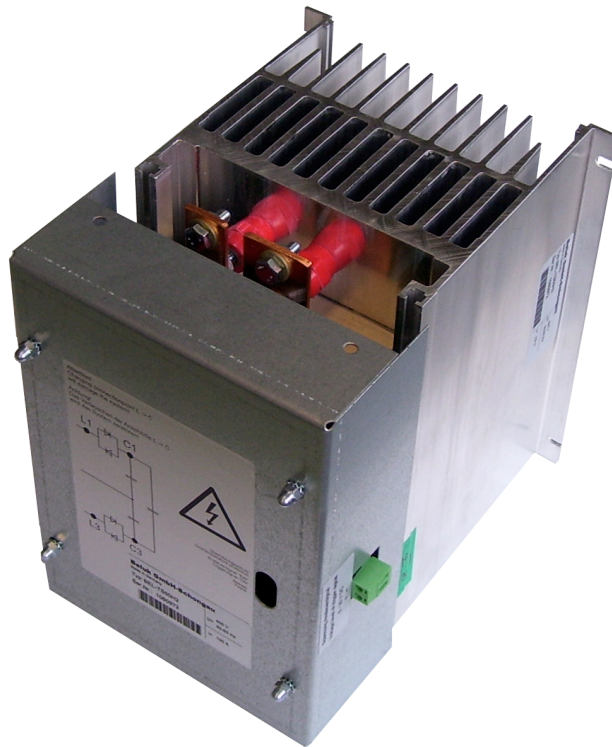


Technical Documentation



Static Contactor BEL-TS xx H2

Rapid switching of capacitors in LV-grid

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Static Contactor for rapid switching of Capacitors in Low Voltage Grids



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1. Important Information

This documentation points to specialists enabling them to select and connect the static contactor BEL-TS as well.

Any application of BEL-TS must comply with national rules any time, even though not specified in this documentation.

Please don't forget the earth-link!

2. Application

Static contactors BEL-TS are used for switching capacitors in 3-phase-systems. In comparison with contactors the static contactor calls special attention to switch in without inrush current, smooth disconnecting procedure and high switching frequency. These characteristics will be guaranteed by firing unit, basic characteristic of thyristors and diodes and Beluk recommendations.

Static contactors BEL-TS are used when rapid, high frequently, switching of capacitors is requested without any disadvantageous reactions.

These demands could appear at following items, especially:

- Windmill Plants
- Lifts and Cranes
- Primary pulsed Welding Plants

3. Components of Static Contactors

Static contactor BEL-TS basically contains components as following:

Thyristors, diodes, heatsink, firing unit

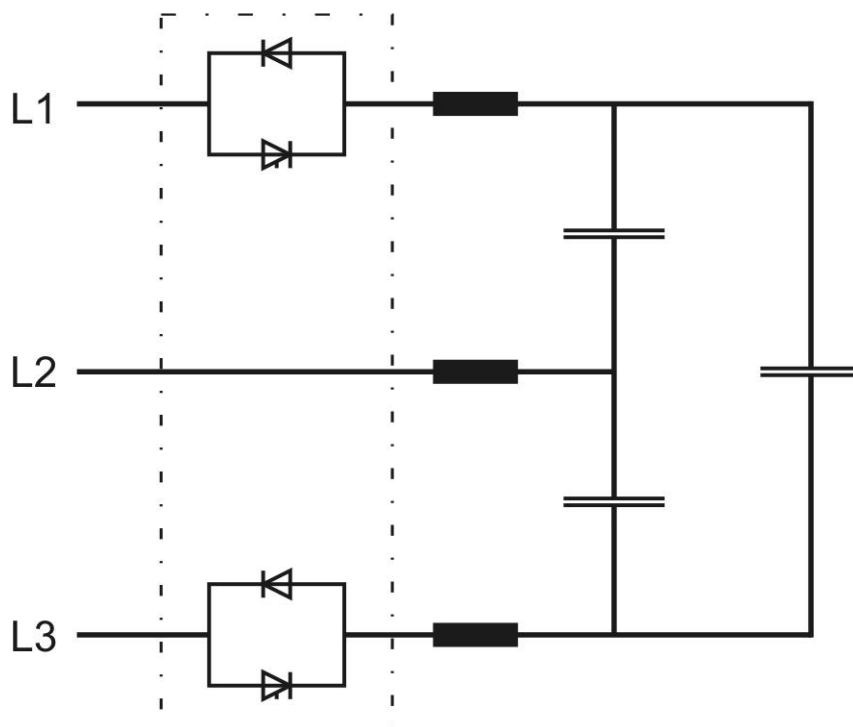
Thyristors are semi-conducting units, which may be controlled by firing impulse at gate from locked into semi-conducting condition. Semi-conduction means current may flow in “one way” direction, from anode to cathode. Thyristors will lock again, if flowing current decreases to zero. To control alternating current, thyristor and diode in antiparallel mode are requested, as provided in BEL-TS. As with all active components on-state voltage and forward slope resistance define power losses between anode and cathode at semi-conductors, finally, which results in heat to be diverted by heatsink.

The firing unit becomes significant; it generates firing impulses to control thyristors into semi-conducting condition. Firing impulses will be started by an external DC-voltage 8 – 30 V. To avoid any inrush currents the impulses will be transmitted to the gate of the thyristor(s) in case of voltage between anode and cathode becomes zero. In switching capacitors this means, that any charge voltage must be synchronous to grid's voltage to avoid any transients during switching procedure.

The max. DC voltage at switched-off capacitors can be upto 150% of peak of mainsvoltage. Due to the continuous DC-voltage of disconnected capacitors to at least peak of mainsvoltage, the discharging devices must be dimensioned correctly. In practical use, this means that discharging reactors are not allowed to be used, because the continuous DC-voltage would destroy them. It is recommended to use discharging resistors, which are dimensioned for a permanent connection to DC-voltage in height of peak voltage of the mainsvoltage. The dimensioning of discharging resistors must be in the way, that the capacitors are discharged after disconnecting the system from mainsvoltage in the necessary time.

4. Switching mode

Static controller BEL-TS may be used in choked capacitor banks and unchoked as well. Please take care that in unchoked capacitor banks maybe thyristors are destroyed by current transients, which are cause by fast changings of the voltage. At choked capacitors banks please take care that the higher currents are not exceeding the max. current of static contactor.





5. Installation of the static contactor BEL-TS

Thyristor switches of type BEL-TS have to be placed in the way, that no danger for people is caused. typically this is achieved by mounting them in a switchboard.

When installing the switches it is to be respected, that in the thyristor losses are generated, which have to be handed out to the environment by the heat sink. In continuous operation temperatures up to 100°C are possible at the heat sink. Because of this the static contactor has to be mounted in the way, that no other components or cables are damaged because of the high temperature. Distances have to be chosen accordingly. Additionally it is prohibited, that connection leads have contact with the heat sink. The insulation can melt and short circuits with extreme high currents can be caused.

Generally static contactors should be mounted in the way, that they don't heat each other. By assembling them vertical it must be ensured, that there can be a vertical airflow through the heat sink.

Additionally the switchboard must be cooled sufficient. The air temperature inside the cabinet must not exceed the limit for the ambient temperature given by the data sheet of the thyristor manufacturer.

For dimensioning the switchboard cooling the power losses of the static contactor can be calculated with the following formula:

$$P_{loss} = (n \cdot I / A \cdot V_T)W$$

n = number of switched phases

I = phase current

V_T = on-state voltage

Examples:

15kVar at 400V	2x22Amps	approx. 40W
25kVar at 400V	2x36Amps	approx. 70W
50kVar at 400V	2x72Amps	approx 130W
75kVar at 400V	2x108Amps	approx. 200W
100kVar at 400V	2x144Amps	approx. 250W

When dimensioning the cabinet cooling also the losses of other components, e.g. chokes or capacitors, have to be included.

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It is advantageous, when the static contactors are mounted in the way, that the heated air can directly exhaust of the cabinet.

5.1 Examples for installations of static contactors

The air flow in the graphics is displayed by arrows.

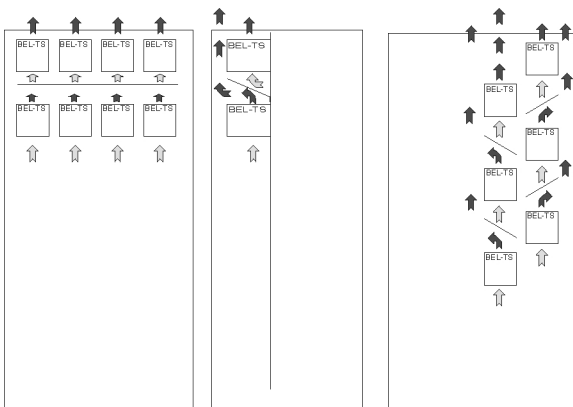


cold air flow with max. 45°C



hot air flow with more than 45°C (temperatures over 100°C are possible!)

Example for correct installation:



For a correct installation please note, that the supply air for the static contactors does not exceed 45°C! Probably discharged air from other components has to be deflected by heat deflectors.

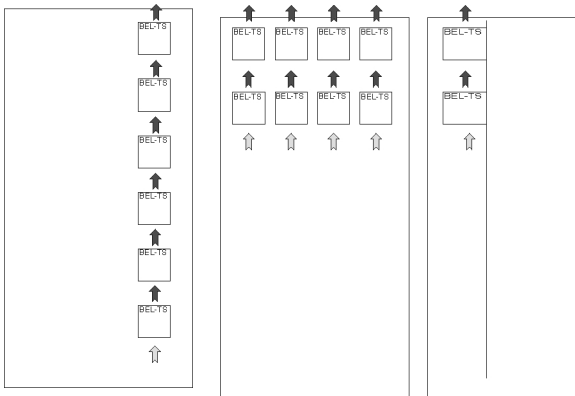
The top side of the cabinet should not be closed, so that the hot air can stream out of the switchboard unhindered.

The bottom side of the cabinet should also have big holes for the cool air supply.

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Examples for wrong installation:

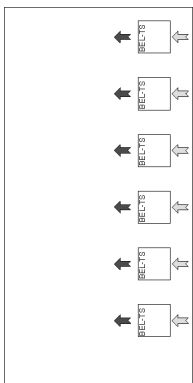
a)



Attention: installation error!

The static contactors are placed in the way, that the cooling air of the bottom switches heats the switches placed above. This causes thermal overload and dependent on the ambient temperature a short- or middle-term demolition of the thyristors can be provoked.

b)

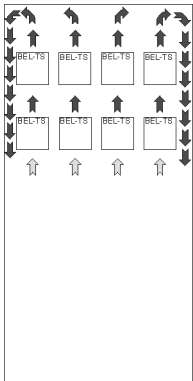


Attention: installation error!

The static contactors are placed in the way, that no vertical air flow is generated. Because of this the cooling capacity of the heat sink is reduced. Despite of the correct ambient temperature the thyristors aren't cooled sufficiently. This causes thermal overload and dependent on the ambient temperature a short- or middle-term demolition of the thyristors can be provoked.

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c)

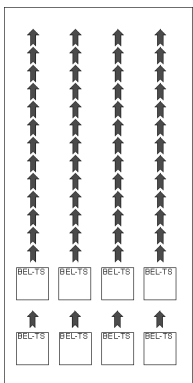


Attention: installation error!

The top side of the switchboard is completely closed. The cooling air accumulates in the top area of the cabinet and heats the complete switchboard.

This causes thermal overload and dependent on the ambient temperature a short- or middle-term demolition of the thyristors and also other components, e.g. capacitors, can be provoked.

d)



Attention: installation error!

The static contactors acting as heat generators are placed in the bottom area of the switchboard. Hot discharged air heats all components in the cabinet.

This causes thermal overload and dependent on the ambient temperature a short- or middle-term demolition of the thyristors and also other components can be provoked.

6. Electrical connection of static contactors

Thyristor switches can't separate electrical circuits. Because of this suitable arrangements for the separation from the power system have to be made. The lines have to be protected regarding the electrical regulations.

In general capacitor switching thyristors are exposed to very hard environmental conditions. Caused by the charge of the capacitors the voltage at the thyristors can reach the double peak mains voltage. Especially for the usage with non-choked capacitors very high currents can occur caused by voltage transients. Furthermore short circuits in the grid are supplied by the discharging currents of the capacitors.

These currents can damage the thyristors!

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Thus it is recommended to protect the static contactors in critical cases with fuses. The referring values for the fuses have to be requested. Please respect that pure semiconductor fuses don't protect the lines. Because of this a combination of fuses for the lines (gL) and for the thyristors (gR) has to be chosen. The usage of fuses type gRL is also possible.

7. Maintenance of static contactors

Generally thyristor switches are maintenance-free. But nevertheless some points have to be respected:

- Thyristor switches , equipped with fan, have to be checked for the correct fan function every 2 years. If a fan is defective, it has to be replaced by the original part. Using another fan with less air flow can cause overheating and this can destroy the thyristors.
- Generally the heat sinks have to be cleaned regularly, because the cooling capacity can be reduced by pollution.
- Pollution between the connections of the thyristors have also to be removed, because of this leakage distances are reduced. This can cause a voltage flashover.



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8. Technical Data

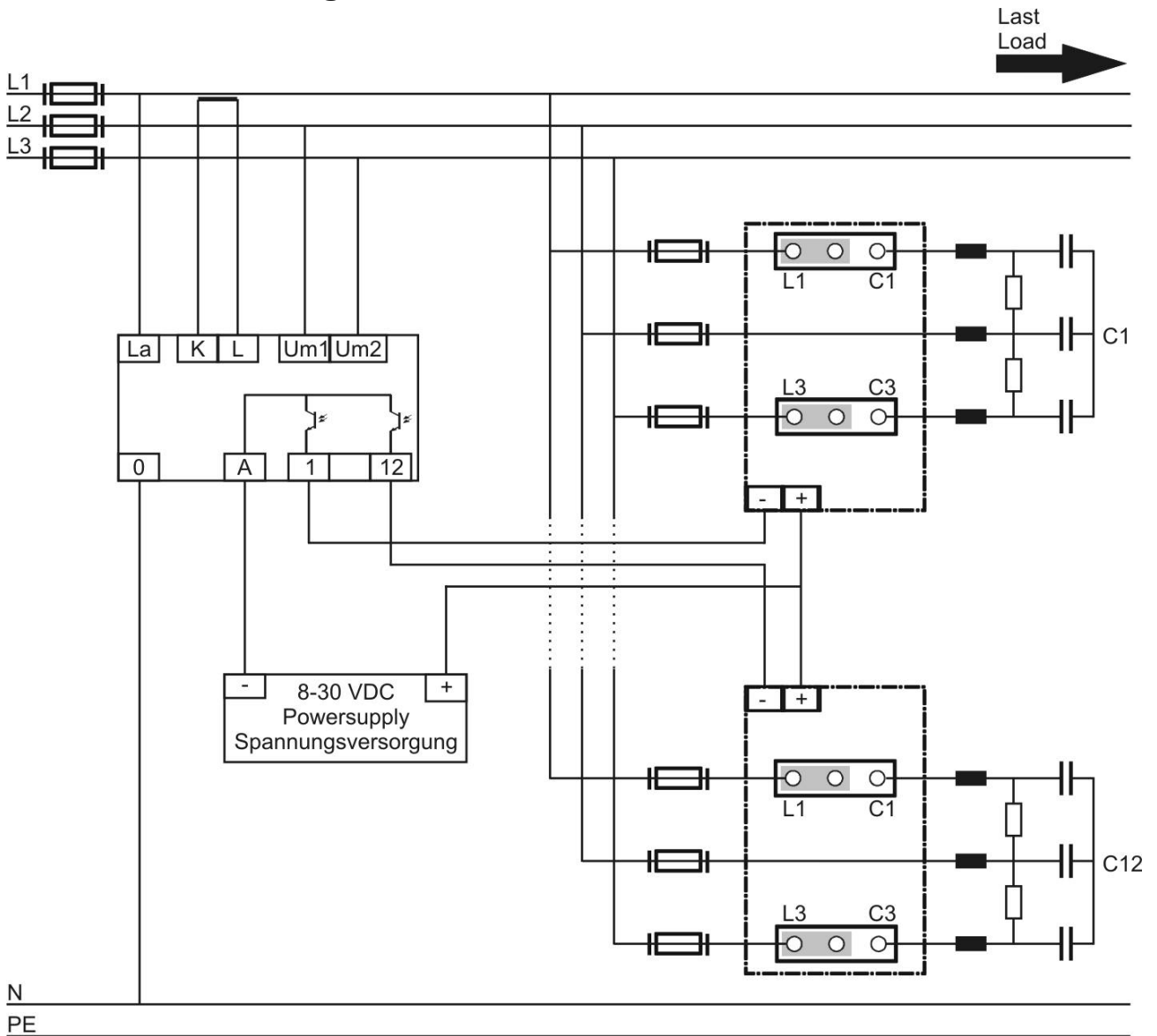
Typ	BEL-TS15H2			BEL-TS25H2			BEL-TS50H2		
Mains voltage / V (+/- 10%)	400	440	480	400	440	480	400	440	480
Nominal current / A	22	20	18	36	33	30	72	66	60
Max. continuous current A	26	26	26	50	50	50	100	100	100
i^2t ($T_{vj}=125^{\circ}C$, 8,3...10ms) / A^2s	1150	1150	8000	3600	3600	8000	15000	15000	10500
V_{RRM} , V_{DRM} / V	1800	1800	2200	1800	1800	2200	1800	1800	2200
Discharge capacitors	Attention: It's not allowed to use discharge reactors. The used discharge resistors have be dimensioned bigger as in applications with contactors.								
Recovery time	Typically 1 period								
Switched phases	2, half controlled								
Supply voltage	From power circuit (optional: separate supply)								
Power consumption supply	max. 9VA								
Voltage trigger signal	8 - 30V DC								
Consumption trigger signal	2mA at 12V DC								
Over temperature protection	N / A			integrated in firing unit					
Dimensions w x d x h / mm	appr. 185 x 202 x 188			appr. 200 x 160 x 215					
Weight	2,9			4,3					
Power losses at nominal current / W	41	37	33	68	61	52	122	111	104
Cooling	AN, air natural								
Protection class	IP 20			IP10					
Humidity	10% - 95% (without moisture condensation)								
Max. altitude	1000m above sea level (operation at higher altitude with reduced power possible)								
Max. ambient temperature	+45°C (operation with nominal power) +65°C (operation with reduced power)								
Min. ambient temperature	-10°C								



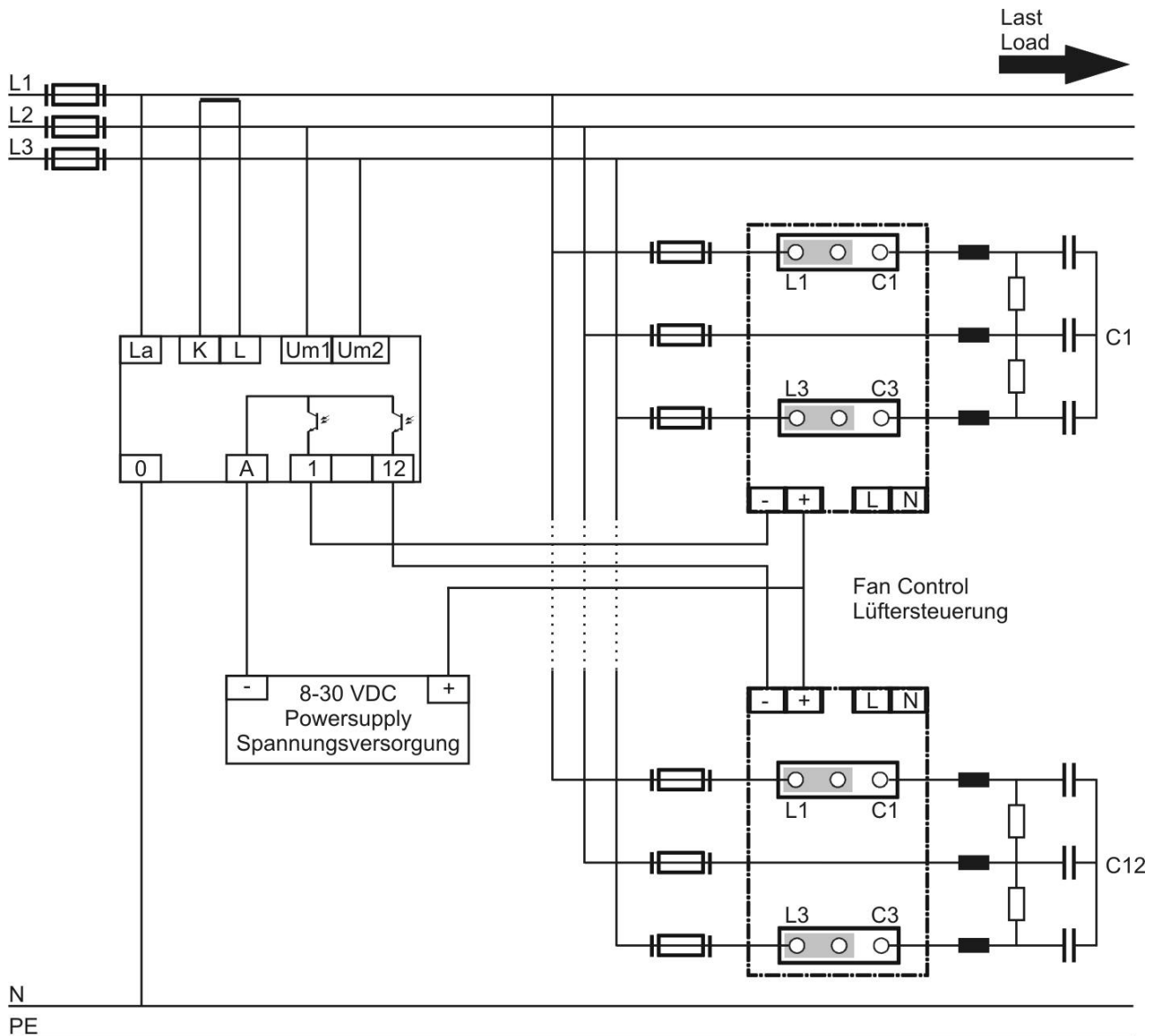
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Typ	BEL-TS75H2			BEL-TS100H2			BEL-TS125H2
Mains voltage / V (+/- 10%)	400	440	480	400	440	480	480
Nominal current / A	109	99	90	144	131	120	150
Max. continuous current A	145	145	145	193	193	170	193
i^2t ($T_{vj}=125^{\circ}C$, 8,3...10ms) / A^2s	15000	15000	10500	125000	125000	72000	115000
V_{RRM} , V_{DRM} / V	1800	1800	2200	1800	1800	2200	2200
Discharge capacitors	Attention: It's not allowed to use discharge reactors. The used discharge resistors have be dimensioned bigger as in applications with contactors.						
Recovery time	Typically 1 period						
Switched phases	2, half controlled						
Supply voltage	From power circuit (optional: separate supply)						
Power consumption supply	max. 9VA						
Voltage trigger signal	8 - 30V DC						
Consumption trigger signal	2mA at 12V DC						
Over temperature protection	integrated in firing unit						
Dimensions w x d x h / mm	appr. 260 x 160 x 215						
Weight	5,6						
Power losses at nominal current / W	205	184	172	250	224	244	261
Cooling	AF, Air forced (Fan control voltage can be select when ordering. Possible is 120V AC respectively 230V AC)						
Protection class	IP10						
Humidity	10% - 95% (without moisture condensation)						
Max. altitude	1000m above sea level (operation at higher altitude with reduced power possible)						
Max. ambient temperature	+45°C (operation with nominal power) +65°C (operation with reduced power)						
Min. ambient temperature	-10°C						

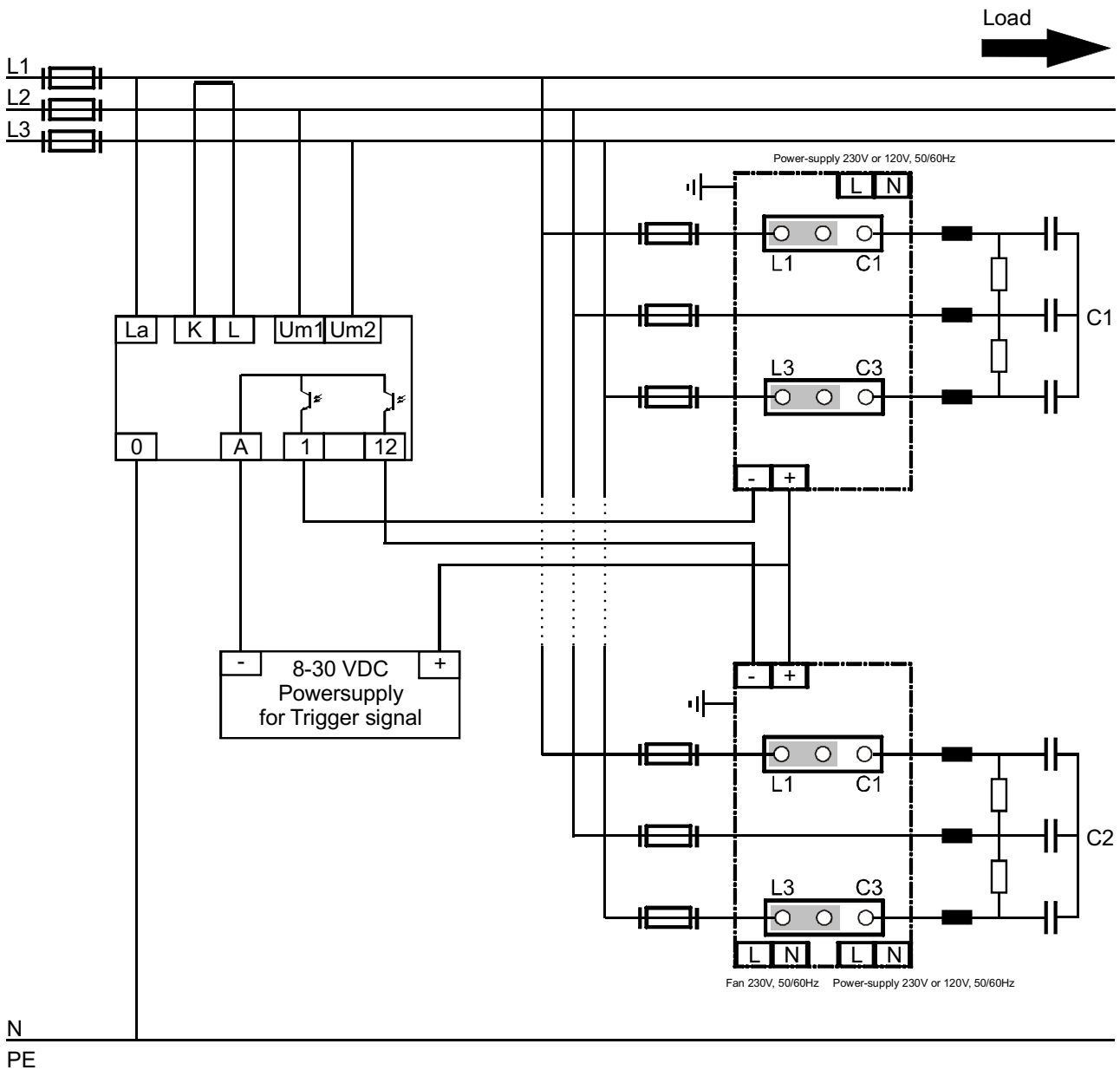
9. Connection diagrams



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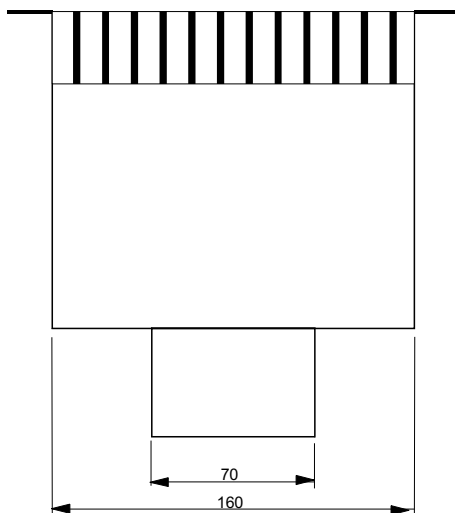
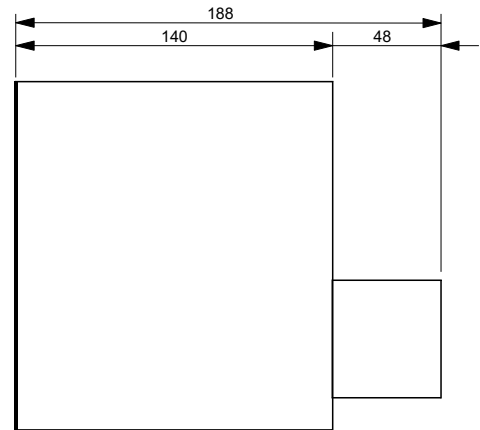
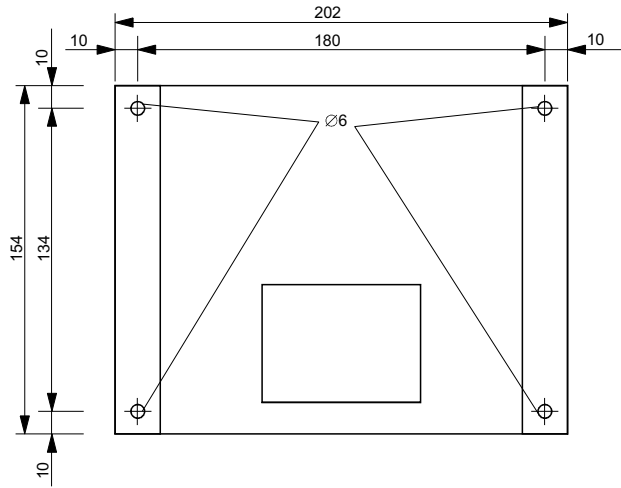


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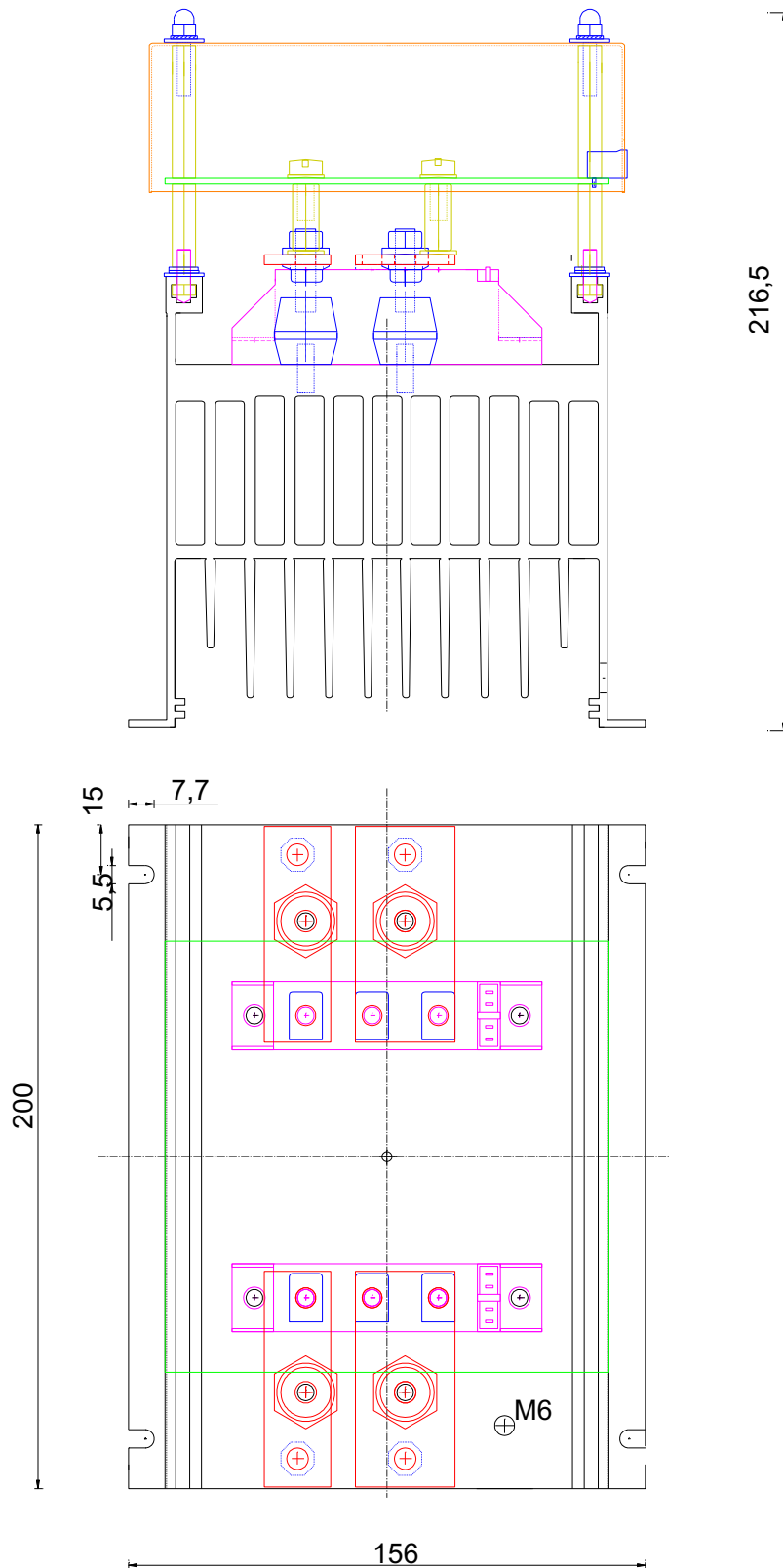
10. Mechanical drawings

BEL-TS15H2



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BEL-TS25H2, BEL-TS50H2



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BEL-TS75H2, BEL-TS100H2

