

KDV 4

Supply Module for Direct Mains Connection to 3x AC 380 ... 460 V

Description of Application

DOK-POWER*-KDV*4.1****-ANW5-EN-P



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to 3x AC 380 ... 460 V

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The purpose
of this document

In this document you will find

- the definition of the area of application
- the electrical lay-out
- the mechanical control cabinet lay-out
- assembly and installation plan
- guidelines for selecting additional components
- troubleshooting guidelines

Warning and Caution
Symbols

Symbol	Definition	Explanation
	Warning	Disregarding this symbol may cause serious personal injury and property damage.
	Caution	Attention must be paid to this important information.

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1. INDRAMAT Modular AC Drive System Construction

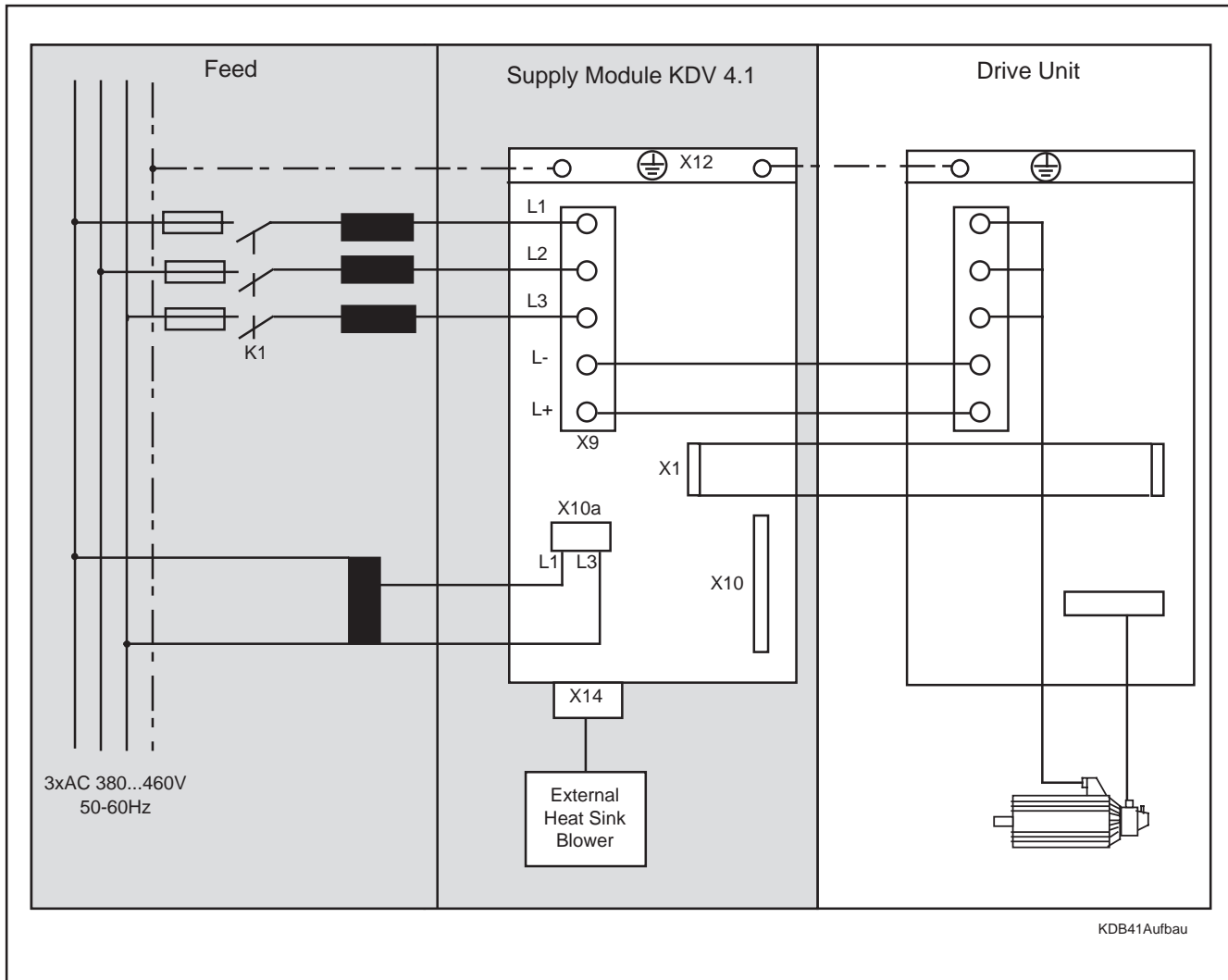


Figure 1.1: Supply module KDV 4 as a part of the modular INDRAMAT AC Drive System.

The INDRAMAT AC drive system consists of a supply and a drive module. Several drives can be mounted to a single supply module. Supply module KDV 4.1, with its feedback capability, is a component of the INDRAMAT modular AC drive system.

Supply module KDV 4.1 provides the link circuit d.c. voltage for the power supply and the control voltages for all connected INDRAMAT spindle- and servo-drive modules.

1.1. Primary Functions of Supply Module KDV 4

Power for Drives Held in Readiness

The controlled three-phase bridge of the KVD 4 rectifies the mains alternating current. Buffer capacitors provide sufficient smoothing.

In the event that the drives are run with a generator, the KDV 4 will function as an inverter.

In the event of power failure or if the power supply should be switched off, then the energy fed back as a result of the braking of the motors will be assimilated by the bleeder resistor, which is switched parallel to the buffer capacitor.

Electronics Supply

The KDV 4 provides the +24VL and +/- 15VM for all connected drive modules.

In the event of power failure, Power is supplied to the electronics by the link circuit d.c. voltage. As a result, the drive electronics can still function when the drive runs as a generator.

Monitoring the Drive Systems

The KDV 4 has been equipped with extensive control functions. These communicate with the drive modules over the signal voltage bus.

The Bb1-contact of the KDV 4 is of ultimate importance to the operational readiness of the drive systems. Powering down is possible only after it closes.

2. Area of Application

The KDV 4 with mains feedback is an economical solution for continuous drive power starting at approximately 10 kW and continuous feedback power greater than 1kW.

The KDV4 needs no power transformer for mains voltages from 3 x 380 ... 460V, 50 ... 60 Hz.

Supply module KDV2, with built-in 2-kW-bleeder resistor, is available for smaller continuous feedback requirements.

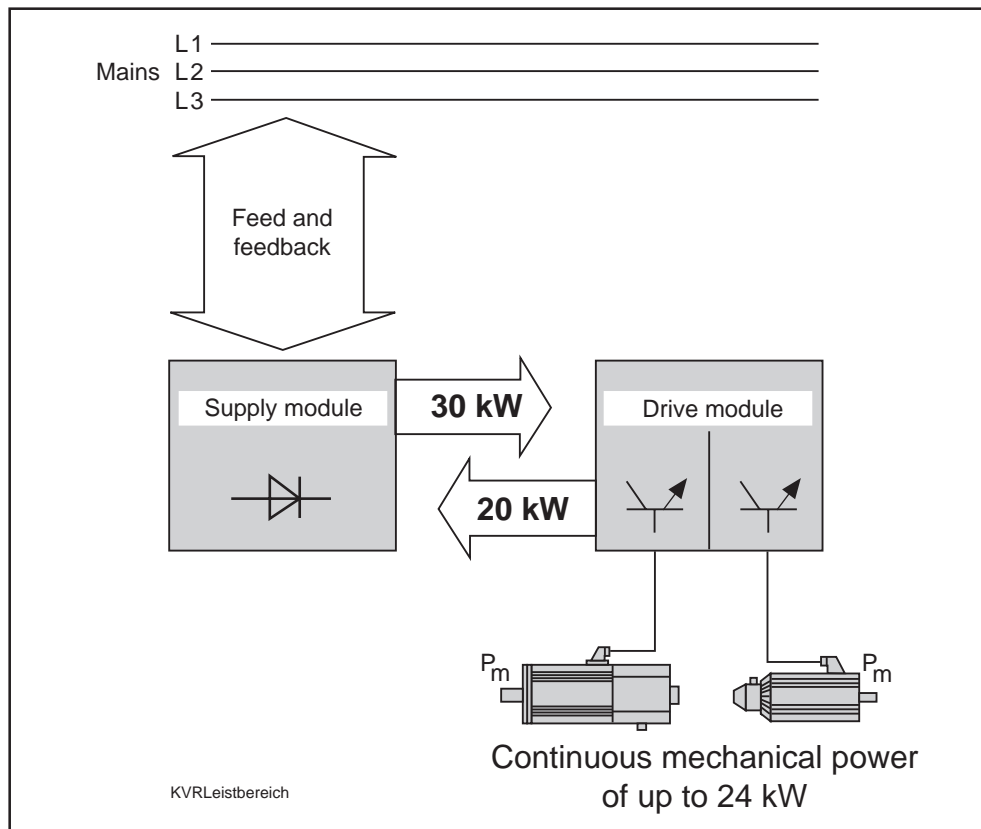


Figure 2.1: The power range for KDV 4 supply module applications.

2.1. The KDV4's Physical Power Graduations

Additional components can be used to match the demands of the application to the usable power of the KDV 4..

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Required additional components for mains supply with KDV 4.1-30.3		
$\frac{P_{DC}}{kW}$	$\frac{P_{KB-3}}{kW}$	$\frac{P_{KB-03}}{kW}$	$\frac{P_R}{kW}$	$\frac{P_{BM}}{kW}$	$\frac{W_{max}}{kWs}$	$\frac{P_m}{kW}$	$\frac{P_{mKB-3}}{kW}$	$\frac{P_{mKB-03}}{kW}$	Smoothing Choke	Commutation Choke	Additional Capacitor
14	22	48	14	40	100	11,2	17,6	40	GLD14	KD19	---
22	30	48	20	40	100	17,6	24	40	GLD15	KD20	CZ1.02
30	30	48	20	40	100	24	24	40	GLD15	KD20	TCM1.1-04
<div> <div> (1) P_{DC} = Link Circuit Continuous Power </div> <div> (2) P_{KB-3} = Link Circuit Short-Term Power for 3 s (accelerating spindle drives) </div> <div> (3) P_{KB-03} = Link Circuit Short-Term Peak Power 0.3s (accelerating servo-drive) </div> <div> (4) P_R = Continuous feedback power </div> <div> (5) P_{BM} = Peak bleeder power </div> <div> (6) W_{max} = Maximum feedback energy </div> <div> (7) P_m = Mechanical power for duty cycles longer than 10 s. </div> <div> (8) P_{mKB-3} = Mechanical short-time power for 3 s (accelerating primary drives) </div> <div> (9) P_{mKB-03} = Mechanical peak power for 0.3 s (accelerating servo-drives) </div> </div>											

Figure 2.2: Typical Power Graduations Achieved by Combinations of Additional Components.

2.2. Technical Data

Designation	Symbol	Unit	KDV 4.1-30-0
Power section input			
Nominal input voltage	U(ACN)	(V)	3 x 380 ... 460 ($\pm 10\%$) 50 ... 60 Hz
Power section output			
Link circuit dc voltage	U(DC)	(V)	320 ($\pm 10\%$)
Link circuit continuous power	P(cont)	(kW)	30 (with add. capacitor 4 mF) 22 (with add. capacitor 2 mF) 14 (without add. capacitor)
Link circuit peak power	P(peak)	(kW)	48
Continuous feedback power	P(RD)	(kW)	20 (with add. capacitor 2 mF) 14 (without add. capacitor)
Peak feedback power	P(RS)	(kW)	40
Continuous bleeder power	P(BD)	(W)	0
Peak bleeder power	P(BM)	(kW)	40
Maximum feedback energy with power off	W	(kWs)	100
Power loss inside the control cabinet	P(v)	(W)	150
Power loss outside the control cabinet	(P(v)	(W)	500
KDV Weight	m	(kg)	21
Weight of mech. mounting accessories	m	(kg)	1,7
Weight of fan unit LE4	m	(kg)	4,2
Control Voltage Output			
+ 24 V Load voltage	U(L)	(V)	22 ... 26
+ 24 VL Constant current	I(UL)	(A)	11,5
+ 24 VL Standing wave ratio		(%)	2
± 15 V Measuring voltage	U(M)	(V)	14,9 ... 15,1
+ 15 VM Constant current	I(+UM)	(A)	2
- 15 VM Constant current	I(-UM)	(A)	2
± 15 VM Standing wave ratio		(%)	0,1
Auxiliary voltage and fan supply			
Input voltage	U(AC)	(V)	230 (-15 +10%)
Frequency	f	(Hz)	50 ... 60
Auxiliary power input voltage	P	(VA)	500
Power input fan supply	P	(VA)	70 VA per heat sink fan
Operating Conditions			
Permissible ambient temperature range with nominal data		(°Celsius)	+5 ... +45
Maximum permissible ambient temperature with reduced nominal data		(°Celsius)	55
Storage and transport temperatures		(°Celsius)	-30 ... +85
Assembly altitude without reduction of nominal data			max. 1000m above sea level
Permissible humidity in accordance with to humidity classification			F as per DIN 40040
Insulation classification			C as per DIN 570110
Protection Category			IP 10 as per DIN 40050

Figure 2.3: Technical Data of Supply Module KDV 4.1

2.3. Functional Power Features

- **It is possible to operate the drives for extended duty cycles even while braking.**

The energy produced by braking the motor is fed back into the mains with little loss.

- **The mains voltage of the power supply is variable over a wide range**

A power supply of 3 x 380 ... 460V, 50 ... 60Hz is possible. A power transformer is not required in most cases.

- **The drive system's response to a power failure can be programmed by providing an external bridge -**

- without the bridge, the drives brake at maximum torque;
- with the bridge, a signal is sent via a zero potential contact to the CNC control. The CNC control then guides the powering down of the drives. Expensive tools or instruments are protected against damage.

- **Controlled link circuit voltage**

No reduction in drive dynamics in the event of mains under-voltage.

- **Charging current limit of the link circuit capacitor**

The starting current need not be taken into consideration when selecting the switching devices for the power supply. The life expectancy of the switching devices increases.

- **High load-carrying ability of the control voltage.**

Up to ten drive modules can be connected to one supply module.

- **Monitoring the earth connection of connected drives**

Immediate powering down in the event of a fault by opening the Bb1 contact and an optical display on the LED.

- **Service Friendly**

Both the electronic supply and the signal exchange can be simply plugged in.

3. Control Circuits

The control of the mains contactor and the link circuit short circuit represent the operating principle recommended by INDRAMAT. This section will outline different control possibilities. The choice of control and its effect depends on the range of functions of the entire facility and is the responsibility of the facility manufacturer.

3.1 Differentiating Features of the Control Circuits

A: Immediate or delayed powering down in an emergency.

The INDRAMAT-AC drives can still brake even with power switched off. This means that it is possible in an emergency to **immediately switch off** power. The energy contained in the movement of the drives is transformed into heat in the bleeder resistor of the supply module.

Shutting down the drives takes precedence over protecting the bleeder resistor against overload. Frequent consecutive and arbitrary emergency stops (e.g., when commissioning) can overheat the bleeder resistor.

A feedback energy of 100 kW is permissible over a period of five minutes. If, as a result of a specific application, more feedback energy is expected, then powering down must be delayed.

B: Shutting down the drives because of faulty drive electronics with or without dc-bus short circuit.

The short-circuiting of the dc-bus voltage is a supplementary safety factor in addition to braking in the presence of a problem.

Synchronous motors (MAC; MDD) are always brought to a standstill by braking them with the dc-bus **short circuit**, regardless of whether the drive electronics are still working or not. Asynchronous motors (2AD; 1MB) **do not** brake with short-circuited link circuit voltage.

Intact drives can be halted by braking them at maximum torque **without dc-bus short circuiting**. It must be assumed that those drives with either faulty control electronics or disrupted feedback lines will slow down without electrical braking. The link circuit short circuit can only then be obviated if a slowing down without braking does not damage the unit. Motors with mechanical brakes are an alternative.



The best way to shut the drive down if there is a fault, on the one hand, depends on the drive equipment configuration. It also depends on the overall task of the facility. Only the facility designer can make this final decision. The following recommendations should, therefore, only be viewed as a general reference for the facility designer!

C: Controlled braking of the drives by the drive electronics or position-controlled by the controller in an emergency stop or a power failure.

The **drive controller** generally shuts down the drive in an emergency stop or mains failure. It submits a command value in an emergency stop or a signal from the drive-internal monitor. A controlled braking of the drives at maximum torque results.

Some cases (e.g., electronically coupled gear-tooth machines) necessitate a guided drive shutdown in an emergency or with mains failure. The CNC-controller brakes the drives **position-controlled** in an emergency or as a result of a signal from the internal drive monitor.

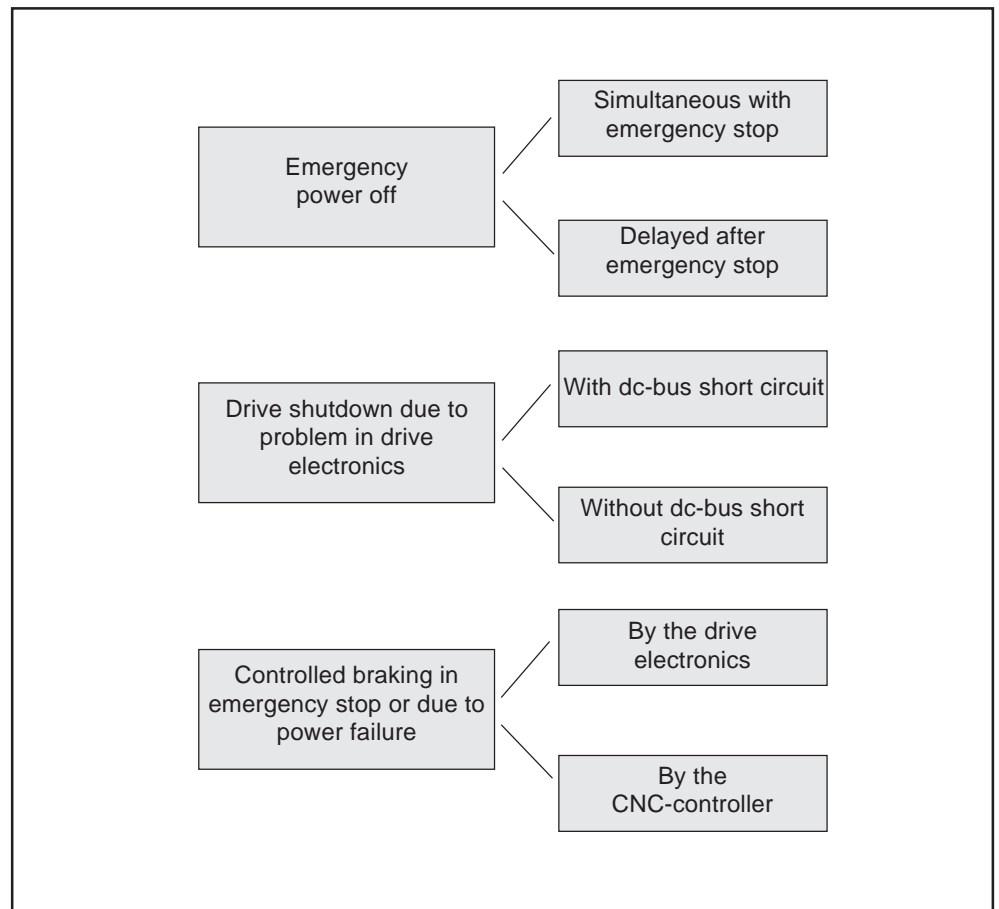


Figure 3.1: Differentiating control circuit features

3.2 DC bus short-circuiting

The DC bus short-circuit recommended by INDRAMAT is conceived to protect either machine or plant against damage in the event of a drive failure. This can be used to brake motors with permanent magnetic excitation even in the event of drive control failure. This function cannot, however, be the only safety device used to protect personnel.

Circuit design

This DC bus short-circuit contactor can switch the "short-circuit current" on but not off. The DC bus short-circuit contactor may not be re-applied, once released, until the DC bus has discharged. The following recommended circuits (sections 3.3 ... 3.7) will make interference-free operations possible. Programming the PLC appropriately does not guarantee the correct switching sequence. The varying contactor actuating times can possibly trigger the mains contactor before the DC bus short-circuit contactor is opened. This means that the mains contactor should additionally be locked by means of an auxiliary contact of the DC bus short-circuit contactor.



DANGER

The DC bus short-circuit resistor is not secured against accidental contact. There is the danger of high-voltages (greater than 50 V).

Electrical shock resulting from contact

==> use an appropriate cover, see that it is in place or properly mounted



CAUTION

Thermal damage caused by DC bus short-circuit contactor and resistor in the event of faults in the control or contactor is possible.

Damage or loss due to fire is possible inside the control cabinet.

==> use an appropriate cover, see that it is in place or properly mounted

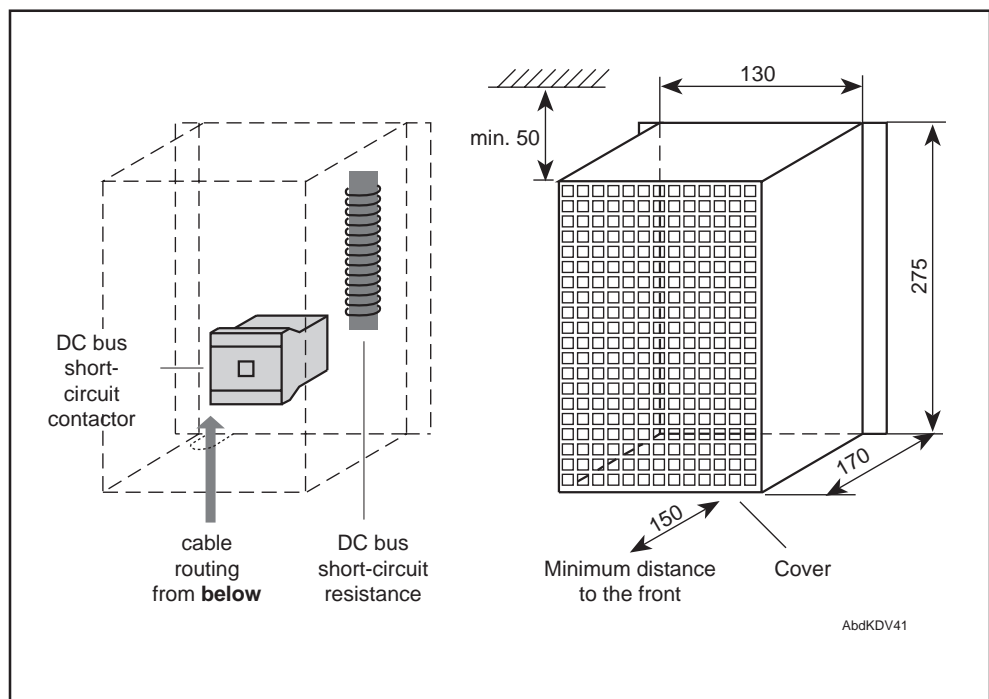


Fig. 3.2: Suitable covers and unit arrangements for the DC bus short-circuit

Switching frequency A maximum of six switching procedures is permitted per minute.

The number of possible switching sequences is reduced if the sum of the rotary drive energy and the energy stored in the additional capacitance is greater than 1500 Ws. Otherwise, the DC bus short-circuit resistor will be overloaded. The number of the permissible DC bus short-circuit actuations can be calculated as follows:

$$S = \frac{1500 \text{ W} \cdot 60 \frac{\text{s}}{\text{min}}}{(W_{\text{rot}} + W_{\text{ZW}})}$$

S = number of permissible actuations per minute (max. 6)
 W_{rot} = energy content of the drive given in Ws
 W_{ZK} = energy stored in the additional capacitance given in Ws

Service life The DC bus circuit contactor has a service lifespan of 20,000 actuations.

Maximum drive torque Once the DC bus is short circuited, the drive will be decelerated with the short-circuit torque. This torque may be higher than the maximum torque indicated in the selection list. Particularly, if the relationship maximum torque to short-term operating torque is less than 1.3, then there will probably be increased torque.



Increased torque with short-circuited DC bus is possible.

Damage to mechanical transmission parts, machine damage from dimensional shifting that has gone unnoticed.

==> mechanical transmission elements must be laid out in terms of the torque at with a short-circuited DC bus.

A list of the short-term torque for MDD motors can be requested. The following formula can be used to calculate maximum torque with a short-circuited DC bus.

$$M_{\text{ZK}} = \frac{K m^2 \cdot \omega}{\sqrt{(R_A + R_{\text{ZK}})^2 + (\omega p L_A)^2}}$$

$$M_{\text{maxZK}} = M_{\text{ZK}} + M_H$$

M_{maxZK} = max . drive torque with short-circuited DC bus
 M_{ZK} = short-circuit torque in Nm
 M_H = decel torque of the holding brake in Nm
 $K m$ = current torque or voltage constant in Vs/rad
 ω = angle speed in rad/s
 R_A = winding resistance of the motor in Ω
 R_{ZK} = DC bus short-circuit resistance in Ω (2.2 Ω)
 p = number of pole pairs; for MAC and MDD the following applies:
 size ≤ 41 ; $p = 2$
 size ≥ 63 ; $p = 3$
 L_A = winding inductance of the motor in H

3.3 Control circuits for immediate emergency stops with dc-bus short circuit



This is the controller circuit normally used!

This controller circuit achieves a high level of safety with little effort. It most effectively uses the monitoring features built into the drive system.

Typical uses:

- if the KDV 4.1 supplies feed drives only;
- if asynchronous drives and feed drives are operated with one KDV 4.1.

Features:

Power off occurs simultaneously with the initiation of emergency stop. The energy contained in the drives is transformed into heat. The KDV 4.1 bleeder resistor can take up a maximum of 100 KWs over a five minute period. Shutting down of the drives takes precedence over protecting the bleeder resistor against overload. Frequent consecutive and arbitrary emergency stops (e.g., when commissioning) can damage the KDV 4.1 and are not permitted.

The dc-bus short circuit always stops synchronous motors by braking them regardless of whether the drive electronics are still functioning or not. The link circuit short circuit only snaps in when there is a fault in the drive. If the emergency stop button is hit, then the asynchronous primary drives will also brake.

In an emergency stop, or with a signal from the monitoring devices of the KDV 4.1 (e.g., mains failure), the drive electronics will brake the drives position-controlled at maximum torque.



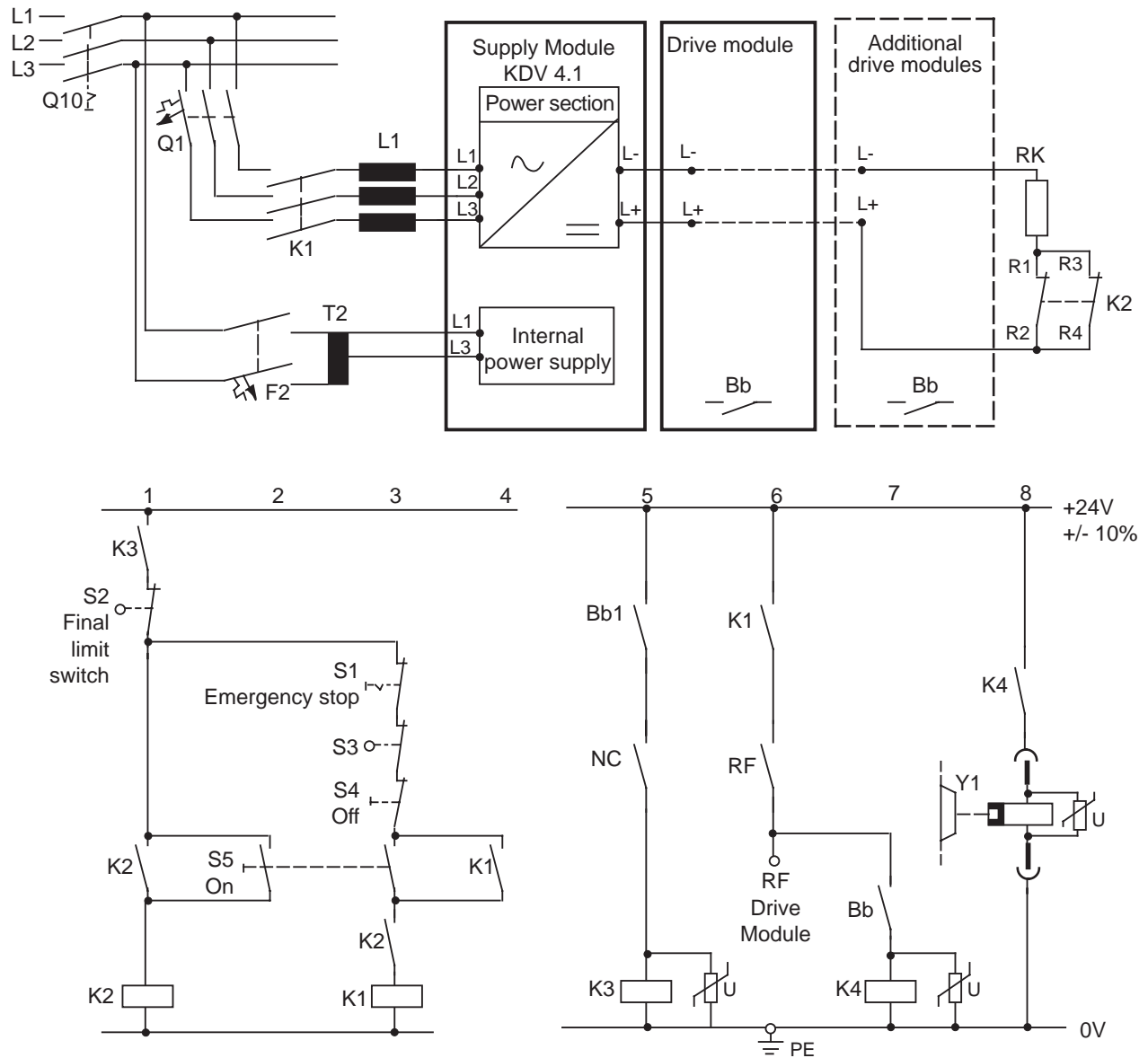
The NCB bridge (X10/13 . X10/14) must be closed!

Operating Characteristics:

The power contactor is immediately switched off when the emergency stop button is hit. The controller enable of the drives is switched off by an auxiliary contact of the power contactor. Drive-internally this causes the set-point of all attached drives to be set to zero. There is a controlled braking of all drives.

A drive fault message from the KDV 4.1 (Bb1 contact), a fault message from the CNC control (servo fault), or the overrunning of the final position switch mean that the dc-bus short circuit will snap in.

- Control Circuits:
- immediate powering down in an emergency stop
 - with dc-bus short circuit
 - in an emergency stop, controlled brake by the drive electronics



Bb1 = Supply module ready (drive system)
 Bb = Drive module ready
 F2 = Electronics and fan supply fuses
 K1 = Mains contactor
 K2 = Link circuit short circuit contactor
 K3 = Decoupling Bb1
 K4 = Holding brake control
 L1 = Commutation choke
 NC = Controller fault message
 - open with fault in drive (servo-fault)
 - closed in emergency stop
 Q1 = Power supply fuse
 Q10 = Master switch

RF = Controller enable signal
 RK = Link circuit short circuit resistor
 S1 = Emergency stop
 S2 = Final axis limit switch
 S3 = Safety doors
 S4 = Power off
 S5 = Power on, link circuit short circuit cancelled
 T2 = Autotransformer
 Y1 = Electrically released holding brakes for feed drive
 Note release delay! Speed set point
 100 ms after RF-ON

ATTENTION: The contactor should not be turned on again within 0.5 s after K2 is cancelled. It must be prevented that K2 is temporarily cancelled by the opening and closing of S2 or K3, and then started up again. K2 can otherwise be damaged. Contactor K2 can only be switched on again, once it has been shut down, by a defined command (e.g., S5)

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Figure 3.3: Controller circuit with dc-bus short circuit for immediate power down in an emergency

3.4. Control circuit for delayed powering down with dc-bus short circuit

Application: In exceptional cases, when large amounts of energy (spindle drives) are transformed into heat during braking and the danger of a thermal overload of the bleeder resistor is present. The bleeder resistor can be loaded with a maximum of 100 kW over a five-minute period.

Typical application:

- when one KDV 4.1 operates asynchronous drives and feed drives.

Features: The first thing that an emergency stop does is initiate the braking of the drives. **Power shutdown is delayed.** Drive energy is fed back into the mains. Drive energy is only transformed into heat in the event of a power failure or drive trouble.

The dc-bus short circuit always stops synchronous motors by braking them, regardless of whether the drive electronics are still working or not. The dc-bus short circuit **only snaps in with drive problems**. Should the emergency off button be pressed, then there will also be a braking of the asynchronous primary drives.

There will be a position-controlled braking of the drives by the **drive electronics at maximum torque in an emergency stop or due to a signal from the control monitors in the KDV 4.1 (e.g., power failure).**



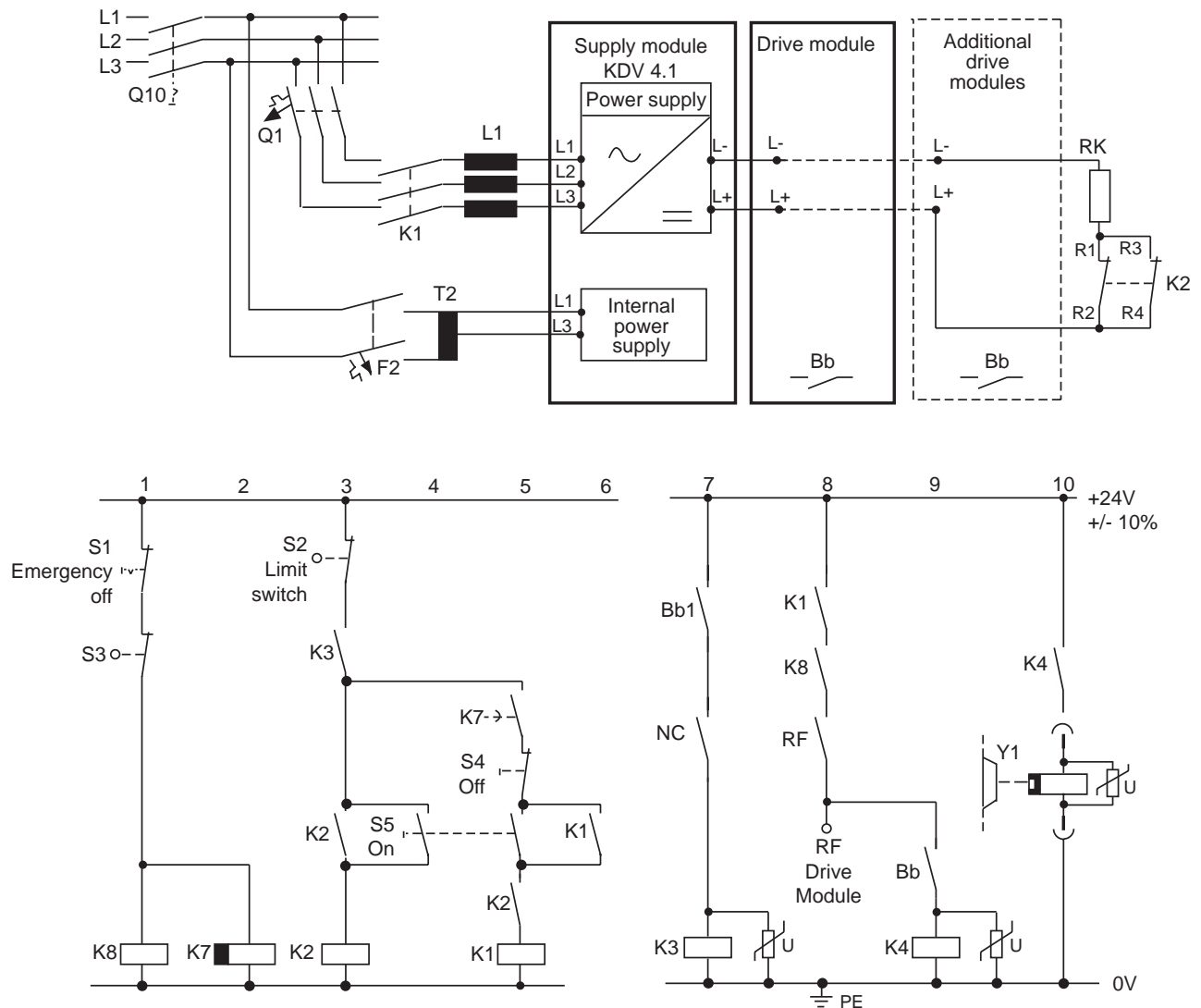
The NCB bridge (X10/13 - X 10/14) must not be closed!

Operating Characteristics:

The controller enable signals of the drives are immediately switched off in the event of an emergency. This causes the set-point value of all attached drives to be internally set to zero. There is a controlled braking of the drives. The power supply is shutdown delayed over the period of time it takes to brake the asynchronous drives.

The power is immediately shut off with a drive fault message from the KDV 4.1 (Bb1-contact), a fault message from the CNC controller (servo-fault), or if the final limit switch is overrun. The controller enable signal of the drives is also switched off by an auxiliary contact of the mains contactor, and the dc-bus short circuit snaps in.

- Control circuits:
- immediate powering down in an emergency stop
 - with dc-bus short circuit
 - in an emergency stop, controlled brake by the drive electronics



Bb1 = Supply module ready (drive system)
 Bb = Drive module ready
 Q1 = Power supply fuse
 F2 = Electronics and fan supply fuses
 K1 = Mains contactor
 K2 = Link circuit short circuit contactor
 K3 = Decoupling Bb1
 K4 = Holding brake control
 K7 = Drop in voltage delayed
 K8 = Emergency stop contactor
 NC = Controller fault message

Q10 = Master switch
 RF = Controller enable signal
 RK = Link circuit short circuit resistor
 S1 = Emergency stop
 S2 = Final axis limit switch
 S3 = Safety doors
 S4 = Power off
 S5 = Power on, link circuit short circuit cancelled
 Y1 = Electrically released holding brakes for feed drive
 Note release delay! Speed set point value 100 ms after RF-ON.

ATTENTION: The contactor should not be turned on again within 0.5 s after K2 has been cancelled. It must be prevented that K2 is cancelled by temporarily opening and closing S2 or K3, and then started up again. K2 can otherwise be damaged. Contactor K2 can only be switched on again, once it has been shut down, by a defined command (e.g., S5).

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Figure 3.4: Controller circuit with dc-bus short circuit for delayed powering down in an emergency.

3.5. Control circuit for immediate powering down without dc-bus short circuit

Application: In those cases where it suffices to switch off power to protect the facility from damage, e.g., overrunning the final limit switch or a problem in the drive electronics.

Typical application:

- the KDV 4.1 supplies only asynchronous drives, and,
- the final limit switches of the feed axes are sufficiently damped.

Features **Power off occurs simultaneously** with actuation of emergency stop. The energy contained in the drives is transformed into heat. The KDV 4.1 bleeder resistor can take up a maximum of 100 kW over a five minute period. The powering down of the drives takes precedence over protecting the bleeder resistor against overload. Frequent consecutive and arbitrary emergency stops (e.g., commissioning) can damage the KDV 4.1 and are not permitted.

The dc-bus voltage is not short-circuited. The dc-bus short circuit has no additional braking effect on asynchronous drives if there is a problem with the drive electronics. There will be no controlled braking of the drives if the dc-bus is short-circuited.

There will be a controlled braking of the drives **by the drive electronics at maximum torque** in an emergency stop or with a message from the control monitors in the KDV 4.1 (e.g., power failure).



The NCB bridge (X10/13 . X10/14) must not be closed!

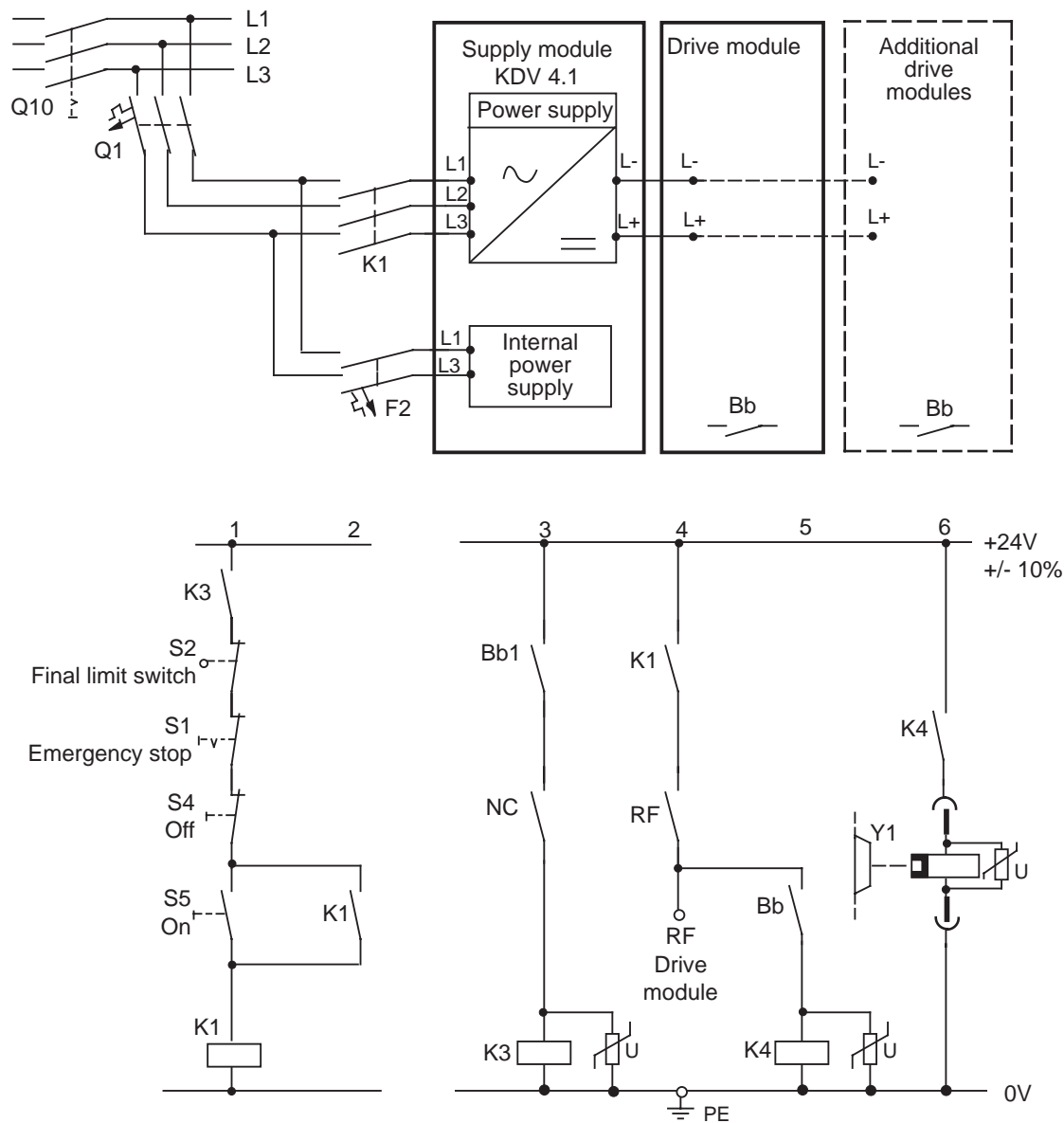
Operating characteristics

The power contactor is immediately turned off once the emergency stop sequence is initiated. The controller enable signals of the drives are also switched off by an auxiliary contact of the power contactor. This causes the set-point value of all attached drives to switch to zero. There is a controlled braking of all drives.



The drives will slow down uncontrolled with a fault in the drive electronics. This control circuit should therefore only be used if a slowing down without braking cannot damage the unit. Motors with mechanical holding brakes are an alternative.

- Control circuits:
- immediate powering down in an emergency stop
 - without dc-bus short circuit
 - in an emergency stop, controlled brake by the drive electronics



Bb1 = Supply module ready (drive system)
 Bb = Drive module ready
 F2 = Electronics and fan supply fuses
 K1 = Mains contactor
 K3 = Decoupling Bb1
 K4 = Holding brake control
 NC = Controller fault message
 Q1 = Power Supply Fuse
 Q10 = Master switch

RF = Controller enable signal
 S1 = Emergency stop
 S2 = Final axis limit switch
 S4 = Power off
 S5 = Power on
 Y1 = Electrically released holding brakes for feed drives
 Note release delay! Speed set point 100 ms after RF-ON.

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Figure 3.5: Controller circuit without dc-bus short circuit for immediate powering down in an emergency stop

3.6. Control circuit for delayed powering down without dc-bus short circuit

*Application
(Only in exceptions!)*

A **delayed powering down** is necessary if the danger of a thermal overload of the bleeder resistor due to excessive energy content is present. The bleeder resistor can be loaded with a maximum of 100 kW over a five-minute period.

Typical application:

- the KDV 4.1 only supplies asynchronous drives, and,
- the final limit switches of the feed axes are sufficiently damped.

Features:

The first thing to happen once the emergency stop is actuated is a braking of the drives. **There is a delay in power shutdown.** The energy contained in the drives is fed back into the mains. Drive energy is only then transformed into heat if there is a power failure or drive trouble.

DC-bus voltage is not short-circuited. The dc-bus short circuit has no additional braking effect on asynchronous drives when there are problems with the drive electronics. There will be no controlled braking of the drives, if the dc-bus voltage is short-circuited.

There will be a controlled braking of the drives by the **drive electronics at maximum torque** in the event of an emergency stop or a signal from the control monitors in the KDV 4.1 (e.g., power failure).



The NCB bridge (X10/13 - X10/14) must not be closed!

*Operating
characteristics:*

The drive enable signal is immediately turned off once the emergency stop sequence is initiated. This causes a set-point value of all attached drives to switch to zero. There is a controlled braking of all drives. Powering down is delayed for the time it takes to brake the asynchronous drives.

Both the power and the controller enable signals of the drives are immediately switched off if there is a drive fault signal from the KDV 4.1 (Bb1-contact) a fault message from the CNC controller (servo-fault), or if the final limit switch is overrun.



CAUTION

The drives will slow down uncontrolled with a fault in the drive electronics. This control circuit should therefore only then be used if the facility will not be damaged by this bringing to rest without brakes. Motors with mechanical holding brakes can be used as an alternative.

- Control circuits:
- delayed powering down in an emergency stop
 - without dc-bus short circuit
 - in an emergency stop, controlled brake by the drive electronics

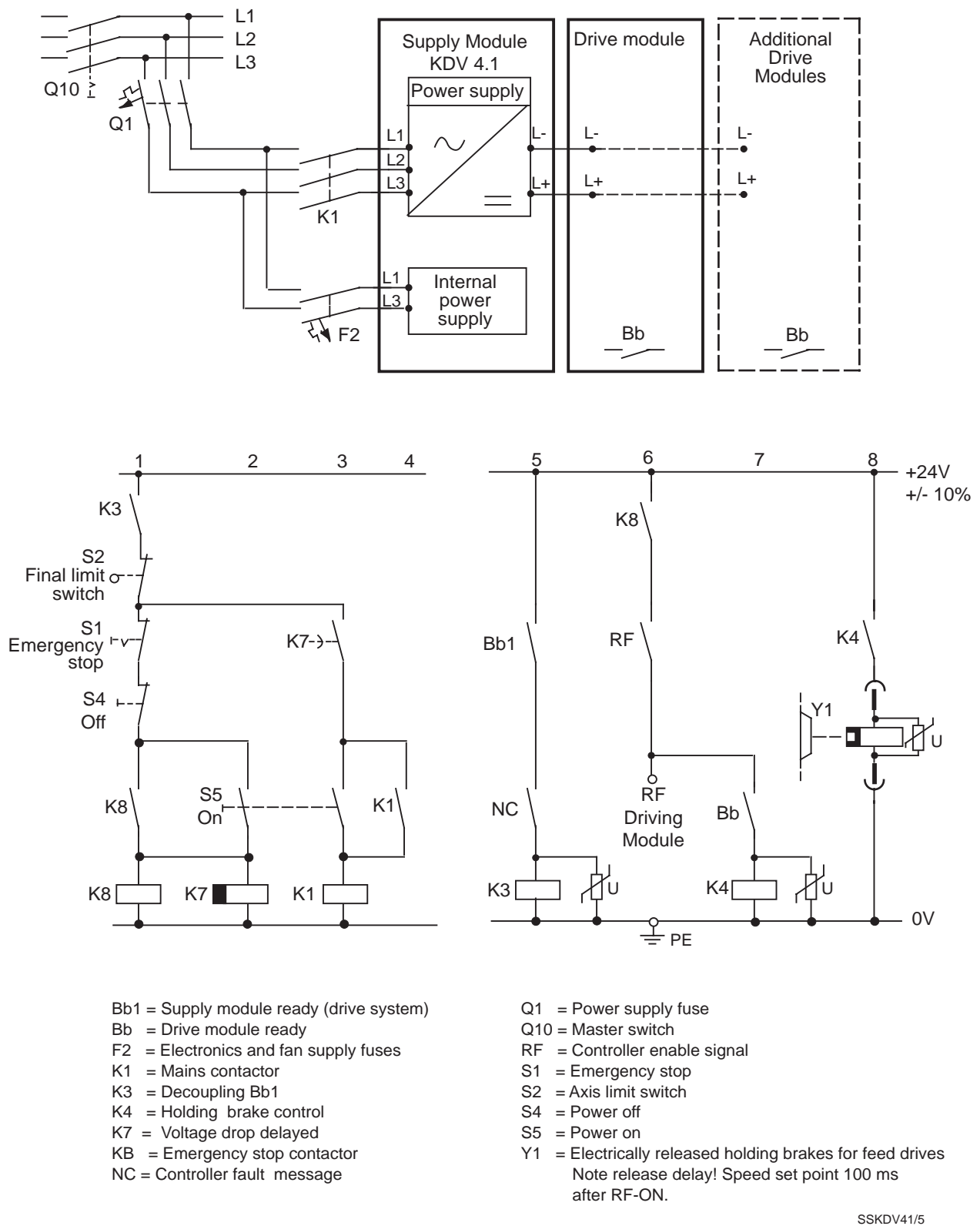


Figure 3.6: Control circuit without dc-bus short circuit for delayed powering down in an emergency stop

3.7. Control circuits for position-controlled braking of the drives in an emergency stop or a power failure

*Application:
Only in exceptions!*

In drives coupled as an electronic drive via the CNC controller, and which cannot accept an angle fault even in a power failure or an emergency stop situation.



Do not use the NCB bridge in digital drives with SERCOS interface. The programmable fault response of digital drives makes a position-controlled braking possible without the NCB bridge. The NCB bridge prevents the drives from receiving the message that there is a problem in the power supply.

Features

The power is simultaneously switched off with the actuation of the emergency stop sequence. The energy contained in the drives is transformed into heat. The bleeder resistor in the KDV 4.1 can take up a maximum of 100 kW over a five minute period. The braking of the drives takes precedence over protecting the bleeder resistor against overload. Frequent consecutive arbitrary emergency shutdowns (e.g., commissioning) can damage the KDV 4.1 and are not permitted.

The dc-bus voltage is not short-circuited so that power will be available for a position-controlled braking of the drives.

The CNC control brakes the drives position-controlled in an emergency stop or a signal from the control monitor of the KDV 4.1 (e.g., mains loss). The energy either stored or fed back into the link circuit must be greater than the energy required to excite the asynchronous drives, or for the retreat action.



The NCB bridge (X10/13 - X10/14) must be closed!

*Operating
Characteristics*

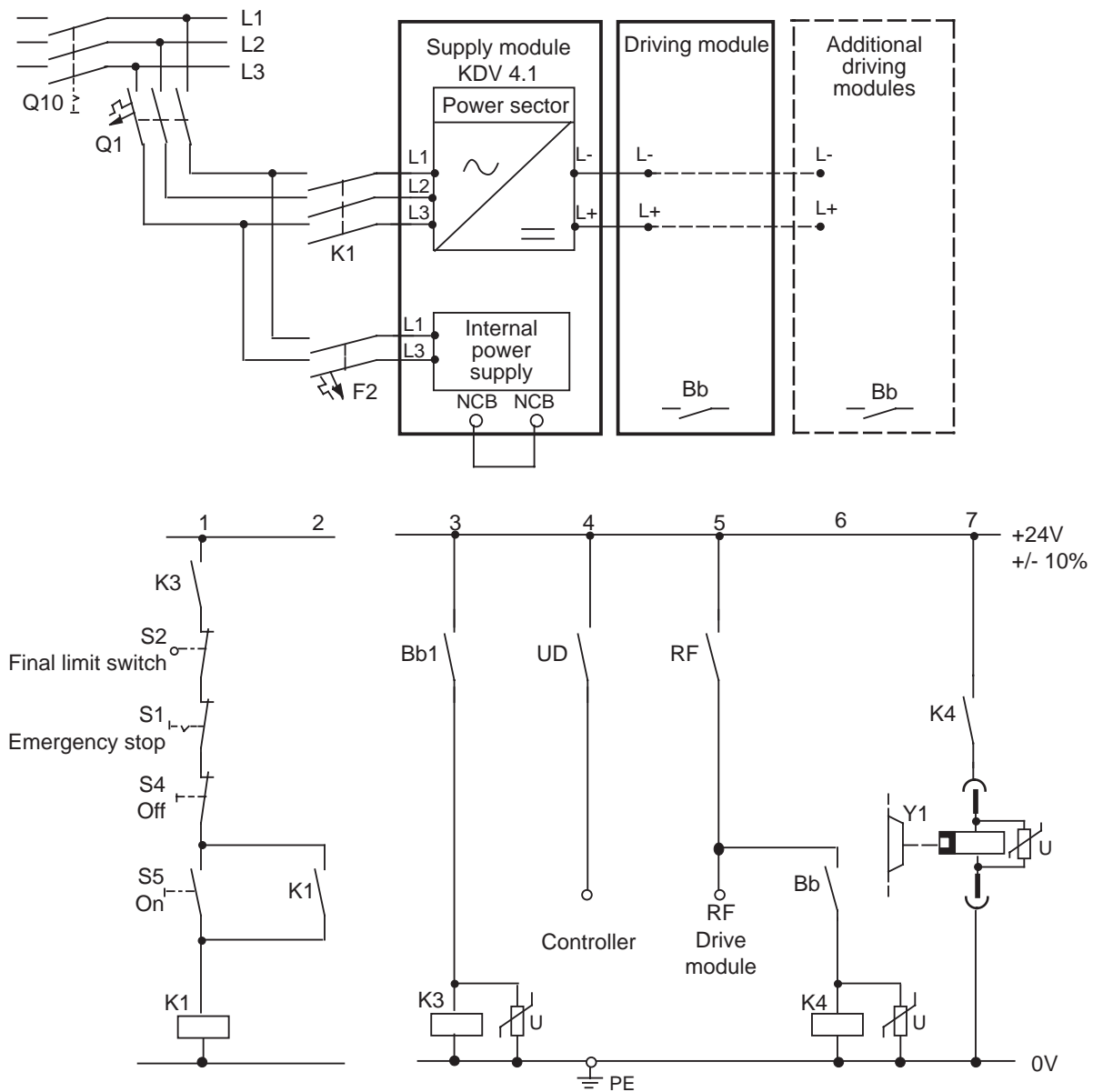
The power contactor is immediately switched off once the emergency stop sequence is initiated. The CNC controller brakes the drives position-controlled. The drives controller enable signals must not be switched off by the power contactor.



CAUTION

The set-point value of the drive modules to switch to zero is suppressed by the NCB bridge with trouble in the power supply. The master controller must, in any case, guarantee the shutting down of the drives. This means that the master controller must definitely evaluate the UD contact of the KDV 4 and stop the drives if the contact opens. It is otherwise assumed that the drives will slow down uncontrolled if there is a problem with the power supply.

- Control Circuits:
- immediate powering down in an emergency stop
 - without dc-bus short circuit
 - in an emergency stop, position controlled brake by the CNC-controller



SSKDV41/3

Figure 3.7: Control circuit for position-controlled braking in the event of an emergency stop or power failure situation.

4. Electrical connections

4.1. Connection diagram

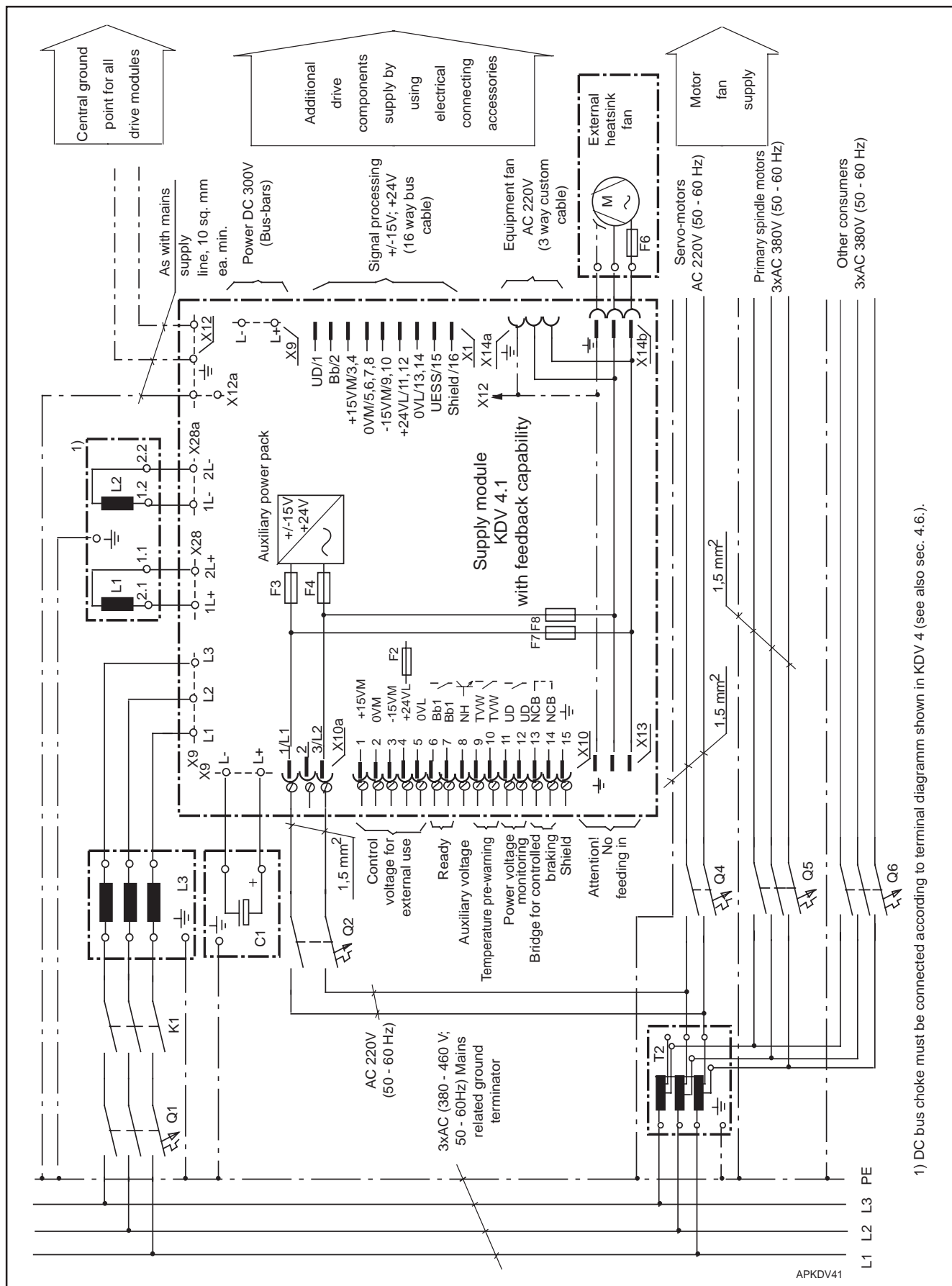


Figure 4.1: Connection diagram of a KDV 4.1 with feedback capabilities

4.2. Power section of the mains connection

Rated voltage KDV 4.1: 3 x AC 380..460V \pm 10 %

Rated frequency KDV 4.1: 50 ... 60 Hz

Only commutation choke KD is needed with three-phase networks of rated voltages of 3 x 380 ... 460V to connect the KDV 4.1 to the mains (commutation choke selected as per Section 2.1).

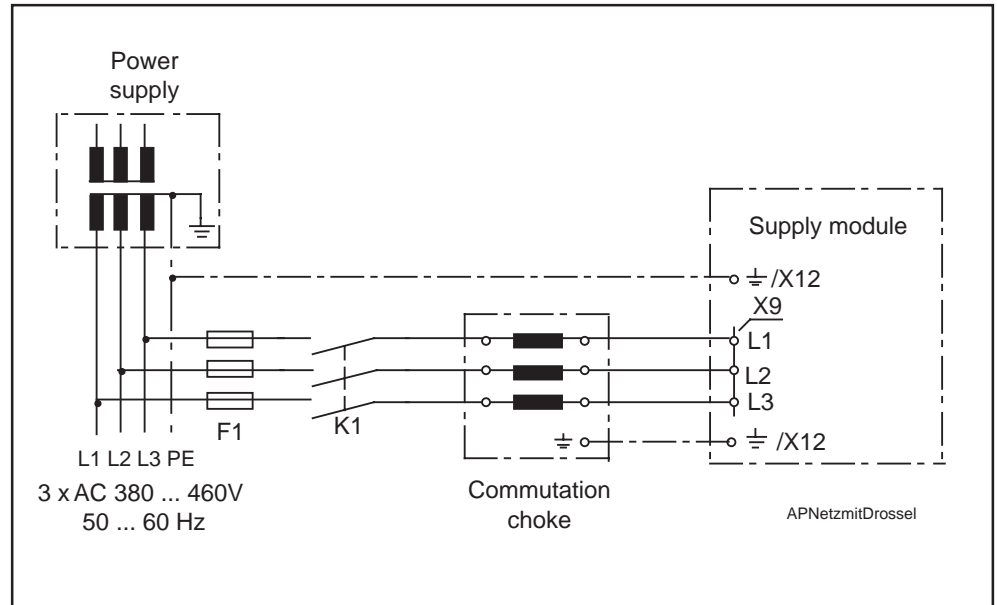


Figure 4.2: KDV 4.1 connected to mains with rated voltages of 3 x 380 ... 460V.

If the mains current is smaller than 3 x 380V, or, greater than 3 x 460V, then a transformer with a secondary voltage of 3 x 380V is needed.

If INDRAMAT transformers are used, then transformer power must not drop below the following values:

Autotransformer: DST: min. transformer power: S=10 kVA

Isolating transformer: DLT: min. transformer power: S=25 kVA

Scattered inductance may not exceed 0.5 mH per strand if INDRAMAT transformers are not used.

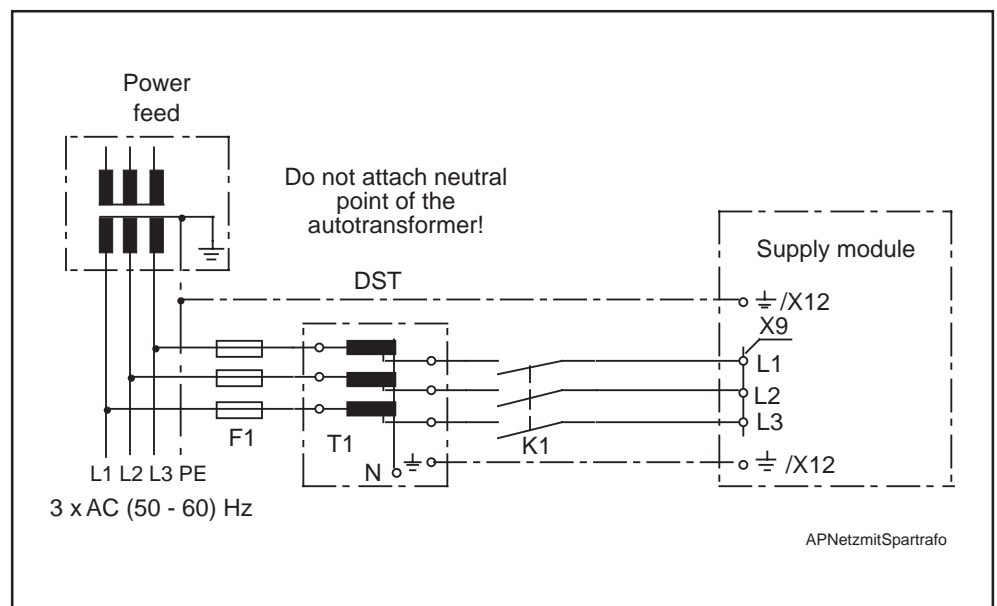


Figure 4.3: Mains connection of the KDV 4.1 using an autotransformer

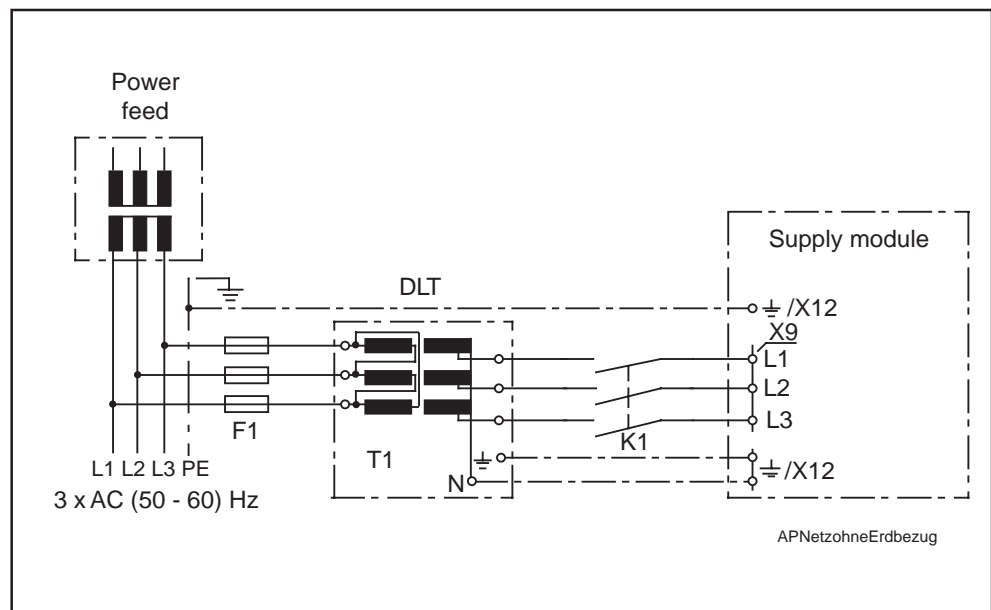


Figure 4.4: KDV 4.1 mains connection using an isolating transformer

The following formula is used to calculate the transformer power needed:

$$S = P_{DC} \times \sqrt{2} \times U_{sec} / 320 \text{ V}$$

S = Transformer power in kVA (mains connection power)

P_{DC} = Link circuit power in kW

U_{sec} = Nominal secondary transformer voltage (KDV 4.1 connection voltage)

The above formula is used to calculate the mains connection power of the drive system with direct mains connection. The mains voltage is then used instead of secondary transformer current.

4.3. Power circuit breaker

The following recommendations apply to direct KDV 4.1 connection to 3 x 380 ... 460 V, as per the connection diagram.

Link circuit continuous power in kW	Mains current in A	Circuit breaker Fa. Siemens 3VE..	Setting Range in A	Setting Value in A
10,0	26	4200-. CS..	36...50	39
12,5	32	4200-. CT..	45...63	48
15,0	38	4200-. CT...	45...63	57
17,5	45	5201-. CS...	63...80	68
20,0	51	5201-. CS..	63...80	77
22,5	57	5201-. CS..	63...80	80
25,0	64	5201-. CS..	63...80	80
27,5	70	5201-. CS..	63...80	80
30,0	77	5201-. CS..	63...80	80

Figure 4.5: Recommended circuit breaker for 380V three-phase networks (Q1 as per connection diagram in Section 4.1)

If fuses are used to secure the power supply, then semi-conductor fuses are not required. gL classification fuses will suffice. Fuses should be selected as per the mains current.

4.4. Mains contactor

The following contactor choices apply to the direct connection of the KDV to 3 x 380V ... 460V AC mains, as per the connection diagram.

The mains current should guide the choice. Starting current peaks do not have to be taken into consideration because the KDV 4.1's charging current limit with link circuit power is equal to or greater than 10kW.

Link circuit power in kW	Mains current in A	Mains contactor Fa. Siemens
10,0	26	3TB 44
12,5	32	3TB 44
15,0	38	3TF 46
17,5	45	3TF 46
20,0	51	3TF 47
22,5	57	3TF 47
25,0	64	3TF 48
27,5	70	3TF 48
30,0	77	3TF50

Figure 4.6: Recommended mains contactor (K1 as per the connection diagram in Section 4.1).

4.5. Mains connections for electronics and fan

Voltage: 230 V AC
 Current: 2,2 A for electronic supply
 0,3 A per heat sink fan
 Terminal: X10a/1 - X10a/3

The same terminal supplies the electronics and equipment fans of the connected drive module. Both the electronics supply and the equipment fan in the KDV 4.1 have separate fuses.

Only the lead line requires a short-circuit guard inside the control cabinet (e.g., line circuit breaker 10A, trip characteristic L).

4.6. Link circuit choke

The KDV 4 must always be operated with one inductance in the „L+“ and one in the „L-“ line.

Link circuit chokes GLD 14 and GLD 15 each contain an inductance for „L+“ and L-“.

Designations for Ordering the Link Circuit Choke	
Link circuit power	two inductances 2 x 1mH
up to 15 KW greater than 15 KW	GLD 14 GLD 15

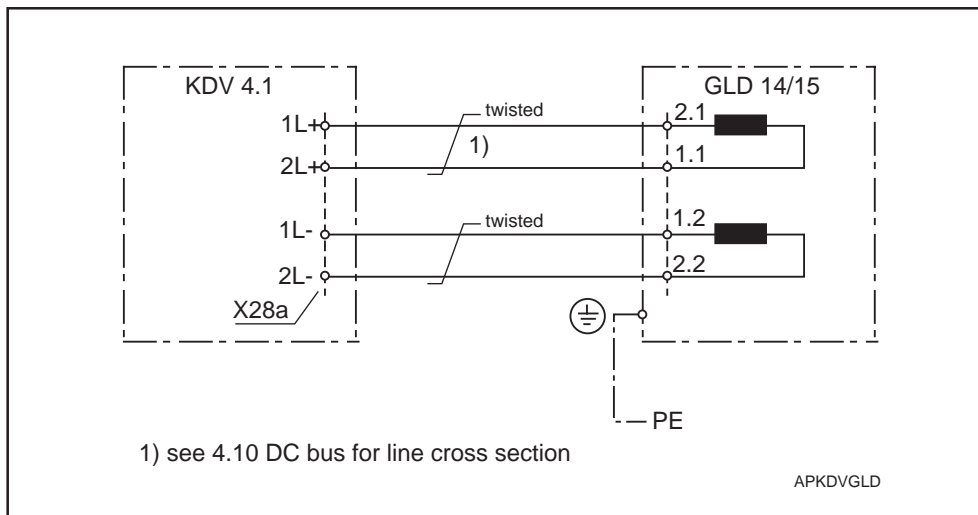


Figure 4.7: Smoothing choke connection



If the DC bus choke is incorrectly connected, then this could result in damage to the equipment, or the equipment may not work properly.

Damage to equipment, a drop in regenerated power from the KDV 4 and increased mains regeneration are possible.

Connect DC bus choke as shown above.

Check this connection when commissioning the machine.

4.7. Additional capacitors

Additional capacitors CZ 1.02 or additional capacitors module TCM can be connected to the d.c. voltage link circuit to heighten the performance of the KDV 4.1.

An additional capacitor with 4mF is needed to implement maximum equipment power (see Section 2.1).

It is necessary, in some cases, for drives to run free after a power failure. Energy stored in the link circuit can be used for this purpose. Additional capacitors can increase the energy stored in the link circuit. A maximum of 8mF additional capacitors can be connected.

4.8. Fault current safety devices

Do not install an residual current operated device in the KDV 4's mains lead (as per VDE 0160, Section 6.5).

4.9. Minimum clearance to flammable materials

The bleeder resistor is set in a separate cabinet within the KDV 4. Such flammable materials as lines and cables must maintain a minimum clearance of 100 mm upwards and 40 mm sideways and forwards.

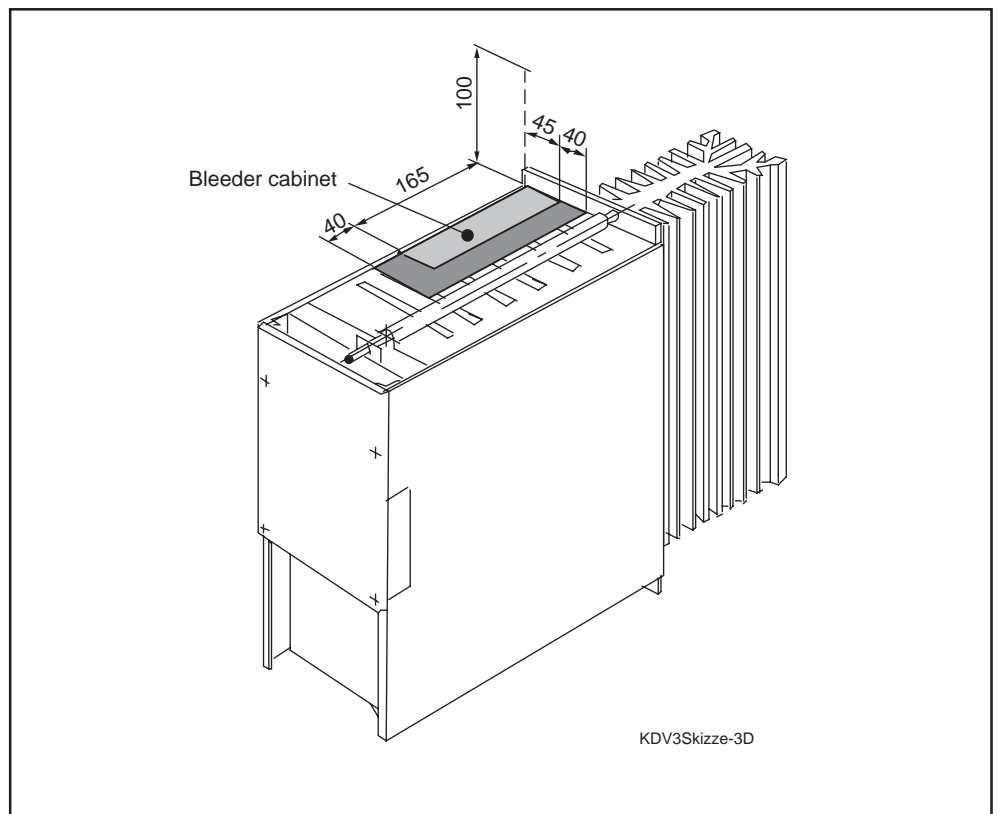


Figure 4.8: Safety clearance to flammable materials.

4.10. DC voltage link circuit

Use the bus-bars in the connection accessories of the drive modules for the connections. Use individual twisted strands (maximum 2m length) for longer connections.

Link circuit power in kW	Minimum cross section in mm ²
14	10
22	25
30	35

4.11. Electronics supply and signal exchange bus connections

The bus connection is terminated at one end with a plug. This assures that the correct plug is used. This end plug is a part of the electronic connection accessories delivered with the supply module.

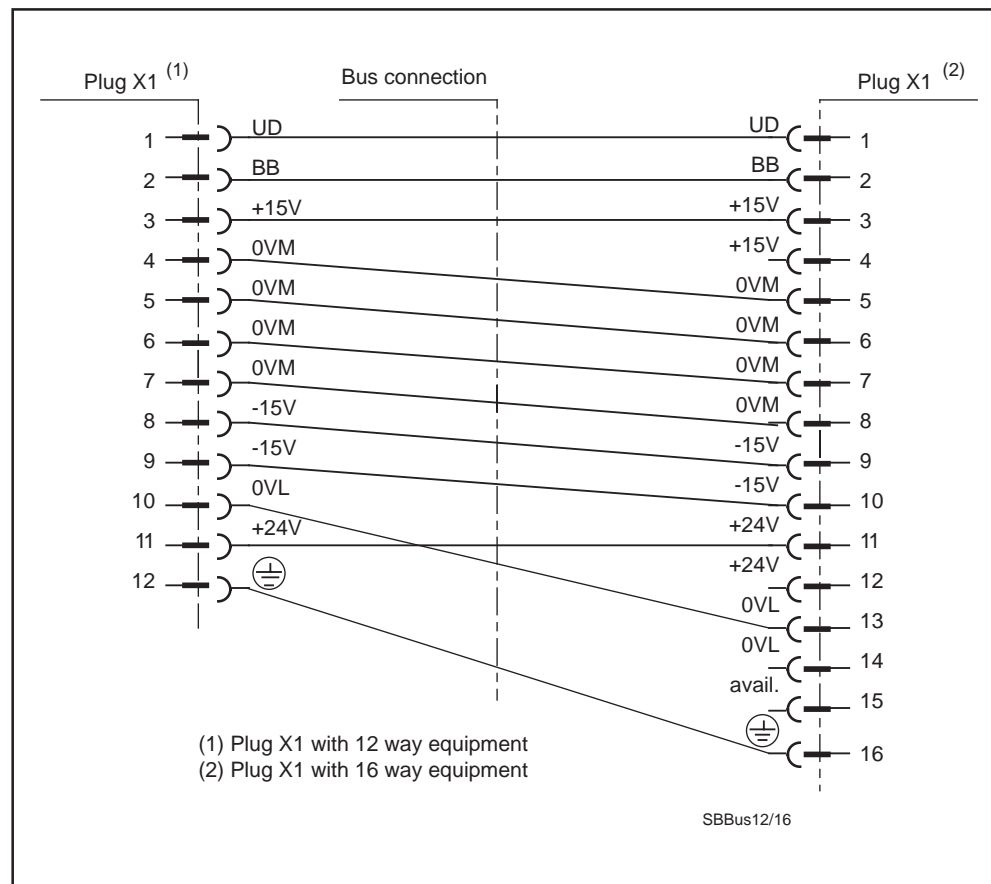


Figure 4.9: Bus connection cable for signal processing

4.12. Control cabinet



No other voltages except those listed in the data sheet or the interface description should be connected. All KDV4 connections must be disconnected before any high-voltage testing of the control cabinet is performed.

4.13. Mains supply earthing requirements

Grounded threephase mains

The KDV 4 can be connected to earthed, threephase mains supplies without the need for potential isolation.

Ungrounded threephase mains

On non-earthed threephase mains supplies (IT mains), the phase-to-phase voltage is present during an earth fault between the case and the power connection of the KDV 4. The KDV 4 can be protected against overvoltages if

- the KDV 4 is connected via a transformer, and
- if the machine is protected by overvoltage conductors.

Connecting the KDV 4 via an isolation transformer offers the best protection against overvoltage and the greatest degree of operating safety.

Overvoltages

- Periodic overvoltages at the KDV 4 between the phase conductor (1U1, 1V1, 1W1, 2U1, 2V1, 2W1) and the housing should not be permitted to exceed 1000V (peak value).
- Non-periodic overvoltages, as per VDE 0160, between the phase conductor and the housing are permissible for the KDV 4 in terms of the following diagram.

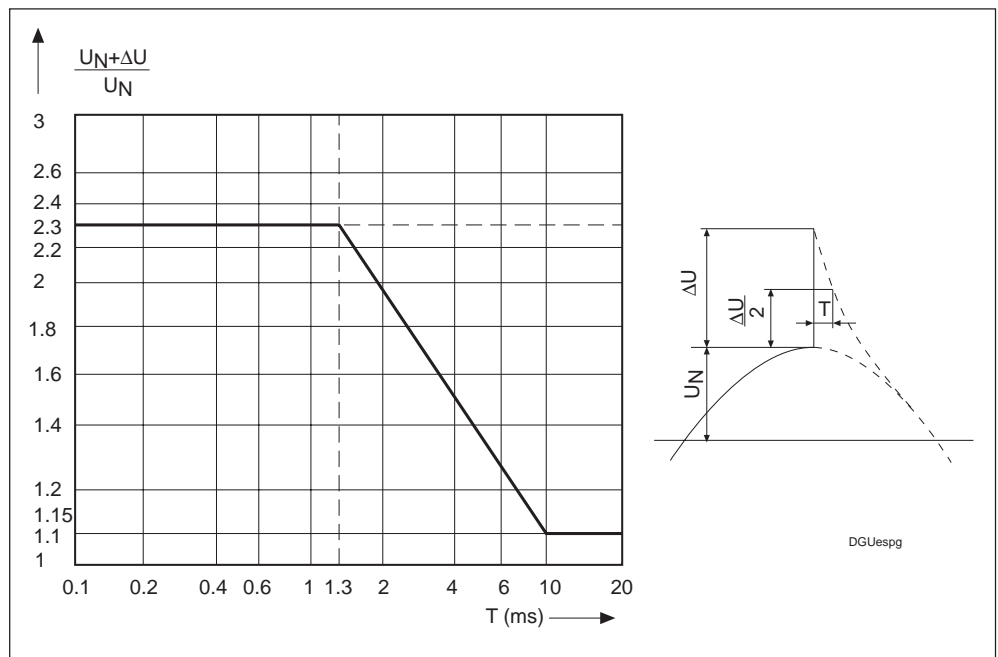


Figure 4.10: Permissible non-periodic overvoltages as per VDE 0160

The KDV 4 can be connected to 3 x 460V.

The maximum permissible overvoltage is thus:

$$460 \text{ V} \times \sqrt{2} \times 2.3 = 1490 \text{ V}$$

5. Interface description

5.1. Signal voltage

Signal voltages can be tapped from terminal strip X10. These terminals are there for measuring and testing purposes. If these voltages are used outside the KDV 4.1, then attention must be paid that no disruptive voltages are coupled in (short, shielded lines).

Maximum permissible load must not be exceeded. The $\pm 15 V_M$ are fused against short-circuiting. The $+24V_L$ are secured by fuse F2.

X10/1	$+15V_M$	Measuring voltage 100 mA
X10/2	$0V_M$	Reference potential measuring voltage
X10/3	$-15V_M$	Measuring voltage max. 100 mA
X10/4	$+24V_L$	Load voltage max. 1A
X10/5	$0V_L$	Reference potential load voltage

5.2. "Ready" State

Bb1 contact (X10/6 - X10/7)

Maximum load: DC 24 V/ 1 A

Operating status	Contactor dead	Fault	Ready
Output	open	open	Closed

The KDV 4.1 Bb1 contact is of higher ranking importance than that of the others. The Bb1-contact connects the drive system to the emergency stop sequence. Powering down is not permitted until it closes.

The Bb1 contact closes if the electronic supply is connected to terminal X10a and no fault is present.

The Bb1 contact opens in the event of the following faults:

- tachometer fault
- excessive temperature in the drive modules
- drive module bridge fuses
- loss of $\pm 15V_M$ / $+ 24 V_L$ signal voltage
- open bus connection of missing plug
- heatsink temperature of the KDV 4.1 too high
- overcurrent in the KDV 4.1 power supply
- earth connection in the drive system
- bleeder overloaded

5.3. Electronics supply functioning

HSM - Auxiliary voltage signal (X10/8)

Transistor output: max. 100 mA

Operational status	No current	Fault message	Electronics supply functioning
Output	0V	0V	+24V

If there is a problem with the electronics supply (auxiliary voltage during operation, then auxiliary voltage signal will switch to 0V. The LED auxiliary voltage extinguishes.

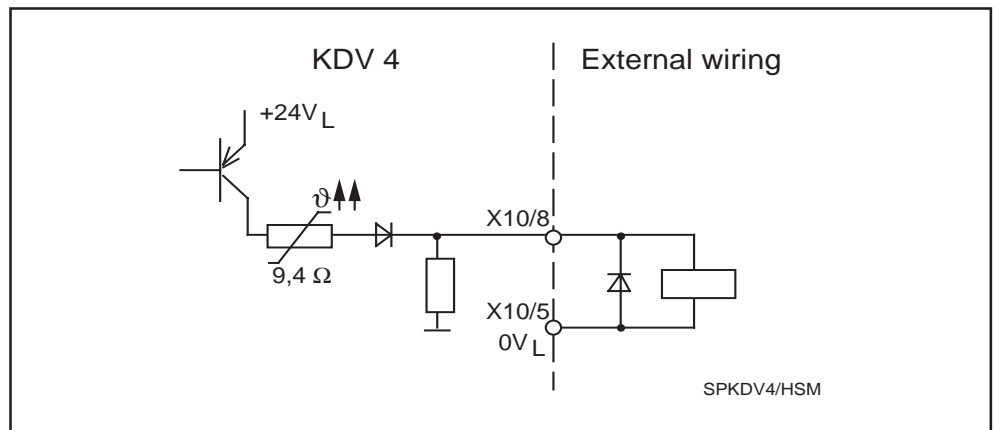


Figure 5.1: Output wiring auxiliary voltage signal

The drives remain operable. The Bb1 contact blocks off the ability to power back up once it is shut off.



The same terminals supply the electronics and equipment fans of the connected drive modules. If the auxiliary current signal does not come up, then it must be relied upon that the KDV 4.1's temperature control or the drive modules will respond.

5.4. Temperature pre-warning

TVW-Contact (X10/9 - X10/10)

Maximum load: DC 24V / 1 A

Operating Status	Contacteur dead	Temperature too high	Temperature acceptable
Output	open	open	closed

The temperature pre-warning contact opens when heatsink temperatures get too high. The red LED "TÜ" lights up. The Bb1 contact interrupts the emergency stop sequence after 30 seconds.

The reaction of the drive system to this fault depends on the NCB bridge (see Section 5.6).

If an CNC controlled shutdown is needed, then the drives should be shut down within 30 seconds after a response from either the pre-temperature warning of the KDV or one of the drive modules.

5.5. Power supply functioning

UD-Contact (X10/11 - X10/12)

Maximum load: DC 24 V / 1 A

Operating status	Contactor Dead	Fault	Power functioning
Output	open	open	closed

The UD-contact acknowledges that the power supply is in order. It opens with the following problems:

- no right rotating field
- power failure/phase failure
- link circuit voltage less than 200 V

The response of the drive system to any of these faults depends on the „NCB“ bridge (see Section 5.6).

Should a CNC-guided shutdown become necessary, then, if the UD contact responds, the drives need to be shutdown by a master controller.

5.6. Drive shutdown due to fault in power feed

Input - Terminals (X10/13 - X10/14)

NCB Bridge

Bridge	Open	Closed
Controlled braking in an emergency stop or due to power failure	by the drive electronics	by the CNC controller

In the event of problems in the power supply and within the drive system, the speed set-point value of all connected drive modules is switched to zero if the NCB bridge is open. The drives are braked at maximum torque. In the event of drive failure, the Bb1 contact additionally shuts down the power supply.

Set-point zero is suppressed with the following faults if the NCB bridge is closed:

- Problem in power supply
 - mains failure/phase failure
 - link circuit voltage less than 200 V
- Drive fault
 - open bus connection or missing plug
 - KDV 4.1 heatsink temperature too high
 - overcurrent in KDV 4.1 power section
 - bleeder overload

This makes a CNC-guided shutdown of the drives in the event of mains or phase failure possible. The energy generated during braking must be greater than the energy consumed.

The Bb1 contact always shuts down power in the presence of a drive failure.



CAUTION

If the set-point value zero switch is dropped, then a master controller must guarantee the shutting down of the drives with a closed NCB bridge. This means that the master controller evaluates the UD contact and shuts the drives down when the contact opens. Otherwise, switching the power off means that there will be an uncontrolled slowing down of the drives.



Do not use the NCB bridge in digital drives which have a SERCOS Interface. The programmable fault response of digital drives makes a position-controlled shutdown without the NCB bridge possible. The NCB bridge blocks the message to the drives that there is a fault in the power supply.

5.7. Fan output

Fan output /X13, X14a, X14b)

These plugs are only for equipment fans.



CAUTION

Do not connect external voltages to these plugs. The KDV 4.1 could be damaged.

6. Troubleshooting guidelines

Extensive searches and repairs are unacceptable because of the production losses which these represent.

The design of INDRAMAT AC drives makes a complete exchange of the individual units without weary adjustment work possible.

This means that any service due to problems restricts itself to locating the problem either in the motor, the supply module or the drive module. Then it limits itself to a complete replacement of the entire problem unit.

6.1. Locating the problem

Problems with axes movements are generally caused by the interaction of the CNC controller, supply and drive modules, motor, mechanical and position measurements, or the faulty adjustment of the individual components to each other. The KDV 4 is equipped with an extensive diagnostic system so that any problem can be quickly located.

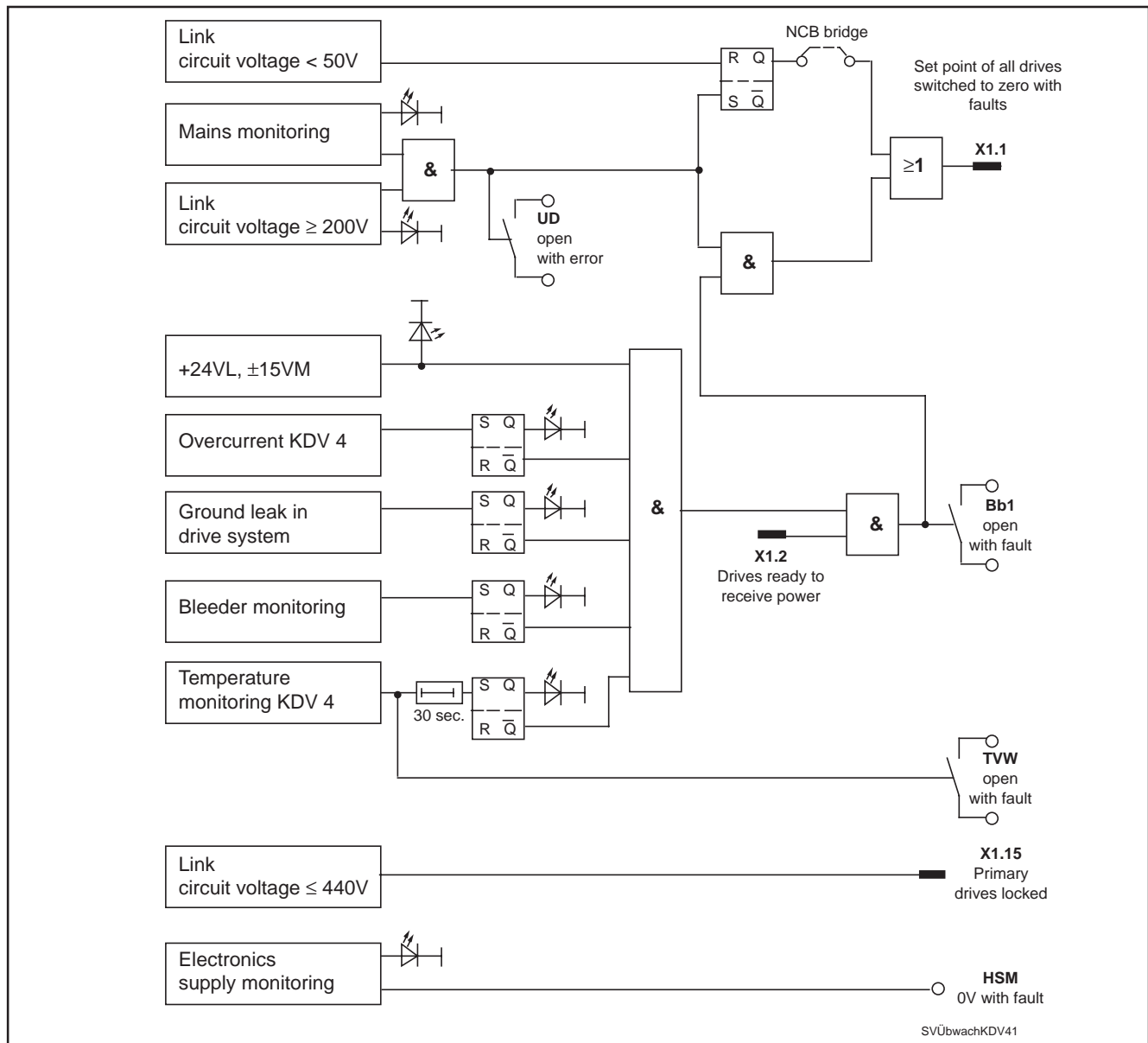


Figure 6.1: The monitoring and diagnostics systems of the KDV 4

6.2. Safety Guidelines

System faults increase the risk of accidents. People, equipment and drives are in danger.



CAUTION

*Guidelines on
Protecting People*

Only trained personnel should locate and eliminate faults.

Danger from moving drives:

Unintentional drive movement during the localization process is possible.



CAUTION

Personnel must not remain within the danger zone. Protective measures, such as bars, covers, planks and light barriers must not be removed or turned off. Access to the emergency stop switch must be quick and ready.

The following applies to working within the danger zone:



CAUTION

Secure the unit against being switched back on.

Switch all power off when working within the danger zone.

Wait until the link circuit has completely discharged itself (approx. five minutes). Check link circuit voltage by testing it.

*Danger from
high voltage*

Dangerous voltage can develop at the following points:

- at all supply module connections, their chokes and capacitors, at all mains connections, and fan supply connections X13 and X14;
- at the drive modules, motor and all motor connections.



CAUTION

Before working on electrical equipment:

- **Use the main switch to turn off all power. Secure the switch against being turned back on again.**
- **Await the discharge time of the link circuit (approx. five minutes). Check the link circuit voltage by testing it.**
- **Do not move the motor. Motor revolutions create voltage at the motor connections.**

Before turning the equipment on:



CAUTION

Do not turn the voltage on until the contact guard is mounted. (This is part of the delivery.)

*Guidelines on
Protecting the Machine*



Note the following to prevent damage to machines:

- Only trained personnel must perform the initial commissioning of the machine.
- Secure the emergency stop and final limit switch.

*Protecting the
Equipment*



Prior to turning anything on:

**All wiring must comply with that of the KDV 4.1 connection diagram.
Check the path of the current in the facility.**











Electrostatic Loads

Electrostatic loads endanger electronic parts.

Discharge all objects which come into contact with the equipment by grounding them.

6.3. Diagnostic displays and fault list

Attention: The messages only apply if the "+24V, $\pm 15V$ " message display is a constant green light.

Light emitting diode		OFF 	ON 
	AUX.-VOLT. Hilfsspannung	No electronics supply [1]	Electronics supply working
	+24V/$\pm 15V$	Signal voltage interrupted [2]	Signal voltage working
	MAINS FAULT Netzüberwachg.	Power not on or interrupted [3]	Power supply working
	POWER OK Leistung OK	Power not on or interrupted, link circuit voltage interrupted [4]	Power supply working
 (1)	BLEEDER OVERL. Überl.	Brake capacity of drive within permissible range	Shutdown due to excessive braking energy or fault in KDV [5]
 (1)	TEMP. FAULT KK-Übertemp.	Equipment temperature within permissible range	Shutdown due to excessive equipment temperature [6]
 (1)	OVERCURRENT Überstrom	Power supply current within permissible range	Shutdown due to overcurrent, short circuit in KDV4, drive module, cable or in the motor [7]
 (1)	EARTH CON. Erdschluß	No earth connection in drive system	Shutdown due to earth connection in KDV4, drive module, cable or in motor [8]

(1) Message and equipment lock stored. Reset by pressing reset button or powering electronics back up.
 [] Fault message (see "Fault messages and remedies")

DAKDV41/Anzeigen

Figure 6.2: KDV 4 diagnostics displays

*(1) Electronics
not being supplied*

6.4. Fault list and remedies

Possible causes:

- fuse F3 or F4 defective
- lead interrupted

Remedies:

- Check voltage at X10a (220V AC).
- Check fuses F3 and F4.

*(2) No controller
voltage*

Possible causes:

- Fuse F3 or F4 defective
- Maximum load of signal voltage exceeded
- Link circuit current after mains failure less than 180V DC

Remedies:

- Release bus connections to drive modules and measure signal voltages.
- Check fuses F3 and F4

*(3) Power not on or
interrupted*

Possible causes:

- No right rotational field at X9
- Phase missing at X9

Remedies:

- Check power at X9 3 x 380 ... 460 V AC
- Check rotational field at X9.

*(4) Power not on or
interrupted, fault in link
circuit*

Possible causes:

- No right rotational field at X9
- Phase at X9 missing
- Link circuit current less than 200 V DC
- Link circuit smoothing choke not or wrong connected

Remedies:

- Check mains feed at X9 3 x 380 ... 460 V AC
- Check rotational field at X9
- remove bus-bars to drive modules and measure link circuit voltage at X9 (L+, L-).
- Check link circuit choke for correct connection

*(5) Powering down
due to excessive
braking energy*

Possible causes:

- Excessive stored energy in drives while braking due to emergency stop or mains failure
- Bleeder resistor defective
- Fault in KDV 4

Remedies:

- Check energy content of drives
- Delayed powering down in an emergency stop

*(6) Shutdown due to
excessive equipment
temperature*

Possible causes:

- Fan not connected or defective
- Fuses F6, F7 or F8 defective
- Heatsink dirty
- KDV 4 overloaded
- Excessive ambient temperatures

Remedies:

- Check fan including F6, F7 and F8
- Clean heatsink
- Check load
- Check ambient temperature
- Test TVW contact

*(7) Shutdown due to
overcurrent*

Possible causes:

- Drive module defective
- Short circuit in KDV 4
- Excessive mains inductance
- Motor power cable damaged
- Motor winding fault

Remedies:

- Check drive modules and appropriate motors and cable
- Check mains feed (mains transformer)

(8) Shutdown due to earth leakage

Possible cause:

- Defective drive module
- Motor power cable damaged
- Short circuit in motor housing

Remedies:

- Check drive module with appropriate motors and cables

6.5. Equipment fuses

Item	Symbol	Fine-wire fuse 5x20 mm
+ 24V _{Lext} (output)	F2	2A/250E average inertia
Auxiliary voltage fuse L1	F3	10A/250E inert
Auxiliary voltage fuse L3	F4	10A/250E inert
external heat sink fan	F6	0,63A/250E average inertia
fan fuse (L1)	F7	10A/250E inert
fan fuse (L3)	F8	10A/250E inert

The fuses, with the exception of F6, are mounted to the front of the equipment (F6 is located at the equipment fan).

7. Dimensional data

7.1. Dimensional data for supply module KDV 4

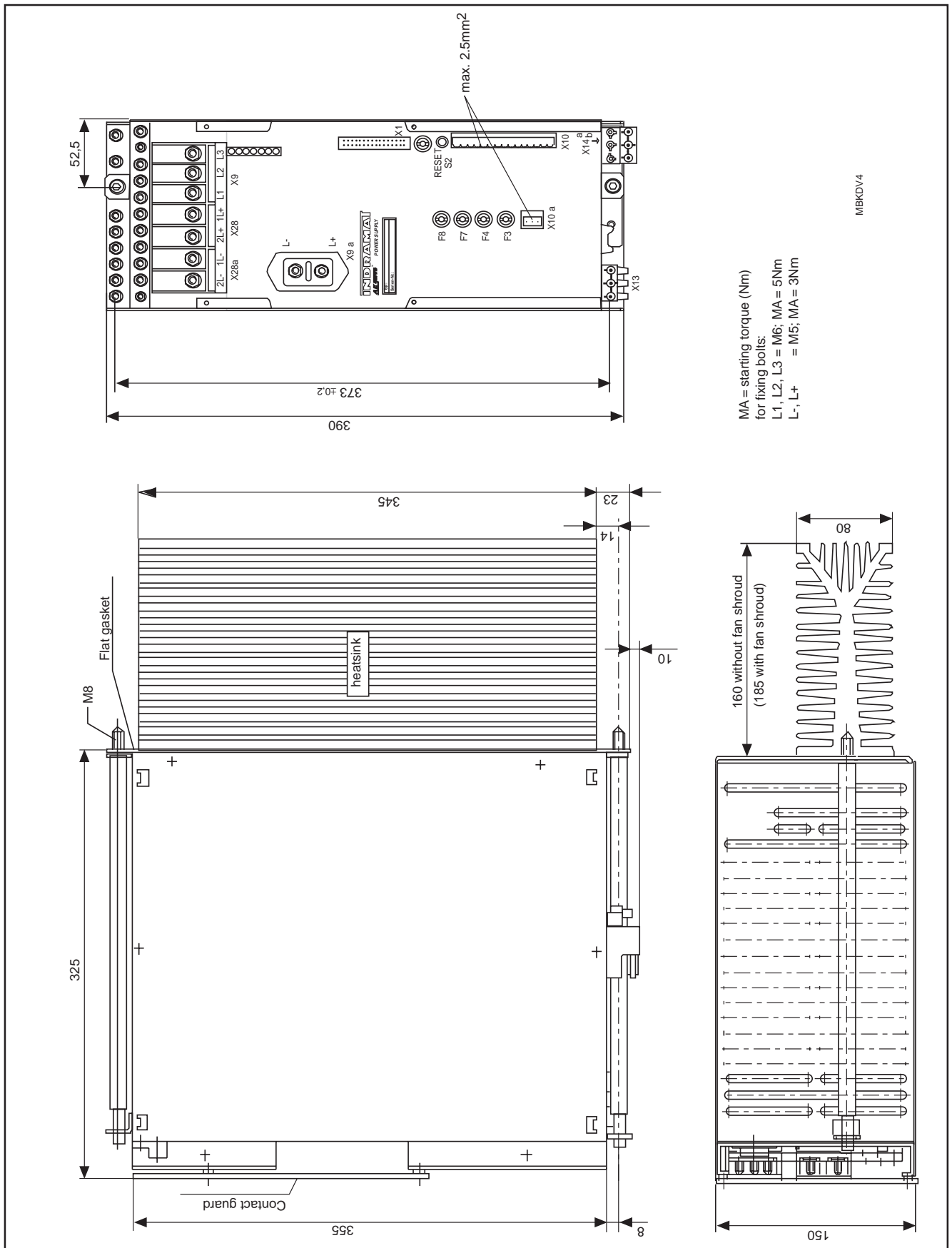


Figure 7.1: Dimension data for supply module KDV 4

7.2. Control cabinet plan with drill diagram

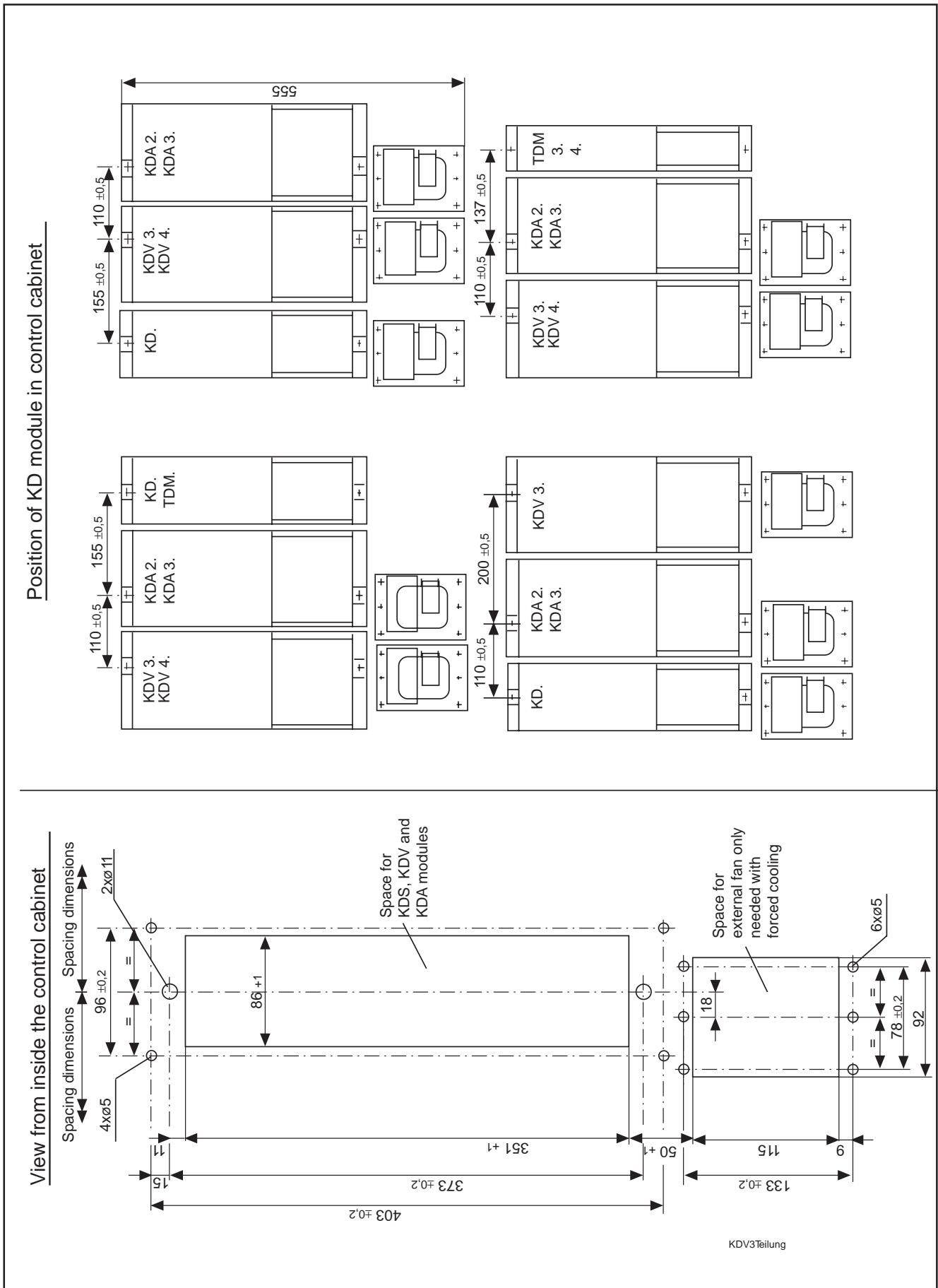


Figure 7.2: Control cabinet plan with drill diagram.

7.3. Assembling the control cabinet

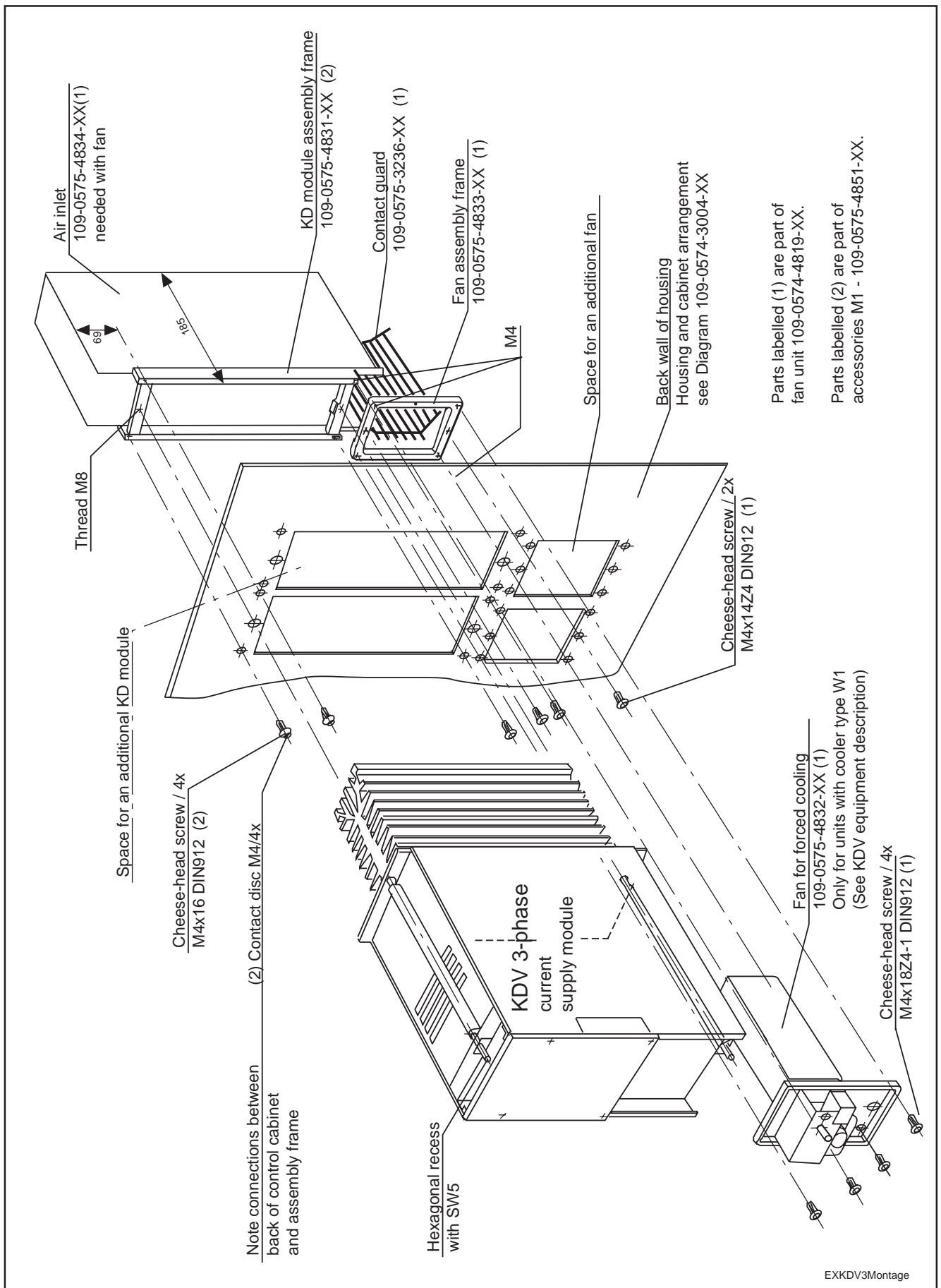


Figure 7.3: Control cabinet assembly

7.4. Dimensional data for additional capacitor CZ 1.02

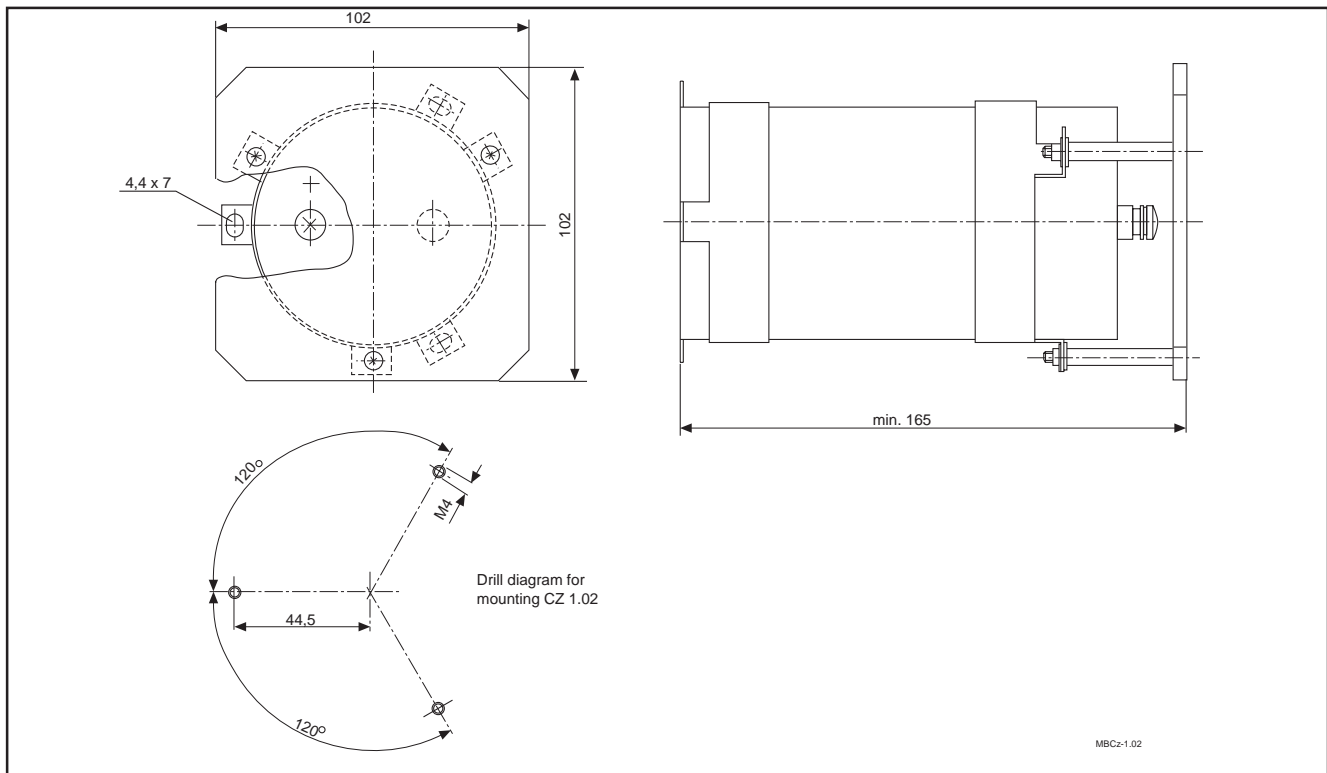


Figure 7.4: Dimensional data for additional capacitor CZ 1.02

7.5. Dimensions Sheet for Additional Capacitor TCM 1.1

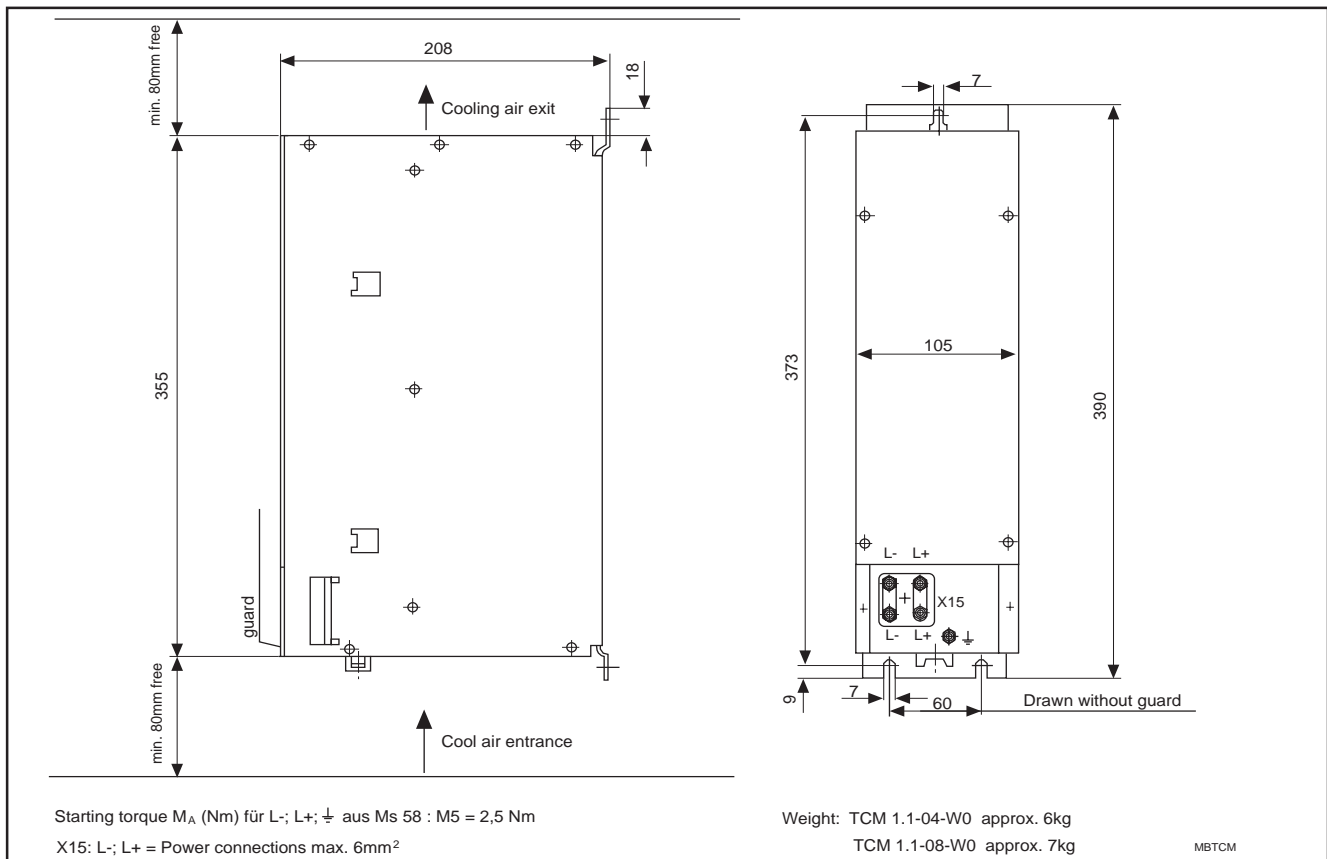
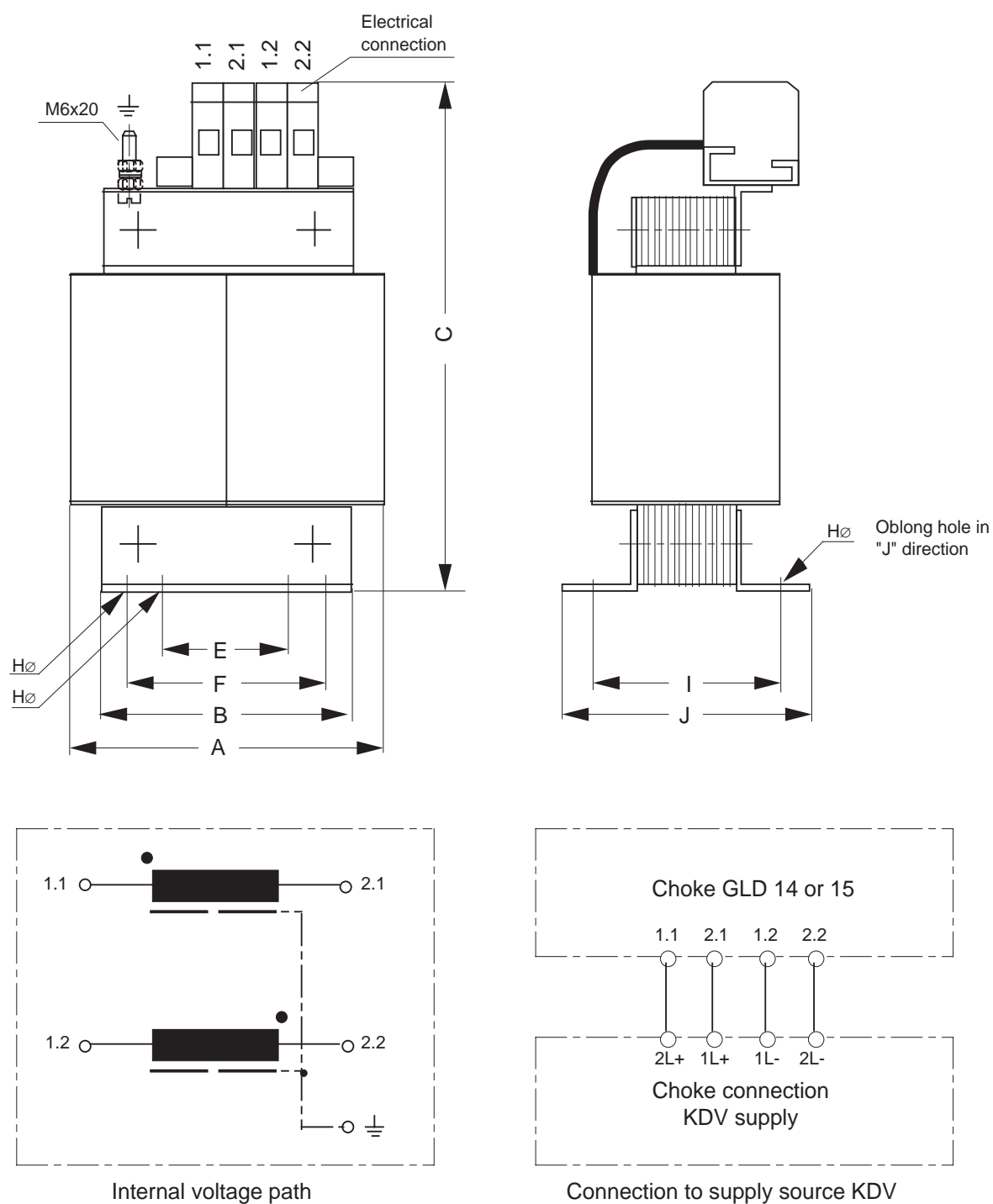


Figure 7.5: Dimensional data for additional capacitors module

7.6. Dimensional data for link circuit choke GLD 14/15

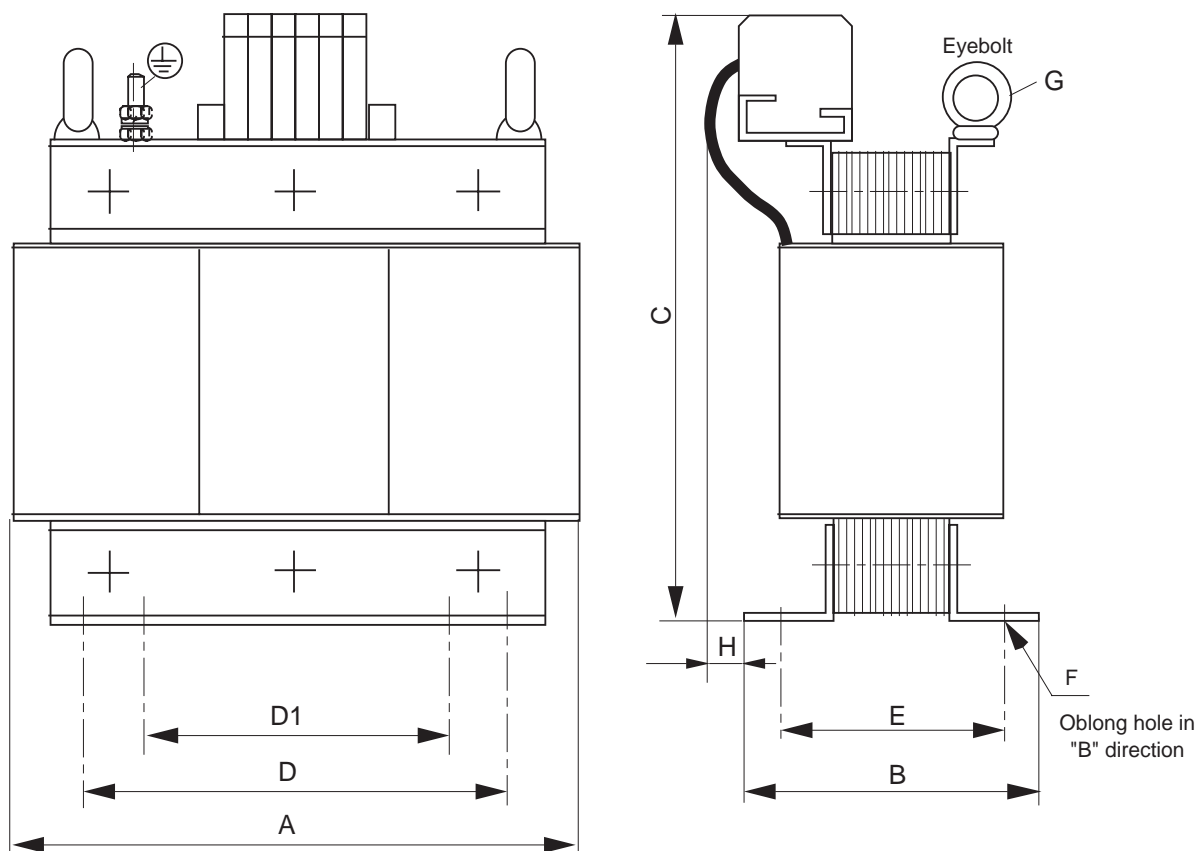


Type	mH/A per coil	dimensions in mm								electrical connection	weight kg
		A	B	C	E	F	H \emptyset	I	J		
GLD 15	1,0/100	200	150	340	80	120	11x18	115	145	35mm ²	25
GLD 14	1,0/50	140	102	245	--	75	7x15	95	117	16mm ²	9,5

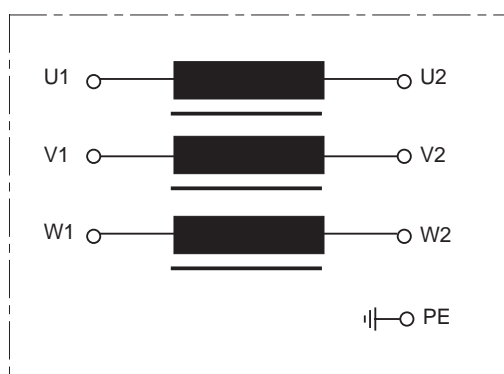
MBGLD14/15

Figure 7.6: Dimensional data for link circuit choke GLD 14/15

7.7. Dimensional data for commutation choke KD 19/20



Switching diagram:



Dimensions table:

Type	Current/ A	Dimensions in mm										Terminals /mm ²	Weight/ kg
		A	B	C	D	D1	E	F	G	H	⊥		
KD 19	45	150	90	190	100	70	70	6x10		20	M5	16	6,5
KD 20	90	240	120	260	170	110	90	11x18	M8	25	M8	35	18

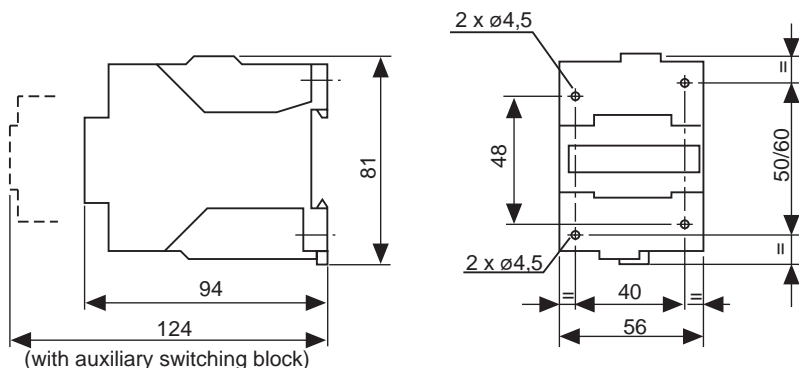
MBKD19/20

Figure 7.7: Dimensional data for commutation choke KD 19/20

7.8. Link circuit short circuit contactor

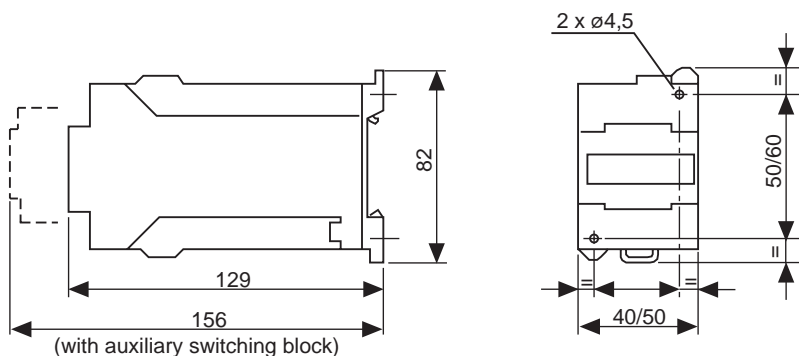
Alternating voltage actuation

- Contactor 220V AC 50/60Hz
LC1-D258 MA 65
- Contactor 110V AC 50/60Hz
LC1-D258 FA 65
- Auxiliary block LA1-D22 A 65
- Overvoltage restrictor
LA9-D 0 9980



Direct current actuation

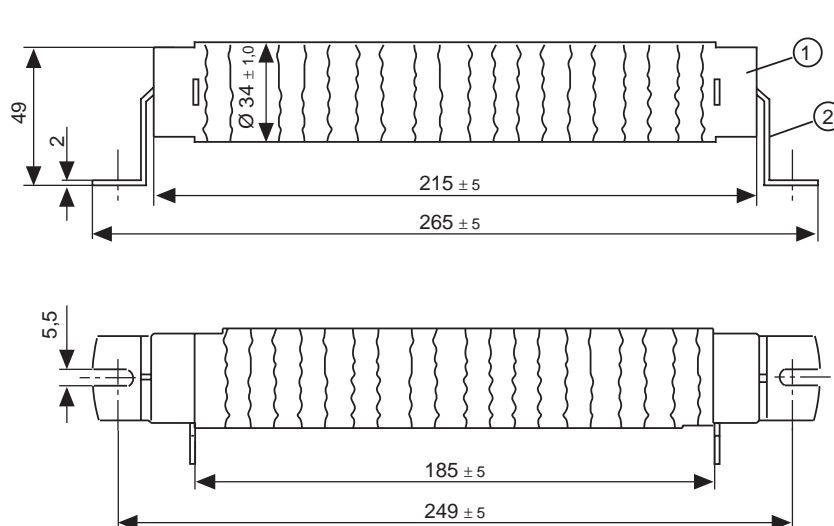
- Contactor 24V DC
LP1-D258 BW 65
- Auxiliary block
LA1-D22 A 65
- Overvoltage restrictor
LA9-D221



KDV3ZwKrschütz

Figure 7.8: Link circuit short circuit contactor

7.9. Link circuit short circuit resistor



① Link circuit short circuit resistor
Type: ZSB 30 x 215 - 2R2 ± 10 %

② Assembly angle
Type: Z- Angle

KDV3WidZSB

Figure 7.9: Dimensional data for link circuit short circuit resistor

8. Order Information

8.1. KDV 4 type key

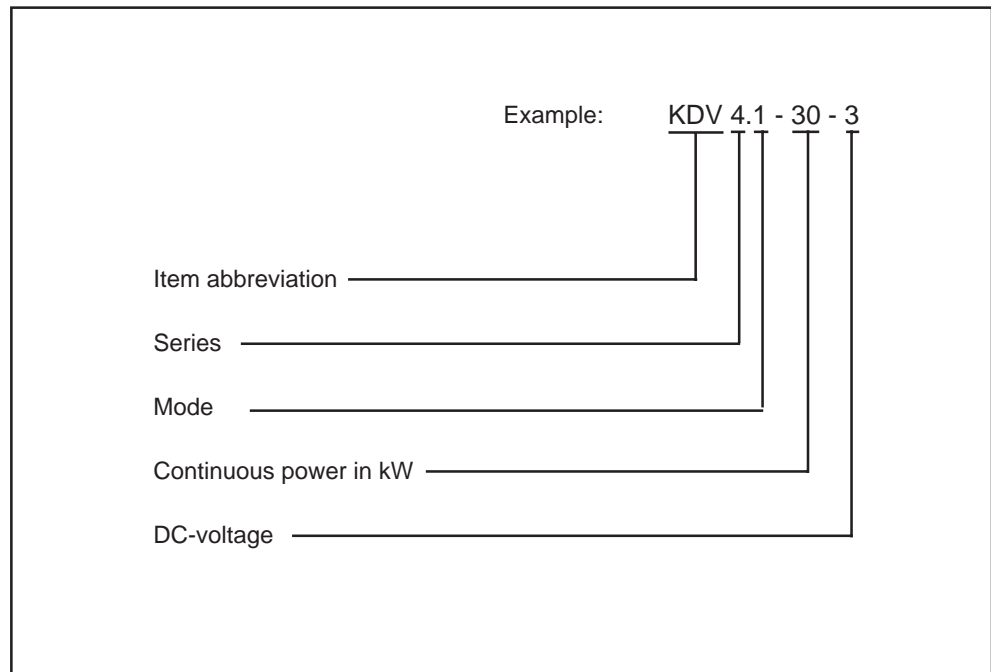


Figure 8.1: KDV 4 supply module type key

8.2. Available KDV 4 supply module versions and accessories

Item	Available Versions
Supply Module	KDV 4.1-30-3
Electrical connection accessories	E7-KDV E8-KDV E9-KDV (see Section 8.3)
Mechanical assembly accessories	M1-KD
Fan unit	LE 4-220
Link circuit smoothing choke	GLD 14 GLD 15
Additional capacitors	CZ 1.02 TCM 1.1-04-W0
Commutation choke	KD 19 ...see dimensional data Section 7 KD 20 ...see dimensional data Section 7

8.3. Electrical accessories

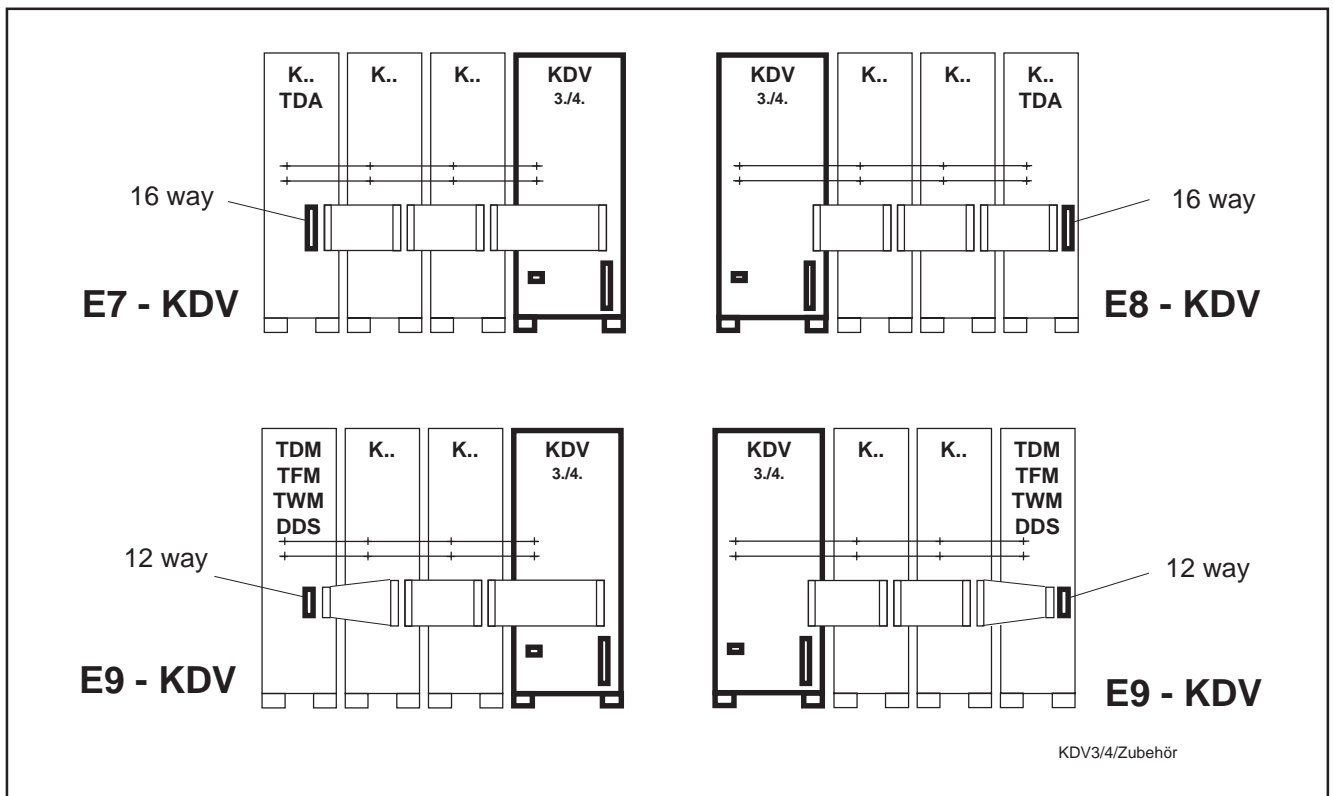


Figure 8.2: Overview of the electrical accessories

8.4. Parts list for the mains supply unit

Pos.	Item
1.0	Supply module KDV 4.1-30-3
1.1	mechanical assembly accessories M1-KD
1.2	electrical connecting accessories E.-KDV
1.3	fan unit LE 4-220
2.0	Link circuit smoothing choke GLD Available versions as per Sections 2.1 and 4.6
3.0	Commutation choke KD Available versions as per Section 2.1
4.0	Additional capacitors Available versions as per Section 2.1

