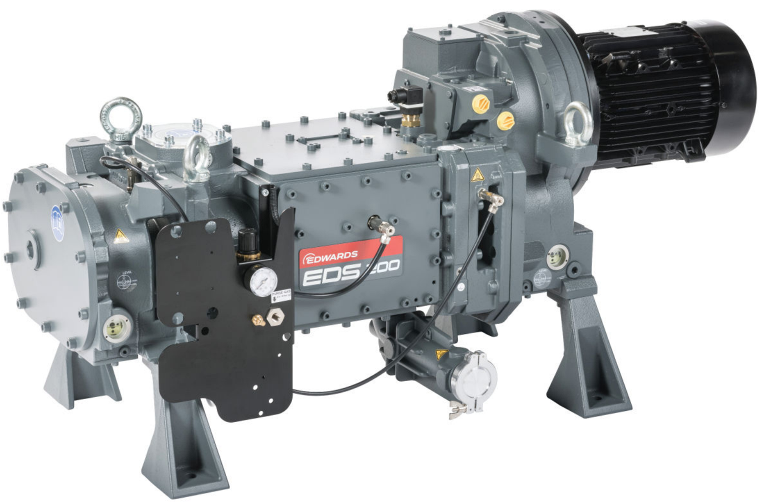
EDS Pumps Electrical Connection

EDS200, EDS300 AND EDS480

edwardsvacuum.com



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Original instructions

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Associated publications

Publication title	Publication number
Chemical (ATEX) Dry Vacuum Pumps EDS200 and EDS300	A41801880
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We accept no liability for loss of profit, loss of market or any other indirect or consequential loss whatsoever.

Product warranty and limit of liability are dealt with in our standard terms and conditions of sale or negotiated contract under which this document is supplied.

You must use this product as described in this manual. Read the manual before you install, operate, or maintain the product.

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1. Safety and compliance

For safe operation from the start, read these instructions carefully before you install or commission the equipment and keep them safe for future use. Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions.

1.1 Definition of Warnings and Cautions

Important safety information is highlighted as warning and caution instructions which are defined as follows. Different symbols are used according to the type of hazard.

WARNING:

If you do not obey a warning, there is a risk of injury or death.

CAUTION:

If you do not obey a caution, there is a risk of minor injury, damage to equipment, related equipment or process.

NOTICE:

Information about properties or instructions for an action which, if ignored, will cause damage to the equipment.

We reserve the right to change the design and the stated data. The illustrations are not binding.

1.2 Trained personnel

For the operation of this equipment “trained personnel” are:

- skilled workers with knowledge in the fields of mechanics, electrical engineering, pollution abatement and vacuum technology and
- personnel specially trained for the operation of vacuum pumps

1.3 Safety symbols

The safety symbols on the products show the areas where care and attention is necessary.

The safety symbols that we use on the product or in the product documentation have the following meanings:

	Warning/Caution An appropriate safety instruction must be followed or caution to a potential hazard exists.

2. Important safety information

Take note of appropriate precautions and obey the safety instructions that follows:

- Protect the motor against overloading.
- Connect the pump to the plant control. With plant control, the pump and the emergency stop circuits will not restart automatically. The pump must be switched on manually after the automatic restart.
- Disconnect the pump from the power supply before the maintenance or service.
- Use the pump only at the intended frequency (refer to the EDS industrial manual (publication number - A41802880) and EDS chemical manual (publication number - A41801880 and A41803880) for the details).

3. Introduction

This manual describes the additional information required for electrical connection for the EDS pumps. Follow the information given in this manual for safe and normal operation of the pump.

4. Technical data

4.1 General technical data

Protective relays for motors (like circuit breakers) are equipped with a trip-free release. Protective relays switch off the motor, although the switch is in on position.

The on and off position of a switch is distinguishable (for example, by colour - red or green, by letters - I or O, by position - on or off).

Release mechanism against short circuit releases: The initial current is adjusted to 8 to 16 times the value of the nominal current (I_N) of the protective relay of the motor.

To protect the motor against overload, adjust the release mechanism as follows:

- Motor at operating temperature and 1.2 I_N: release it within 2 hours
- Motor at operating temperature and 1.5 I_N: release it within 2 minutes.
- Switch the frequency of the protective relay of the motor to approximately 25-50 switching processes per hour.

Table 1 EDS200 Electrical data

Motor	Unit	6528581 (6531093)		6528580		6531102	ATEX T3 6531563
Net frequency	Hz	50	60	50	60	60	50
Nominal power	kW	7.5 (5.5*)		5.5			
Nominal current at operating voltage of YY-Circuit	A	23.6	23.5	22.93	20.4	-	-
	V	200	200	200	230	-	-
Nominal current at operating voltage of Y-Circuit	A	13.1	12.4	11.34	10.1	8.0	12.0
	V	380	380	400	460	575	400
Initial current (peak, when switching on the pump) (low voltage)	A	185	155	153	158	-	-
	V	200	200	200	230	-	-
Start-up time (approximately) (low voltage)	Second	4.2 (6.3*)	6.5	6.3	5.6	-	-
Initial current (peak, when switching on the pump) (high voltage)	A	118	103	85.5	86.6	53.5	66.7
	V	380	380	400	460	575	400
Start-up time (approximately) (high voltage)	Second	3.2	4	5.5	4.6	6.2	7
Nominal frequency	Hz	50	60	50	60	60	50
Frequency range	Hz	30 - 50	30 - 60	30 - 50	30 - 60	30 - 60	
Efficiency class	-	IE3					
Apparatus protection classes (DIN 40050/7.80)	-	IP55					
Class of temperature protection	-	F					
Temperature sensor in the engine coil	-	PTC					
Operating mode (DIN VDE 0530 T.1/7.91)	-	S1 (continuous operation)/S9 (motor nameplate)					S1

For ATEX T4, refer to *Table: EDS300 Electrical data**.*

** for 6531093 motor configuration.*

Table 2 EDS300 Electrical data

Motor	Unit	6528581		6528549		6528583	ATEX 6530468
Net frequency	Hz	50	60	50	60	60	50
Nominal power	kW	7.5					
Nominal current at operating voltage of YY-Circuit	A	27.9	28.0	24.3	24	-	-
	V	200	200	200	230	-	-
Nominal current at operating voltage of Y-Circuit	A	15.2	14.6	13.8	12	9.9	13.9
	V	380	380	400	460	575	400
Initial current (peak, when switching on the pump) (low voltage)	A	200*	204*	200	180	-	-
	V	200	200	200	230	-	-
Start-up time (approximately) (low voltage)	Second	4*	8*	4	5.5	-	-
Initial current (peak, when switching on the pump) (high voltage)	A	122*	120*	100	90	71.1	97.4
	V	380	380	400	460	575	400
Start-up time (approximately) (high voltage)	Second	5*	5*	4	5.5	6.1	5
Nominal frequency	Hz	50	60	50	60	60	50
Frequency range	Hz	30-50	30-60	30-50	30-60	30-60	
Efficiency class	-	IE3					
Apparatus protection classes (DIN 40050/7.80)	-	IP55					
Class of temperature protection	-	F					
Temperature sensor in the engine coil	-	PTC					
Operating mode (DIN VDE 0530 T.1/7.91)	-	S1 (continuous operation)/S9 (motor nameplate)					S1

** Calculated values.*

Table 3 EDS480 Electrical data

Motor		Unit	6539380		6539335		6539381	ATEX 6539341
Net frequency		Hz	50	60	50	60	60	50
Nominal power		kW	11					
Nominal current at operating voltage of YY-Circuit		A	38.5	37.3	38.8	34.1	-	-
		V	200	200	200	230	-	-
Nominal current at operating voltage of Y-Circuit		A	21.9	19.9	19.5	16.8	13.5	19.4
		V	380	380	400	460	575	400
Initial current (peak, when switching on the pump) (low voltage)		A	400	376	435	482*	-	-
		V	200	200	200	230	-	-
Start-up time (approximately) (low voltage)		Second	2.5	3.5	3	3.6*	-	-
Initial current (peak, when switching on the pump) (high voltage)		A	263	244	224	241	156	171
		V	380	380	400	460	575	400
Start-up time (approximately) (high voltage)		Second	1.8	2.5	2.5	2.6	3.3	3.3
Nominal frequency		Hz	50	60	50	60	60	50
Frequency range		Hz	30-50	30-60	30-50	30-60	30-60	
Efficiency class		-	IE3					
Apparatus protection classes (DIN 40050/7.80)		-	IP55					
Class of temperature protection		-	F					
Temperature sensor in the engine coil		-	PTC					
Operating mode (DIN VDE 0530 T.1/7.91)		-	S1 (continuous operation)/S9 (motor nameplate)					S1

** Calculated values.*

5. Installation

5.1 Load circuit

5.1.1 Connection to the main power supply

The EDS pumps are classified as group II. To connect to the local electricity supply obey the steps that follows:

- Make sure that the power supply can supply the required energy, frequency and voltage to the pump.
- Design the power supply of the power supply firm and the local installation in a way that it is sufficient and the voltage drop at the power supply is less than the given limit by the power supply firm. If the local electricity supply is inadequate, consider other options such as:
  - power supply cables with bigger diameter
  - separation of loads to more than one circuit, etc.

The necessary motor data is given in *Technical data* on page 9 (or refer to EDS industrial manual (publication number- A41802880) and EDS chemical manual (publication number - A41801880 and A41803880)).

It is undesirable if the inrush current during motor start-up causes a temporary voltage decrease. The conditions to avoid the temporary voltage decrease is as follows:

- Alternating current motors $P \leq 1.4$ kW or a 3-phase alternating current motors $I_A \leq 60$ A.
- The kind of start-up (refer to the example given in *Start-up* on page 33) must be agreed by the power supply firm in the case of:
  - high performance motors ($P > 1.4$ kW or $I_A > 60$ A)
  - particularly difficult start-up
  - frequently switching on
  - varying current input.

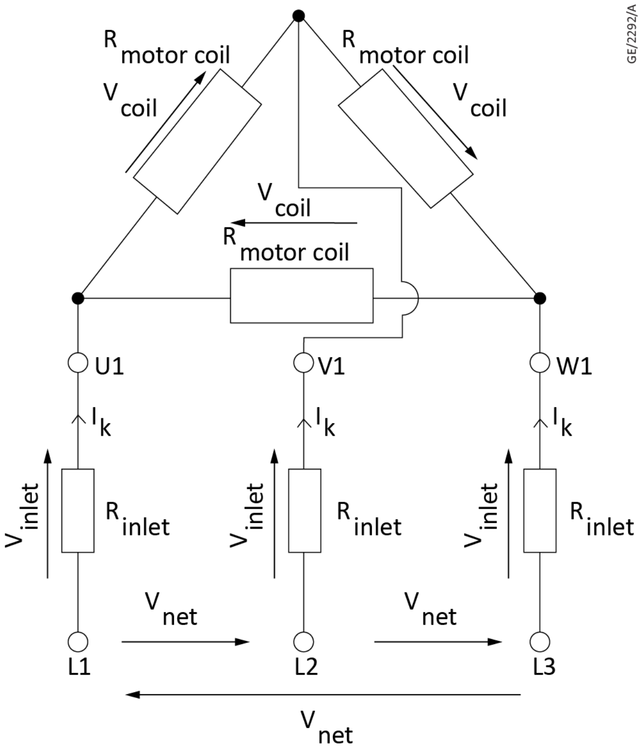
5.1.2 Voltage drop at the power supply

Design the power supply of the pumps in a way that it is sufficient to transport the power and the current to the pump at start-up time (refer to *Protective relay for the motor (general) and class 30* on page 21).

The ohmic resistance of the power supply with the motor coil creates a voltage divider.

For example, in the Δ-circuit:($R_{inlet} + R_{motor\ coil} + R_{inlet}$). Refer to *Figure: Example for the voltage divider*.

Figure 1 Example for the voltage divider



Consider a pump in the 400 V/50 Hz network with a initial current of 85.5 A and a nominal current of 10.1 A (refer to *Table: EDS200 Electrical data* in Y-Circuit 400 V/ 50 Hz). The length of the power supply cable is 30 m.

In the first case, the surface area of the power supply cable is 4 mm².

$$\rho_{cu} = 0.017 \frac{\Omega \,.\, mm^2}{m}$$

$$l = 30 \text{ m}$$

$$A = 4 \text{ mm}^2$$

$$R_{inlet} = \frac{\rho_{cu} \,.\, l_{inlet}}{A_{inlet}} = \frac{0.017 \frac{\Omega \,.\, mm^2}{m} \,.\, 30 \text{ m}}{4 \text{ mm}^2} = 0.1275$$

$$2 \,.\, R_{inlet} = 2 \,.\, 0{,}128\,\Omega = 0.256\,\Omega$$

$$V_{inlet} = 2 \,.\, R_{inlet} \,.\, I_k = 0{,}256\,\Omega \,.\, 85{,}5\text{ A} = 21.89\text{ V}$$

$$V_{motor\ coil} = V_{net} - V_{inlet} = 400\text{ V} - 21.89\text{ V} = 378.11\text{ V}$$

The pump voltage drops at start-up from 400 V to approximately 380 V. So the start-up time gets longer.

The voltage at the pump must be 400 V ± 10%, so the value of the voltage at the pump is close to the minimum value demanded by the motor. The voltage drops to the terminal are not considered yet.

Because of the longer start-up time, the protective relay of the motor releases. Use thick power supply cables so that the pump cannot reach the nominal rotational speed.

In the second case, the surface area of the power supply cable is 10 mm².

$$\rho_{cu} = 0.017 \frac{\Omega \, . \, mm^2}{m}$$

$$l = 30 \, m$$

$$A = 10 \, mm^2$$

$$R_{inlet} = \frac{\rho_{cu} \, . \, l_{inlet}}{A_{inlet}} = \frac{0.017 \frac{\Omega \, . \, mm^2}{m} \, . \, 30 \, m}{10 \, mm^2} = 0.051 \, \Omega$$

$$2 \, . \, R_{inlet} = 2 \, . \, 0{,}051 \, \Omega = 0.102 \, \Omega$$

$$V_{inlet} = 2 \, . \, R_{inlet} \, . \, I_k = 0{,}102 \, \Omega \, . \, 85{,}5 \, A = 8.7 \, V$$

$$V_{motor\ coil} = V_{net} - V_{inlet} = 400 \, V - 8.7 \, V = 392.3 \, V$$

The second case shows less voltage drop than the first case.

During the design of the power supply, consider the whole length (also the length of the power supply cable before safety devices/switchgears).

As the voltage at the pump is high, thicker and shorter power supply cable are designed.

5.1.3 Fuses

The fuses protect against a short circuit. The motor protective relay, which is connected afterwards, also has a safety device for short circuit. The high initial current and start-up time requires these 'slow blow' fuses.

Fuses are classified according to two categories:

1. Design:
   - Screwing system (D system and DO system)
   - Blade contact system (NH system and HH system)
2. Utilisation categories marking with two or more letters:
   - the first letter gives the function class:

     g = full range fuse (for overload and short circuit)

     a = back-up fuse (for short circuit).
   - the second letter gives the object, which must be protected:

     G(L) = conductors and cables

     M = switchgears

     R = semiconductor elements

     B = mining industry plants

     Tr = transformators.

Circuit symbol

Figure 2 Circuit symbol - Single phase

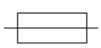
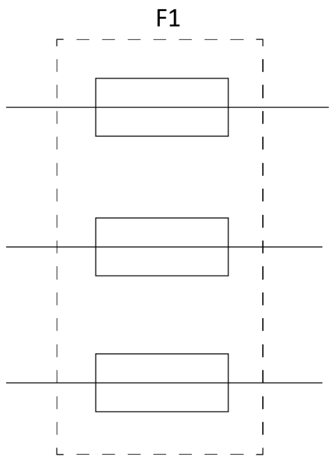


Figure 3 Circuit symbol - 3-phase



Example to choose the fuse

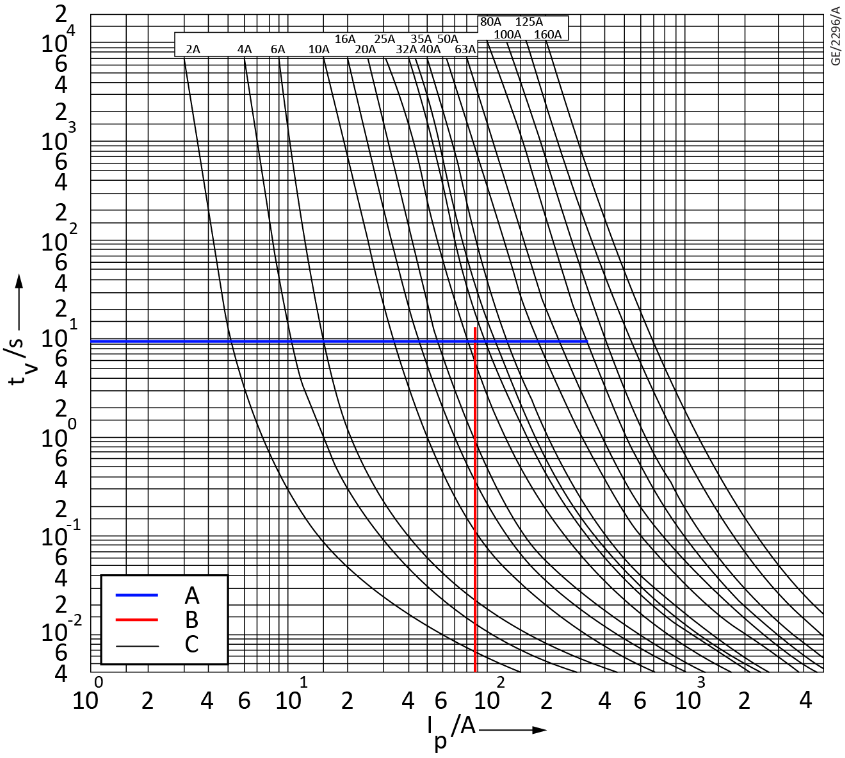
Type of fuse: NH system and HH system

Manufacturer: Jean Müller

Description: NH-Sicherungseinsatz Kombi-Melder gG 400V 16A M000GL16/4

Figure 4 Fuse NH system and HH system

Figure 5 Fuse characteristic



A. Start-up time - 5.5 seconds

B. Initial current - 85.5 A

C. Normal current - 11.3 A

The fuse characteristic shows a 25 A fuse is sufficient with a nominal voltage.

Design of the power supply

To design the power supply, you must consider the factors that follows:

- the maximum load capability of the cables and conductors for a fixed installation in buildings
- operating temperature - 70 °C
- ambient temperature - 25 °C and
- allocation of rated current I_N of overcurrent protection devices with $I_Z \leq 1.45\ I_N$.

Figure 6 Design of the power supply

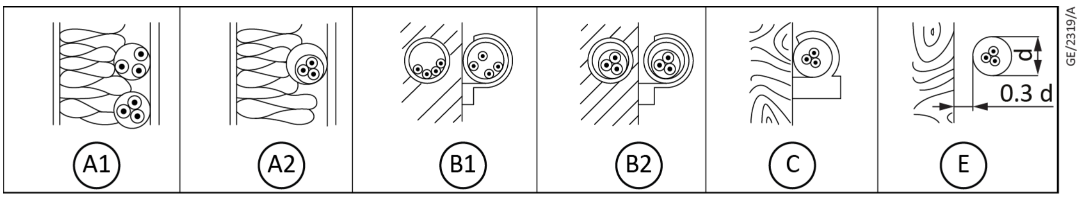


Table 4 Design of the power supply

Reference installation		A1		A2		B1		B2		C		E	
Installation		In thermal insulated walls				In installation pipes				On a wall			
Number of loaded wires		2	3	2	3	2	3	2	3	2	3	2	3
Nominal cross section Cu in mm^2		Current capability (I_Z) in A Nominal current (I_N) in A											
Ambient temperature 25 °C													
1.5	I_Z	16.5*	14.5	16.5*	14	18.5	16.5	17.5	16	21	18.5	23	19.5
	I_N	16	13	16	13	16	16	16	16	20	16	20	16
2.5	I_Z	21	19	19.5	18.5	25	22	24	21	29	25	32	27
	I_N	20	16	16	16	25	20	20	20	25	25	32	25
4	I_Z	28	25	27	24	34	30	32	29	38	34	42	36
	I_N	25	25	25	20	32	25	32	25	35	32	40	35
4	I_Z	-	-	-	-	-	-	-	-	-	35**	-	-
	I_N										35**		
6	I_Z	36	33	34	31	43	38	40	36	49	43	54	46
	I_N	35	32	32	25	40	35	40	35	40	40	50	40
10	I_Z	49	45	46	41	60	53	55	49	67	60	74	64
	I_N	40	40	40	40	50	50	50	40	63	50	63	63
10	I_Z	-	-	-	-	-	-	-	50**	-	63**	-	-
	I_N								50**		63**		
16	I_Z	65	59	60	55	81	72	73	66	90	81	100	85
	I_N	63	50	50	50	80	63	63	63	80	80	100	80
25	I_Z	85	77	80	72	107	94	95	85	119	102	126	107
	I_N	80	63	80	63	100	80	80	80	100	100	125	100
35	I_Z	105	94	98	88	133	117	118	105	146	126	157	134
	I_N	100	80	80	80	125	100	100	100	125	125	125	125
50	I_Z	126	114	117	105	160	142	141	125	178	153	191	162
	I_N	125	100	100	100	160	125	125	125	160	125	160	160

** With wall construction: Outer skin with 10 mm fibre boards, thermal insulation with 100 mm of mineral fibre, inner skin with 25 mm of fibre boards with heat conductivity 0.1 W/(K m) perpendicularly and 0.23 W/(K m) parallel to plate plane.*

*** Does not apply for installation on a wooden wall.*

The nominal current (I_N) of the safety device must not be more than current capability I_Z ($I_N \leq I_Z$).

Safety devices can also be used to protect other devices against overload. In this case, I_N of the safety device has to be equal or less than the rated current of the device.

Fuses with I_N = 13 A, 32 A and 40 A are at present not standardised. Alternatively, the next smaller amperage I_N is to be selected.

The selection of the fuse and the installation of the power supply depends on the design of the power supply (refer to DIN VDE 0100 T.430/11.91, DIN VDE 0298 T.4/02.88). Obey the instructions that follows:

- The nominal cross section of the power supply cable with installation C (on a wall) at the ambient temperature must be 10 mm².
- If the longer power supply cable is required, other calculations (like calculation of the resistance of the power supply, voltage drop at the power supply, etc.) must be done. Refer to *Voltage drop at the power supply* on page 13.
- If the ambient temperature is high, the power supply must be calculated again. Use the correction factors given in *Correction factors* on page 20.

Temperature stability of the power supply

Make sure that the power supply cable having 105 °C temperature stability is used for the power supply of the pump. Refer to *Design of the power supply* on page 17.

For the power supply cable having temperature stability less than 105 °C (for example, 80 °C), the wires in the clamp box of the pump must be insulated with the attached silicone hose against the thermal demand. This also applies to the two wires of the PTC resistor (clamps 10 and 11).

The power cable with the temperature stability of 105 °C is common with UL and CSA conductors.

Recommended values for the current load of the multicore UL and CSA conductors at an ambient temperature of 30 °C are given in *Table: Recommended values for AWG*.

Table 5 Recommended values for AWG

AWG* number	Nominal cross section / (mm²)	(Nominal) Current load / (A)		
		Up to 3 wires	4 to 6 wires	7 to 24 wires
24	0.21	2	1.6	1.4
22	0.33	3	2.4	2.1
20	0.52	5	4	3.5
18	0.82	7	5.6	49
16	1.31	10	8	7
14	2.08	15	12	10.5
12	3.32	20	16	14
10	5.26	30	24	21
8	8.35	40	32	28
6	13.29	55	44	38
4	21.14	70	56	49
3	26.65	80	64	56
2	33.61	95	76	66
1	42.38	110	88	77

** American Wire Gauge (AWG)*

Correction factors

Table 6 Correction factor for UL and CSA conductors (more than 30 °C)

Ambient temperature (°C)	Correction factors (f)
31-40	0.82
41-45	0.71
46-50	0.58

Note:

The permitted operating temperature is between 10 °C and 40 °C.

The power supply cable of the EDS300 in the YY-Circuit at 50 Hz net (IN = 28 A) at an ambient temperature of 31 - 40 °C has to be dimensioned with a nominal cross-section of AWG 8 (8.35 mm²) or thicker.

Table 7 Correction factor according to DIN (more than 30 °C)

Ambient temperature (°C)	Correction factors (f)
10-30	1
35	0.93
40	0.87
45	0.79
50	0.71

Protective relay for the motor (general)

(Refer to DIN VDE 0530 T.1/7.91, DIN VDE 0660 T.104/9.82)

Characteristics

Protective relays for motors are switchgears and overload protection device. They protect the pump against overload, not starting up or loss of a phase in the 3-phase current supply. Some protection functions are optional. If these protection functions are not included in the protective relay, it is advisable (or often according to regulation necessary) to add them to the circuit (for example, fuses).

Thermal release mechanism against overloading

A resistance (wire) is connected to a bimetal. If the magnitude of the current is too high, the resistance gets warmer (P = U x I). The bimetal bends with rising temperature and releases the release mechanism. The protective relay switches off the motor.

The release mechanism acts slowly (slow bending of the bimetal), so that the high initial current can flow during the start-up time without any problem (depending on the kind of switch adjustable or readable from the current/time characteristic of the switch) so that the motor operates.

The protective relay for the motor must be adjusted to the nominal current of the motor. For example, I_NES 300/50 Hz/ΔΔ = 28 A.

Electromagnetic release against short-circuit (optional)

If the short-circuit current (I_k) flows through an integrated coil, the coil creates a magnetic field which trips the release mechanism and switches off the motor.

If the release mechanism reacts fast, the reaction time is standardised.

Release mechanism voltage-decrease-coil (optional):

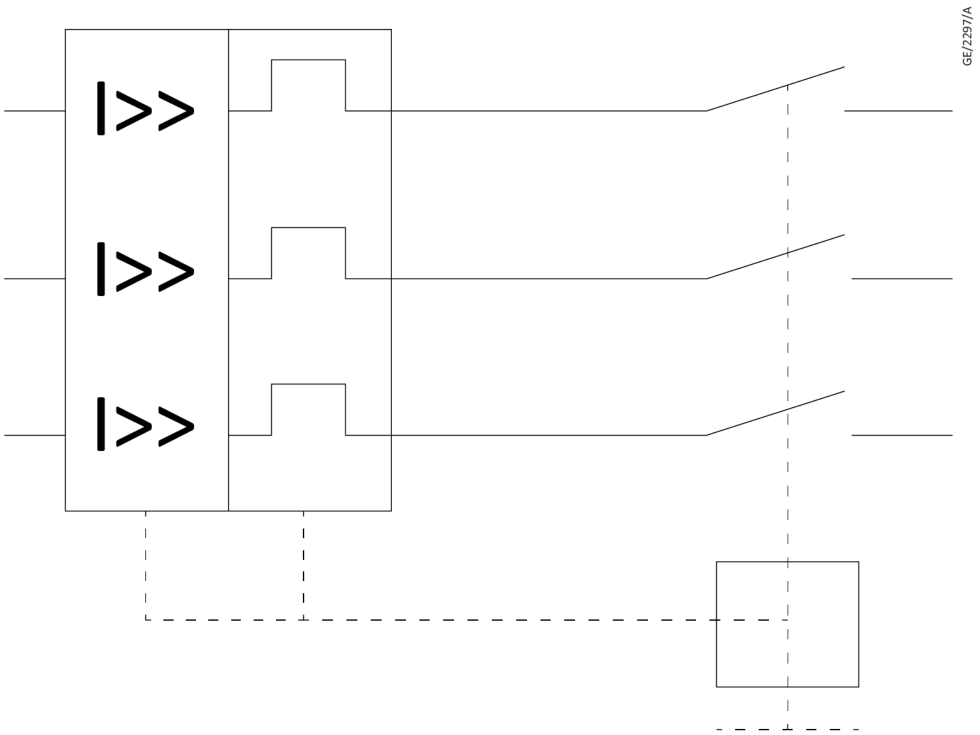
This release mechanism prevents an uncontrolled restart of the motor after voltage failure (danger of accident).

Further possibilities of release mechanisms

Full protection of the motor: Protective relay for the motor with additional temperature monitoring 'locally', which means that the release mechanism monitors the temperature of the motor coils by resistors (for example, Negative Temperature Coefficient (NTC)/ Positive Temperature Coefficient (PTC), or something similar) or by sensor technology and switches off the motor at a temperature limit. This release mechanism has the advantages that:

- it switches off the motor in the case of overload
- it switches off the motor in the case of a high ambient temperature rise, which is dangerous for the insulation of the motor coil.

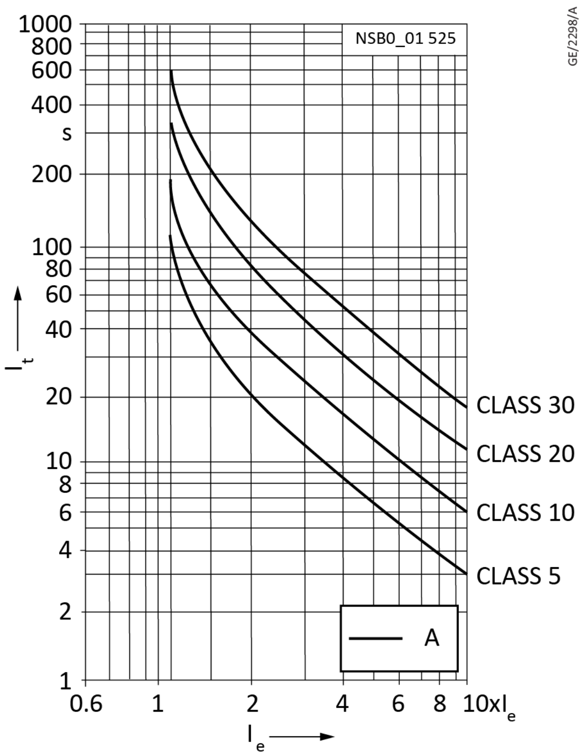
Figure 7 Circuit symbol of the protective relay



5.1.4 Protective relay for the motor (general) and class 30

The motors of the pumps are protected with a thermal overload protection of class 30 (according to IEC 60947-4). Protective relays of class 30 release is released, at the latest after 30 seconds.

Figure 8 Release characteristic for a 3-phase load



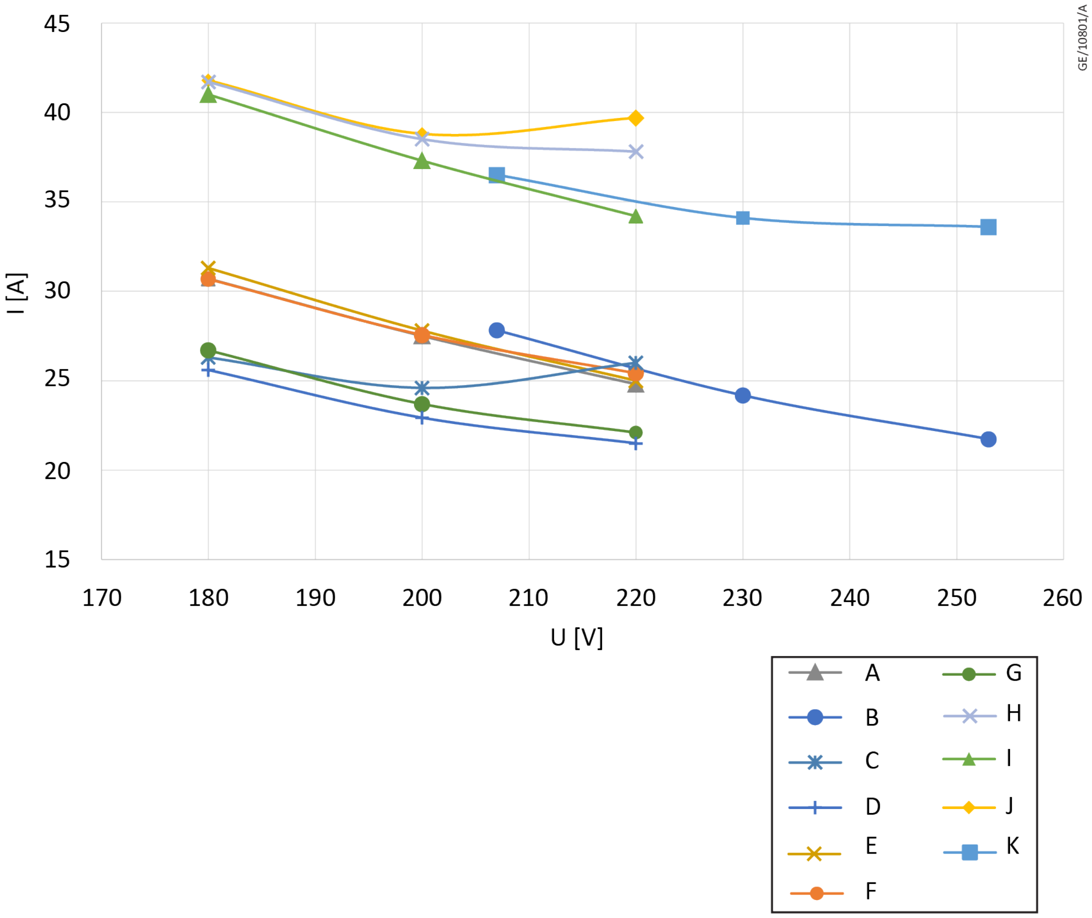
A. Class

The I_E is the current to which the motor protective relay has to be adjusted to. The release characteristic of a 3-phase loaded overload protection relay in cold condition applies when all the 3-phase are loaded with an equal current. With a phase failure, the electronic overload relays switch off the load even faster to protect itself against heating up.

The unbalanced load is switched off depending on the degree of unbalance. The *Figure: Release characteristic for a 3-phase load* shows a principle representation of a characteristic. The characteristics of the individual electronic overload relays can be inquired with the manufacturer.

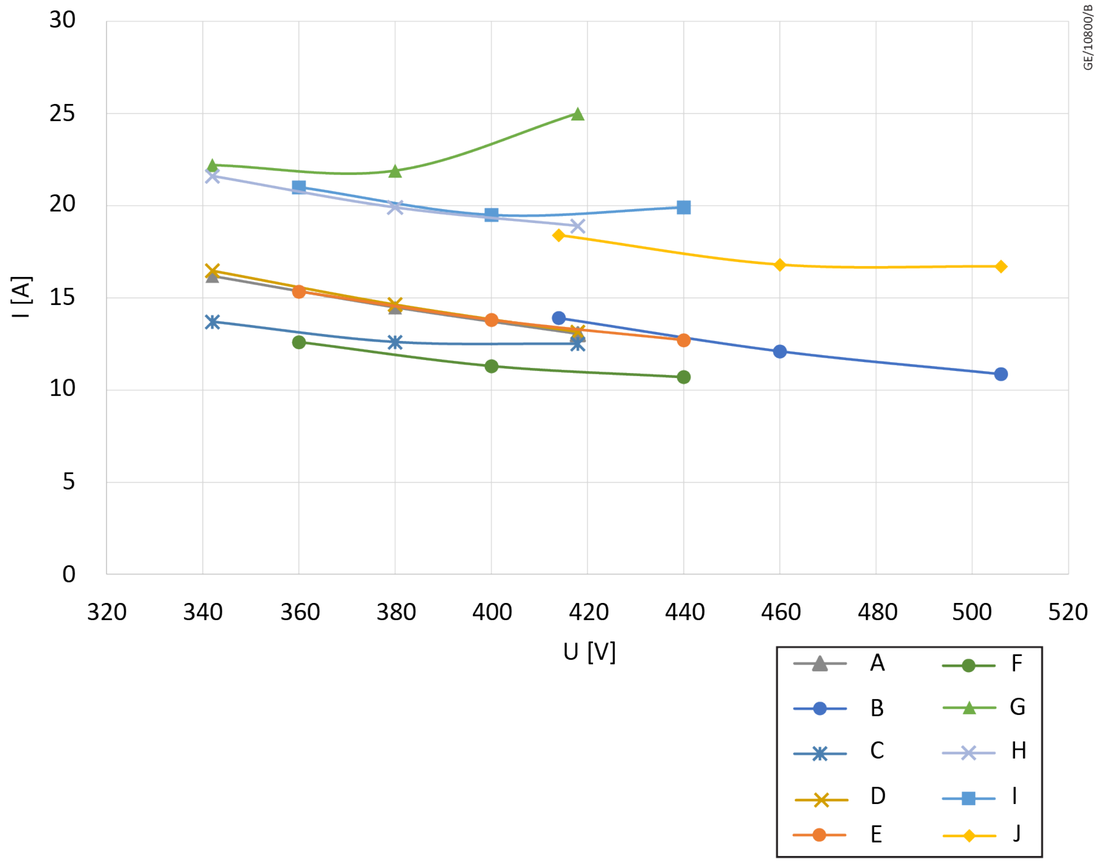
For the optimal adjustment to the existing supply network of the protective relay for the motor, the characteristics shown in *Figure: Nominal current motor low voltage* and *Figure: Nominal current motor high voltage* must be used.

Figure 9 Nominal current motor low voltage



A. 6528581 7.5 kW 200 V / 380 V 50 Hz
B. 6528549 7.5 kW 230 V / 460 V 60 Hz
C. 6531093 5.5 kW 200 V / 380 V 50 Hz
D. 6528580 5.5 kW 200 V / 400 V 50 Hz
E. 6528581 7.5 kW 200 V / 380 V 60 Hz
F. 6528549 7.5 kW 200 V / 400 V 50 Hz
G. 6531093 5.5 kW 200 V / 380 V 60 Hz
H. 6539380 11 kW 200 V / 380 V 50 Hz
I. 6539380 11 kW 200 V / 380 V 60 Hz
J. 6539335 11 kW 200 V / 400 V 50 Hz
K. 6539335 11 kW 230 V / 460 V 60 Hz

Figure 10 Nominal current motor high voltage



- A. *6528581 7.5 kW 200 V / 380 V 50 Hz*
- B. *6528549 7.5 kW 230 V / 460 V 60 Hz*
- C. *6531093 5.5 kW 200 V / 380 V 60 Hz*
- D. *6528581 7.5 kW 200 V /380 V 60 Hz*
- E. *6528549 7.5 kW 200 V / 400 V 50 Hz*
- F. *6528580 5.5 kW 200 V / 400 V 50 Hz*
- G. *6539380 11 kW 200 V / 380 V 50 Hz*
- H. *6539380 11 kW 200 V / 380 V 60 Hz*
- I. *6539335 11 kW 200 V / 400 V 50 Hz*
- J. *6539335 11 kW 230 V / 460 V 60 Hz*

Note:

Motor protective relays manufactured by other manufacturers can also be used.

Figure 11 Schneider Electric TeSys D LR9D32, fit to LC1D09 - D38

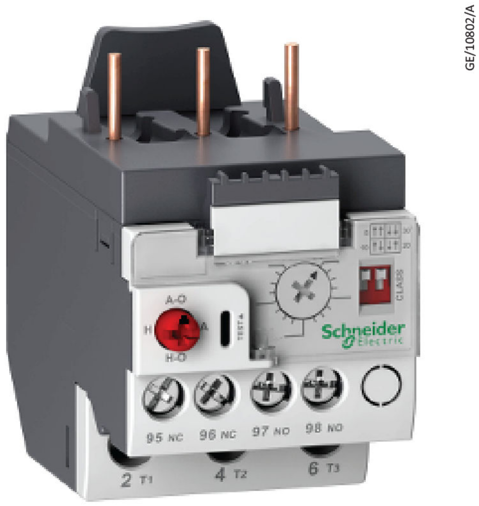


Figure 12 Siemens 3RB20, 3RB21

Figure 13 ABB

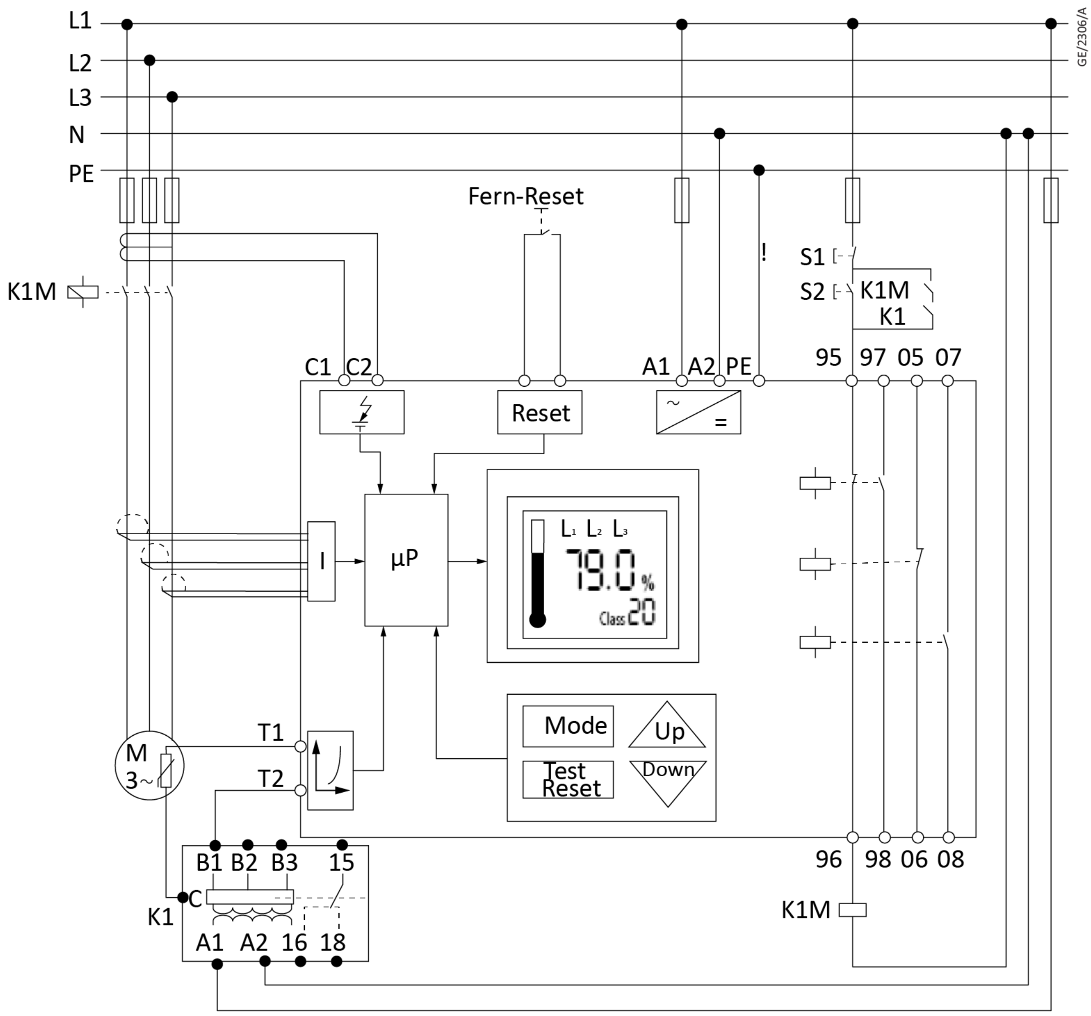
Type	Current range	Class
E45DU45	15 A to 45 A	Selectable
E80DU80	27 A to 80 A	Selectable

Figure 14 Moeller

ZEV Innovative is a motor protection system for currents from 1 A to 820 A (this system is also suitable for ATEX areas).

Figure 15 Moeller connection

Figure 16 Moeller connection scheme



5.1.5 Startup procedures, operating with frequency converter

WARNING: ROTATING PARTS

Risk of injury. Do not open the fan case by removing the cooler, as this exposes the spinning fan blades.

CAUTION: REVERSE ROTATION

Risk of damage to equipment. If the rotary field is in the wrong direction, the reverse rotation may damage the pump. Do not rotate in the wrong direction for more than three seconds. The rotation field test should be done by two persons.

Check the rotary field of the supplying network after you connect the pump. The pumps are delivered with the correct direction of rotation (on the load side), the direction of rotation is left on the fan side.

On the user side, the power supply is supplied with the correct direction of rotation, test it with a rotary field testing set.

Testing the direction of the rotary field

To prevent the damage to the pump obey the instructions that follows:

1. After the electrical connection of the motor, test the rotary field.
2. This must be done with atmospheric pressure in the intake line (the valves must be switched according to it).
3. Switch on the pump for about one second. Observe the rotation of the fan. The direction arrow is on the drive side beneath the fan cover.
4. Test the rotation looking from the load side towards the case of the fan.
5. If possible, test the rotation of the pump with an open intake line and outlet line, with locked dirt catch sieve.

Operation with the frequency converter

Operating with the frequency converter helps to reduce the initial current of the motor. It can also be used to adjust the speed (process pressure control).

The speed of the pump is adjustable from 30 Hz to the nominal frequency (refer to *Table: EDS200 Electrical data*, *Table: EDS300 Electrical data* and *Table: EDS480 Electrical data*). It is not allowed to exceed the nominal frequency (refer to the EDS industrial manual (publication number- A41802880) and EDS chemical manual (publication number - A41801880 and A41803880) for the values). The temperature monitoring with the PTC release mechanism is obligatory, because of additional losses due to the pulsation of the current. The value of the additional losses depends on the procedure of the modulation. It can be reduced with filters.

The parameters of the used converters must be in accordance with:

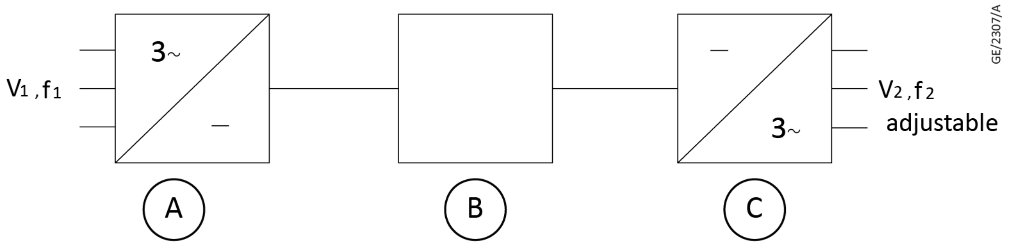
1. the nominal motor current
2. the limits given by the motor protector class 30 characteristic.

In combination with the obligatory PTC connection all other frequency converter parameters (for example, overload) can be changed.

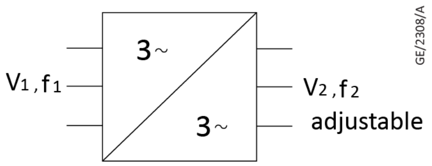
When the frequency converter is used, electromagnetic radiation is generated. The relevant standards and guidelines for the limits of this radiation must be considered. To reduce the electromagnetic radiation:

- Shielded wires and cables
- Shielded cable entries
- Filters for motors
- EMC suitable mass connection of the frequency converter and the pump are suitable.

Figure 17 Circuit symbol of the frequency converter



Short:



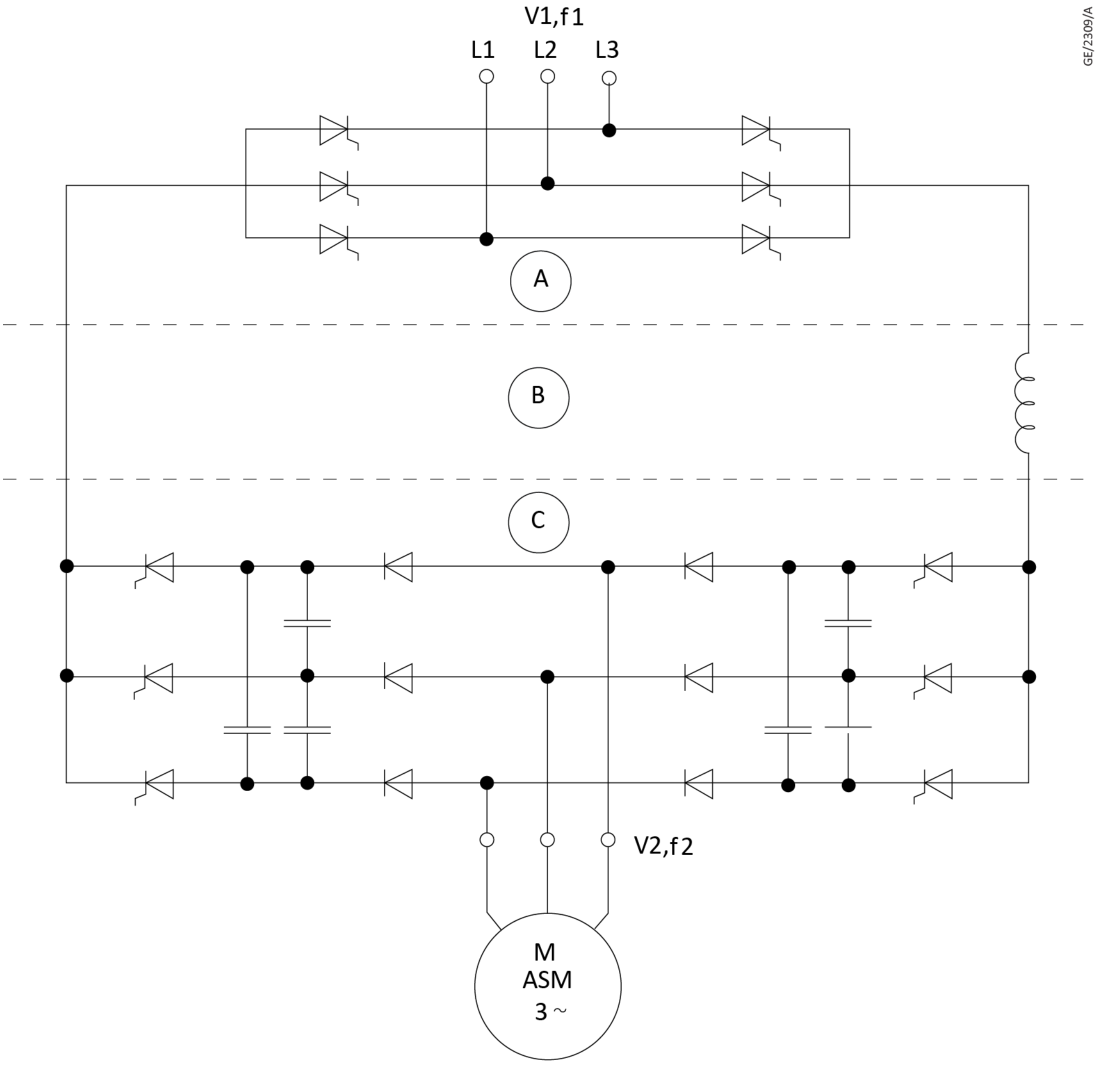
Frequency converters are available in several variations and controls:

1. Electronic basis:
   a. Pulse Amplitude Modulation (PAM) frequency converter
   b. Pulse Width Modulation (PWM) frequency converter
2. Engine – generator principle (refer to Leonhard theorem):

- A motor propelled by net number 1 (U_1, f_1) transfers its mechanical energy to a generator, which feeds its new values (U_2, f_2) to net number 2.

Refer to *Figure: Load circuit (without fuses and switches)* for an operation with a frequency converter on an electronical basis assumption (can be placed in the switch box, less losses).

Figure 18 Load circuit (without fuses and switches)



The inner structure can also be checked with the field-effect of transistors instead of thyristors.

Advantages of a start-up with frequency converters are:

- Load rejection of the line
- Reduction of the initial current
- Optimal motor protection
- Number of revolutions is adjustable
- Optimal energy input.

Disadvantages of a start-up with frequency converters are:

- Electromagnetic radiation
- Shielded cables are essential
- Reduction of the torque at the start-up
- Application of a filter for the motor
- Higher investment is required.

The manufacturers of frequency converters

Figure 19 Omron G7 / E7

Figure 20 Hitachi L300P-150 HFE

Figure 21 Vacon NX / NXL series

Note:

Frequency converters of the Vacon company have the capability to connect to the PTC-monitoring and are certified for ATEX applications.

5.2 Control circuit

5.2.1 Connection of the PTC - monitoring

CAUTION: INSULATION DAMAGE

Risk of damage to equipment. If the inner temperature of the motor coils gets excessively high (which can not be recognised by the protective relay) the insulation of the coils will be damaged.

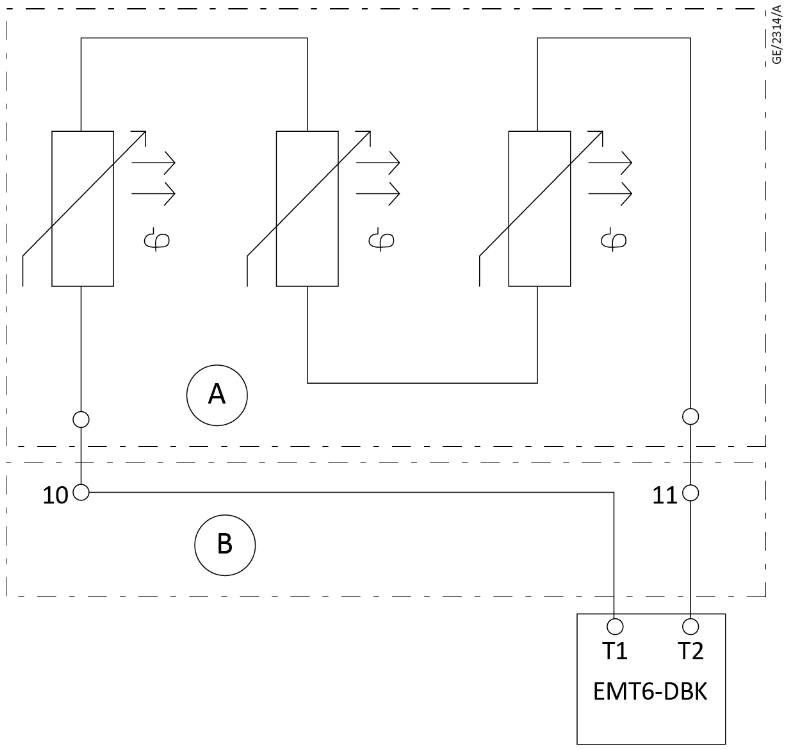
To monitor the temperature, the coils of the motor are equipped with PTC resistors (clamps 10 and 11 in the terminal board). The clamps must only be connected to a release device (for example, Klöckner Möller EMT6-DBK, refer to *Figure: EMT6-DBK thermistor protection multifunctional relay*).

Do not connect voltages higher than 2.5 V to the clamps. The release device has to be separated galvanically from the control circuit of the pump. Make sure that there is no electrical connection either by interconnecting the two circuits or by common earth.

The monitoring of the PTC resistors is a protection against overheating at the motor coils and to observe the temperature classes for ATEX pumps.

Figure 22 EMT6-DBK thermistor protection multifunctional relay

Figure 23 Connection diagram - EMT6-DBK



A. Motor *B. Terminal board*

6. Operation

6.1 Load circuit operation

6.1.1 Release of the safety device

Release mechanism against the short circuit releases: The system must be switched off and the reason for the release must be found and corrected by the trained personnel.

Reasons for a release of the mechanism against short circuit are:

- Short circuit between two conductors
- Long duration of overcurrent.

6.1.2 Release of the class 30 protective relay for the motor

Release mechanism against overload releases: The system must be switched off and the reason for the release must be found and corrected by the trained personnel.

Reasons for a release of the mechanism against overloading the motor are:

- Blocking of the drive (brake / mechanical blocking)
- Long duration of the operation with small overload
- Damage of the bearing (motor or pump)
- Temperature of the release mechanism is too high
- Use of the flush kit to clean the pump.

6.1.3 D-Circuit, DD-Circuit

Start-up

The dual-voltage motors with a voltage ratio of 1:2 have a terminal with 9 or 12 clamps, depends on whether they are started with direct or with the star-delta circuit.

Direct start-up

- Y-Circuit: In the 3-phase / 400 V / 50 Hz and 3-phase / 460 V / 60 Hz net, motor must be switched directly to the Y-Circuit
- YY-Circuit: In the 3-phase / 200 V / 50 Hz and 3-phase / 200 / 230 V / 60 Hz net, motor must be switched directly to the YY-Circuit.
- The connection of the motor is shown in the *Figure: Connection scheme*.

Operation with the frequency converter

- Y-Circuit: For the 3-phase / 400 V / 50 Hz and 3-phase / 460 V / 60 Hz net, it mus be switched to the Y-Circuit
- YY-Circuit: For the 3-phase / 200 V / 50 Hz and 3-phase / 200 / 230 V / 60 Hz net, the motor after frequency converter must be switched to the YY-Circuit
- The connection of the motor is shown in the *Figure: Connection scheme*. The number of revolutions is adjustable from 1800 to the nominal value (refer to *Table: EDS200 Electrical data*, *Table: EDS300 Electrical data* and *Table: EDS480 Electrical data*). The nominal value cannot be overrun.

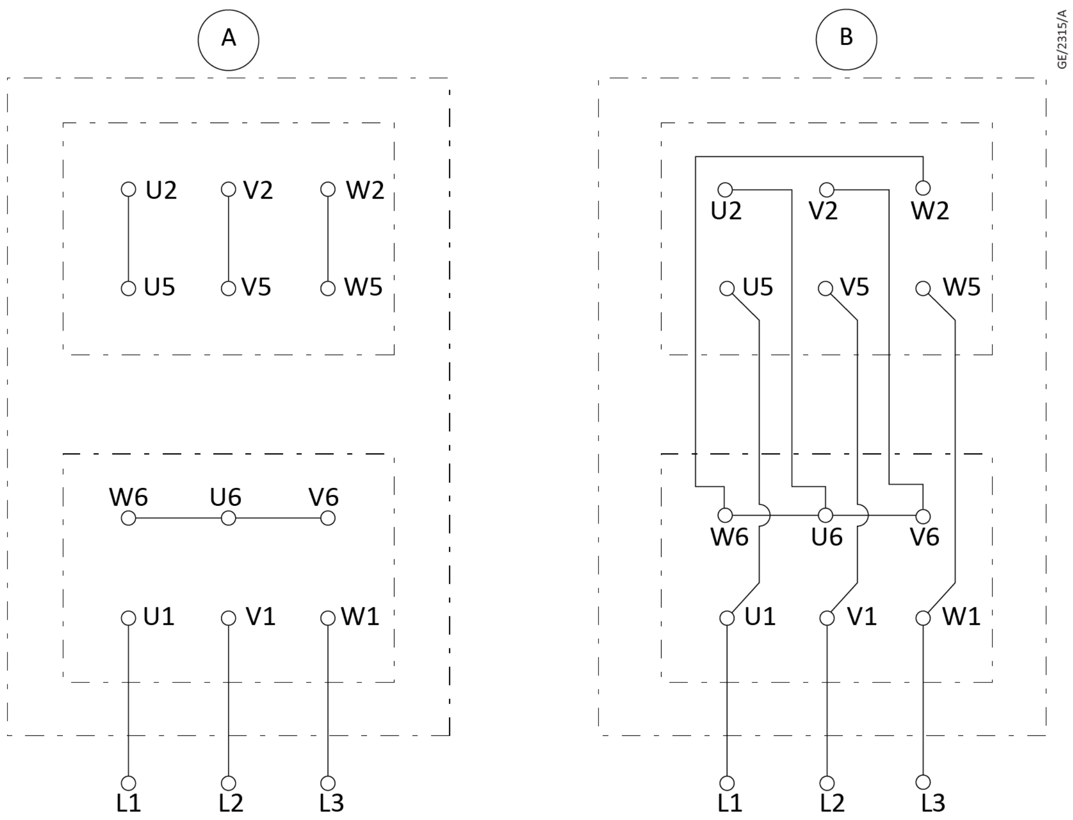
The operation with a frequency converter appear EMI's in a high ratio. The constructor has to observe the guidelines, rules and the given limit values. To reduce the electromagnetic influence use:

- Shielded power supplies
- Shielded cable entrances
- Motor filters
- EMC suitable bonding of the frequency converter and the pump must be mounted.

Note:

Depending on the height and the quality of the voltage of the frequency converter (additional inserted warmth of the motor coil), operating conditions may not occur at the same time as in the normal operation (for example, backpressure and surrounding temperature of 40 °C at maximum load). Because of that, the PTC resistors have to be monitored.

Figure 24 Connection scheme

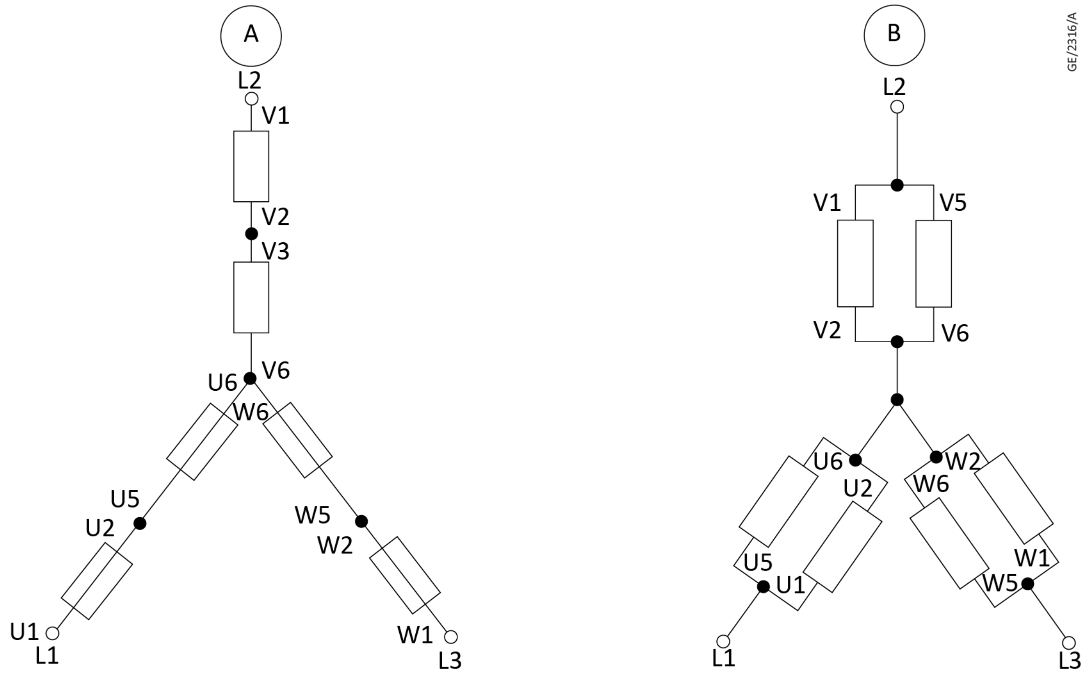


A. Y-Circuit *B. YY-Circuit*

Circuits

The *Figure: Connection at the terminal board* is a simplified additional demonstration for the connection at the terminal board.

Figure 25 Connection at the terminal board



A. Y-Circuit

B. YY-Circuit

6.1.4 Safety device against uncontrolled restart

CAUTION: UNCONTROLLED RESTART

Risk of injury and damage to equipment. After a power failure, the pump will operate without a preventive wiring if the power returns, protect the pump from the uncontrolled restart (for example, by wiring or release mechanisms).

An example for protection against the uncontrolled restart is a release mechanism, it is an optional device integrated into the protective relay of the motor (voltage decrease coil).

6.1.5 Safety device against uncontrolled start in the wrong direction

WARNING: REVERSE ROTATION OF THE PUMP

Risk of injury and damage to equipment. In the case of a power failure, the pump may run in reverse direction. To prevent this, connect the pump to a vacuum chamber and install a valve (for example, an electrical cut off valve) on the side of the feed line to disconnect the feed line from the pump.

6.2 Control circuit operation

6.2.1 Galvanic separation

Galvanic separation of the monitoring from the pump is necessary to protect the monitoring from Electro Magnetic Interference (EMI). This ensures the normal operation of the pumps and the monitoring does not receive wrong values. Avoid dangerous touch voltage and/or destruction of measuring devices by one-sided defects in the insulation.

A consequent galvanic separation results in advancement of the electromagnetic compatibility. The surrounding EMIs cause troubles and waves on cables and measuring lines and it can not pass through the monitoring and measuring devices.

6.2.2 Release of the PTC – monitoring

Release mechanism against improper temperature raising in the motor coils releases: The pump must be switched off and the reason of the release has to be found and corrected by the trained personnel.

Common reasons to release this mechanism are:

- Overload of the motor
- Circuit to a blocked rotor
- Long operation with small overload
- Improper ambient temperature rise
- Fan without function / cover, fan is dirty
- Lubricant too hot
- Abnormality from the nominal voltage / jitter of the frequency
- One phase start-up
- High switching frequency.

6.2.3 Atmosphere Explosible (ATEX)

See the explanations and definitions for the subject ATEX from the respective manual (refer to publication number - A41801880 and A41803880).

6.3 Characteristics of ATEX pumps

WARNING: EXPLOSIVE AREAS

Risk of injury and damage to equipment. If the pumps are operated in explosive areas, the pumps have to be ordered with respective to ATEX design to prevent the danger of accidents and explosion.

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