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# TSM-LC THYRISTOR MODULES — INSTALLATION AND MAINTENANCE

Electronic capacitor switch for dynamic PFC, 10 to 200 kvar

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$\approx 5$  ms

switching time, without transients

10 – 200 kvar

capacitive loads per module

380 – 400 V

net voltage, 50/60 Hz

10 – 24 V DC

trigger signal, galvanically uncoupled

## 1 B44066T\*\*\*\*E402 · Version 4 · September 2013 WHAT THE TSM-LC IS

The TSM-LC series for dynamic PFC are fast, electronically controlled, self-observing thyristor switches for capacitive loads. They switch PFC capacitors within a few milliseconds, as often and as long as required, and replace the contactor in a dynamic (“real time”) compensation step. Triggering can come from a dynamic power factor controller, a PLC, or directly from the installation with an adequate control signal.

### Applications – fast, highly fluctuating loads

 Pressing

 Elevators

 Wind turbines

 Welding machines

 Cranes

 Any fast changing load

## ✓ Features

- Component for the design of dynamic PFC systems in 380 V and 400 V grids (50/60 Hz)
- Automatically adapted by microprocessor to detuned and conventional capacitor branches (up to 14 %) – optimised switching behaviour
- Available for capacitive loads from 10 to 200 kvar
- Monitoring of voltage, phase sequence and temperature; status LEDs
- Switching without time lag; no system perturbation (no transients); no noise during switching
- TSM-LC100 and TSM-LC200: auxiliary voltage 230 V AC needed for the fan
- Maintenance-free, long operational life, compact design ready for connection



### For your safety

Disregarding the guidelines in this manual can result in operational failure, bursting and fire. Ensure you are using the correct module type for your application; thyristor modules must not be installed or used in case of mechanical or any other kind of damage. Do not use or store them in a corrosive atmosphere (chloride or sulfide gas, acid, alkali, salt); in dusty environments regular cleaning is required. Only flame-retardant, self-extinguishing materials may be used near capacitor switching devices.

## 2 INSTALLATION AND CONNECTION

1

Mount the module directly on a mounting plate, vertical, with at least 100 mm free space above and below and 50 mm on the left and right.

2

The main terminals are bus bars or terminal clamps: connect them directly to the branch fuse and to the capacitor (pictures 1 – 3).

3

**Use superfast electronic fuses as branch fuses** to protect the semiconductor – this is mandatory, and the basics of dimensioning must be obeyed.

4

Feed the trigger signal (10 – 24 V DC from a dynamic PF controller or an adequate control system) into the input-signal terminal. Triggering acts without delay.

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If a larger stage output is needed, several modules can be cascaded.

## What the steps above connect to – TSM-LC50



The exploded view above is an illustration prepared for this edition, not a manufacturer's service drawing; the numbers belong to the illustration and are not manufacturer part numbers. 1 Ventilated front cover · 2 Control and gate-drive circuit board · 3 Low-voltage control connector · 4 Status indicator LEDs · 5 Two AC thyristor switching branches · 6 Four separate power terminals / busbars · 7 Thermal interface · 8 Finned heat sink and mounting support. It does not replace pictures 1 – 3 of the manual: the main terminals of step 2 are item 6, the trigger signal of step 4 enters at item 3, and the heat sink of item 8 is what the free space above and below the module serves. The exterior is taken from a photograph of a TSM-LC whose power suffix is not visible, and the same illustration stands for the 25 and 50 kvar modules. Illustrative exploded view; not to scale. Catalog dimensions and identity limitations are listed separately. Internal geometry and OEM subcomponent part numbers are unverified.

## 3 DISCHARGE RESISTORS AND CURRENT-LIMITATION REACTORS

### Fast discharge resistors EW-22

If a fast re-switching time of the capacitors is required, the fast discharge resistors EW-22 (ordering code B44066T0022E400) have to be used – at least one per step for all TSM-LC types.

| MODULE                       | EW-22 NEEDED                 |
|------------------------------|------------------------------|
| TSM-LC-I (single-phase)      | standard resistor sufficient |
| TSM-LC10, TSM-LC25, TSM-LC50 | 1                            |
| TSM-LC100                    | 1 – 2 in parallel            |
| TSM-LC200                    | 2 – 4 in parallel            |

### PFC systems without detuning reactors

Current limitation reactors of the BD series have to be used, two units per step. The TSM-LC200 is only suitable for detuned systems, so it needs no current limitation reactor.

| MODULE             | BD REACTORS                 | ORDERING CODE   |
|--------------------|-----------------------------|-----------------|
| TSM-LC-I           | 1 × BD-100                  | B44066T0100E400 |
| TSM-LC10 / 25 / 50 | 2 × BD-100                  | B44066T0100E400 |
| TSM-LC100          | 2 × BD-200                  | B44066T0200E400 |
| TSM-LC200          | none (detuned systems only) | —               |

## 4 PUTTING INTO OPERATION

After switching on the voltage (engaging the branch fuse) the module is ready for operation. When the voltage is switched on for the first time, the internal processor optimises the switching behaviour to the connected steps (with or without reactors) and stores these parameters internally, giving optimised switching times later.

## Status LEDs, per phase

 standby

 module on

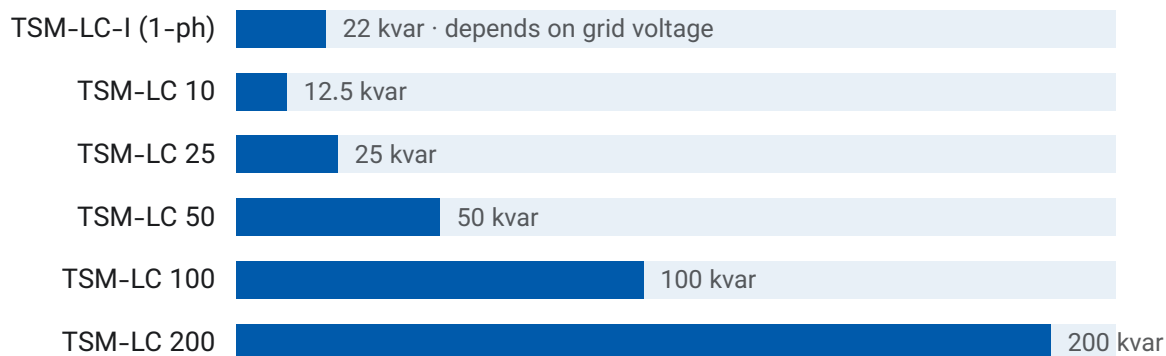
 under-voltage

 phase missing

 over-temperature  
varies with the type of switch

## 5 TECHNICAL DATA

### Maximum power per module type



|                      |                                                                                                                    |
|----------------------|--------------------------------------------------------------------------------------------------------------------|
| Net voltage          | 380 ... 400 V (50/60 Hz); TSM-LC-I (single-phase): 230 ... 525 V                                                   |
| Auxiliary supply     | TSM-LC-I: 24 V DC; TSM-LC100 and TSM-LC200: 230 V AC                                                               |
| Max. voltage allowed | conventional PFC (without reactors): 440 V · detuning 7 %: max. 440 V (no upward tolerance) · detuning 14 %: 400 V |
| Max. current         | depends on cooling and location of the system — in doubt, contact the regional sales representative                |
| Activation           | 10 ... 24 V DC (approx. 20 mA) via terminal clamp, internally galvanically uncoupled                               |
| Switching time       | approx. 5 ms                                                                                                       |
| Re-switching time    | depends on the degree of detuning and the capacitor's discharge resistor                                           |
| Display              | 2 LEDs per phase: operation / error plus triggering signal                                                         |
| Monitoring           | permanent monitoring of net voltage, phase, temperature and operation status                                       |
| Main circuit         | direct connection, 4-pole via bus bar / terminal clamps (TSM-LC-I: 2-pole, single-phase switching)                 |
| Power dissipation    | $P_v (W) = 2.0 \times I (A)$ ; at 400 V / 50 kvar approx. 150 W                                                    |
| Mounting position    | vertical; min. 100 mm upwards and downwards, min. 50 mm right and left; direct mounting on the plate               |

|                               |                                  |
|-------------------------------|----------------------------------|
| Operating ambient temperature | –10 °C ... 55 °C at nominal load |
|-------------------------------|----------------------------------|

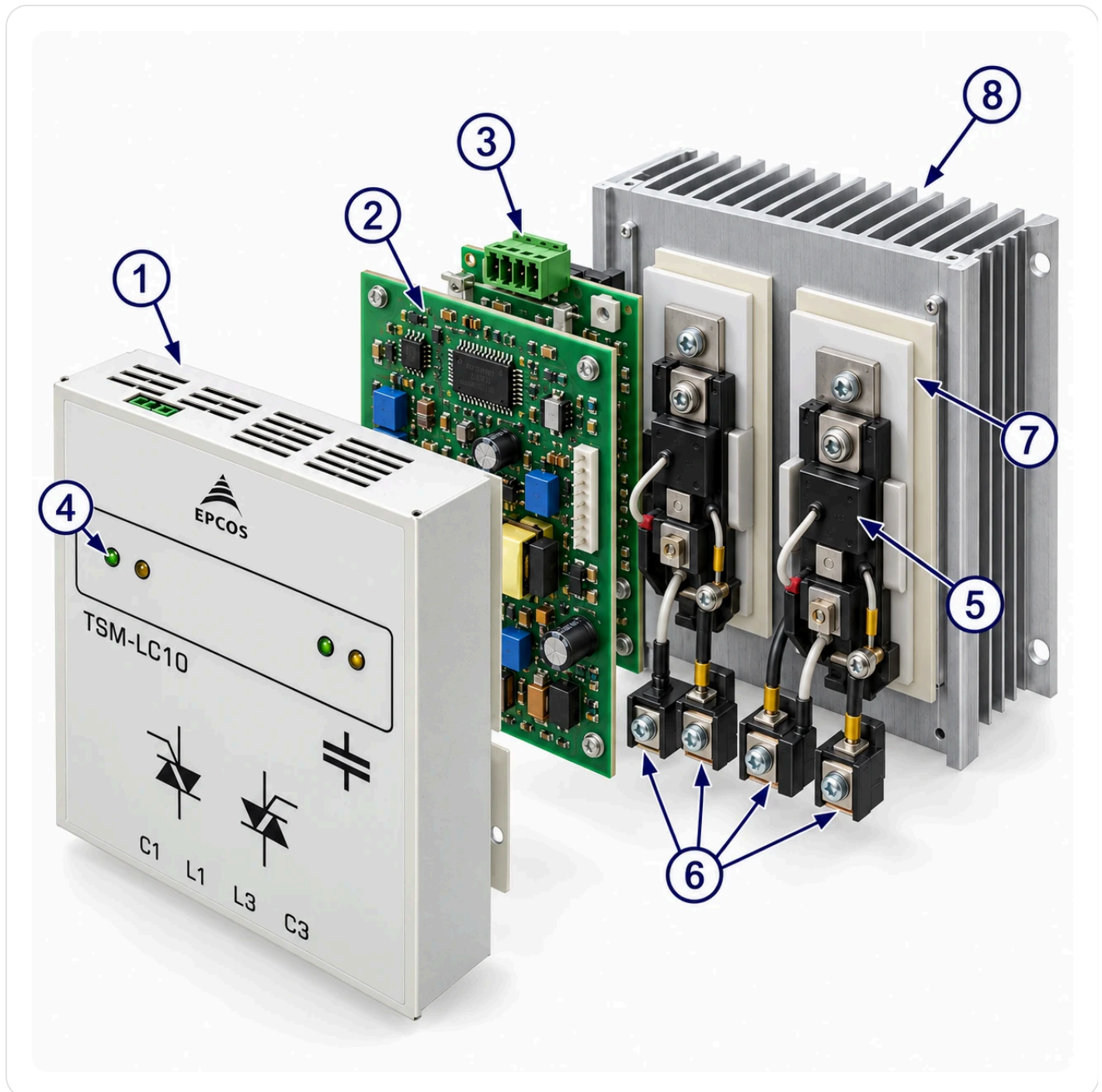
#### Fuses — 3 × electronic “superfast”

| MODULE   | FUSE                   |
|----------|------------------------|
| TSM-LC-I | 63 A (NH00, AC 690 V)  |
| 10 kvar  | 35 A (NH00, AC 690 V)  |
| 25 kvar  | 63 A (NH00, AC 690 V)  |
| 50 kvar  | 125 A (NH00, AC 690 V) |
| 100 kvar | 250 A (NH1, AC 690 V)  |
| 200 kvar | 450 A (NH2, AC 690 V)  |

#### Dimensions and weight

| MODULE        | W × H × D (MM)  | WEIGHT  |
|---------------|-----------------|---------|
| TSM-LC-I      | 70 × 200 × 150  | 1.5 kg  |
| TSM-LC10      | 163 × 152 × 75  | 1.75 kg |
| TSM-LC25 / 50 | 157 × 200 × 180 | 4.8 kg  |
| TSM-LC100     | 157 × 240 × 195 | 5.5 kg  |
| TSM-LC200     | 250 × 480 × 160 | 11.5 kg |

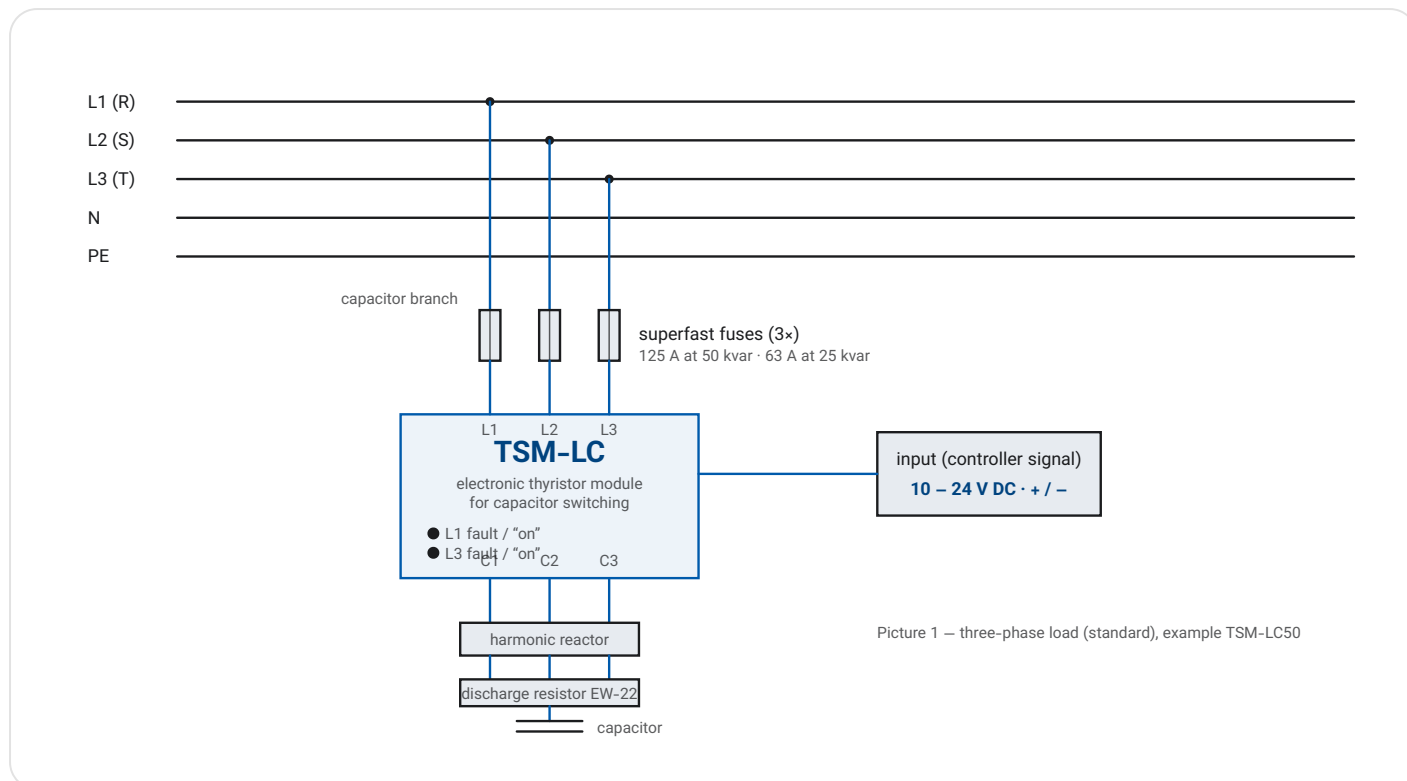
## TSM-LC10 — the same construction in the smallest frame



The exploded view above is an illustration prepared for this edition, not a manufacturer's service drawing; the numbers belong to the illustration and are not manufacturer part numbers. 1 Ventilated front cover · 2 Control and gate-drive circuit board · 3 Low-voltage control connector · 4 Status indicator LEDs · 5 Two AC thyristor switching branches · 6 Four separate power terminal clamps · 7 Thermal interface · 8 Finned heat sink and mounting support. The exterior is taken from a photograph of a legacy TSM-LC10, the 163 × 152 × 75 mm frame of the table above; in the smallest module the four power connections are terminal clamps rather than busbars. Illustrative exploded view; not to scale. Catalog dimensions and identity limitations are listed separately. Internal geometry and OEM subcomponent part numbers are unverified.

## 6 CONNECTING DIAGRAM

Picture 1 – three-phase load (standard), example TSM-LC50



Picture 2 of the manual is the connecting diagram for a two-phase load (e.g. single-phase welding machines), with fuses in each phase (4 pcs.), two single-phase capacitors of 25 kvar each, and the note that the standard discharge resistors are sufficient (special resistors EW 22 not required). Picture 3 shows single-phase switching with the new TSM-LC-I (standard connection), load line to line: max. capacitive power 10 kvar at 230 V, 16 kvar at 400 V, 18 kvar at 440 V, 20 kvar at 480 V and 22 kvar at 525 V (110 V on request); dimensions 200 × 70 × 140 mm (H × W × D).

## 7 SAFETY, MAINTENANCE AND NOTES

### ⚡ General

- The TSM-LC thyristor modules may only be used according to their intended utilisation and only in combination with appropriate safety devices (e.g. superfast fuses).
- Install them so that no uncontrolled high currents and voltages can occur in case of faults; in critical networks install surge arresters or

other protection externally.

- Protect the devices against humidity and dust and assure sufficient ventilation.
- Connect them to the grid only if any possible harm or danger to human beings or the PFC system is eliminated.



**Special note – capacitors stay charged**

Because of the switching principle, the power capacitors are permanently loaded to the peak value of the grid voltage (DC) even when switched off. Therefore: use 440 V capacitors in standard systems (without reactors) and 525 V capacitors in detuned systems; replace the standard discharge resistors by the special EW-22 type ( $2 \times$  peak value of nominal voltage occurs); never use fast discharge reactors in dynamic systems (a reactor is a DC short circuit); in systems without reactors two BD100 current-limiting reactors per module are mandatory; protect the modules with superfast electronic fuses marked as such – never replace them with standard fuses; guarantee protection against contact and put up warning signs, because no electrical isolation exists in the switched-off state and parts may not be touched until the capacitors are completely discharged.



## **Maintenance, repair**

Deactivate the TSM switch and release the main circuit breaker; make sure the TSM cannot be switched on during maintenance and check that there is no voltage at all. Maintenance is for specially skilled personnel only; repairs only by the manufacturer of the TSM-LC module. Failure to follow the cautions may result, worst case, in premature failures or physical injury.



## **Important notes (EPCOS)**

- Statements about the suitability of products for certain applications are based on typical requirements and are not binding; the customer must check whether a product is suitable for the particular application.
- A malfunction or failure of electronic components before the end of their usual service life cannot be completely ruled out; applications with a very high level of operational safety need protective circuitry or redundancy.

- Warnings, cautions and product-specific notes must be observed; some products may contain substances subject to restrictions (see the Material Data Sheets); products and specifications may change – check before ordering.
- Orders are subject to the “General Terms of Delivery for Products and Services in the Electrical Industry” (ZVEI) unless agreed otherwise. EPCOS, MKK, PhaseCap, PhiCap and the other names listed are registered trademarks.

① This page is a re-typeset edition of the original document; where they differ, the manufacturer's file prevails. For technical questions,



## SABA KHAZEN MANUFACTURING & INDUSTRIAL CO.

Saba Khazen Industrial Company, established in 1994, is the first and only manufacturer of gas capacitors MKK and resin capacitors MKP under Siemens Germany license in Iran. With the slogan of superior quality and customer satisfaction, the company provides regular after-sales services. It is also the official representative of EPCOS and BELUK Germany, offering a wide range of power factor correction equipment and harmonic elimination solutions to industries.

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