

Reference Manual



BEL-TS

BELUK Thyristor switches

Fast capacitors switching
in low-voltage grids



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1. Revision history

Date	Name	Revision	Changes
03.01.18	SMi	1.0	First edition
03.05.19	SMi	1.1	New revision numbering and connection schematic, fuse types adapted, installation diagrams renewed, connection diagram renewed, layout changes
08.07.19	SMi	1.2	Specification of the trigger input as "optoelectronic trigger input"



2. Safety notes

The following **safety notes and instruction** have to be read attentively and carefully. Familiarize yourself with the device before installation, commissioning and operation. The following symbols are found in the instruction manual and on the back of the device to indicate hazards and problems or to give specific instructions.

DANGER

DANGER indicates a dangerous situation which cause death or severe injuries if it is not avoided.

WARNING

WARNING indicates a dangerous situation which may cause death or severe injuries if it is not avoided.

CAUTION

CAUTION indicates circumstances which may damage or destroy the device in case of non-observance, but do not cause injuries.

NOTE boxes provide information about the correct operation of the devices. Special features are highlighted and discussed in more detail.



3. Applications

BELUK thyristor switches are designed for fast switching capacitor stages in three-phase power grids. In comparison to power contactors, thyristor switches have several advantages. These advantages primarily result from the elimination of mechanical components and the smart control of the thyristor modules.

Thyristor switches differ from contactors by their very fast switching behavior, which allows a fast reaction to load changes in the millisecond range. Additionally, the pure electrical control of the thyristor modules enables a wear-free switching with low power grid perturbations. This is important to observe the EN 50160 standard for voltage quality in public power grids. The precise determination of the switch-on point and the smooth switch-off process prevent transient current peaks and anticipate commutation dips in the voltage curve. This results in a considerably longer operating time for compensation systems and in a trouble-free power grid operation.

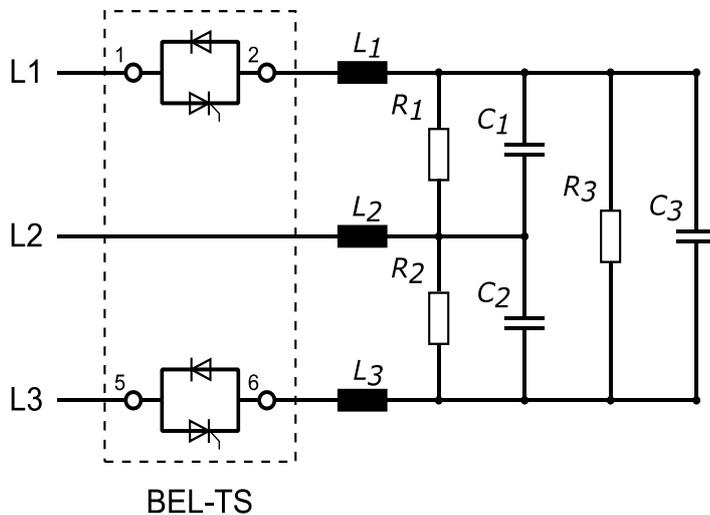
These features are required, for example, in compensation systems which are responsible for the reactive power compensation of **presses, lifts, cranes or welding systems**.

BELUK thyristor switches are suitable for switching detuned and undetuned capacitor stages.

⚠ CAUTION

Please consider that undetuned capacitor banks can destroy the thyristor-diode modules during the on-switching process due to high transient inrush currents.

Example with detuning chokes and discharge resistors:



External components:

- L_1, L_2, L_3 : Chokes (detuning)
- R_1, R_2, R_3 : Discharge resistors
- C_1, C_2, C_3 : Capacitors (compensation)



4. Device setup

4.1 General

BELUK thyristor switches consist of two thyristor-diode modules, a heat sink with or without fan, the electronic control unit and a housing.

4.2 Thyristor-diode module

Thyristors are semiconductor devices which are switched from the blocking state into the conductive state by a firing pulse at the gate. Here, the current can only flow from the anode to the cathode. In order to be able to switch alternating currents, a diode is connected antiparallel to each thyristor (thyristor-diode module). The modules enter the blocking state again when there is no more current flows through the thyristor. In a power grid with a frequency of 50 Hz, this occurs every 10 ms.

4.3 Control unit

The smart control unit applies a signal to the thyristor modules which change from blocking into the conductive state. However, the signal is only applied if an external device, e.g. reactive power controller, enables the firing pulses via the optoelectronic trigger input. In order to prevent transient current surges while switching on, the thyristors are only switched on if the voltage across the thyristor module approaches to zero. At this point, the power grid voltage is equal to the current charging voltage of the capacitor.

In order to protect the thyristor switch against overheating, the heat sink temperature is permanently monitored. If the temperature rises above **85 °C** at the measurement point due to an impermissible overload, the firing pulses are disabled. The thyristor switch does not resume operation, until the temperature at the measurement point drops below **75 °C**.

4.4 Cover

In the top cover of the BELUK thyristor switches, three LEDs provide information about the current state of the device.

-  **Green LED:** Power supply is available. The thyristor switch is ready.
-  **Yellow LED:** An external signal is applied. The firing pulses are enabled and the device switches the capacitor stage.
-  **Red LED:** Overtemperature protection is activated. The device is disabled until it is cooled down again.



5. Commissioning

5.1 Installation

In order to avoid danger to persons, it is recommended to mount the devices into a switch cabinet. The thyristor switches are mounted at the heat sink base.

During operation, the modules generate heat which is dissipated to the environment by the heat sink. This must be taken into account when dimensioning the control cabinet.

NOTE: During the continuous operation, a temperature of up to 100 °C is possible at the heat sink.

The thyristor switch must be mounted in a way that the dissipated heat does not affect or damage any surrounding components or wiring. For this reason, distances must be sufficiently dimensioned.

When installing several thyristor switches into a switch cabinet, it must be ensured that the devices do not heat up each other. Furthermore, it is important to align the devices in a way that a vertical air flow is possible through the cooling fins. With regard to devices which come with a fan, the fan must be pointing downwards. Moreover, a sufficient cooling of the cabinet must be ensured.

NOTE: When dimensioning the control cabinet, the power dissipation of the thyristor switches and all installed components, like chokes or capacitors, must be taken into account. The power loss specification of the available thyristor types can be found in the data sheet.

Installation examples:

When mounting the thyristor switches, it is important that the hot air can exit the control cabinet. In the following diagrams, the air flow is illustrated by colored arrows.

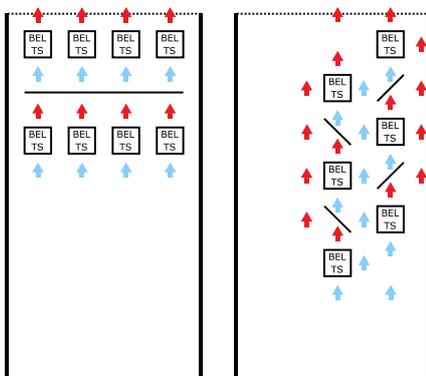


cold air flow with **max. 45 °C**



hot air flow with **more than 45 °C**

Example of a correct installation:



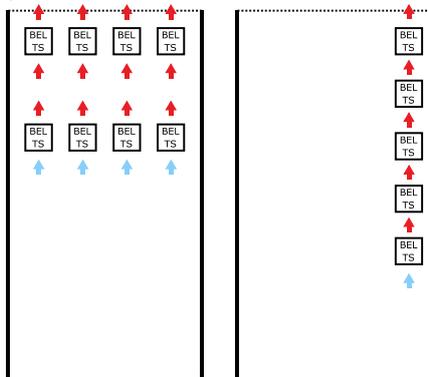
Please note that the supply air of the thyristor switches **must not exceed a temperature of 45 °C** in order to guarantee a continuous operation. Probably, the dissipated air from other components has to be deflected by heat deflectors.

The top side of the cabinet should not be closed in order to enable a direct dissipation of the hot air. The bottom side of the cabinet should also have big slots for a cool air supply. It could be necessary to mount the cabinet on a pedestal.



Examples of wrong installations:

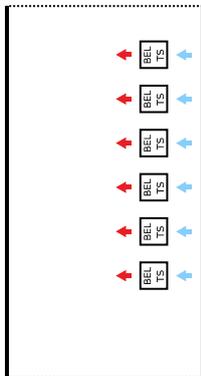
a)



Caution: installation error!

The thyristor switches are placed in a way that the hot exhaust air of the lower devices heat up the upper thyristor switches.

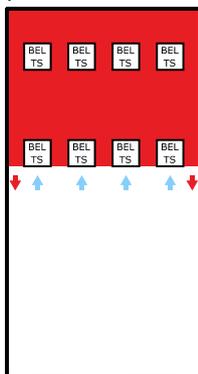
b)



Caution: installation error!

The thyristor switches are placed in a way that the air flow is horizontal instead of vertical. Therefore, the cooling capability of the heat sink is significantly reduced. Despite of the correct ambient temperature, the thyristor-diode modules will not be sufficiently cooled.

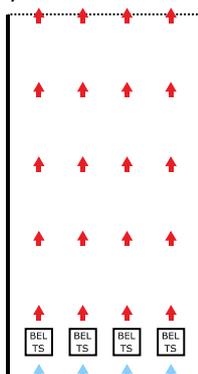
c)



Caution: installation error!

The top side of the cabinet is completely closed. The hot dissipated air accumulates in the top area of the cabinet and heats up the whole cabinet.

d)



Caution: installation error!

Placing the thyristor switches at the bottom of the cabinet, the dissipated heat increases the temperature of the whole cabinet.



5.2 Wiring

Danger

Installation, commissioning and maintenance may only be carried out by a qualified electrician. An electrician is a person who has the ability, experience and knowledge necessary for the construction, installation and operation of electrical devices and systems and who has been instructed in the identification and avoidance of possible hazards.

During installation, the relevant regulations for the installation of switchgear and for accident prevention must be observed. Devices with damaged or open housings or terminals must not be operated on the power grid and must be disconnected immediately.

In order to illustrate the electrical installation of the devices, various connection diagrams are provided in Chapter 8.

After installing the thyristor switch into a control cabinet, the grounding cable has to be connected to the intended grounding screw.

The respective phases must be connected to terminals L1 and L3. The switched outputs of the device, C1 and C3, must be connected to the detuned or undetuned capacitor stages.

CAUTION

The capacitors are charged to the power grids peak voltage when they are switched off. For this reason, **special discharge resistors**, which are designed for this permanent DC voltage, must be used. **Discharge chokes** must not be used in this application.

Designing the discharge circuit, the legally determined discharge times must be observed after the entire system has been disconnected. In order to ensure a correct design, the required information must be obtained from the manufacturer of the capacitors.

The control terminal (trigger signal) of the device must be connected to a reactive power controller. A positive signal in the range of 8 V - 30 V DC enables the thyristor switch.

Using thyristor switches with fan, a fan voltage of 115 V AC (option **C**) or 230 V AC (option **B**) must be provided, depending on the thyristor type.

There are also thyristor types available which require a separate power supply. These devices must be connected to a 115 V AC (option **C**) or 230 V AC (option **B**) power supply, using the respective terminals.

Thyristor switches **cannot disconnect circuits**. For this reason, precautions are necessary to allow the separation from the power grid.

Moreover, the cables must be **protected in accordance with the applicable regulations**. It is important to note that semiconductor fuses do not provide a cable protection. Thus, fuses for the line protection (**gG**) and fuses for the protection of the thyristor-diode modules (**gR**) are required. However, fuses of the type **gS** can also be used. When selecting the fuses, the current integrals (i^2t), specified in the data sheet of the thyristor-diode modules, must be taken into account.



6. Maintenance

Generally, thyristor switches are maintenance-free. Nevertheless, some points have to be taken into account to ensure the long-term operation of the devices.

- Thyristor switches, equipped with a **fan**, have to be checked **every 2 years**. If the fan is **defective**, it has to be **replaced** by an **original part**!
- The heat sink has to be cleaned regularly, since the cooling capability could be reduced by pollution.
- Pollution between the connectors of thyristor-diode modules must be removed as well, otherwise the creepage distances can be reduced.

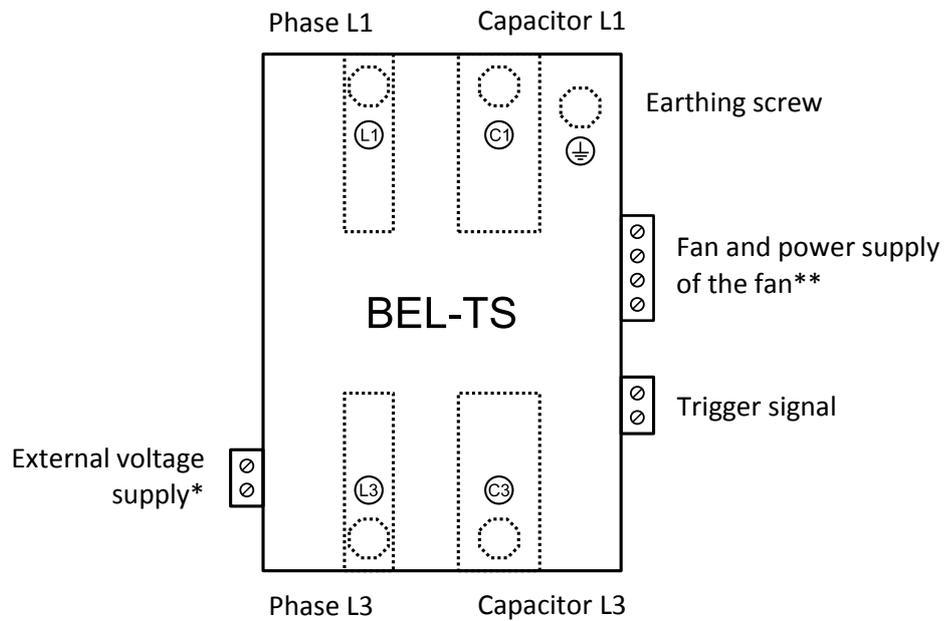
7. Technical specifications

Technical specifications and information about all BELUK thyristor switches are available in a separate document, which can be found at <https://beluk.de>.



8. Appendix

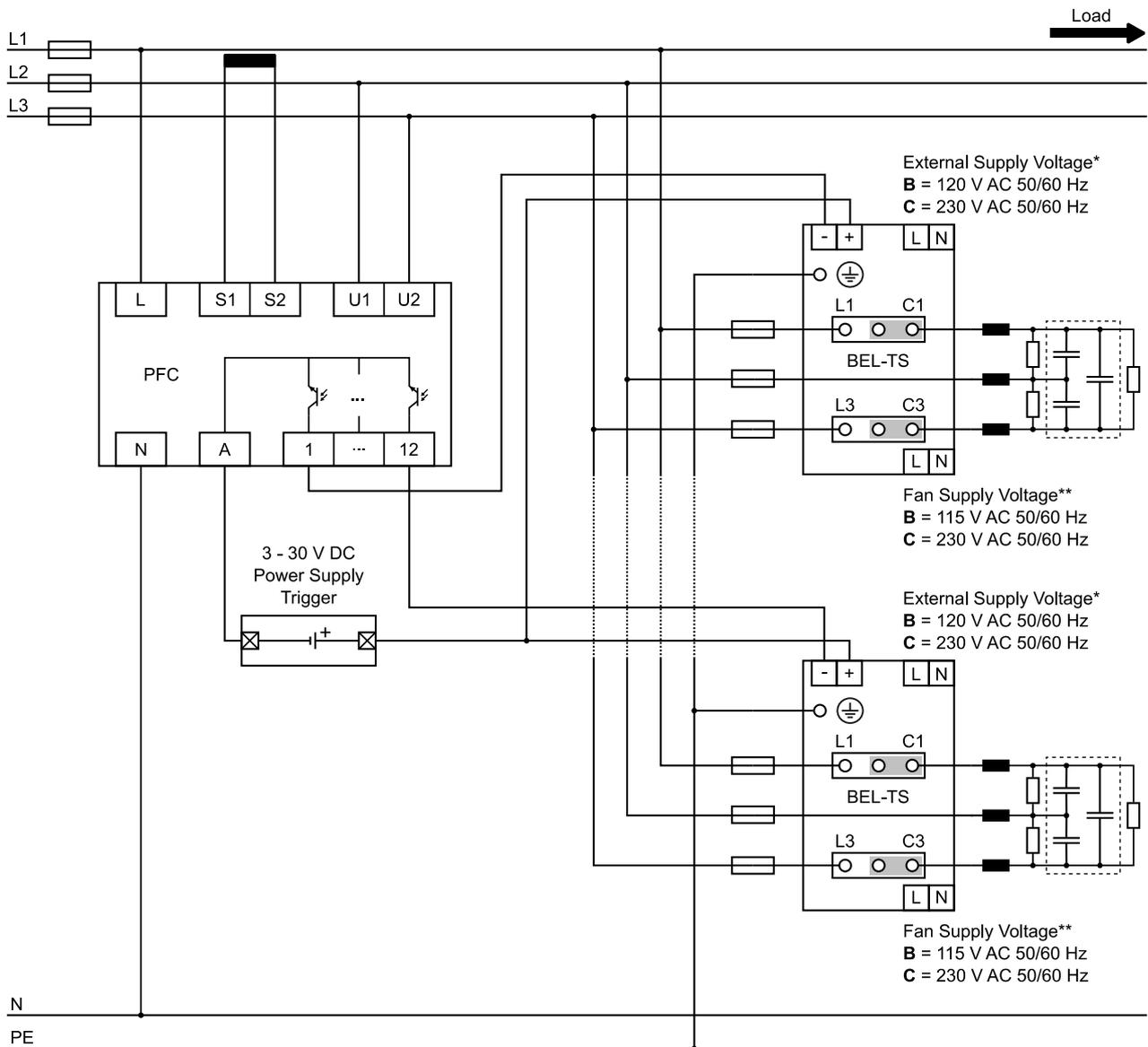
8.1 Connections



* Depends on the thyristor type. This connector is only available on devices with an external power supply.

** Depends on the thyristor type. This connector is only available on devices with a fan.

8.2 Schematic



* Depends on the thyristor type. Using BELUK Thyristor switches, which require an external power supply, connecting a power supply to the respective pins **L** and **N** is mandatory.

** Depends on the thyristor type. Using BELUK Thyristor switches, which come with a fan, the fan's power supply must be connected at the respective pins **L** and **N**.