

KVR 1.3-30-3 Supply Module for Direct Mains Connection to 3 x AC 380...480 V

Application Manual

DOK-POWER*-KVR*1.3****-ANW1-EN-P



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Purpose of documentation In this document you will find

- the definition of the area of application
- the electrical lay-out
- the mechanical lay-out of the control cabinet
- assembly and installation instructions
- guidelines for selecting additional components
- fault-finding tips

Change procedures

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1. Installing the INDRAMAT modular AC drive system

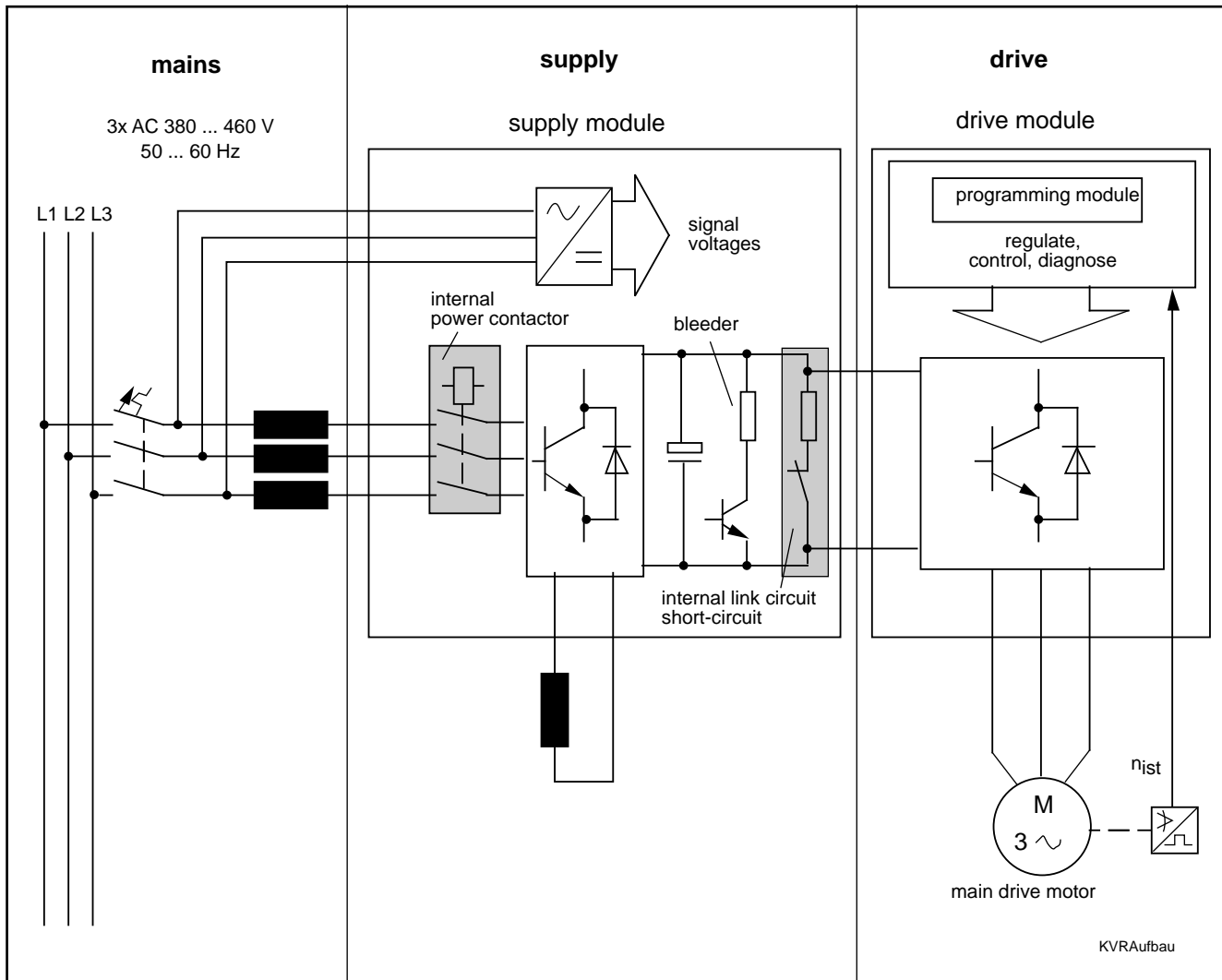


Figure 1.1: KVR 1 supply module as a part of the modular INDRAMAT AC drive system

The INDRAMAT AC Drive System consists of a supply and the drive modules. Several drives can be mounted to a single supply module. Supply module KVR 1.3, with its regeneration capability, is a component of the INDRAMAT modular AC drive system.

Supply module KVR 1 provides the link circuit d.c. voltage for the power supply and the control voltage for all connected INDRAMAT main and servo-drive modules.

1.1. Main functions of supply module KVR 1

Power supply of the drives

The power rectifier of the KVR rectifies the three-phase mains alternating voltage and provides a regulated link circuit d.c. voltage for the drives power supply.

The KVR 1 operates as an inverter in the event the drives are generator-driven, and feeds the power back into the mains. Buffer capacitors provide sufficient smoothing.

In the event of a power failure, or, if the power supply should be switched off, then the energy regenerated as a result of the braking of the motors will be assimilated by the bleeder resistor in the KVR 1.

The KVR1's internal power contactor makes it possible to isolate the drives from the mains.

Supply to the electronics

The KVR supplies the drive module's electronics via the signal voltage bus. In the event of a mains failure, the signal voltages will receive power from the d.c. link circuit. As a result, the drive electronics remain operational when the drives are in generator mode.

Drive monitoring system

The KVR has been equipped with extensive monitoring functions. These communicate with the drive modules via the signal voltage bus.

The Bb1 contact of the KVR is very important for the drive system operation. The power supply can be connected only when Bb1 contact is closed.

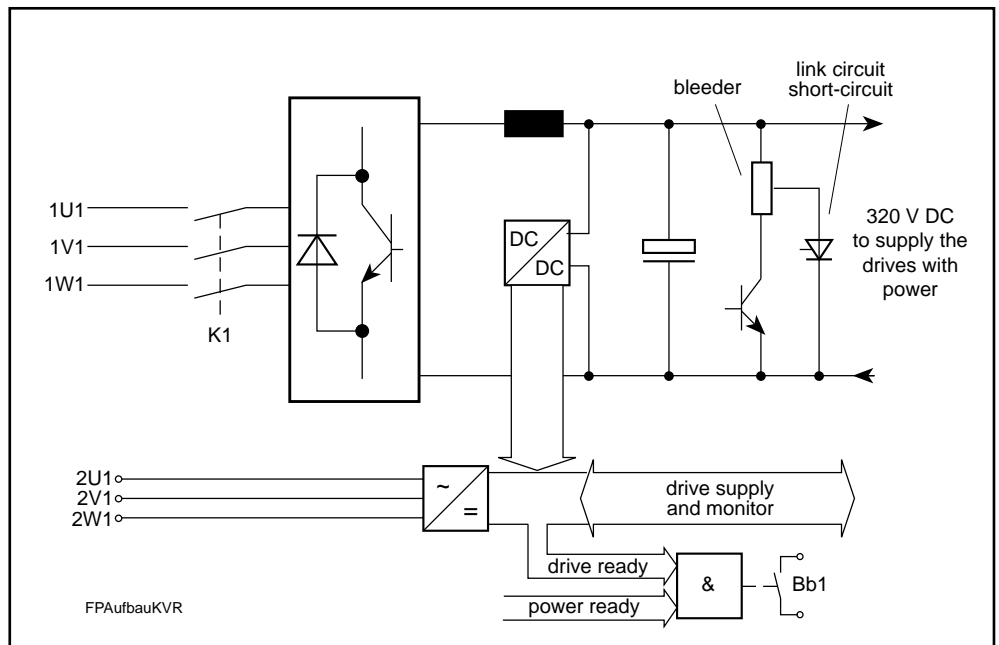


Figure 1.2: The KVR 1.3 supply module as part of the Indramat AC drive system

2. Area of application

It is possible to operate the Indramat drives supply modules of the KVR series at a continuous mechanical rate of 24 kW. The KVR feeds the regenerated energy created by the braking of the motors back into the mains. The continuous regeneration power can equal 20 kW. The KVR is thus particularly well-suited for those applications where high continuous regeneration power is required.

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

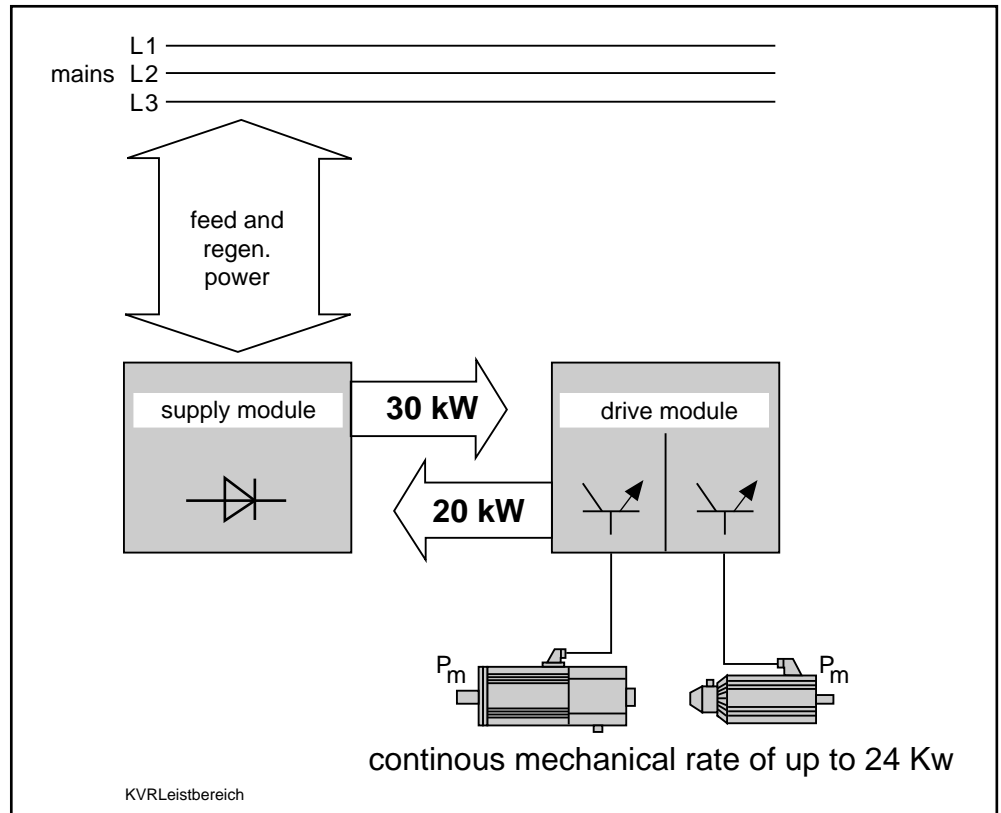


Figure 2.1: Power range for supply module KVR 1.3

2.1. Power ratings

The effective performance of the KVR 1 can be adapted to the demands of the respective application by using additional components.

(1)		(2)		(3)		(4)	(5)	(6)	Supply module KVR 1.3-30-3 additional components			
P_{DC} kW		P_{KB-3} kW		P_{KB-03} kW		P_{BM} kW	W_{max} kWs	P_m kW	smoothing choke	commutation choke	link capacitor	bridge capacitor
in- coming	regen.	in- coming	regen.	in- coming	regen.							
15	10	30	20	45	25	40	100	12	GLD 17	KD 23	---	---
25	16	50	32	75	37	40	100	20	GLD 18	KD 24	---	CZ 1.2-01-7 or TCM 2.1-01-7
30	20	60	40	90	50	40	100	24	GLD 19	KD 25	CZ 1.02	TCM 2.1-02-7

(1) P_{DC} = link circuit continuous power	(4) P_{BM} = peak bleeder power
(2) P_{KB-3} = link circuit short-term power 3 s (accel/decel of main drives)	(5) W_{max} = maximum regen. energy
(3) P_{KB-03} = link circuit peak power for 0.3 s (accel/decel of servo drives)	(6) P_m = mechanical power for ON time > 10 s

Figure 2.2: Power range of the KVR 1.3

2.2. Overload capabilities

It is possible to overload the KVR for a short period in order to accelerate feed and main drives. The highest possible acceleration rate must be taken into consideration in the projection and may not be exceeded.

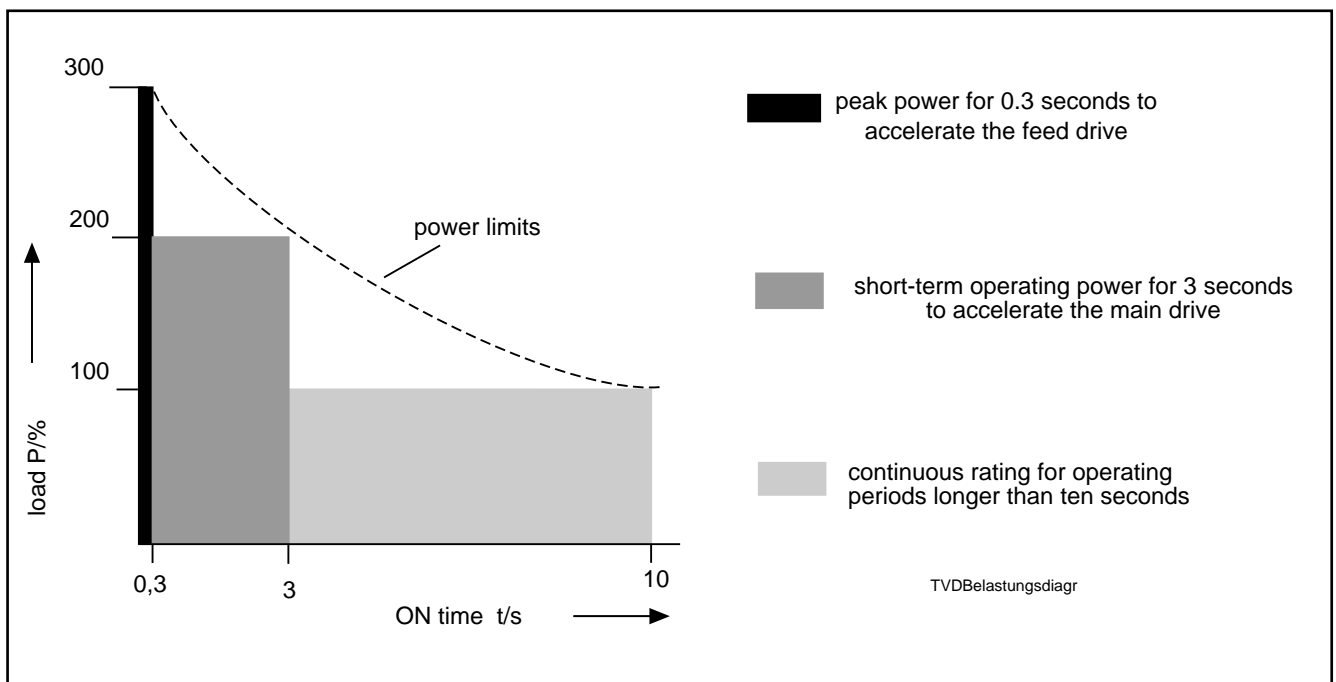


Figure 2.3: Load diagram - KVR 1

2.3. Data sheet for the KVR 1.3

Description	Symbol	Unit	KVR 1.3-30-3
Power supply			
Input Voltage	U(ACN)	(V)	3 x 380 ... 480 ($\pm 10\%$)
Frequency	f(N)	(Hz)	50 ... 60 Hz
Link circuit D.C. voltage	U(DC)	(V)	320 ($\pm 5\%$)
Continuous link circuit power (feed and regeneration)	P(DC)	(kW)	30/20 (with links and link circuit capacitors of 2 mF)
Link circuit peak power	P(KB-03)	(kW)	90
Peak bleeder power	P(BM)	(kW)	40
Continuous bleeder power	P(BD)	(kW)	Bleeder designed only for E-stops
Maximum regeneration energy with power off	W(max)	(kWs)	100
Power dissipation inside control cabinet at maximum equipment load	P(V)	(W)	170
Power dissipation outside control cabinet at maximum equipment load	P(V)	(W)	480
KVR 1.3 weight	m	(kg)	31
Weight of mechanical accessories	m	(kg)	1.7
Weight of LE 4 fan	m	(kg)	4.2
Electronics supply			
Input voltage	U(AC)	(V)	3 x 380 ... 460 ($\pm 10\%$)
Frequency	f(N)	(Hz)	50 ... 60
Power consumption at maximum load	S(el)	(VA)	500
Fan supply			
Input Voltage	U(AC)	(V)	230 (+6/-10%) or 115 ($\pm 10\%$)
Frequency	f(N)	(Hz)	50...60
Maximum power consumption	S(L)	(VA)	70 (per heatsink ventilator)
Control voltage output			
+24 V Load voltage	U(L)	(V)	22 ... 26 (ripple 2%)
+24 V Continuous current	I(UL)	(A)	11
± 15 V Measuring voltage	U(M)	(V)	14.9 ... 15.1 (ripple 0.1%)
+15 V Continuous current	I(+UM)	(A)	2.0
-15 V Continuous current	I(-UM)	(A)	2.0
Environmental Conditions			
Permissible ambient temperature at rated data	T(amb)	($^{\circ}$ C)	+5 ... +45
Maximum ambient temperature at reduced data	T(m.amb)	($^{\circ}$ C)	+55
Storage & transportation temperatures	T(L)	($^{\circ}$ C)	-30 ... +85
Installation altitude without derating			maximum 1000 meters above sea level
Permissible relative humidity			maximum 95%
Permissible absolute humidity			25g water/m ³ air
Degree of contamination			non-conductive dirt/no condensate
Protection category			IP 10 as per DIN 40 050

Figure 2.4: Data sheet - KVR 1.3

2.4. Conditions of use

Increased ambient temperatures

The ratings and control voltages listed in the data sheet for the KVR 1 are valid with ambient temperatures of +5° to +45° C. The maximum permissible ambient temperature is +55 °C. The output data thus drops as depicted in the following diagram.

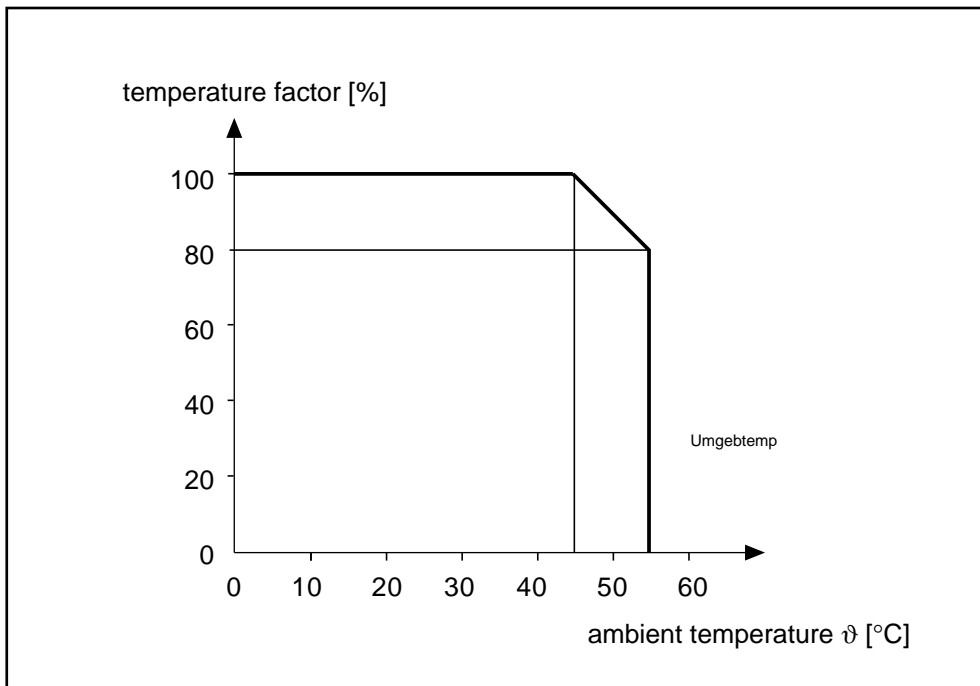


Figure 2.5: Drop in power data with increased ambient temperatures.

Installation elevation exceeds 1000 meters

The KVR 1.3's output power data drop in accordance with the following diagram when installation altitude is above 1000 meters.

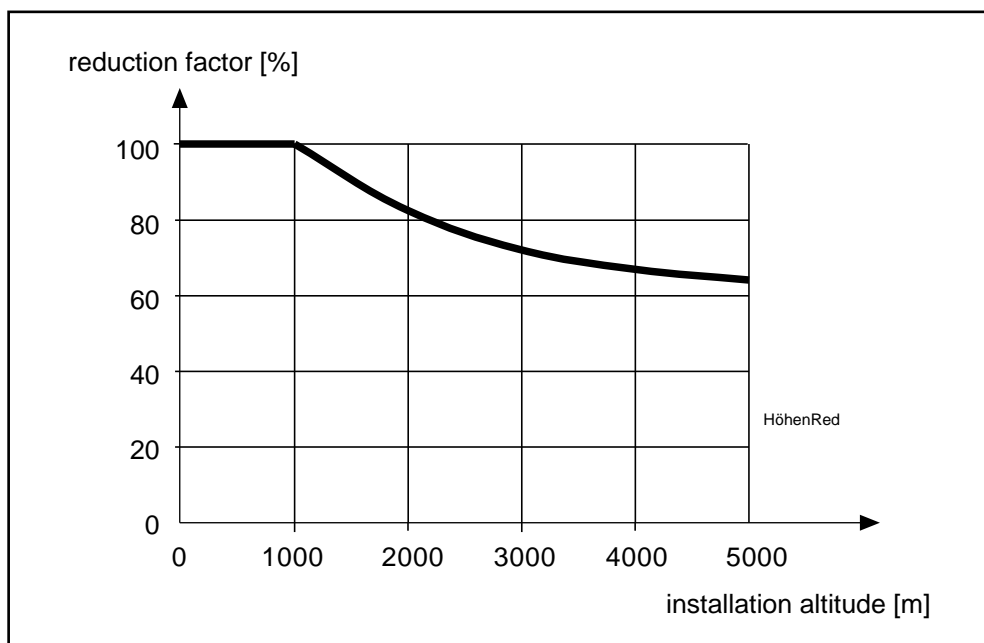


Figure 2.6: Drop in data with installation altitude above 1000 meters

2.5. Functional power features

- **It is possible to operate the drives for long periods even while braking**
The energy created by braking the motor is fed back into the mains with little loss of power.
- **Direct mains connection**
The KVR can be directly connected to 3 x AC 380...480V, 50...60 Hz mains without the use of a transformer.
- **Power shutdown with the use of internal contactors**
The contactor which shuts down the drive's power supply is a component of the KVR1.
- **Internal link circuit short-circuit**
Internal link circuit short-circuits have the ability to brake synchronous motors in the event of a problem in the electronics of the motor.
- **High overload capability**
Peak power of 90 kW to accelerate motors.
- **Loss of heat due to energy in the control cabinet**
The heatsink is located outside the control cabinet. This makes compact control cabinets possible.
- **Fuse protection is possible with circuit breakers**
 - Expensive semi-conductor fuses are not needed.
 - No special fuses for exports.
- **The drive systems reaction to a power failure can be programmed by adding an external link.**
 - Without the links, the motors brake at maximum torque.
 - With the links, there is a signal to the NC control via a voltageless contact. Thus, the shutdown of the motors can be guided by the NC. Expensive tools or workpieces are protected against damage.
- **Controlled bridge voltage**
No reduction in drive response in the event of mains undervoltage.
- **Charging current limiting for bridge capacitors**
The inrush current can be ignored when selecting the switchgear for the power supply. The service life of the switchgear is increased.
- **High capacitance of the control voltage**
It is possible to connect ten drive modules to one supply module.
- **Service friendly**
 - Signal lines are connected with screw terminals.
 - A numeric display makes extensive diagnostics and controlled elimination of faults possible.

3. Electrical connections - installation guidelines



The KVR 1.3 installation plan found in this document is a recommended guideline of the equipment manufacturer.

The wiring diagram of the machine manufacturer should be used for installation.

3.1. Terminal diagram

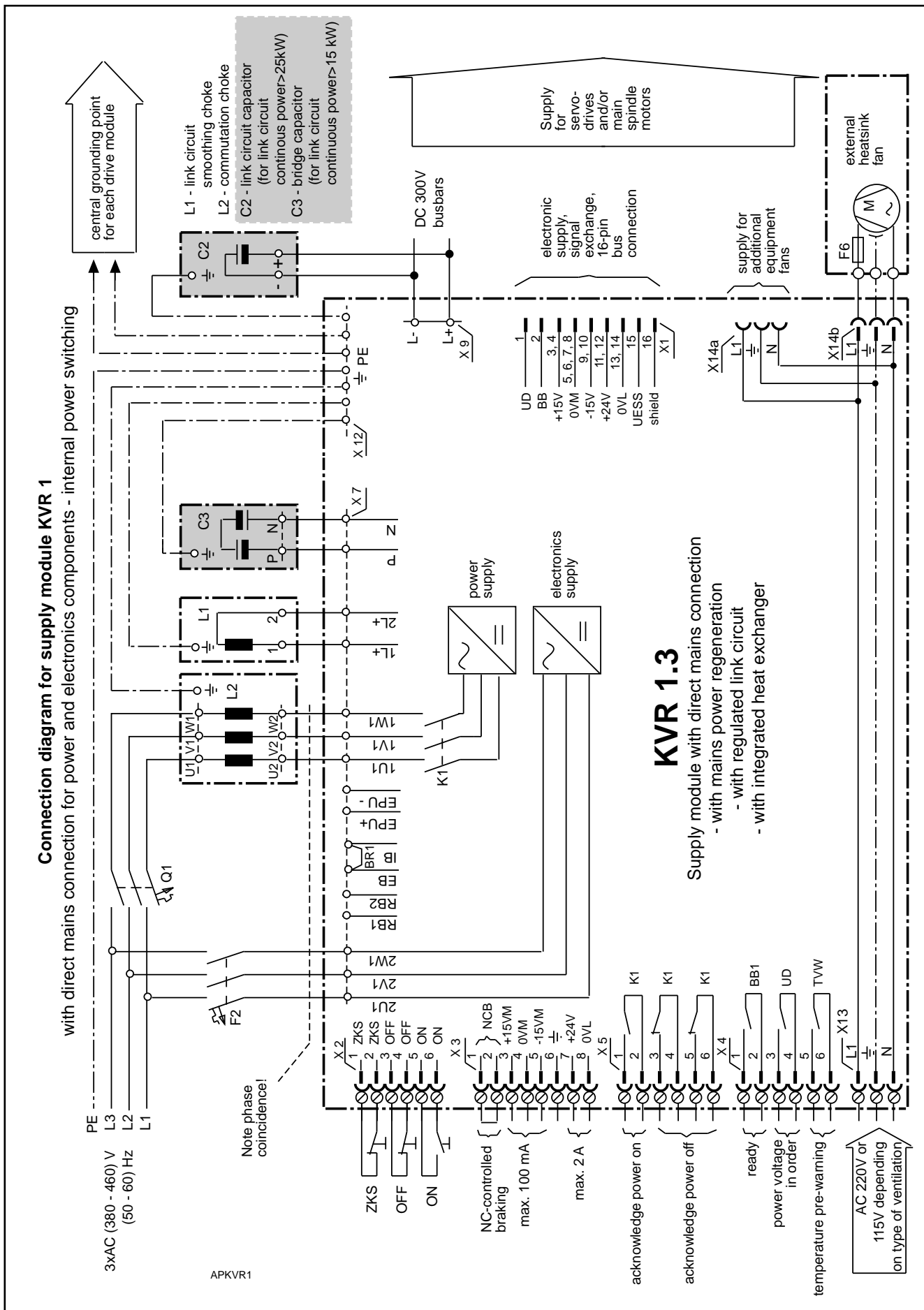


Figure 3.1: Connection plan - supply module KVR 1

3.2. Mains connection - power section

Direct mains connection

The KVR can be connected to threephase networks with 3 x AC 380...480V, 50...60 Hz without the use of a transformer.

Supply module KVR 1, with its ability to regulate current, offers the lowest possible mains power without reactive current load.

Current regulators in switched-mode power supplies cause mains system perturbation, the level of which does not depend on known system conditions (short-circuit power, mains inductance) at the installation site of the machine.

The KVR is basically operated with a commutation choke to eliminate mains reactions.

If the link circuit continuous rating is greater than 15 kW, an additional link capacitor is required (see 3.8).

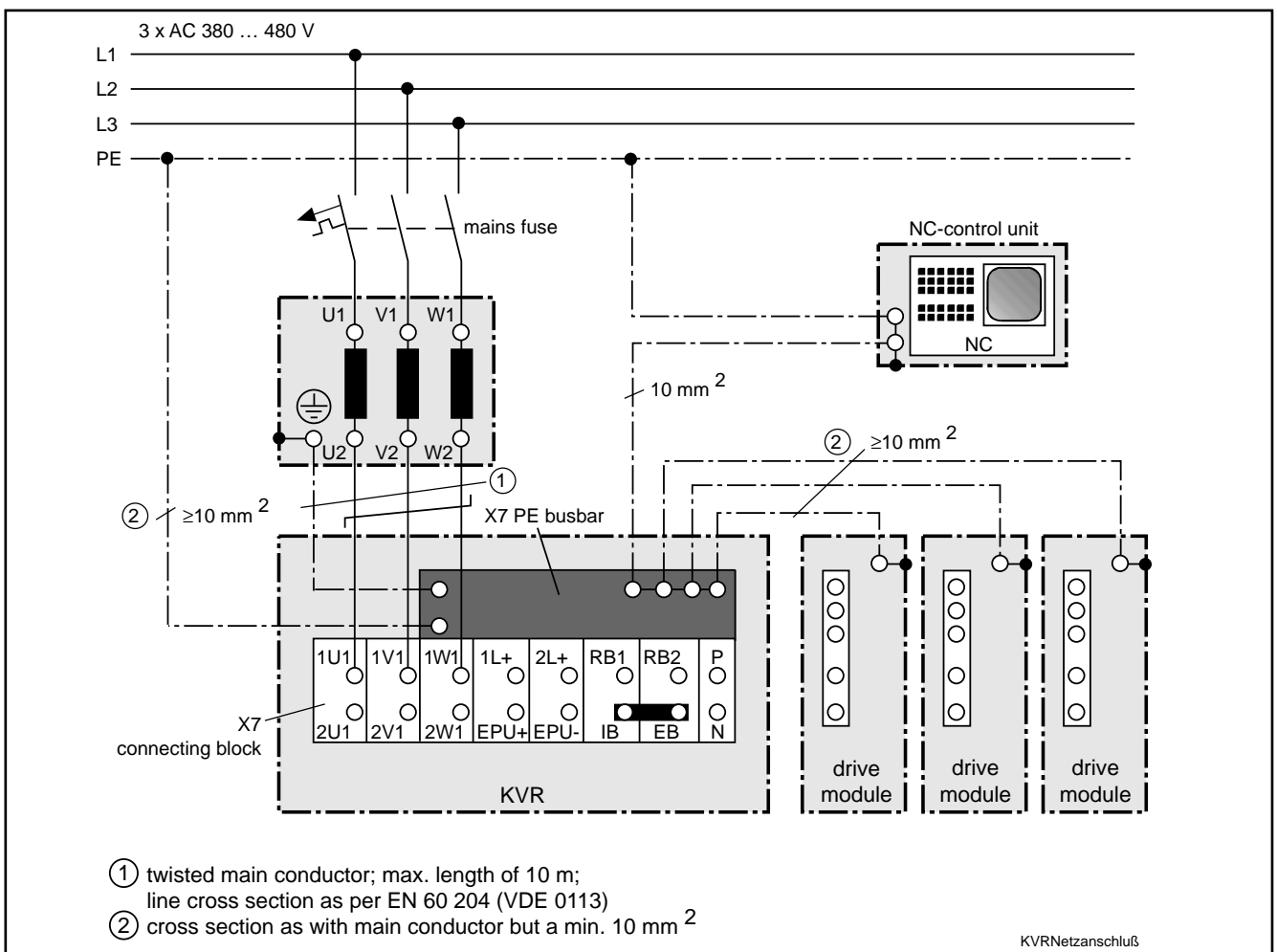


Figure 3.2: Mains connection power component KVR

Cross-section of the power supply line, and recommended fuses, see section 3.3.

Each drive module must be separately connected with a ground wire to the PE busbar of the KVR.



The leakage current coming over the PE conductor exceeds 3.5 mA AC. As a result, the KVR 1.3 requires a permanent connection.

Also see section 3.13.

Mains connection via a transformer

If the mains voltage is less than 3 x AC 380 V or greater than 3 x AC 460V, then a transformer can be used to adapt the mains voltage.

The mains inductance (stray inductance) of transformers can vary considerably dependent upon power and type. For this reason, a commutation choke will be necessary even when a transformer is used.

Required transformer power:

$$S_{TR} = P_{DC} \times \sqrt{3 \times U_N} / 25.5$$

S_{TR} = transformer power in VA
 P_{DC} = continuous link circuit power in W
 U_N = transformer output voltage in V

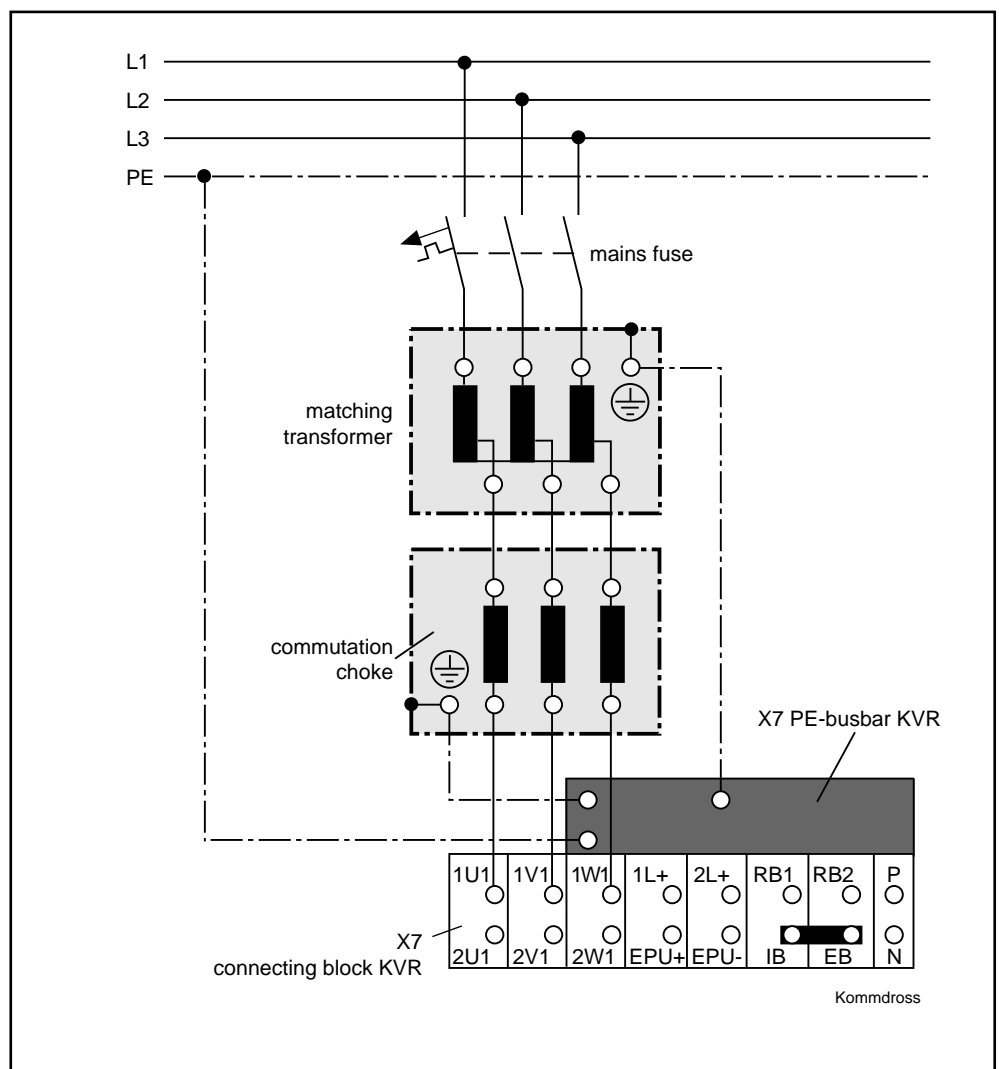


Figure 3.3: Mains connection of the KVR via a transformer

3.3. Fuse protection with direct mains connection

The mains connection for KVR 1's power component with direct mains connection can be secured with the use of gL-type circuit breakers or fuses.

The fuse rating must not exceed 63 A.

The following recommendations apply to fuses with circuit breakers for direct mains connections.

If fuses are used, then fuses of the type gL may be used. Semi-conductor fuses are not required. The fuses selected must correspond to the mains current.

$$I_N = \frac{P_{DC}}{\sqrt{U_N \times 25.5}}$$

I_N = mains current in A

P_{DC} = continuous link circuit rating in W

U_N = mains voltage in V

link circuit power	connected load at 380V	mains current at 380V 480V	power circuit breakers Siemens type	set current	cross section of mains line ³⁾
15 kW	20 kVA	30 A 27 A	3VU1600-.MP00 ¹⁾	30 A	6 mm ²
25 kW	33 kVA	50 A 45 A	3VF1231-1FH41-.... ²⁾	50 A	16 mm ²
30 kW	40 kVA	60 A 54 A	3VF1231-1FK41-.... ²⁾	63 A	16 mm ²

¹⁾ Maximum back-up fuse (gL) as per manufacturer: 200A NH with voltages up to 500 V
²⁾ Maximum back-up fuse (gL) as per manufacturer: 160A NH
³⁾ Line cross section as per EN60204 - B1 installation type - correction factors not considered

Figure 3.4: Recommended fusing of the KVR 1.3

3.4. Mains supply earthing requirements

Grounded threephase mains

The KVR 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 KVR. The KVR 1 can be protected against overvoltages if

- the KVR 1.3 is connected via a transformer, and
- if the machine is protected by overvoltage conductors.

Connecting the KVR 1.3 via an isolation transformer offers the best protection against overvoltage and the greatest degree of operating safety.

- Overvoltages*
- Periodic overvoltages at the KVR 1.3 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 KVR 1.3 in terms of the following diagram.

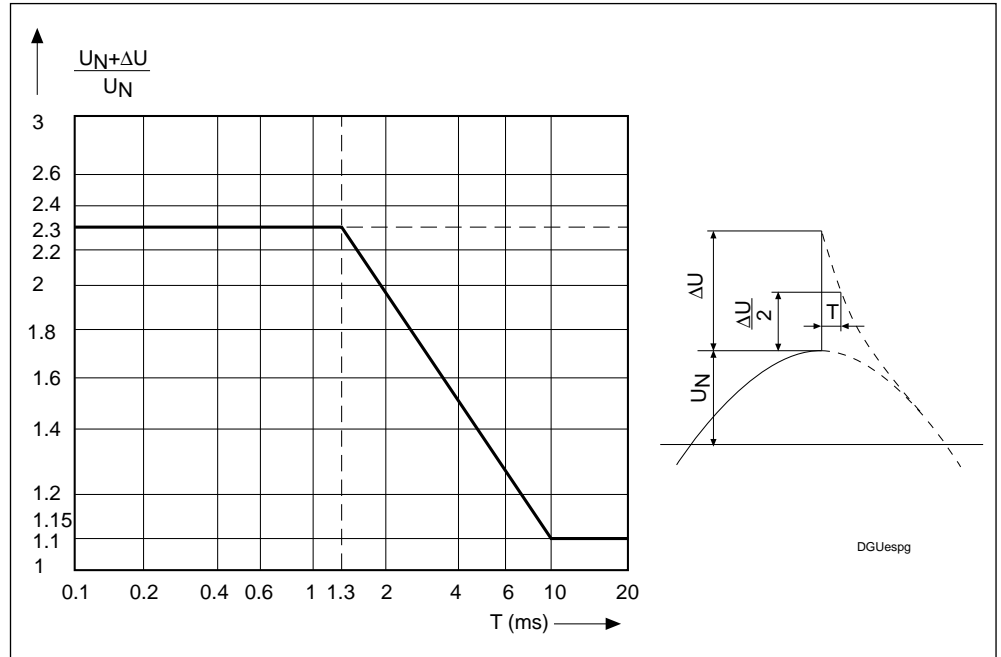


Figure 3.5: Permissible non-periodic overvoltages as per VDE 0160

The KVR 1.3 can be connected to 3 x 480V.

The maximum permissible overvoltage is thus:

$$480 \text{ V} \times \sqrt{2} \times 2.3 = 1560 \text{ V}$$

3.5. Commutation choke

A commutation choke is used to operate the KVR to eliminate mains reactions. (For connections and wiring diagrams see sections 3.3. and 3.2., for power loss, see section 7).

The size of the commutation choke is determined by the continuous link circuit power required for the drives.

Continuous link circuit power	Commutation choke
up to 15 kW	KD 23
up to 25 kW	KD 24
up to 30 kW	KD 25

Use the busbars found in the connection accessories of the drive module to connect the drive modules to the d.c. voltage link circuit.

Use twisted single core leads with longer connections (maximum one meter length).

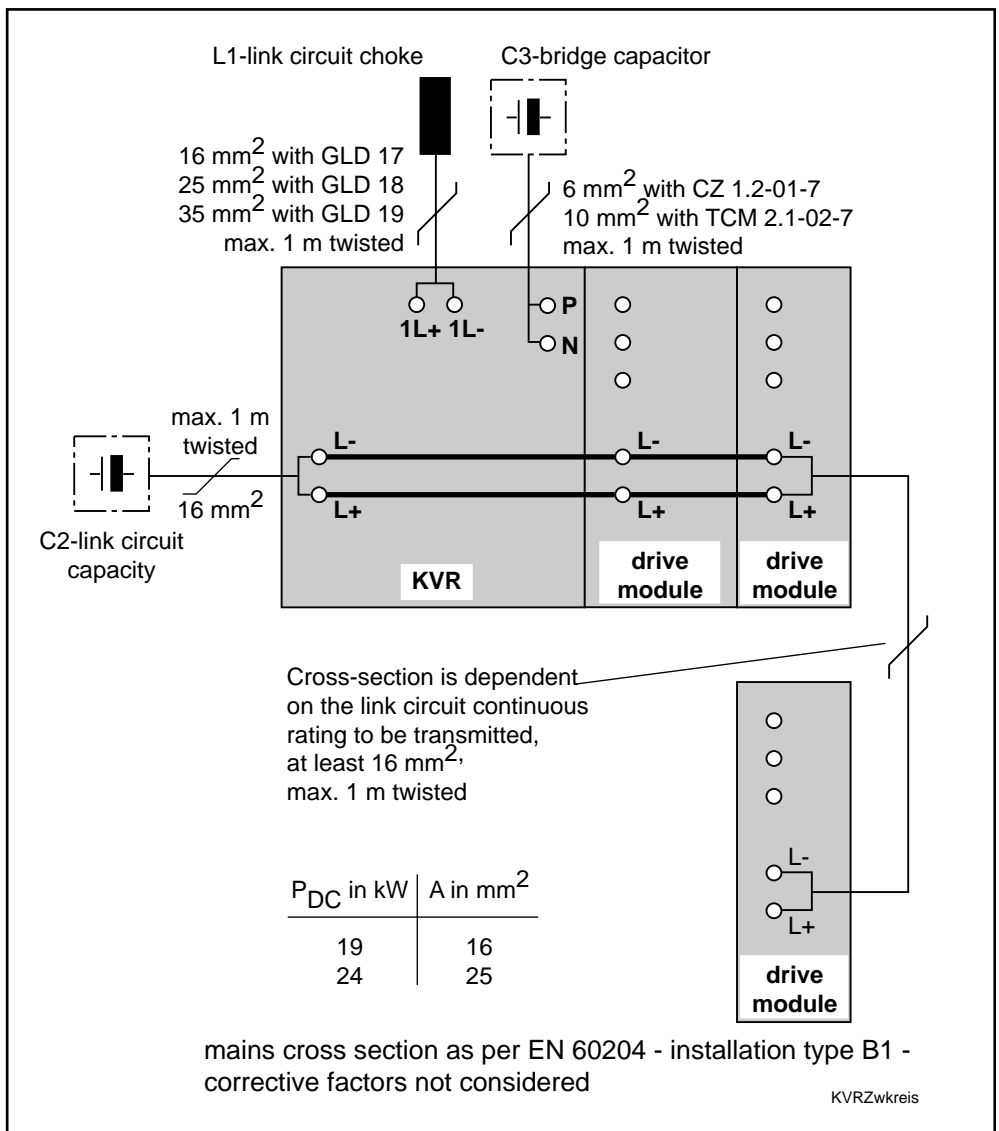


Figure 3.6: Wiring the DC voltage link circuit

3.7. Link circuit choke

The KVR 1 must always be operated with a link circuit choke in the "L+"-line. (For length of line and wiring lay-out, see 3.6; power loss, see section 7).

Continuous link continuous power	Link circuit choke
up to 15 kW	GLD 17
up to 25 kW	GLD 18
up to 30 kW	GLD 19

3.8. Link capacitor

When link circuit power is greater than 15 kW, the KVR is operated with an additional link capacitor to eliminate mains noise.

The voltage at P and N of the KVR can equal up to 715 V. (Line length and wiring lay-out see 3.6.)

Continuous link circuit power	Link capacitor
15 kW	—
25 kW	CZ 1.2-01-7
30 kW	TCM 2.1-02-7

3.9. Additional capacitors at the link circuit

To increase the KVR1's performance, additional capacitor CZ 1.02, or additional capacitance module TCM 1.1, may be connected to the d.c. link circuit. (Mains length and wiring lay-out, see 3.6.)

Continuous link circuit power	Additional capacitor
up to 25 kW	—
up to 30 kW	CZ 1.02

In a few applications the drives have to retract following a mains failure or an E-stop. The energy stored in the link circuit can be used for this. The stored link circuit energy can be increased by further additional capacitors.

Maximum additional capacitor: $C_{\max} = 18 \text{ mF}$ (e.g., 22 x TCM 1.1-08.WO).

3.10. Electronics and fan supply

Electronics supply Connection voltage: 3 x AC 380...480V, 50...60 Hz
Connecting power: 500 VA (with electronics running at maximum).

It is necessary for the mains connections for power and electronics to be in phase for the KVR to be able to feed back into the mains.

The mains connection line for the electronics only requires a short-circuit switch. Commercial circuit breakers may be used, e.g., heavy-duty switch 3VU 1300-OMKOO-4...6 A (made by Siemens).

Maximum back up fuse equals 10 A.

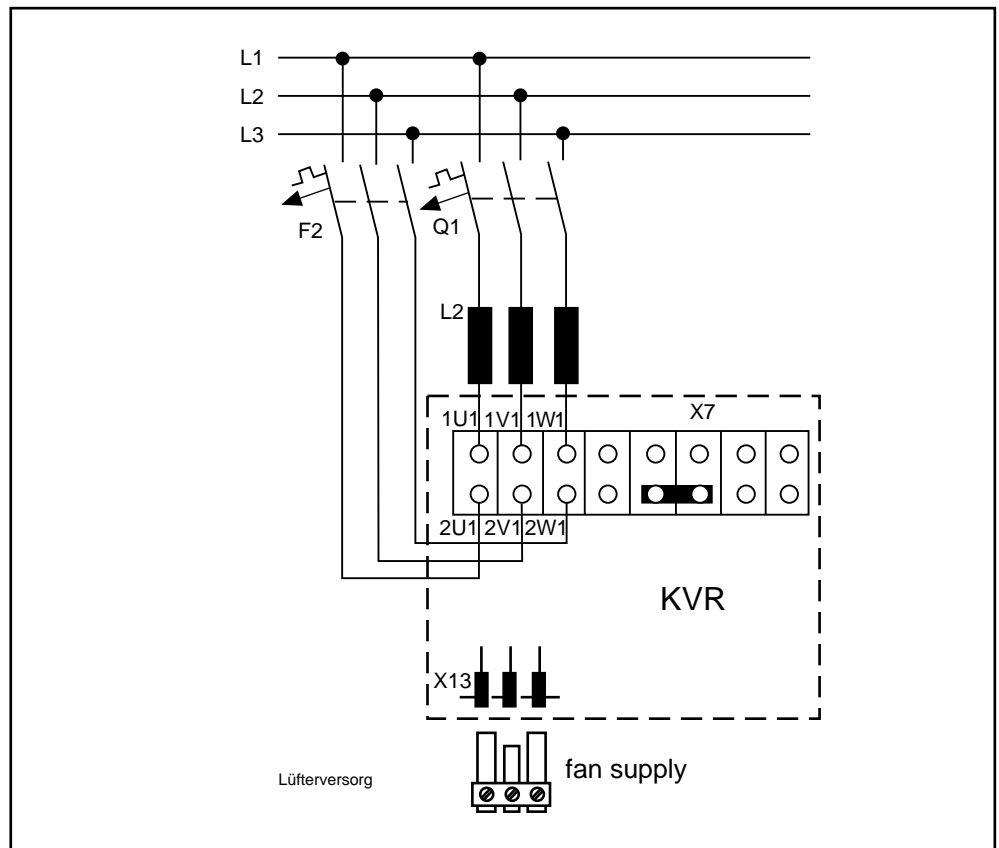


Figure 3.7: KVR mains connection of the electronics and fan supply

Fan supply All external heatsinks are connected to plug X13/KVR.

Connection power: 70 VA per heatsink fan

Connecting voltage:

fan unit LE4-220 AC 220/230 V 50/60 Hz

fan unit LE4-115 AC 110/115 V 50/60 Hz

3.11. Electronics buffer

Terminal box X7/EPU+EPU-.

Connection cross-section equals 1 mm².

An additional capacitor may be necessary if the drives are to be shutdown position controlled in the event of a power failure. Ouptut UD reports a power failure. The NC control must then initiate a position controlled shutdown of the drives within 10 ms for the drive electronics to remain functional. If it takes the drives more than 10 ms to feed energy back into the link circuit, then additional capacitors should be used to maintain power supply to the electronics.

An aluminum electrolytic capacitor is recommended due to lack of space.



The voltage between EPU+ and EPU- can reach DC 450V. The capacitor must be able to handle this voltage. To avoid damage, rate the KVR for a maximum of 680 μF.

Buffer time	Buffer capacitor (with maximum electronics load)
20 ms	150 μF
50 ms	270 μF
100 ms	680 μF

3.12. Bus connection for electronics supply and signal exchange

Bus connection X1 has two functions:

- voltage supply to drive electronics
- exchange of signals between supply and drive module(s)

The bus connection line is part of the electrical accessories of the drive module.

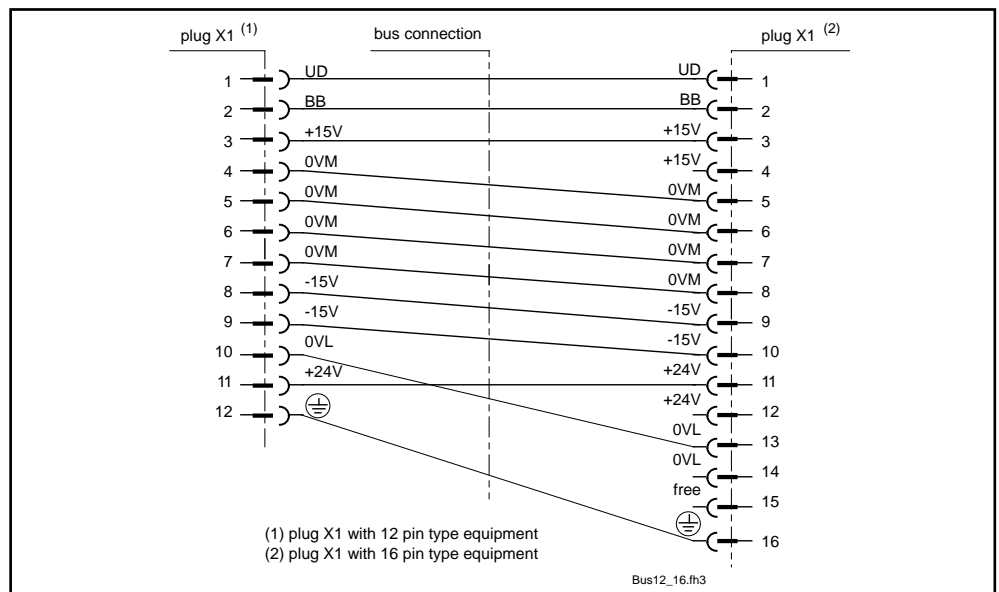


Figure 3.8: Bus connection transition from 12-pin to 16-pin bus plugs

For checking the correct plug connection, the bus connection is terminated with an end plug. The KVR's power cannot be switched on without the end plug. The KVR can also be located in the center of the drive package. In that case, only one end of the bus connection requires the terminal plug.

The terminal plug is a part of the KVR's electrical accessories.

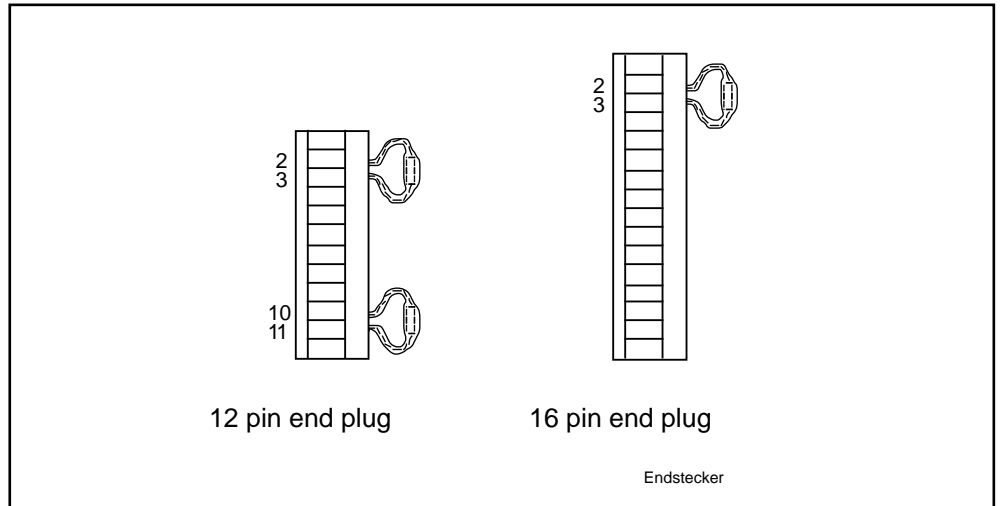


Figure 3.9: End plug to terminate bus connection

3.13. Fault current protective device

It is recommended that the overcurrent fuse (fuse, power circuit breaker) switch the machine off if there is a short in the housing. If an FI current limiting type circuit breaker is absolutely required in TT-mains because of the extent of the grounding resistance, then the following must be noted.

The capacitive leakage currents in switch-mode drives generally flow to earth.

The extent of the leakage current depends on


- the number of drives used
- the length of the motor power cable
- the grounding conditions at the installation site

The leakage current is inevitably increased, if steps are taken to improve the electromagnetic compatibility (EMC) of the machine (mains filter, shielded lines). This means that FI current limiting type circuit breakers with nominal fault currents equal to less than 0.3 A should generally **not** be used!



False tripping can occur when inductances and capacitances are switched on (interference suppression filters, transformers, contactors, magnetic valves).



Commercially available pulse current sensitive FI current limiting type circuit breakers (machine identification ) do not guarantee the protection of electronic devices with threephase link circuits (B6 circuit). The protection of electrical apparatus mounted to a pulse current sensitive FI current limiting type circuit breaker together with devices which have a B6 circuit, can be affected.

Use either FI current limiting type circuit breakers which switch off with d.c. fault currents, or mount an isolation transformer into the mains supply line.

If isolation transformers are used, then these should tune the overcurrent protective device to the impedance of the fault loop so that there is a powering down given a fault. Connect the star point of the secondary winding with the protective conductor of the machine.

3.14. Control cabinet check



No voltages other than those specified in the data sheet or in the interface notes must be connected.

All KVR1 connections must be isolated prior to high-voltage testing of the control cabinet.

3.15. Mounting the KVR 1.3 in the control cabinet

The heatsink of the KVR.3 is located on the back of the unit. It should be mounted so that the heatsink protrudes out of the back of the control cabinet. The greatest amount of heat (approximately 80%) is lost outside of the control cabinet, therefore, compact control cabinets may be used. This either completely eliminates or reduces any additional costs for control cabinet air conditioning.

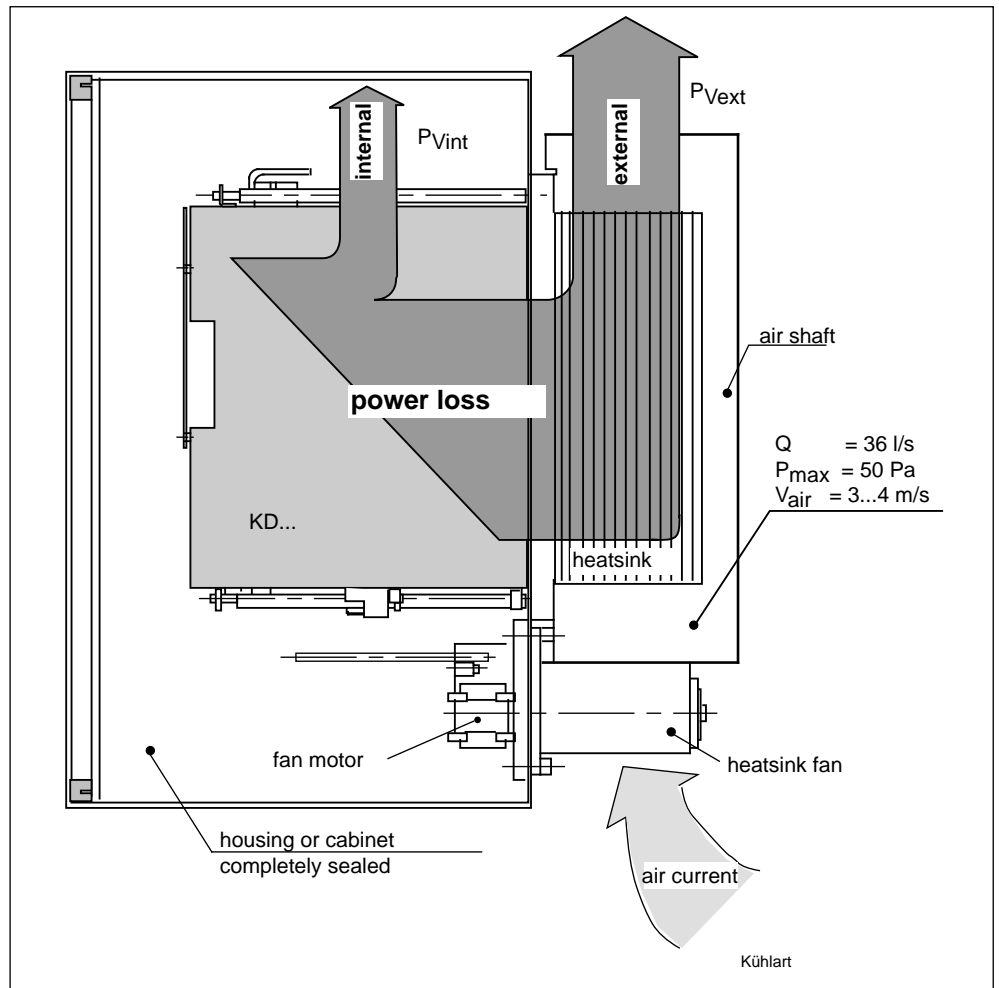


Figure 3.10: Mounting the KVR in the control cabinet and distributing heat loss

*Cooling with
INDRAMAT's heatsink*

A shaft is needed for the air used in the cooling process. The air shaft and the heatsink are supplied as part of the fan unit LE 4-

*Cooling with a central
fan*

In the event that several heatsinks are cooled by a shared fan in a shared air shaft, then there must be enough cool air. To be certain, check air stream Q.

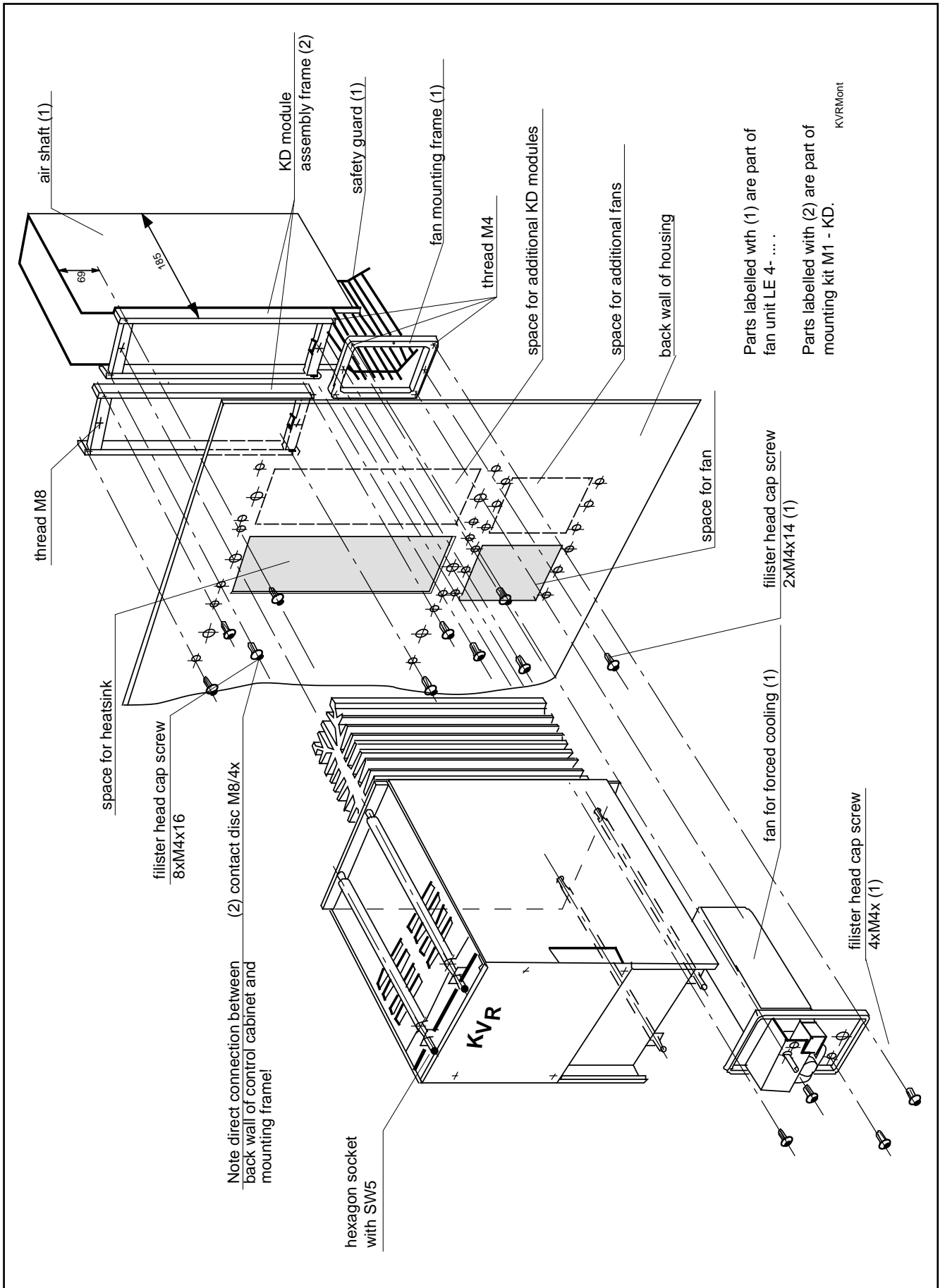


Figure 3.11: Mounting the KVR in the control cabinet

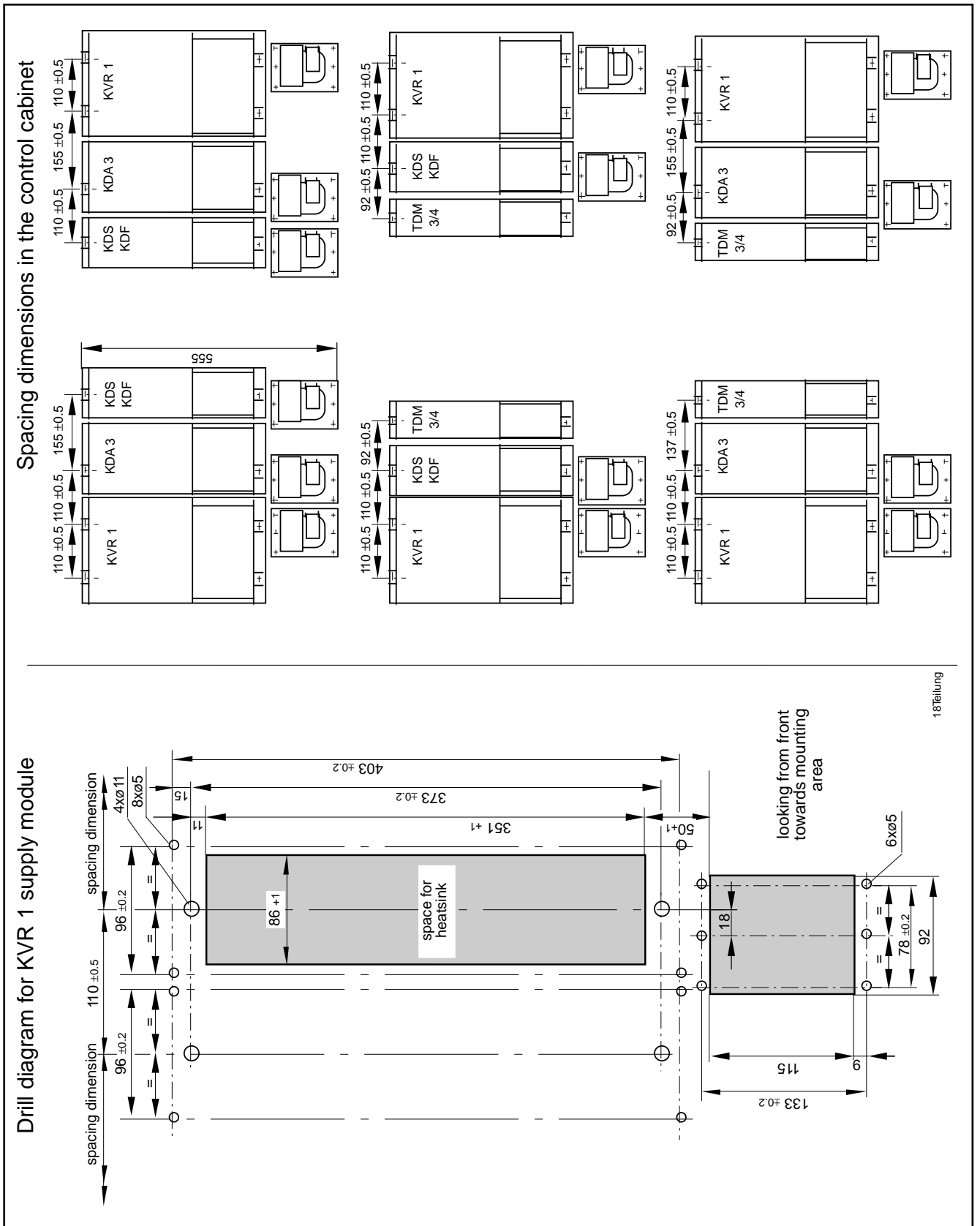


Figure 3.12: Spaces and dimensions within the control cabinet

3.16. Heat due to energy loss inside control cabinet

The heat loss of the KVR is dependent upon the continuous output of the link circuit. The greatest loss of heat occurs outside the control cabinet. The heat loss inside the control cabinet is depicted in the following diagram.

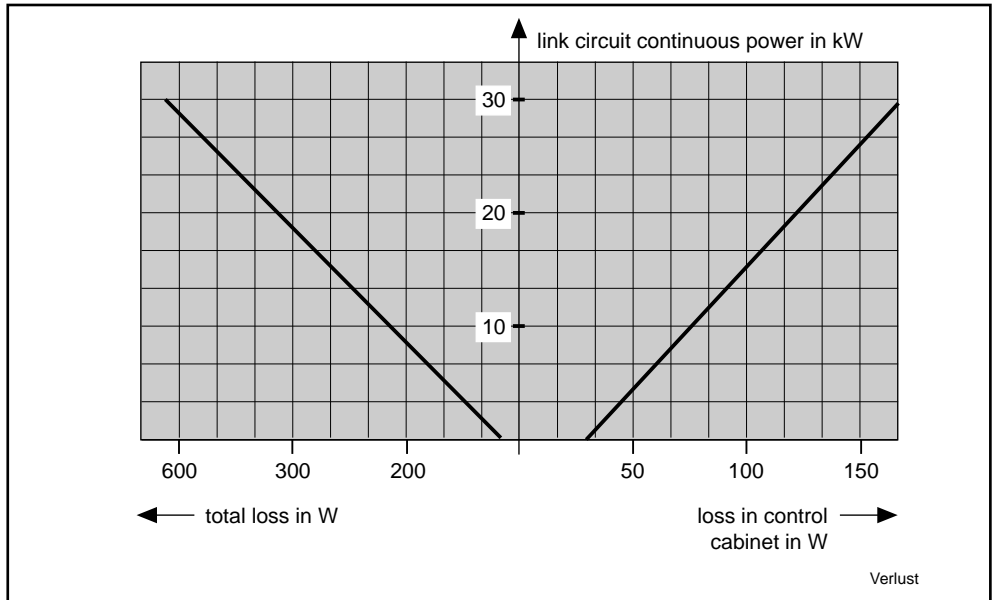


Figure 3.13: Heat from energy loss is dependent on the continuous link circuit power

3.17. Safety clearance inside control cabinet

The bleeder resistor is arranged in a separate housing within the KVR 1. Flammable materials such as conductors and cable channels must have a minimum clearance of 300 mm upwards, and 40 mm to the side and in front of the housing.

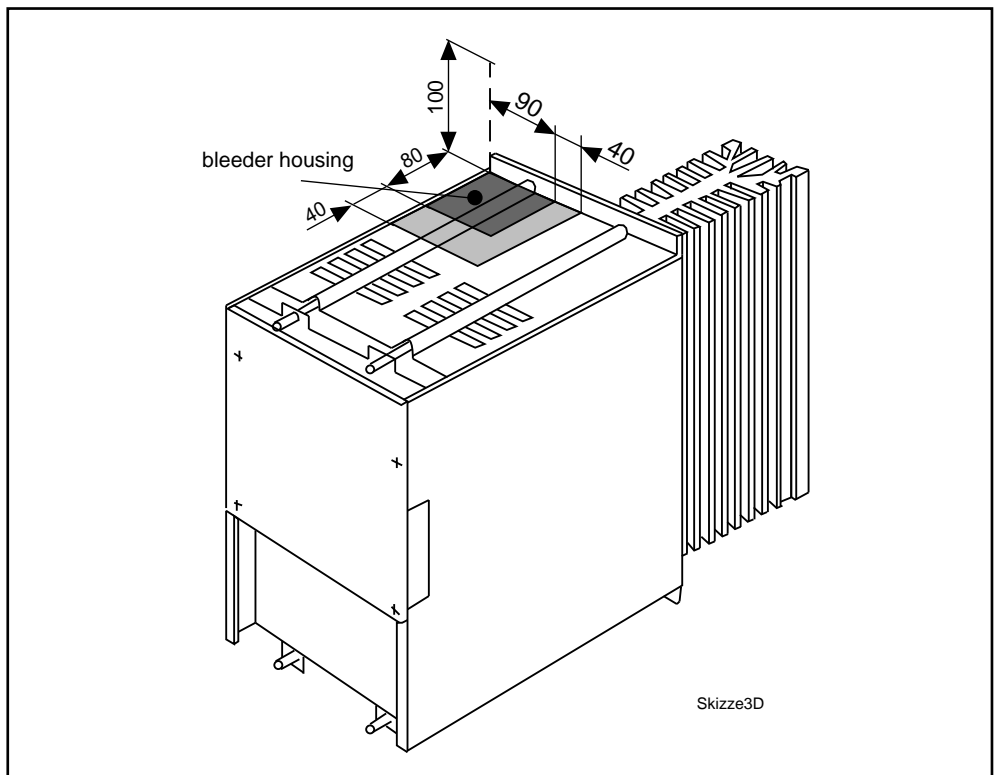


Figure 3.14: Safety clearance inside the control cabinet

3.18. Front view of the KVR 1.3 with accessories

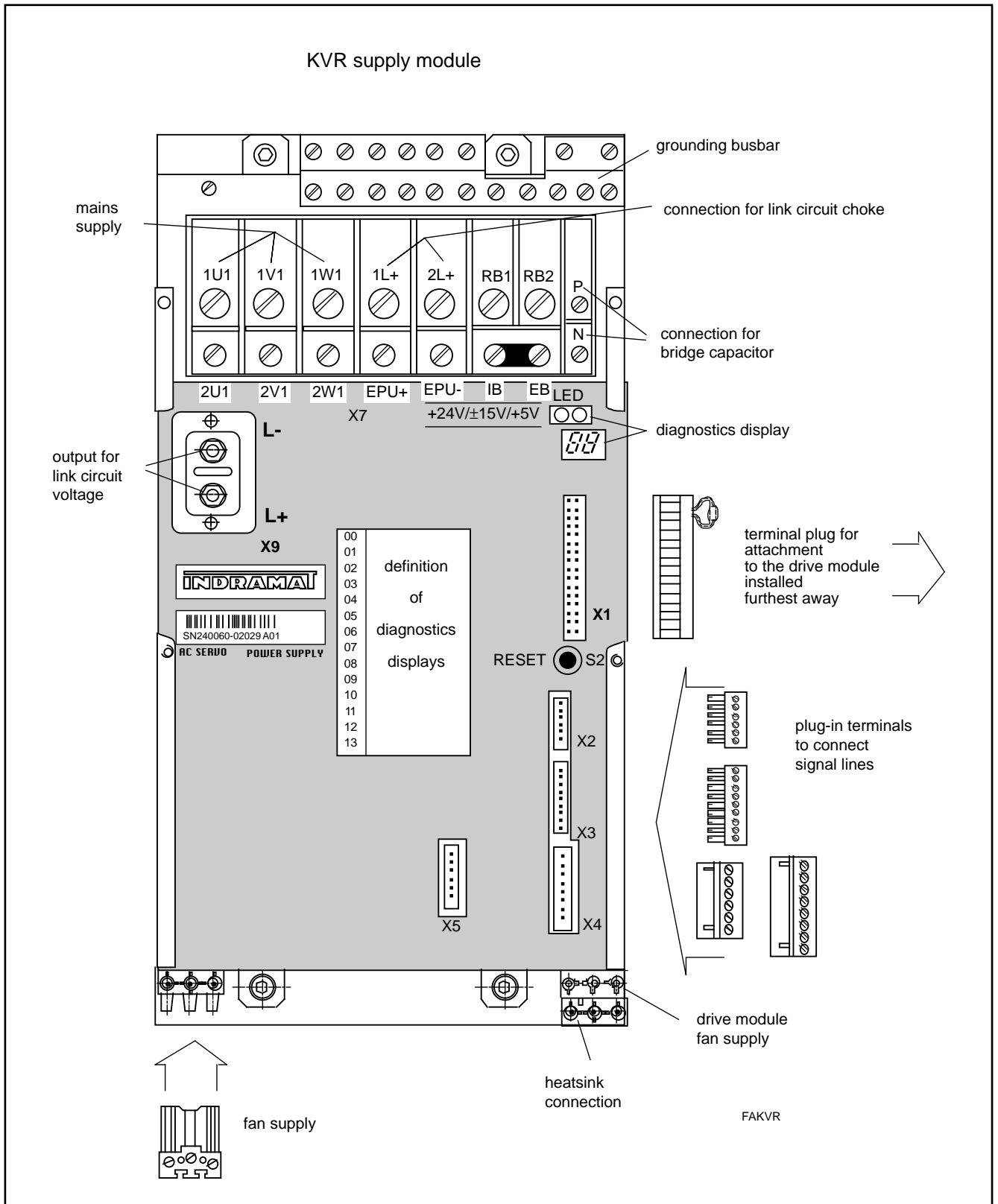


Figure 3.15: Front view of KVR with connecting accessories

4. KVR controller

The control signals of the mains contactor and the link circuit short circuit in the KVR that are suggested by INDRAMAT illustrate the operating principle. Other controller configurations are outlined in this chapter. The choice of control and its effect depends upon the range of functions and the sequence of actions of the whole plant and is the responsibility of the equipment manufacturer.

4.1. Possible fault responses

A: shutdown due to fault in drive electronics

Stopping the drives with or without link circuit short-circuit

In the event of a **malfunction** in the drive electronics, the link circuit voltage is shorted as an additional safety measure to brake the drives to a standstill.

With link circuit short-circuits, synchronous motors are always braked to standstill (MAC or MDD) whether or not the drive electronics are still operational. Asynchronous motors (2AD or 1MB) are not braked if link circuit voltage is short-circuited.

Without link circuit short-circuit, functioning drives are braked at maximum torque. It must, however, be assumed that there will be a slowing down without electrical braking in those drives where the control electronics are disrupted or those where regeneration lines are interrupted. The link circuit short-circuit can only then be obviated, if slowing down without braking will not result in damage. As an alternative, it is possible to use motors with mechanical blocking brakes.



How to best shutdown the drives in the event of a problem is, on the one hand, dependent upon the drive equipment used and, on the other, on its function. For this reason, only the designer can make this decision. The following should, therefore, only be seen as a supportive recommendation for the designer.

Fault response	drive equipment available			recommended reaction	
	modular asynchronous / synchronous drives	modular synchronous drives only	modular asynchronous drives only	link circuit short circuit applied	drive enable and mains contactor OFF
Bb1 contact opens	●	●		●	●
			●		●
limit switch opens	●	●		●	●
			●		●
lag error message from CNC	●	●		●	●
			●		●
E-stop is tripped	●		●		●
		●		1)	●
contacts of photo-electric barriers, safety doors or mats are tripped	●		●		●
		●		1)	●
operator enable key deactivated	●		●		●
		●		1)	●

1) only if dangerous drive movements can be caused by energy still present in the link circuit capacitors

Figure 4.1: Applications of the link circuit short-circuit

B: controlled braking

Controlled braking of the drives during an EMERGENCY STOP (E-stop) or mains failure with set-point zeroing by the drive electronics, or with position control by the NC controller.

With an emergency stop or mains failure, the drives are usually stopped by the **drive controller**. In the case of an E-stop or if the drives' internal monitors are activated, a zero setpoint is initiated by the drive controller and the drives are braked under control at maximum torque.

In a few applications (e.g., electronically-coupled gear-cutting machines), the drives have to be stopped under control in the event of an emergency stop or mains failure. In the case of an E-stop, or if the drives' internal monitors are activated, the drives are braked under **position control** by the NC controller.

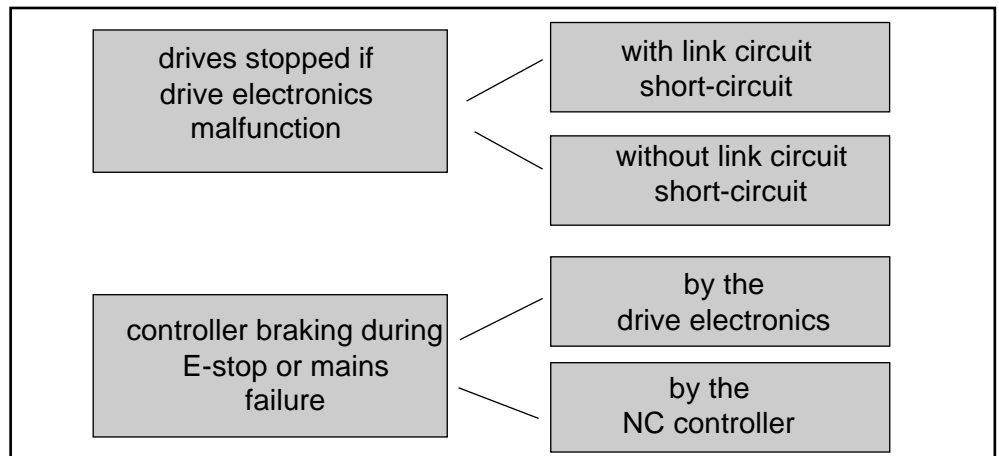


Figure 4.2: Summary of fault responses

4.2. Controlling the KVR with link circuit short-circuit



This control type should be selected under normal circumstances!

Application

A high degree of security is obtained with this type of control at low cost. The monitors built into this drive system are most effectively used.

Typical application:

- if KVR is supplying feed drives only
- if asynchronous main and feed drives are run from one KVR 1.

Features

It is possible to brake the INDRAMAT AC drives even when power is off. It is, therefore, possible in an emergency to **immediately shut off power**. The supply module transforms the energy contained within the momentum of the drive into heat.

With link circuit short-circuit, synchronous motors are always braked to standstill, whether the drive electronics are still functioning or not. The link circuit short-circuit comes into operation only during drive malfunctions. If the E-stop button is pressed, the asynchronous main drives are also braked.

With an emergency stop or when the KVR's monitors are activated (e.g., mains failure), the drives are braked at maximum torque **under the control of the drive electronics**.



Do not close the NCB link on the KVR (X3/1 - X3/2).

Mode of operation

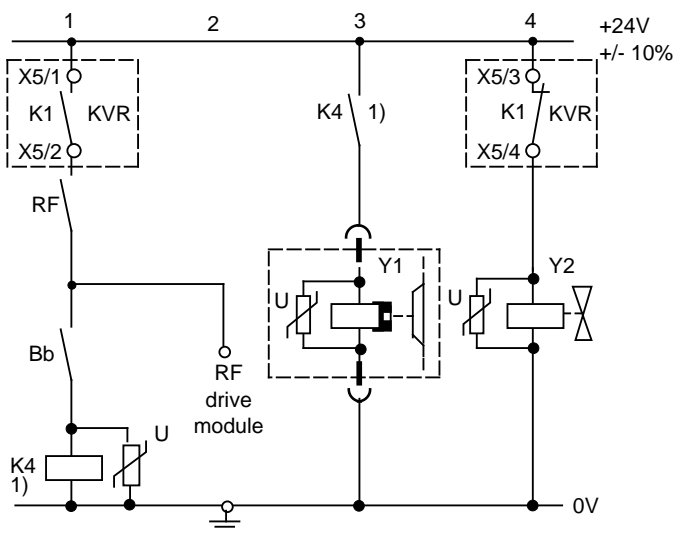
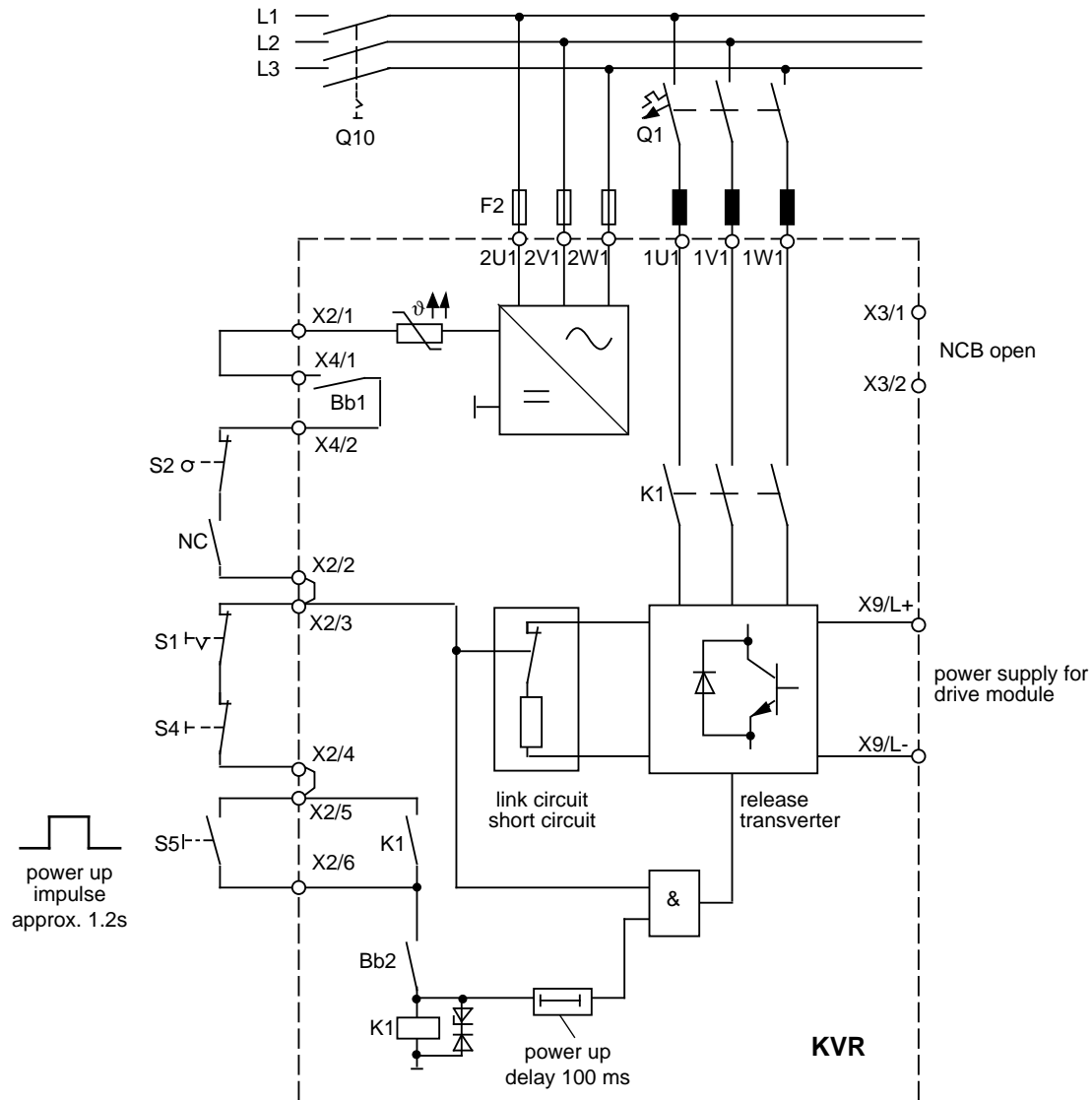
When the E-stop button is pressed, the mains contactor in the KVR 1 drops out immediately. The drives' controller enabling signals are disconnected via an auxiliary contact of the mains contactor. This results in internal set-point zeroing of all connected drives, which then undergo controlled braking.

A drive fault message via the KVR 1 (Bb1 contact), a fault message via the NC controller (servo fault), or overrunning the limit switches results in the mains contactor being de-energized and the link circuit short-circuit then comes into operation.

4. KVR Controller

KVR controller

- immediate power shutdown with E-stop
- with link circuit short-circuit
- controlled braking by drive electronics in an E-stop



- Bb1 = supply module ready (drive system)
- Bb = drive module ready
- F2 = electronics supply fuse
- K1 = mains contactor in the KVR
- K4 = blocking brakes control 1)
- NC = control fault signal
 - open with disrupted drive (servo error)
 - closed with E-stop
- Q1 = power supply fuse
- Q10 = main switch
- RF = controller enabling signal
- S1 = E-stop
- S2 = axis limit switch
- S4 = power off
- S5 = power on
- Y1 = electrically-released blocking brakes for feed drive. Note release delay! Speed command value signal 100 ms after RF-ON
- Y2 = safety doors locked

1) Applies only to blocking brakes of feed drives that are not controlled by the drive module.

SSKVR1

Figure 4.3: Controlling the KVR with the use of link circuit short-circuit

4.3. Controlling the KVR 1 without link circuit short-circuit

In exceptional circumstances, power disconnection is adequate to protect the system from damage when overrunning the limit switch or in the event of a malfunction in the drive electronics.

Typical applications:

- when the KVR 1 is supplying asynchronous drives only
- when the limit switch of the feed drive axis is sufficiently damped

Features

The INDRAMAT AC drives can still brake with power off. This means that power can usually be **immediately switched off** in an emergency. The energy retained in the momentum of the drive is transformed into heat in the bleeder resistor of the supply module.

The link circuit short-circuit is **not short-circuited**. With asynchronous drives, the link circuit short-circuit has no additional braking effect during drive electronics malfunctions. If the link circuit voltage is shortened, asynchronous drives can no longer undergo controlled braking.

With an emergency stop or when the KVR 1's monitors are activated (e.g., mains failure), the drives are braked at maximum torque **under the control of the drive electronics**.



Do not close the NCB link on the KVR (X3/1 - X3/2).

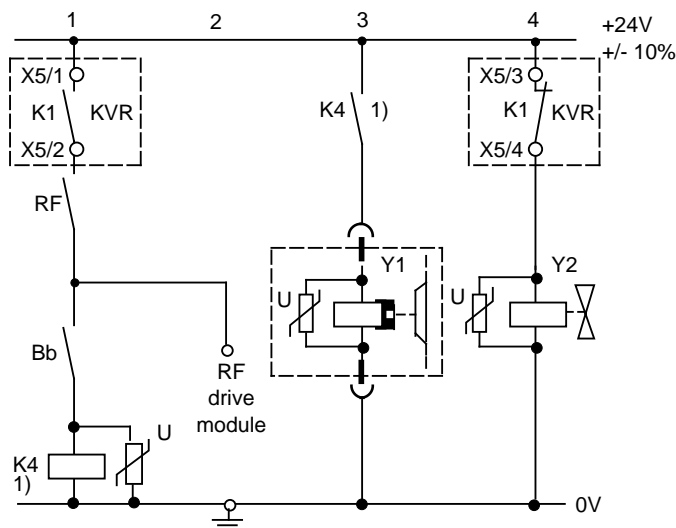
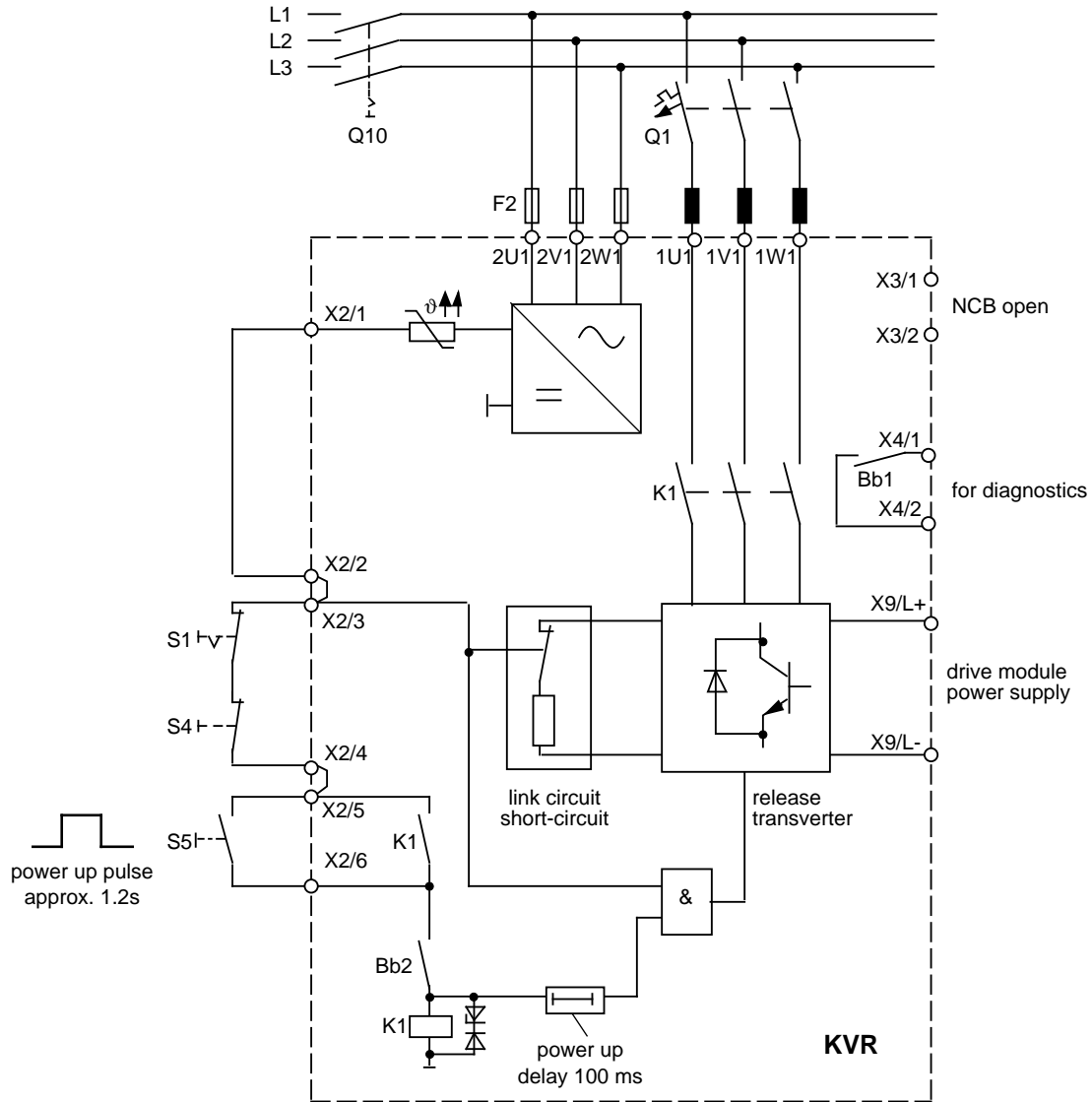
Mode of operation

The mains contactor in the KVR 1 drops out immediately when the emergency stop circuit is broken. The drives' controller enabling signals are disconnected by an auxiliary contact in the mains contactor. This results in internal set-point zeroing of all connected drives, which then undergo controlled braking.



If the drive electronics malfunction, the drives run out of control. Short-circuiting of the link circuit can only be dispensed with, if the system's linear axes can run up to their mechanical fixed stop during a drive malfunction without risk of damage. It is possible, as an alternative, to use motors with mechanical blocking brakes.

- KVR controller
- immediate power shutdown with E-stop
 - without link circuit short-circuit
 - regulated braking by drive electronics in an E-stop



- Bb1 = supply module ready (drive system)
- Bb = drive module ready
- F2 = electronics supply fuse
- K1 = mains contactor in the KVR
- K4 = blocking brakes control 1)
- Q1 = power supply fuse
- Q10 = main switch
- RF = controller enabling signal
- S1 = E-stop
- S4 = power off
- S5 = power on
- Y1 = electrically-released blocking brakes for feed drive. Note release delay! Speed command value signal 100 ms after RF-ON
- Y2 = safety doors locked

1) Applies only to blocking brakes of feed drives that are not controlled by the drive module.

SSKVR/2

Figure 4.4: Controlling the KVR without link circuit short-circuit

4.4. Controlling the KVR to brake the drives under position control

Application In exceptional cases!

Usually in drives that are coupled via the NC controller and which must not adopt an angular error during a mains failure.



Do not use an NCB link in digital drives with SERCOS interface. The programmable fault response of digital drives makes a position controlled braking without an NCB link possible. The NCB link blocks the message going to the drives that the power supply is faulty.

Features The INDRAMAT AC drives can still brake when power is off. This means that power can be immediately turned off in an emergency. The energy retained in the momentum of the drive is transformed into heat in the bleeder resistor of the supply module.

The link circuit voltage is **not short-circuited**, so energy is available for stopping the drives under position control.

With an emergency stop or when the KVR's monitors are activated (e.g, mains failure), the drives are braked by the NC controller **under position control**.

The energy stored or regenerated in the link circuit must exceed that required for exciting asynchronous drives or for return motion.



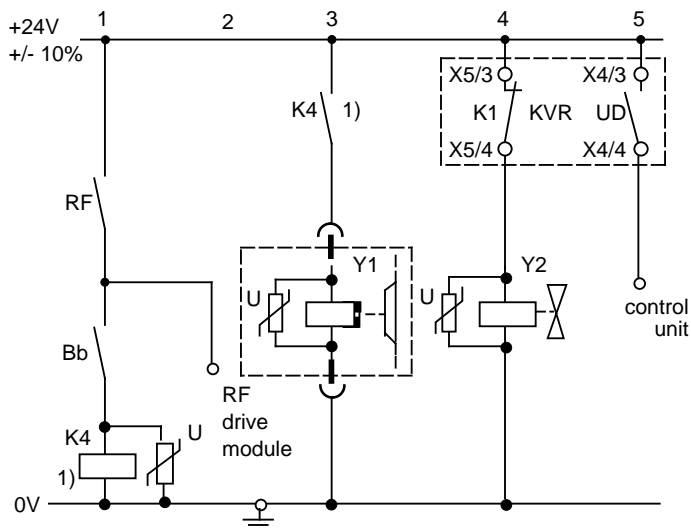
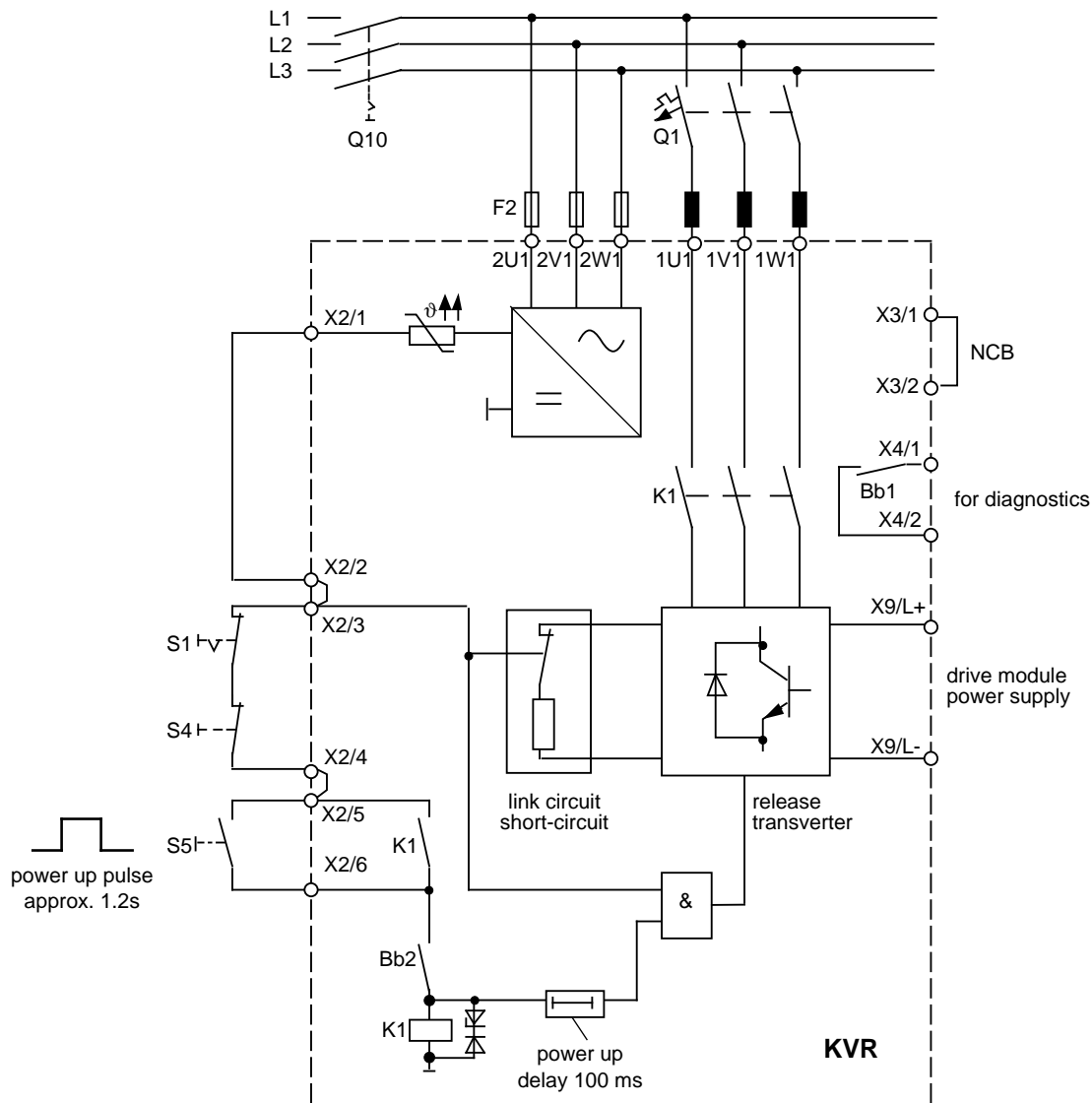
The NCB link on the KVR (X3/1 - X3/2) must be closed. The drives's controller enabling signals must not be disconnected by the mains contactor.

Mode of operation The mains contactor in the KVR drops out immediately when the emergency stop circuit is broken. The NC controller must brake the drives under position control.



With the NCB link in circuit, if the power supply malfunctions, the set-point zeroing of the drive modules is suppressed. The drives must always be stopped by the master controller, i.e., the master controller must evaluate the UD contact of the KVR 1 and stop the drives when the contact opens. Otherwise, with a faulty power supply the drives can run uncontrolled.

- KVR controller**
- immediate power shutdown with E-stop
 - without link circuit short-circuit
 - regulated braking by the drive electronics in an E-stop



- Bb1 = supply module ready (drive system)
- Bb = drive module ready
- F2 = electronics supply fuse
- K1 = mains contactor in the KVR
- K4 = blocking brakes control 1)
- Q1 = power supply fuse
- Q10 = main switch
- RF = controller enabling signal
- S1 = E-stop
- S2 = axis limit switch
- S4 = power off
- S5 = power on
- Y1 = electrically-released blocking brakes for feed drive.
Note release delay! Speed command value signal 100 ms after RF-ON
- Y2 = safety doors locked

1) Applies only to blocking brakes of feed drives that are not controlled by the drive module.

SSKVR/5

Figure 4.5: Controlling the KVR to brake the drives under position control

5. Description of interface

5.1. Link circuit short-circuit

Input ZKS Terminal X2/1 - X2/2
Voltage: DC 24 V Current consumption: 625 mA

Input	open	closed
operating state	power off, link circuit short-circuit closed	power on, link circuit short-circuit open

The power contactor in the KVR can only be connected with the ZKS input closed. As additional security when braking the drives to a standstill during a malfunction in the drive electronics, the link circuit voltage is short-circuited if the ZKS input is open.

5.2. Power OFF

Terminal X2/3 - X2/4

Output OFF Voltage: DC 24 V Current consumption: 625 mA

Input	open	closed
operating state	power off	power on

The power contactor in the KVR can only be connected with input OFF closed. If input OFF is open, e.g., with E-stop, then the contactor in the KVR is disconnected immediately.

5.3. Power ON

Terminal X2/1 - X2/2

Input ON Voltage: DC 24 V Current consumption: 625 mA

Switching rate: 600 operating cycles per hour

Input	open	closed or open and self-holding closed
operating state	power off	power on

With the ZKS and OFF inputs closed and with internal "ready", the KVR's power contactor is connected when the ON input is closed. The contactor is then held on automatically. The ON pulse must be applied for at least 1.2 seconds.

5.4. Stopping the drives during an E-stop or mains fault

NCB link Input - terminals X3/1 - X3/2

Link	open	closed
controlled braking with emergency or mains failure	by the drive electronics	by the NC controller

With the NCB link open, a mains fault or a fault inside the drive system is signalled to the drive. The drives brake at maximum torque. In the case of a drive fault, the power feed is also disconnected by the internal ready signal of the KVR.

In a few applications (e.g., electronically-coupled gear-cutting machines), the drives have to be braked by the NC controller during an emergency stop or a mains fault.

With the NCB link closed, then set-point zeroing is suppressed in the following faults:

- faulty power supply
 - power failure/phase failure
 - link circuit voltage below 200 V
- drive faults
 - open-circuit bus connection or faulty end plug
 - + 24 V_L / +/- 15 V_M signal voltage fault
 - overcurrent in the power circuit of the KVR
 - bleeder overloaded
 - heatsink temperature of the KVR too high

This enables the drives to be stopped under position control during a mains failure or phase failure. The power regenerated during braking must exceed power consumption.

During a drive fault, the power supply is always disconnected by the internal ready signal of the KVR.



With the link closed, due to removal of the set-point zero circuit, the master controller must ensure that the drives are stopped, i.e., the master controller must evaluate the UD contact and stop the drives when the contact opens. Otherwise, if the power feed is removed, the drives can run uncontrolled.

5.5. Signal voltages

The signal voltages can be tapped off of terminal strip X3. These terminals serve measuring and testing purposes. If these voltages are used outside of the KVR, then make sure that no interference voltages are introduced (short, shielded leads).

The signal voltage outputs have short-circuit protection. The maximum permissible loading should not be exceeded so as to prevent damage to the drives.

X3/3	+15 V _M	maximum measuring voltage 100 mA
X3/4	0 V _M	reference potential measuring voltage
X3/5	-15 V _M	maximum measuring voltage 100 mA
X3/6	Mass	screening
X3/7	+24 V _L	load voltage 2 A max.
X3/8	0 V _L	reference potential load voltage

5.6. "Ready" state

Output Bb1 Potential-free contact – Terminals X4/1 - X4/2

Load maximum: DC 24 V/1 A

Ready state	relay de-energized	fault	ready
output	open	open	closed

The Bb1-contact of the KVR is very important. The Bb1 contact signals that the drive system is ready for the power to be applied. Only when it is closed, do the internal interlocks allow the power contactor in the KVR to be connected.

In the event of a fault, the contactor is disconnected and the Bb1 contact opens. If the Bb1 contact is open, then a controlled braking of the drives can no longer be expected. It can, therefore, be used to enable the link circuit short-circuit to come into operation.

The Bb1 contact closes if the supply to the electronics is applied to the terminal block X7/2U1/2V1/2W1 and no fault is present.

The Bb1 contact opens during the following faults:

- tachometer fault
- overtemperature in the drive modules
- bridge protection in drive modules
- failure of the $\pm 15 V_M / +24 V_L$ signal voltage
- open circuit bus connection or faulty end plug
- temperature of the KVR heatsink too high
- overcurrent in the KVR power circuit
- overvoltage
- bleeder overloaded

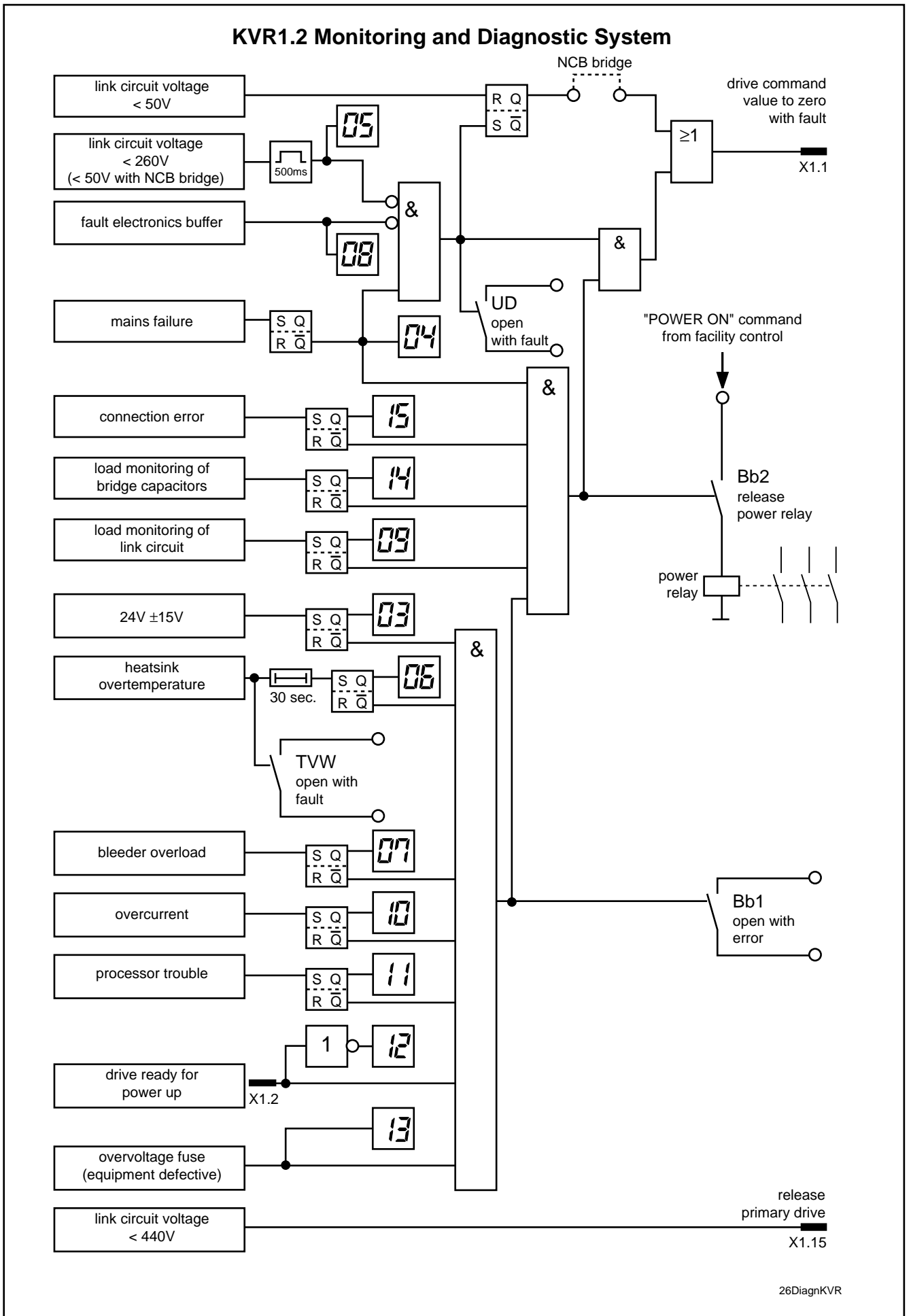


Figure 5.1: KVR monitoring and diagnostics systems

5.7. Power feed working

Potential-free contact - Terminals X4/3 - X4/4

Load max.: DC 24 V/1 A

Output UD

Ready state	relay de-energized	fault	power working
output	open	open	closed

The UD contact acknowledges that the power feed is OK.

It opens for the following faults:

- mains failure/phase failure
- link circuit voltage less than 200 V.

The reaction of the drive system to one of these faults depends on the NCB link (see section 5.4).

If NC-controlled stopping is required, the drives must be stopped by the master controller when the UD contact is activated.

5.8. Temperature pre-warning

Potential-free contact - Terminals X4/5 - X4/6

Load max.: DC 24 V/1 A

Output TVW

Ready state	relay de-energized	temperature too high	temperature within permissible limits
output	open	open	closed

The temperature pre-warning contact opens at unduly high heatsink temperatures. After 30 seconds, the mains contactor in the KVR interrupts the power supply and the Bb1 contact opens.

The reaction of the drive system to this fault depends upon the NCB link (see section 5.4).

If NC-controlled stopping is required, the drives should be stopped within 30 seconds, if the temperature pre-warning is activated in the KVR or one of the drive modules.

5.9. Mains relay energized

Output K1NO Potential-free contact – Terminals X5/1 – X5/2

Load max.: DC 24 V/10 A / AC 220 V/6 A

Ready state	contactor de-energized	contactor energized
output	open	closed

Output K1NO can be interrogated to see if the mains contactor is energized. Contact K1NO, when closed, must be a condition for enabling the drives' controller enabling signal (for exceptions see 4.4).

5.10. Mains contactor dropped out

Outputs K1NC1 and K1NC2 Potential-free contact – Terminals X5/ – X5/4 and X5/5 – X5/6

Load max.: DC 24 V/10 A / AC 220 V/6 A

Ready state	contactor de-energized	contactor energized
output	closed	open

Outputs K1NC1 and K1NC2 can be interrogated to see if the mains contactor has dropped out. For example, it can be used as a condition for enabling the door interlocks.

6. Fault-finding guidelines

Because of the resulting production down-time, lengthy fault-finding and repairs to drive components on the machine are unacceptable.

Thanks to their construction, INDRAMAT a.c. drives enable individual functional units to be easily and completely replaced without adjustments.

This means that in the event of a fault, servicing is limited to fault-location either on the motor, the supply module or the drive module, or its complete replacement.

6.1. Fault-finding

Because of the interaction between NC controller, supply and drive modules, motor, mechanical system and position measurement, poor performance of axis movements can be caused either by a fault in the above devices or if fitted with a comprehensive diagnostic system for rapid fault location.

6.2. Safety guidelines

There is an increased accident risk when problems occur. Personnel, the plant and the drives are at risk.



Localization of problems and the elimination of faults should only be performed by qualified personnel.

Guidelines on protection of personel

Danger from drive movements:
Undesirable drive movements are possible during the localization of problems.



Unauthorized individuals should not remain within the hazardous area. Protective measures such as safety bars, covers and photoelectric barriers should not be removed. There must be free and ready access to the emergency stop switch.

When working within the hazardous area, please note:



When working within the hazardous area, the facility should be voltage free and secured against being switched on.

Wait out the discharge time (approximately five minutes). Check intermediate circuit voltage.

Danger from live parts

Dangerous electrical loads can occur at the following connections:

- At all connections of the supply module and the corresponding chokes and capacitors, especially at mains connections 1U1, 1V1, 1W1 and 2U1, 2V1, 2W1, as well as the connections X13 and X14 of the fan supply.
- At the drive modules, at the motor and the plugs of the motor connections.



Before working on electrical equipment:

- **Switch power to the facility off with the main switch and secure it against the possibility of being turned on again.**
- **Wait for the link circuit to discharge (approximately five minutes). Check the link circuit voltage.**
- **Do not run motors. The motor connections will be electrically loaded if the motor is in motion.**

Before turning the equipment on:



Only turn power on if the contact safety, delivered with the unit, is mounted.

Guidelines on protecting the machine

To avoid any damage to the machine:



- **Only authorized personnel should be permitted to start-up the facility.**
- **Secure E-stop and limit switch functions.**

Guidelines on protecting the machine

Prior to switching on:



The wiring should agree with that of the KVR assembly plan. Check the course of the electricity throughout the unit.

Electrostatic loads

Electrostatic loads endanger electronic components.

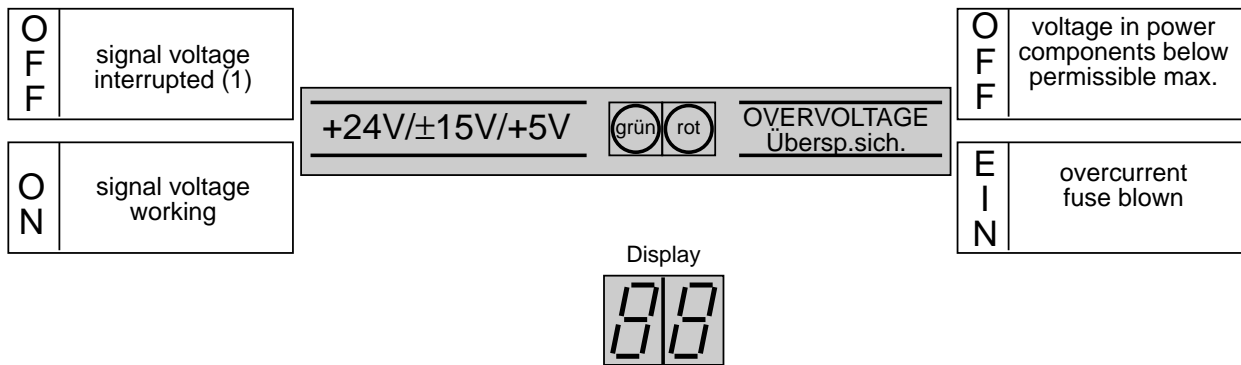
Discharge by grounding all objects that come into contact with the equipment.

6.3. Diagnostics display, fault list

Diagnostic Display for Supply Module KVR 1

Note: Signals only apply if "+24V, $\pm 15V/+5V$ " displays continuous green light

(1) Signals and locking of equipment are stored.
Re-set by pressing reset button or by switching electronic supply back on.



DISPLAY Anzeige	ACCEPTION Bedeutung	explanations
00	POWER Leistung	link circuit voltage within permissible range; KVR ready to supply power
01	POWER OFF Leistung aus	power relay in KVR de-energized
02	POWER OFF WITH ZKS Leistung aus mit ZKS	power relay in KVR de-energized; link circuit short-circuit initiated
03	+24V/ $\pm 15V$ FAULT Fehler	signal voltage disrupted (1)
04	MAINS FAULT Netzfehler	no mains connection; no mains phase (1)
05	UD FAULT Fehler	link circuit voltage exceeds permissible limits
06	HEATSINK TEMP. FAULT Kühlkörper Übertemp.	power switched off due to equipment overtemperature (1)
07	BLEEDER OVERLOAD Überlast	excessive braking energy when power shut down (1)
08	EPU FAULT Fehler	capacitor between X7/EPU+ and X7/EPU short-circuited or incorrectly poled
09	SOFTSTART-FAULT Softstartfehler	link circuit cannot be loaded (1)
10	OVERCURRENT Überstrom	Shutdown due to overcurrent, short-circuit in KVR, in drive module, in cable or in motor (1)
11	CONTROLLER ERROR Prozessorstörung	problem with microprocessor in KVR (1)
12	DRIVE FAULT Antriebsfehler	power turned off due to drive error
13	DEVICE DAMAGED Gerät defekt	overvoltage fuse blown
14	BRIDGE-FAULT Brücken-Fehler	bridge voltage not achieved
15	MISWIRING Anschlußfehler	no phase coincidence between power connection and electronic supply at terminals X7 KVR

DAKVR

Figure 28: Diagnostics display of a KVR 1

6.4. Fault list and remedies

Signals

+24 V/±15 V/+5V

„OFF“ 

Definition: Signal voltage faulty

Possible causes:

- Mains input to electronic supply not present or is faulty.
- Signal voltages exceed maximum loading.
- Link circuit voltage less than 180V a.c. after mains failure.

Remedies:

- Check mains fuses in the control panel.
- Disconnect bus connections to drive modules and measure signal voltages.
- Disconnect signal voltage taps installed in control cabinet outside the KVR or drive modules, and check for short-circuits.

OVERVOLTAGE
Übersp.sich.

„ON“ 

Definition: Initiated by overvoltage fuse in the KVR

Possible cause:

- Fault in KVR power section.
- Equipment defect cause by excessive mains voltage.

Remedies:

- Check mains voltage is not greater tahn 480 V +10 %.
- Replace KVR.

Displays

01

Definition: Power contactor in KVR dropped off

Possible causes:

- STOP or EMERGENCY STOP button has been pressed.

Remedies:

- Switch power on
- Check KVR controller

02

**Definition: Power contactor in KVR dropped off;
link circuit short-circuit initiated.**

Possible causes:

- The unit controller has initiated a link circuit short-circuit.

Remedies:

- EMERGENCY STOP sequence (safety limit switch, Bb1 contact of the KVR, servo-fault signalled by the NC controller, wiring) of the unit must be checked.

03

Definition: Signal Voltage Disrupted

Possible causes:

- Mains connection of the electronics supply either missing or faulty.
- Maximum load of the signal voltage exceeded.
- Link circuit voltage less than 180 V after mains failure.

Remedies

- Check mains fuse in control cabinet.
- Release bus connections to drive modules and measure signal voltage.
- Disconnect signal voltage taps located outside of KVR or drive module in control cabinet and check for short circuits.

04

Definition: Mains voltage faulty

Possible Causes:

- Mains fuse initiated
- Mains phase missing
- Mains voltage too low

Remedies:

- Test mains connection at X7, 3 x AC 380 V ... 480V ± 10%

Displays

05

Definition: Link Circuit Voltage Exceeds Permissible Limits

Possible Causes:

- Mains voltage either too high or too low.
- Link circuit choke either not or incorrectly connected.
- Fault in KVR.

Remedies:

- Check the connection of the link circuit choke; the choke must be between X7/1+ and X7/2L+.

06

Definition: Disconnection due to excessive equipment temperature

Possible Causes:

- Power components of the KVR are overloaded.
- Ambient temperature too high.
- Fan not working.
- Fault in KVR

Remedies:

- Check load
- Evaluate TVW contact
- Check ambient temperature.
- Check fan supply at plugs X13 and X14 a/b.
- Check fuse F6 on the heatsink

07

Definition: Braking energy too high with power off

Possible Causes:

- The energy within the drives too high
- Too many braking actions with power turned off.

Remedies:

- Check energy inside drives
- Permit a delayed drop off of the mains contact with OUT and EMERGENCY OUT.

Displays

08

Definition: Capacitor between X7/EPU+ and X7/EPU-short-circuited or way incorrect.

Possible Causes:

- Capacitor faulty.
- Capacitor way incorrect.
- Faulty wiring.

Remedies:

- Clamp off the capacitor
- Check wiring
- Fault in KVR

09

Definition: Link Circuit cannot be loaded

Possible Causes:

- Too many additional capacitors at the link circuit
- Short circuit in KVR
- Short circuit in a drive
- Link circuit choke either not at all connected or faulty connection
- Link or link circuit capacitor short-circuited or incorrectly wayd.

Remedies:

- Clamp off additional capacitors
- Disconnect busbars to the drives
- Check link circuit choke connection; the choke must be situated between X7/1L+ and X7/2L+.
- Check wiring of links and link circuit capacitors.

Displays

1 0

Definition: Shutdown Due to Overcurrent

Possible Causes:

- Faulty drive module
- Short-circuit in KVR.
- Motor power cable damaged.
- Windings short-circuit of the motor

Remedies:

- Release busbars
- Check drive module and respective motor and cables.

1 1

Definition: Problem with Microprocessor in KVR

Possible Causes:

- Program sequence disrupted.

Remedies:

- Shut supply voltages off and on
- Replace KVR

1 2

Definition: Switched Off Due to Drive Fault

Possible Causes:

- Fault in drive module, regeneration cable, power cable or motor.

Remedies:

- Check drive module diagnoses.
- Sequentially release busbars and bus cables to the drive modules and hit RESET button.

1 3

Definition: Overvoltage Fuse in KVR has initiated.

Possible Causes:

- Fault in KVR power components
- Equipment defect due to excessive mains voltage.

Remedies:

- Check mains voltage; not to exceed 480V + 10%.
- Replace KVR.

Displays

Definition: Link voltage cannot be built up

Damage can be caused by repeatedly switching the unit back on.

Possible Causes:

- Mains fuse blown.
- Mains voltage too low.
- Link capacitor either faulty or way incorrect.
- Short circuit between terminals X7/P and X7/N.

Remedies:

- Check mains connection at X7, 3 X AC 380 V...480V $\pm 10\%$.
- Check lines to link capacitor for short-circuit
- Check link capacitor for correct connection and short-circuit
- Fault caused by switching control voltage off, reset.

15

Definition: No phase coincidence between power and electronic supply

Possible Causes:

- Electronics supply connections way incorrect.

Remedies:

- Check voltage at terminal box X7.
 The terminals 1U1 and 2U1
 1V1 and 2V1
 1W1 and 2W1
 may not feed voltage against each other.

16

Definition: Checksum error

Possible Causes:

- EPROM in the KVR is defective.

Remedy:

- Replace KVR

6.5. Equipment fuses

There are no fuses in supply module KVR 1. The signal voltage outputs +24 V and ± 15 V are secured against short-circuits.

The external heatsink has been secured with a microfuse.

designation	type
F6	5 x 20 0.63A/250E medium time-lag

7.2. Dimensional data for smoothing choke

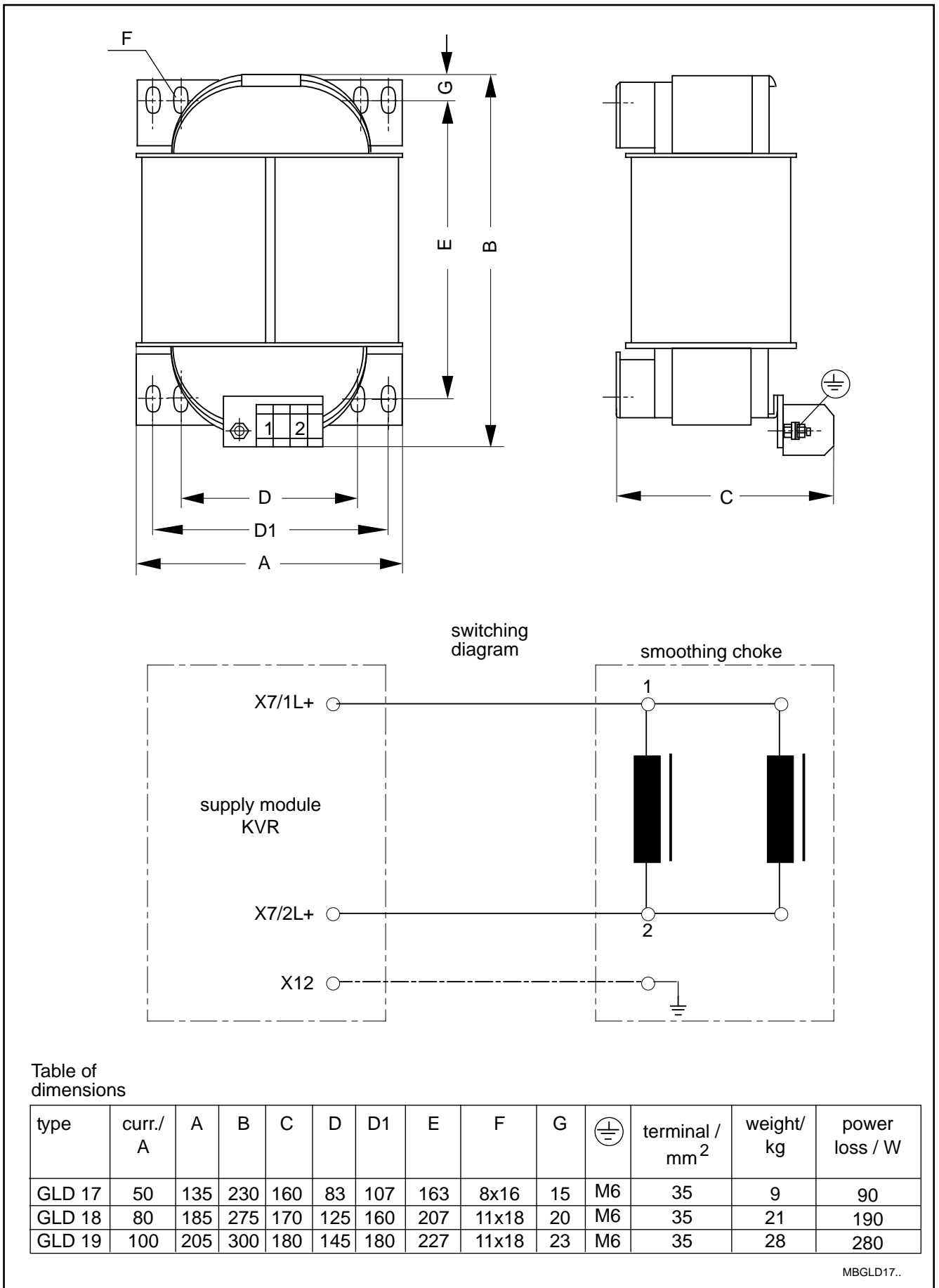


Figure 7.2: Smoothing choke - dimensional data

7.3. Dimensional dat for commutatio choke

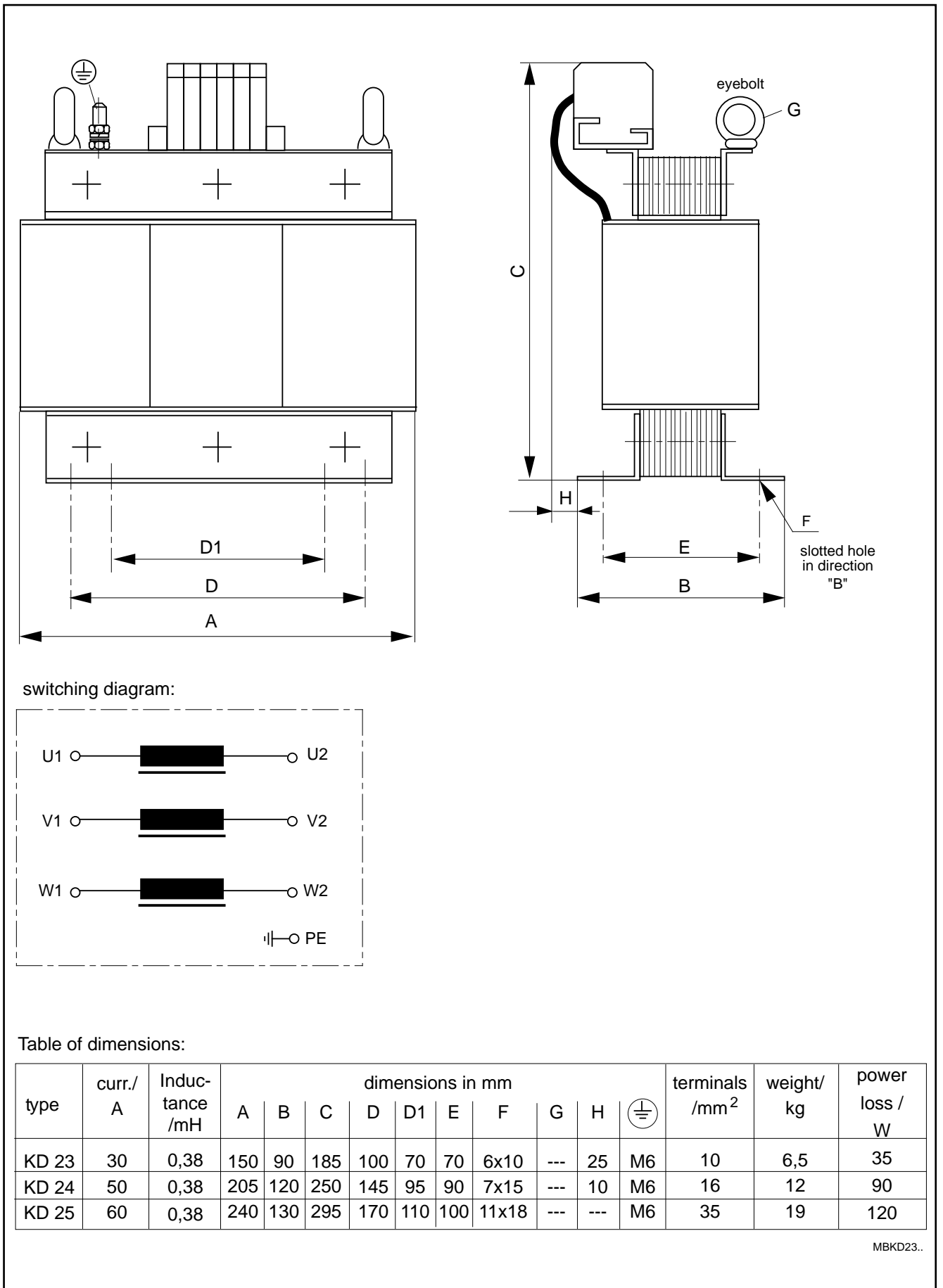


Figure 7.3: Commutation choke - dimensional data

7.4. Dimensional data for link capacitor CZ 1.2-01-7

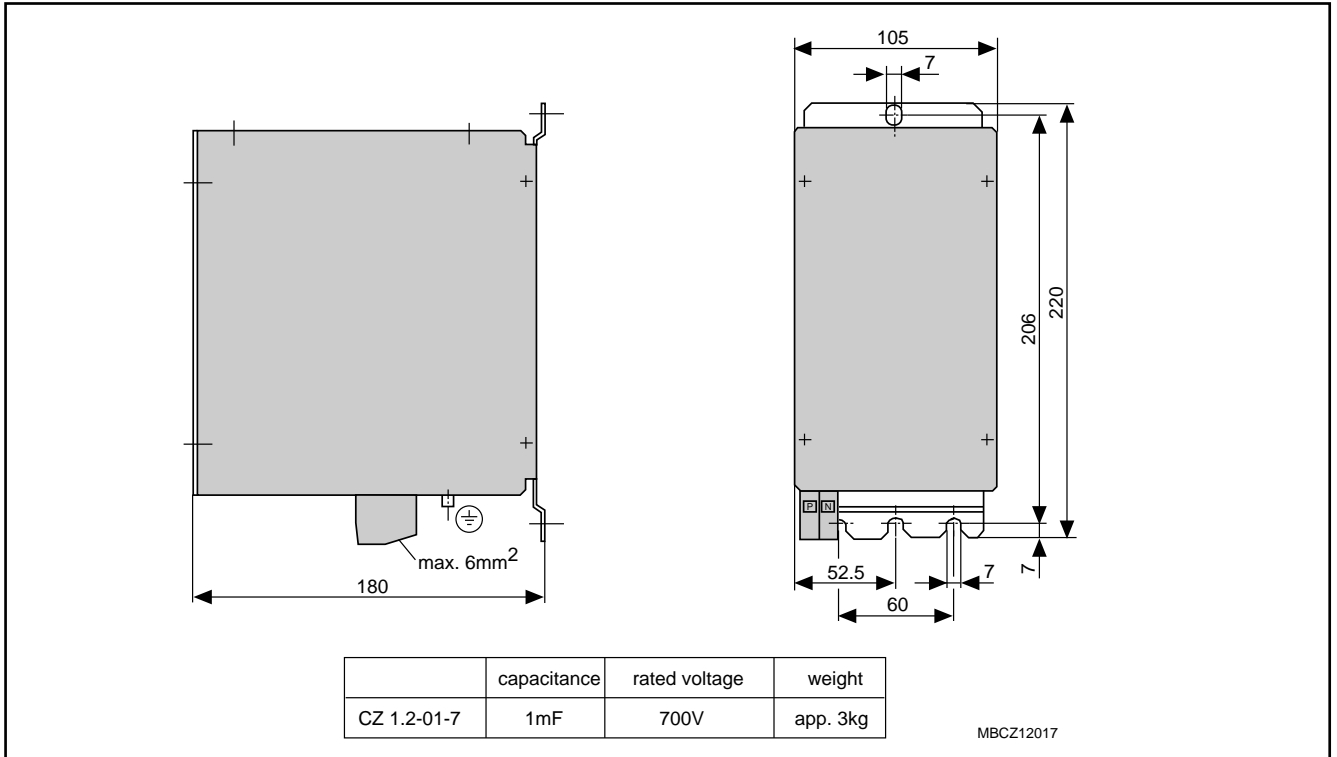


Figure 7.4: Dimensional data for link capacitor CZ 1.2-01-7

7.5. Dimensional data for link capacitor CZ 1.02

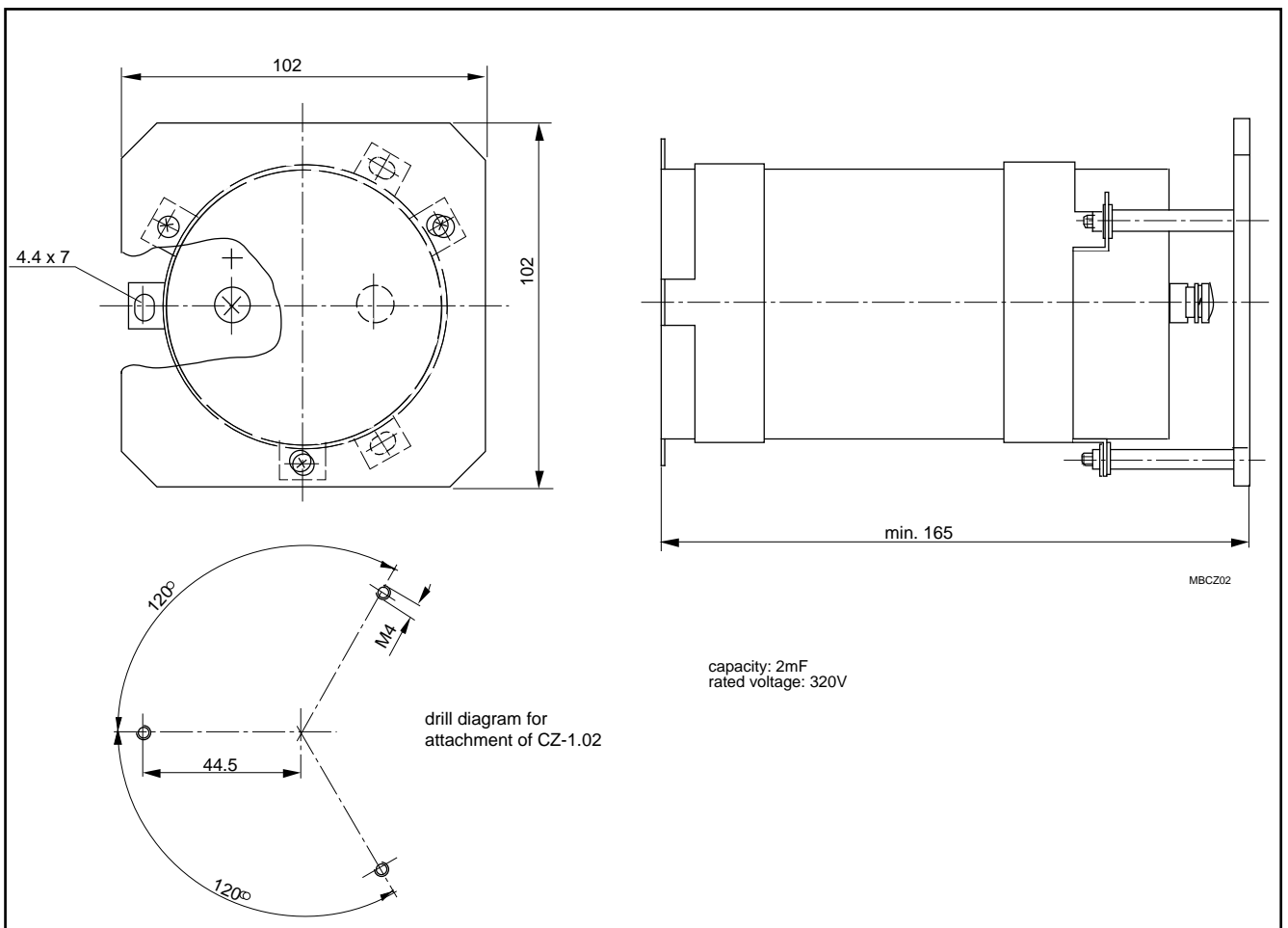


Figure 7.5: Dimensional data for link capacitor CZ 1.02

7.6. Dimensional data for additional capacitor module TCM 2.1 (link capacitor)

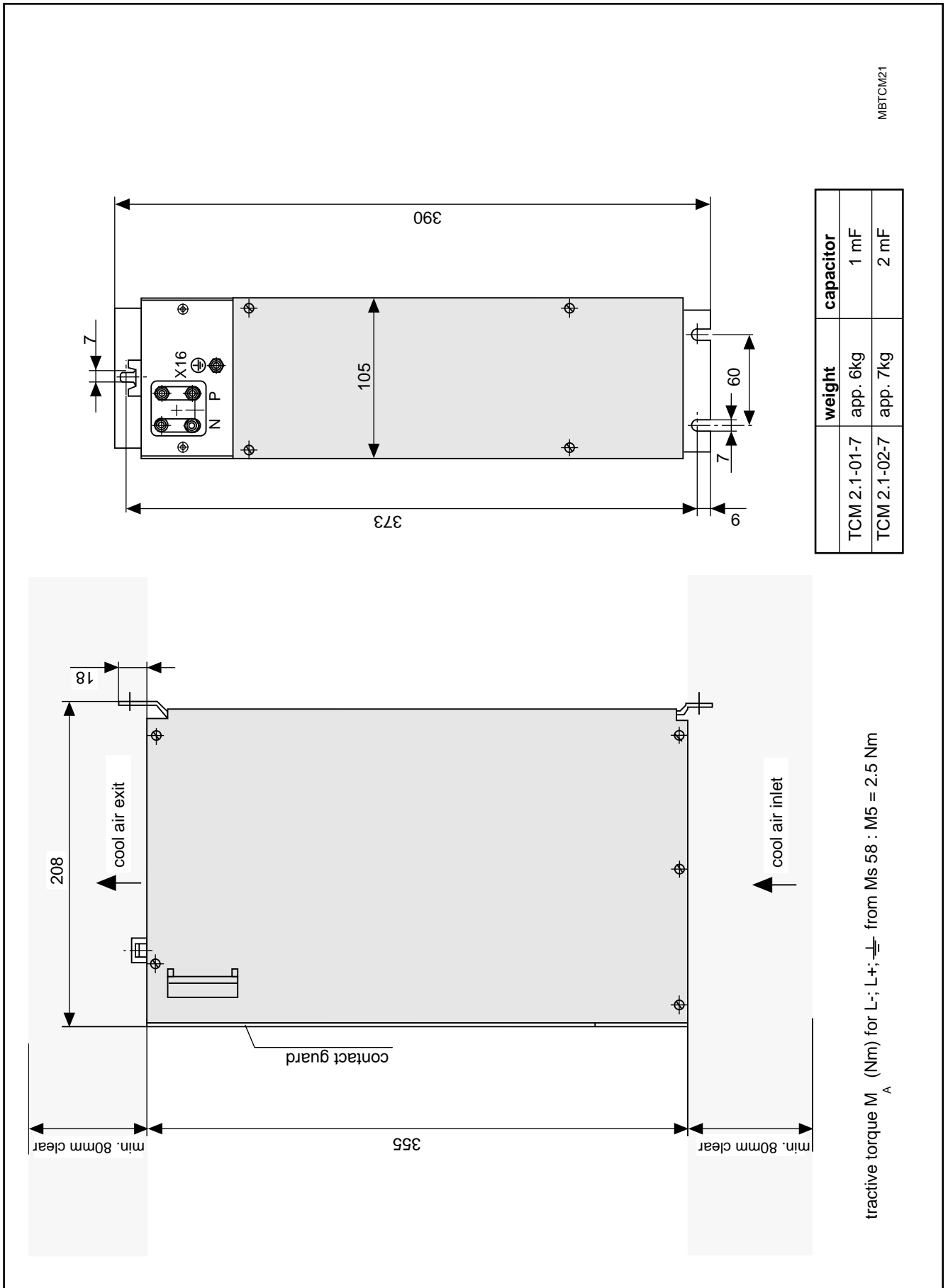


Figure 7.6: Dimensional data for additional capacitor module TCM 2.1

8. Order information

8.1. Type codes KVR 1

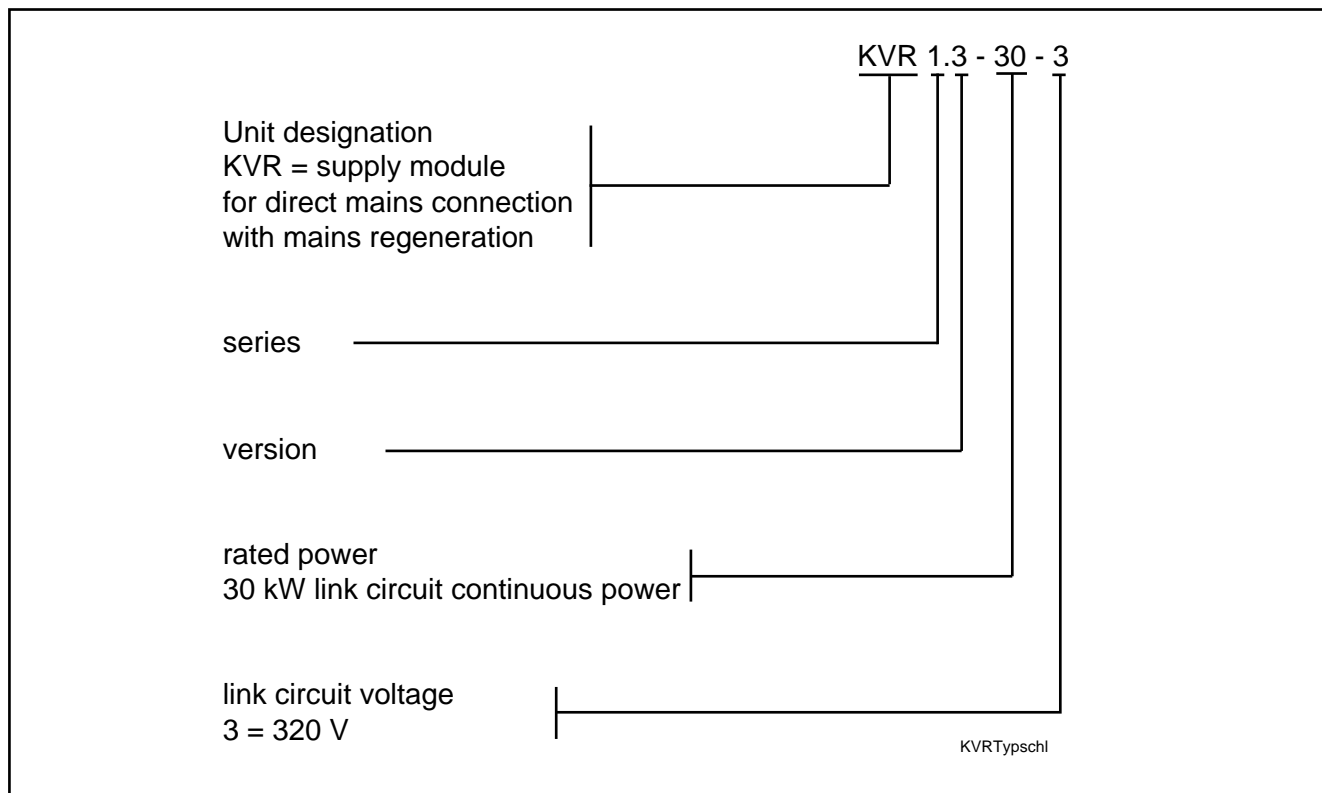


Figure 8.1: Type codes for a KVR 1

8.2. Available versions - supply module KVR and accessories

Lable	Available configurations
1. Supply Module	KVR 1.3-30-3
1.1 Electric connecting accessories	E1-KVR E2-KVR E3-KVR
1.2 mechanical mounting accessories	M1-KD
1.3 fan	LE 4-220 LE 4-115
2. Inductance	
2.1 link circuit smoothing choke	GLD 17 GLD 18 GLD 19
2.2 commutation choke	KD 23 KD 24 KD 25
3. Capacitors	
3.1 link circuit capacitors	CZ 1.02
3.2 link capacitors	CZ 1.2-01-7 TCM 2.1-01-7 TCM 2.1-02-7

8.3. Summary of electrical connecting accessories

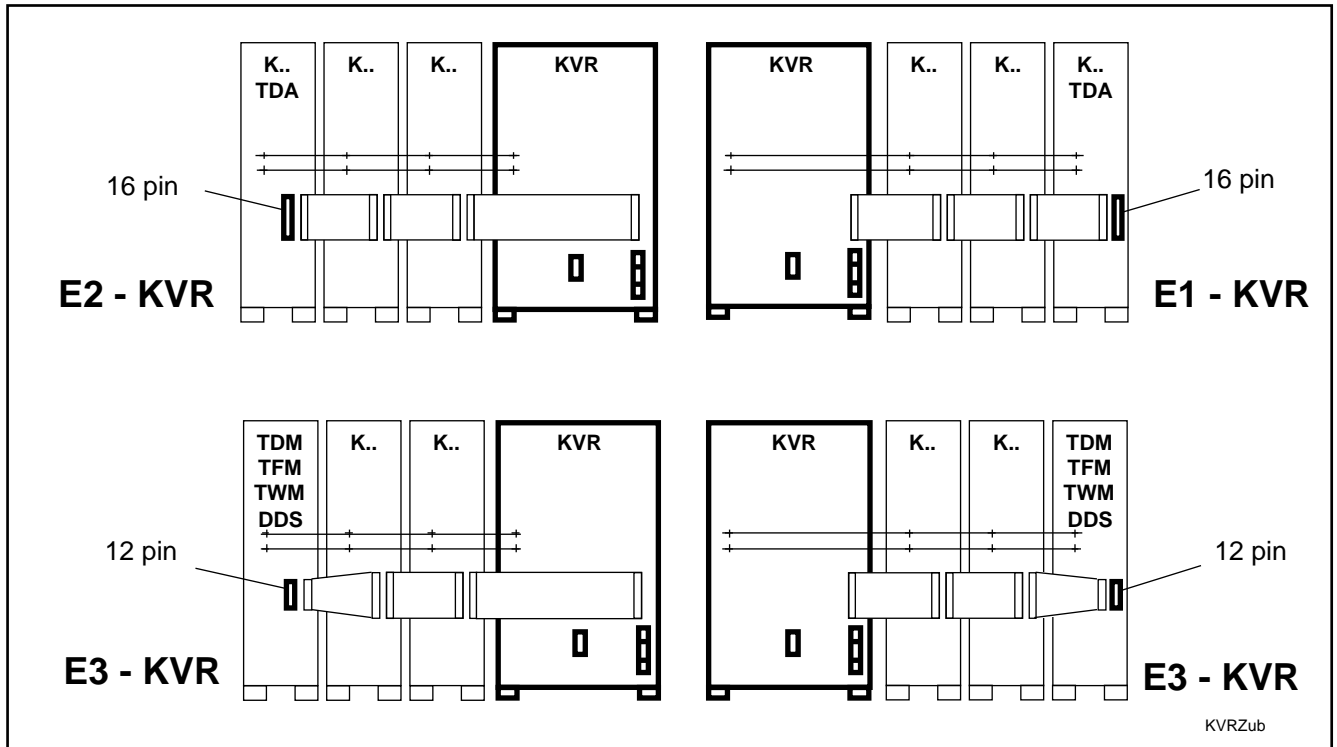


Figure 8.2: Summary of electrical connecting accessories

8.4. Components list for mains supply with KVR 1

Item	Article	Selection see
1.1	KVR 1.3-30-3	
1.2	electrical connecting accessories E.-KVR	section 8.3
1.3	mechanical mounting accessories M1-KD (twice for each KVR)	
1.4	Fan LE4 - ...	
2.1	Link circuit smoothing choke GLD..	section 2.1
2.2	Commutation choke KD..	section 2.1
3.1	Link circuit capacitors CZ 1.02	section 2.1
3.2	Link capacitors CZ 1.2-01-7 or TCM 2.1-0 . -7	section 2.1

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