maintenance-free.

Prohibition of unauthorized modifications

For safety reasons, unauthorized additions or modifications to the drive are not allowed.

NOTE

Before touching the modules, you must discharge electrostatic energy from your body to protect electronic components from high voltages resulting from electrostatic charging. The easiest way to do this is to touch a grounded conductive object before handling components.

Equipment containing components or modules that can be damaged by electrostatic charging are clearly marked as such by the sticker below.

Electronic components must not come into contact with highly insulating material such as man-made fibres from clothing, insulating mats or plastic sheeting/film. Always rest components on a conductive base.

7.2 Troubleshooting

Correct connection of the unit is the basic condition for troubleshooting. You must therefore first check the mains connection and the connecting lines. The subsequent steps are summarized in the table below.

Troubleshooting based on visible signs'

Triggering function	Result (defect)	Possible cause
Application of mains voltage	LEDs do not light up	• Two phases missing (defective fuse) • Power supply defective • Ribbon cable not OK • Short-circuit between supply voltages
	LED H 3 (red)/ DFLI lights up	• Incorrect rotating field (anti-clockwise) • One phase missing (fuse defective) • Rotating field acquisition defective
	LED H 1 (green)/IF does not light up, although H2 (green)/ DFRE lights up	• Switch-on delay defective
	LED H 5 (green)/RF does not light up, although enable command is pending	• Incorrect rotating field, see H3/DFLI • No pulse enable, see H1/IF • Only with additional function 1 fitted: • Relays K1, K2 do not pick up, see H7/Betr. and H8/SG
Application of mains voltage to power unit and control unit	Phase fuses react on switch-on (with the controller inhibited)	• No phase coincidence between power unit and control unit • Pulse unit defective • Thyristors defective
	Motor starts in spite of controller inhibit	• Controller inhibit not effective • Converter or current controller defective • No phase coincidence between power unit and control unit
Controller enable and setting of specified speed value	Motor does not start LED H6 (yellow)/SGR does not light up	• No value specified • Not controller enable, see H5 (green)/RF • Not pulse enable, see H1 (green)/IF
	LED H6 (yellow)/SGR lights up	• No power supply • Phase fuses defective • Motor supply lines or motor not in order • No field excitation • Load torque too high • Current limit set too low • Integrator, controller, converter or pulse unit defective
	Motor accelerates to max. speed and cannot be controlled	• No actual speed value • With speed recording with preceding sign: wrong n_{act} polarity • Actual speed value too low (acquisition wrongly dimensioned) • Integrator, controller, converter defective • Source of specified value not OK

Triggering function	Result (defect)	Possible cause
Under load	Motor does not reach max. speed	• Load too high • Motor not adapted • Actual speed value recording acquisition wrongly dimensioned • Armature voltage: not six pulses
	Motor speed and armature current oscillate periodically	• No speed controller wiring • Speed controller not optimized • Actual current value signal or tachometer signal not OK
	Phase fuses react	• Fuses too weak • No phase coincidence between power unit and control unit • Motor supply line or motor not in order • Thyristor defective • Controller feedback open • Current limitation defective • Current recording defective • Current controller, converter or pulse unit defective
	Phase fuses react after some time	• One or more thyristors did not fire • Irregular firing times

You may need to proceed as follows if you have managed to the find the approximate location of the defect

in the closed-loop and open-loop control unit:
Turn off the power supply to the power unit (AK1 - AK5 deenergized) and check without actual speed and current values.

in the power unit or actual current acquisition unit:
Open the armature circuit and apply an ohmic resistance (R = 100 Ω, I = 6 A) to the power unit.

Carry out further troubleshooting using test measurements (refer to chapter 7.3, Description of Test Points).

Troubleshooting using test measurements

Measuring equipment required:

1 diagnostic adapter 8ZD

1 multi-purpose instrument for DC and AC, high-resistance

1 oscilloscope (2 channels) with voltage divider and isolating transformer

1 RC decade

1 shunt with 100 A/60 mV or 500 A/120 mV or current measuring instrument

1 speed measuring instrument

1 IC clamp

7.3 Description of Test Points

All the major test points of the lid board (closed-loop and open-loop control 3.8201) are routed to three 16-pin DIP plugs (X101, X102, X103). Diagnostic adapter BZS can be connected to these test plugs even when the unit is in operation. Potential-carrying measuring positions can also be checked using the multi-purpose instrument if you observe the relevant VDE (safety) rules.

Closed-loop and open-loop control units in standard execution

Test point on test plug	Designation and short designation	Value, type of curve and tolerance	With additional function 1 Designation and values	With additional function 2 Designation and values
X101/1	Current controller output	-3.8 V ... +10.4 V	as standard version	as standard version
	in WRE	-3.8 V ±0.4 V	"	"
	in GRE	+10.4 V ±0.4 V	"	"
X101/2	Sawtooth +R and -R	+10 V_S ±20 mV	"	"
X101/3	Converter output U_{st}	+0.4 V ... +7.7 V	"	"
	in WRE	+7.7 V±0.3 V	"	"
	in GRE	+0.4 V±0.3 V	"	"
X101/4	Synchronous voltage R	±23 V_S	"	"
X101/5	Synchronous voltage S		"	"
X101/6	Synchronous voltage T		"	"
X101/7	Current controller adapt.		"	"
	With intermittent current: I_{ist} < 0.5 V	+6 V	"	"
	With intermittent current: I_{ist} > 0.5 V	-18 V	"	"
X101/8	Actual current value I_{ist}	0 ... +10 V ±1 V	"	"
X101/9	Sawtooth +S and -S	+10 V_S ±20 mV	"	"
X101/10	Firing pulses: +R for V1	Approx. +24 V, see 2.7.1	"	"
X101/11	+S for V3	Approx. +24 V, see 2.7.1	"	"
X101/12	+T for V5	Approx. +24 V, see 2.7.1	"	"
X101/13	-R for V2	Approx. +24 V, see 2.7.1	"	"
X101/14	-S for V4	Approx. +24 V, see 2.7.1	"	"
X101/15	-T for V6	Approx. +24 V, see 2.7.1	"	"
X101/16	Reference potential BSA	0 V (ground)	"	"

Measuring positions in firing pulse generation	Double pulses	
Diode V507	+R for V1, see 2.7.1	
Diode V508	-R for V2, see 2.7.1	
Diode V527	+S for V3, see 2.7.1	
Diode V528	-S for V4, see 2.7.1	
Diode V547	+T for V5, see 2.7.1	
Diode V548	-T for V6, see 2.7.1	

Standard version of closed-loop and open-loop control

Measuring position on test plug	Designation and short designation	Value, type of curve and tolerance	With additional function 1 Designation and values	With additional function 2 Designation and values
X102/1	Actual speed with U_A control or terminal X13:4	0 ... -10 V	As standard version	As standard version
X102/2	With controller enabled	+24 V ±20%	"	"
X102/3	Not assigned	-	-	Specified value voltage -10 V ±0.6 V
X102/4	Not assigned	-	-	I controller input
X102/5	Specified speed value for n_{min} at R = 5 kΩ	0 ... +1.6 V	"	As standard version
X102/6	Not assigned	-	-	External current limitation MR2 0 ... +10 V
X102/7	With controller inhibited	+6 V	"	As standard version
	With controller enabled	-18 V		As standard version
X102/8	Sawtooth +T -T	+10 V_S ±20 mV	"	"
X102/9	I x R compensation	0 ... 18% I_{act}	"	"
X102/10	Not assigned	-	-	Controller enable +10 V
X102/11	Speed controller output		"	Speed controller output 4-quadrant operation
	I_{spec} max. neg.	-10 V (RA: R235)		-10 V (RA: R235)
	I_{spec} max. pos.	+0.7 V		+10 V (RA: R243)
X102/12	Not assigned	-	-	External current limitation MR1 0 ... -10 V
X102/13	Not assigned	-	-	I controller input
X102/14	U_A actual value	0 ... -10 V ±0.6 V	"	As standard version
X102/15	Integration + controller enable	-18 V	"	"
	Integration + controller inhibit	+6 V	"	"
X102/16	Reference potential BSA	0 V (ground)	"	"

Monitoring functions

X6:4, 3 on 3.8214	Temperature monitoring	opens at excessive temperature	"	"
X6:1, 2 on 3.8214	Field current monitoring	closes at I_E > 0.2 A	"	"

Standard version of closed-loop and open-loop control

			With additional function 1	With additional function 2
Test point on test plug	Designation and short designation	Value, type of curve and tolerance	Designation and values	Designation and values
X103/1	-24 V not stab.	-22 V ... -30 V	As standard execution	As standard execution
X103/2	Not assigned	-	-	-
X103/3	Not assigned	-	-	-
X103/4	Stab. voltage specified value	+10 V ±0.6 V	"	"
X103/5	-18 V	-18 V ±0.6 V	"	"
X103/6	Integrator output	0 ... +10 V ±0.6 V	"	"
X103/7	-15 V stab.	-15 V ±0.8 V	"	"
X103/8	Not assigned	-	-	-
X103/9	+15 V stab.	+15 V ±0.8 V	"	"
X103/10	+24 V not stab.	+22 V ... +30 V	"	"
X103/11	Not assigned	-	-	-
X103/12	Specified speed via integrator	0 ... +10 V ±0.6 V	"	"
X103/13	Specified speed value with tachometer control	0 ... +10 V ±0.6 V	"	"
X103/14	Direct speed controller input (without integrator) n_{spec}	0 ... +10 V ±0.6 V	"	"
X103/15	Not assigned	-	-	-
X103/16	Reference potential	0 V (ground)	"	"

Potential-carrying test points:

AM-KM on 3.8202	Armature voltage U_A	0 ... max. 460 V_{DC} 0 ... max. 600 V_{DC}	"	"
+F -F on 3.8214	Field voltage U_E	190 V or 310 V	"	"
AK 1-3-5 L1-L2-L3 on 3.8214	Power unit Controller supply	3 x 400 V_{AC}/3 x 500 V 3 x 400 V_{AC}/3 x 500 V ±10%	"	"
L11, L12 on 3.8214	Field supply	230 V_{AC} or 400 V_{AC}	"	"
X1: 230 V on 3.8214	Fan - 60 A and above	230 V_{AC} ±400 V_{AC})	"	"

7.4 Spare Parts

When ordering, state the unit number and the designation of the current converter. When ordering printed circuit boards, indicate the number (e.g. 3.8201) as well as the current version (index XX). This index is printed on the back of the board.

Printed circuit boards

Inspected with standard setting; take over missing or different components from the defective printed circuit board.

Closed-loop and open-loop control unit standard:		3.8201.03 (400 V) 3.8201.13 (500 V)
With additional function 1:		3.8201.01 3.8201.11
With additional function 2:		3.8201.04 3.8201.14
With additional functions 1+2:		3.8201.36
Power supply	230 V 400 V 500 V	3.8202.04 3.8202.02 3.8202.03
Field unit 400 V/500 V	5 A: 8 A:	3.8214.01 3.8214.02
Field adapting tachometer	Up to 3 A	19007151
Field weakening control unit	5 A 8 A	BZF 4/5/180 or BZF 4/5/310 BZF 4/5/180 or BZF 4/5/310
Monitoring board:		3.8311.. 3.8336.. 3.8418.01 3.8418.02
Diagnostic adapter		BZD
for size III only		
	Fuse board: Surge suppressor circuit Overvoltage protector Fuse monitoring: Field current converter EK2	3.8222.. 3.8319.. 3.7520.. 3.7519.. 3.8316.., 3.8317..

Components

For line reactors see chapter 5.5, for semiconductor fuses chapter 5.4 and chapter 2.6 for fans

SKKT 26/12	19004069	SKKT 250/12	19004107
SKKT 26/16	19004002	SKKT 250/16	19004108
SKKT 41/12	19004070	SKT 340/12	19004090
SKKT 41/16	19004003	SKT 340/16	19004097
SKKT 56/12	19004071	SKT 600/12	19004019
SKKT 56/16	19004004	SKT 600/16	19004029
SKKT 91/12	19004053	SKT 760/12	19004020
SKKT 91/16	19004000	SKT 760/16	19004030
SKKT 161/12	19004076	SKKH 15/16	19003625
SKKT 161/16	19004077	SKKE 15/16	19003624
		SKKE 15/08	19003603
Rectifier			
SKB 15/12	19003512	CSR 5-120	19003010
SKB 15/16	19003500	SKB 30/16	19008510

Fuses

0.2 A/500 V/m	5 x 30 mm	19008554
2 A/250 V/m	5 x 20 mm	19008512
0.2 A/250 V/m	5 x 20 mm	19008511
8 A/600 V/semiconductor	10 x 38 mm	19008547
16 A/600 V/semiconductor	10 x 38 mm	19008539
0.63 A/500 V/m	5 x 30 mm	19008556

For further semiconductor fuses, see chapter 5.1.

7.5 Disposal

For the most part, the equipment consists of the following components and materials:

Component	Material
Housing, various intermediate panels, fans, support panels	Sheet steel
Heat sink in power unit	Aluminum
Various spacer bolts	Steel
Various spacers, housing of current converter and unit fan, etc.	Plastics
Bus bars in power unit	Copper
Cable harnesses	PVC-insulated copper wire
Power electronics: Module thyristors, mounted on a heat sink	Metal baseplate, semiconductor chip, plastic housing, various insulation materials
PCBs on which all the open- and closed-loop electronics are mounted	Base material: epoxy-resin fiberglass woven material, several layers of copper coating, plated-through, various electronic components such as capacitors, resistors, relays, semiconductor components, etc.

For technical reasons, electronic components might need to contain dangerous materials, so you should not open them.

If the components are used properly, there is no danger to human beings or to the environment.

In case of fire, dangerous compounds may result or hazardous materials may be released.

You must dispose of or recycle equipment or components according to national regulations as well as any applicable local or regional ordinances.

8 APPENDIX

8.1 Manufacturer Declaration

Manufacturer Declaration in Accordance with the EC-Machine Guidelines 89/392/EEC, Appendix II B

We herewith declare that this delivery includes the following specified machine component and that its putting into operation is prohibited until the declaration is made that the machine, in which this component is built in, complies with the regulations of the EC-machine guideline 89/392/EWG, appendix II B.

Specification of the machine component:	**Type:**
Stromrichter/Power Converter	BKD 6 / ... / ... -2 .. ..

Date / Signature of the Manufacturer: 6 February 1997

Information regarding the Undersigned: Head Division

8.2 Declaration of Conformity

EG DECLARATION OF CONFORMITY OF EQUIPMENT REGARDING LOW VOLTAGE DIRECTIVE 73/23/EWG

Specification of the machine component:	**Type:**
Stromrichter/Power Converter	BKD 6 / ... / ... -2 .. ..

Conformity of the significated product with the guidelines will be proved by following rules:

prEN 50178: 1994 (VDE 0160/11.94)

„Equipment of power installation concerned electronic operating materials“

Nuremberg, 6 February 1997

Signature of the Manufacturer:

Dr. Ing. Peter Kreisfeld	Dipl.-Ing. (FH) R.-A. Geller
Head Division	CE-Agent Electronic

8.3 Conditions of Business and Delivery

1 Scope

1.1 Deliveries and performance provided by Baumüller and offers made by Baumüller are exclusively and completely subject to these general terms and conditions (from now on referred to as "these terms"). Unless a mutual agreement has been made which differs from this statement, these terms also apply to future business relationships.

1.2 If a customer places an order with Baumüller, this implies that these terms are accepted. Any counterconfirmations made by persons or legal persons placing an order with Baumüller with reference to their own general terms and conditions or their terms and conditions of purchase are thereby objected to.

1.3 Supplements or modifications to these terms require written consent from Baumüller in order to take effect.

2 Offer and Copyright

2.1 Offers made by Baumüller are subject to confirmation and not binding. Supplements, modifications or ancillary agreements require written consent from Baumüller in order to take effect.

2.2 Any pictures, drawings, measures, weights or other performance specifications are only binding if this is explicitly stipulated in writing. Drawings, dimensional drawings and descriptions of projects are subject to the copyright of Baumüller and must neither be copied nor revealed to third parties without prior written consent from Baumüller. Baumüller reserves the right to demand that these objects are immediately returned to Baumüller if they are not used for orders to Baumüller.

2.3 The purchaser must not use any process engineering knowledge revealed to him in his business relationship with Baumüller for his own purposes and must not reveal that knowledge to third parties. Any violation of this condition makes the purchaser (violator) liable for damages of an amount of DM 70,000

3 Scope and Term of Delivery

3.1 The deadlines and terms specified by Baumüller are not binding unless explicitly specified otherwise in a written agreement

3.2 The delivery term begins at one of the points in time listed below:

- Date of confirmation of order,
- Date on which the purchaser meets all of the technical, commercial or other prerequisites he is obliged to meet
- Date on which a downpayment or security required prior to delivery of the merchandise is furnished by the purchaser.
- If the stipulated downpayments to Baumüller are made delayed, the delivery term is extended proportionally.

3.3 Baumüller has the right to make partial deliveries and provide partial performance and to issue partial invoices for these deliveries or performance at any time of their choice. Excess volume or short deliveries up to 5% of the delivery quantity are permitted. The amount charged is calculated according to the delivery quantity

3.4 Baumüller is not responsible for delayed delivery or performance or the inability to deliver or perform due to acts of god or force majeure or other events which make it impossible or more difficult for Baumüller to deliver - e.g. war, problems in the provision of materials which arise after the time the offer has been made, malfunctions, strike, lock-out, personnel shortage, shortages of means of transportation, instructions issued by the authorities etc. which occur at suppliers of Baumüller or their sub-suppliers. Therefore, Baumüller has the right to postpone deliveries or performance by the duration of the problem plus an appropriate startup time and Baumüller also has the right to withdraw from the contract partially or completely. If the problems persist for more than 3 months the purchaser has the right to withdraw from that part of the contract which has not yet been fulfilled after having fixed an appropriate extension of the time limit.

3.5 The deadline is considered to have been met if the object to be delivered leaves the storage facility on the fixed date or if the purchaser is informed of its availability for shipment on the fixed date.

3.6 Baumüller or subcontractors of Baumüller will install and assemble the delivered objects exclusively subject to conditions and terms separately agreed upon not later than 4 weeks before delivery.

3.7 No claims will be met for compensation due non-delivery or delays in delivery unless it can be proved that Baumüller acted deliberately or was culpably negligent.

4 Passage of risk, acceptance, packing

4.1 Delivery is made free carrier (FRC, INCOTERM 1980). The goods are packed at the discretion of Baumüller at the costs of the customer. The risk is passed to the customer as soon as the consignment has been handed over to the person carrying out the transport or has left the store.

4.2 If the shipment is delayed or becomes impossible due to reasons for which Baumüller is not responsible, the risk is passed to the customer with the notification of readiness for shipment; if the delivery is stipulated to be carried out upon call-forward notice, the goods are regarded as called off at the latest one year after the date of order.

4.3 Special acceptance conditions must be defined at conclusion of the contract at the latest. The acceptance test has to take place in the works of Baumüller. The costs for the acceptance test will be charged to the customer. If the customer omits the acceptance test, the goods are regarded as delivered as stipulated when they leave our works.

5 Prices and terms of payment

5.1 The prices stipulated by Baumüller in the order confirmation plus the respective legal value added tax apply. Additional deliveries and services will be separately invoiced. The prices are valid ex works or store excluding packing.

5.2 If not otherwise agreed upon, the prices stipulated in the order confirmation are binding for 30 days only.

5.3 Payments shall be made in cash without any deductions free paying office of the vendor in the currency agreed upon. Bills of exchange and checks are only accepted on account of payment. The customer has to bear any costs and bank charges arising thereof. A payment is regarded as made only, if the amount is available to Baumüller. In case of payment by check, the payment is regarded as made when the check has been irrevocably cashed

5.4 Invoices are to be paid without deductions within 30 days from the date of issue. Baumüller is entitled to enter payments of the customer on older open invoices in spite of deviating instructions by the customer. If costs and interests have ahead arisen. Baumüller is entitled to enter the payment first on the costs, then on the interests and last on the main service. The customer is entitled to offset, to retain or reduce the payment - independent of notices of complaint or possible counterclaims - only, if Baumüller has explicitly agreed or if the counterclaims have been legally verified.

5.5 If payments are delayed, Baumüller is entitled to charge interest on arrears at a rate corresponding to the interest rate for open credits in current account, however, at least corresponding to the current discount rate of the Deutsche Bundesbank. This does not affect the assertion of another damage caused by delayed payment

5.6 If the customer fails to meet his payment obligations, especially if he does not cash a check or stops his payment or if Baumüller is informed of other circumstances making the credit worthiness of the customer uncertain, Baumüller is entitled to demand advance payments or securities before delivery or to invoice the total remaining amount in the case that instalments had been previously agreed upon.

6 Retention of ownership

6.1 Until all claims for present or future relations have been satisfied, Baumüller can at any time demand securities from the customer. Baumüller will arbitrarily release provided securities if the value of the securities continuously exceeds the claims by more than 20%.

6.2 Any goods delivered remain property of Baumüller until payment has been made in full (=delivery under proviso). Goods delivered under proviso are processed or reconfigured at the purchaser's for Baumüller as the manufacturer but without additional obligations. If Baumüller ownership rights are nullified because the goods are integrated into or assembled to other objects, a portion of the ownership rights of the purchaser to that object covering the amount in question is transferred to Baumüller. The purchaser keeps the property of Baumüller in custody for no charges.

6.3 The purchaser has - unless he is in delay of payment - the right to process and sell the goods delivered under proviso in normal business. However, he must not distress or transfer ownership of the goods delivered under proviso by way of security. The purchaser transfers any receivables arising from the selling of the goods or from another legal reason completely to Baumüller when the goods are received. Baumüller revocably entitles the purchaser to collect the receivables transferred to Baumüller on the account of Baumüller under his own name. Upon request by Baumüller, the purchaser will reveal the transfer.

6.4 If third parties access the goods delivered under proviso, the purchaser will inform them about the ownership rights of Baumüller and will immediately inform Baumüller. Any expenses and damages are paid for by the purchaser.

6.5 If the purchaser violates any of the terms of the contract - in particular if he is in delay of payment - Baumüller has the right to repossess the goods delivered under proviso at the cost of the purchaser or Baumüller has the right to require transfer of the restitution title the purchaser has against third parties. If Baumüller repossesses or distresses the goods delivered under proviso, this does not mean that Baumüller withdraws from the contract. The right to receive payment for damages remains unaffected by this.

7 Warranty

7.1 If the delivered products are faulty or fail to have properties guaranteed by Baumüller or if the products become defective during the warranty period because of faults which occurred or were caused during the process of manufacturing or in case of material defects Baumüller supplies - excluding any other warranty claims by the purchaser, in particular excluding any direct or indirect secondary claims for damages from the purchaser - replacement parts of their own choice or rectifies defects. Multiple rectification is permitted. For essential products and parts not manufactured by Baumüller - in particular if the purchaser has made specifications - the liability of Baumüller is limited to the transfer of the claims for damages Baumüller has against the supplier of these products or parts.

7.2 The warranty period is 12 months and starts on the day the goods are shipped to the purchaser or - if the delivery scope is installed and assembled by Baumüller - the warranty period starts on the day the installation is complete.

7.3 The purchaser is obliged to inspect the delivered goods for damages or defects immediately or at least within two weeks after receiving the goods or - if the product is installed - within two weeks after completion of the installation process. In addition, he is obliged to inform Baumüller of any damages, defects or losses immediately by sending a report created by the carrier or a corresponding report in the form of a statement in lieu of an oath which must have been signed by two witnesses and by the purchaser. In addition, Baumüller must be informed in writing of obvious defects or shortcomings immediately or at least within two weeks after delivery. If shortcomings and defects cannot be detected in thorough tests within two weeks and are found at a later time, Baumüller must be in-formed of these problems immediately after they are detected. Defective products must be submitted to Baumüller for testing on request in the condition in which the defect was detected. Defective products must not be returned to Baumüller unless Baumüller requests in writing that the products are returned. Failure to observe any of the regulations specified above nullifies all warranty claims against Baumüller.

7.4 If rectification or replacements are not successful within an appropriate period of time, the purchaser may either request reduction of the purchase price or cancellation of the delivery contract.

7.5 If Baumüller manufactures a product based on design specifications, drawings, models or other specifications provided by the purchaser, Baumüller is responsible only for the fact that the manufactured product meets the specifications. Baumüller is not responsible for the usability of the product for the purposes the purchaser intends to use it for.

7.6 Excluded from warranty are shortcomings or defects caused by instructions/and or assembly not effected by Baumüller, insufficient equipment of the customer, overload of the components exceeding the capacity specified by Baumüller, negligent and improper treatment and utilization of unsuitable operating materials at the customer. This also applies to shortcomings or defects arising due to material provided by the customer. The warranty does not apply to damages caused by third parties, atmospheric discharges, overvoltages and chemical influences or to the replacement of parts which are exposed to natural wear. The warranty is void if the customer or a third party changes or repairs the units delivered without written permit by Baumüller

7.7 In case of guarantee and/or warranty claims, the motor, the spare part or the unit shall be shipped free of duty and with free packing after prior agreement with Baumüller. Baumüller is freed of any warranty, if the customer returns the defective products without prior agreement or without observing the arrangements.

7.8 Baumüller is entitled to install spare parts and units into the plants of the customer for warranties to be fulfilled within the warranty period, in order to replace the defective products so that the efficiency of the customer's parts is affected as little as possible. The warranty period for installed spare parts and units is 6 months from the date of replacement at the customer. Taking into account the service time for the delivered products, the warranty period of 12 months from date of delivery as specified in point 7.2 remains unchanged.

8 Liability

8.1 Baumüller is liable for information and consulting activities on the utilization of the ordered and delivered products only with written confirmation in accordance with the below regulations. Verbal statements and information are not binding.

8.2 Claims for damages due to impossibility of performance, nondelivery, positive breach of obligations, culpa in contrahendo and unlawful act to Baumüller as well as to the persons employed in performing an obligation are excluded if the damage has not been caused deliberately or grossly negligent or Baumüller is liable according to the product liability law.

9 Lump-sum damages in case of withdrawal

9.1 If the customer withdraws from the written order due to reasons for which Baumüller is not responsible, Baumüller is entitled to charge lump-sum damages of 50% of the net order amount. This applies also if Baumüller withdraws from the contract due to reasons for which the customer is responsible.

10 Miscellaneous

10.1 Place of fulfilment and jurisdiction is Nuremberg. However, Baumüller is entitled to advance claims at the legal place of jurisdiction of the customer.

10.2 The legal regulations applicable in the Federal Republic of Germany are applicable to these conditions and terms of sales and delivery. The regulations or the UN law of sales are excluded.

10.3 If one or several regulations of these conditions and terms of sales and delivery are or become ineffective or if any arising situation and circumstances are not covered by this contract text, jurisdiction will replace or supplement the ineffective or incomplete stipulations by appropriate regulations corresponding to the economic purpose of the intended regulation to the largest possible extent. The validity of the other regulations remains unchanged.

8.4 Index