



## **Film Capacitors – Power Factor Correction**

### **Installation and maintenance instructions for PFC capacitors 44**

|                     |                                         |
|---------------------|-----------------------------------------|
| <b>Series/Type:</b> | <b>SCap series with sigut terminals</b> |
| <b>Date:</b>        | <b>July 2024</b>                        |
| <b>Version:</b>     | <b>1</b>                                |

Inspection of material before Unboxing the capacitors:

**1. Box position upside indicator logo –**

All the boxes are placed as per upside position marked on box.

**2. Maximum stack logo –**

Stacking limit is defined as  $N$  = Number of boxes to be stacked.

**3. Fragile logo –**

Indicates that material packed inside the box is fragile, handle it very carefully. If not handled carefully, capacitors may get damaged / dented.

**4. Moisture protection logo –**

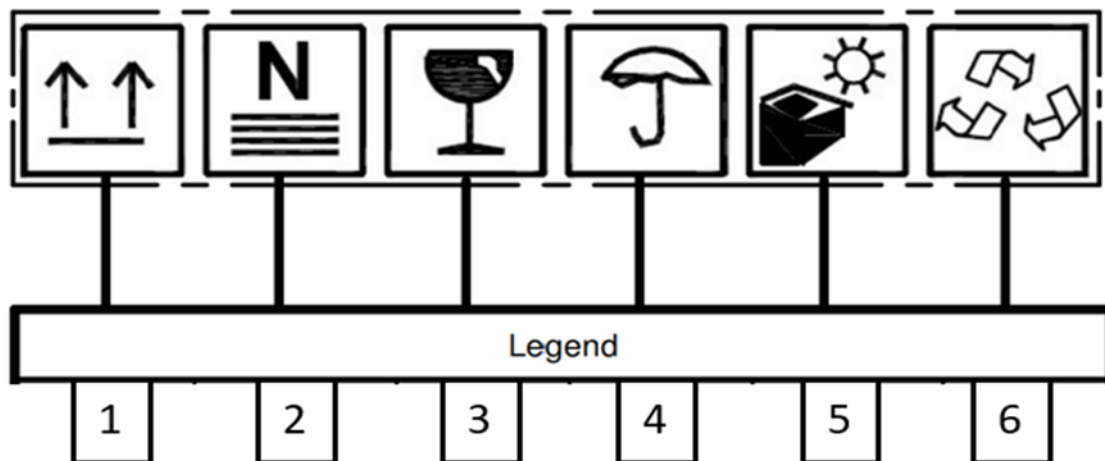
Indicates that material should be protected from external moisture / water spillage / chemical spillage / any kind of liquid material spillage externally.

**5. High temperature protection logo –**

Protect the material from high temperature.

**6. Recycle logo –**

Indicates that packing material is recyclable.



Once this inspection is completed, capacitors to be inspected visually for any kind of dents, damages, broken resistor, missing accessories like Nut & Washer pouches, Discharge resistor supplied separately in pouch.

Against any of such non-conformity, please inform factory through Sales / CSS – Central Service Station.

**Read this first!**

Read the following »Installation and Maintenance Instructions« carefully before installing a capacitor into your application.

**About this manual**

The information stated in this manual applies to typical, approved usage. Please refer to our product specifications, or request our approval for your own individual specifications, before installing capacitors.

**For your safety!**

Disregarding the guidelines in this manual can result in operational failure, bursting and fire. In case of doubt, contact your local sales organization or distributor for assistance.

**General safety notes for installation and operation**

- Ensure you are using the right capacitor type for your application. Please refer to the product catalog and application notes for proper selection of capacitors. Please contact ABB for any assistance required in selection.
- Maintain good, effective grounding of capacitor enclosures.
- Ensure that any faulty units/banks in the system can be isolated.
- Handle capacitor units carefully, as they may be charged even after disconnection due to faulty discharging devices.
- Follow appropriate engineering practices.
- Do not use HRC fuses to power the capacitor up and down (as this could lead to the risk of electrical arcing!).
- Consider capacitor terminals, connected bus bars and cables, and any other devices connected with them, as being energized. The device is electrically charged!

**Storage and operation conditions**

Do not use or store capacitors in a corrosive atmosphere, especially where chloride gas, sulfide gas, acid, alkali, salt, or similar substances are present. In a dusty environment, regular maintenance, and cleaning, especially of the terminals, is required to avoid a conductive path between phases and/or phases and ground.

**Ambient temperature**

The ambient temperature category for most standard capacitors types is –25/D. This means a maximum temperature of 55 °C, an average temperature over 24 hours of 45 °C, and an average temperature in one year not exceeding 35 °C. The maximum casing temperature of 60 °C must not be exceeded. Temperature is one of the main stress factors for polypropylene type capacitors and has a major influence on their useful life expectancy.

**Caution!**

Exceeding the maximum allowed temperature may set the safety device out of operation.

Capacitors should not be used any longer in case of dents, mechanical or any other kind of damage!

Check the integrity of discharge resistors before installation.

## Installation

### Mounting the capacitors

Capacitors installed in a cabinet should be placed on the bottom to minimize the stress temperature.



*Figure 1: Capacitor overview*

### Mounting positions

Capacitors installed in a cabinet should be placed on the bottom to ensure the lowest stress temperature possible.

|                 |                                                                   |
|-----------------|-------------------------------------------------------------------|
| <b>Warning!</b> | Do not install the capacitor in case of dents deeper than 0.5 mm! |
|-----------------|-------------------------------------------------------------------|

## SCap

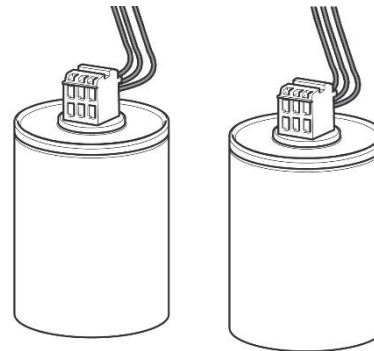


Figure 2: SCap in vertical mounting position.

### Mounting conditions

PFC capacitors must be installed in a cool and well-ventilated place, and not close to objects that radiate heat such as filter circuit reactors and furnaces, or in the direct sunlight.

### Cooling space for capacitors

Make sure that sufficient cooling space is provided (see Figure 3):

- A minimum distance of 20 mm between the capacitors is necessary to maintain sufficient cooling.
- Keep at least 20 mm space above the capacitor and do not attach any mounting components at the crimp or on top. This gap will allow a longitudinal extension of the can in order to ensure that the over-pressure disconnecter can fully extend.



Figure 3: Minimum space over and between the capacitors.

**Using reactors:  
cooling space for cables**

Note that any reactors used in an application operate at a much higher temperature. The distance between the reactor and capacitor must be large enough to stop any reactor heat being conducted via the connecting cable to the capacitor and to prevent the capacitor overheating due to heat radiation from the reactor.

**Fixing threaded bottom stud**

The threaded mounting stud is located at the base of the capacitor:

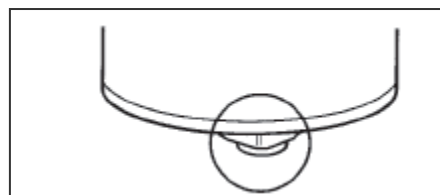


Figure 4: Mounting stud

**Fixing**

The threaded bottom stud must be fastened with the following specified torques:

M12 bottom stud for diameters > 53 mm: torque 10 Nm

M 8 bottom stud for diameters < 53 mm: torque 4 Nm

**Grounding**

The M12/M8 bottom stud is used for grounding. Connect it to the ground by cable or connect the capacitor to any other conductive item which is connected to the ground.

**Note!**

Suitable connectors have to penetrate existing layers of lacquer to ensure good, constant conductivity and sufficient current carrying capabilities.

If grounding is done via the metal chassis the capacitor is mounted to, then the layer of varnish beneath the washer and nut should be removed.

## Connecting

When connecting, avoid bending cable lugs or cables, or the use of other forms of mechanical force on the terminals. Otherwise, leakage could disable the safety device!

Ensure firm fixing of terminals, fixing torque to be applied as per individual specification.

In any case, the maximum specified terminal current may not be exceeded. Please refer to the technical data of the specific series.

Parallel connection of capacitors via the terminal is not recommended.

## Connecting the supply cable

### Cable specification

The connection cable must be of flexible type, material should preferably be copper.

#### Note!

Do not use solid core cables! Recommend to use cable without lug.

Maximum cable cross section is for

■ SCap: 16 mm<sup>2</sup>

Further information can be found in the Appendix.

The connection cables to the capacitor should be dimensioned for a current of at least 1.5 times the nominal current so that no heat is conducted into the capacitor.

### Maximum terminal currents

Do not exceed the maximum permissible current:

- **SCap:** Max. 50 A total RMS current

### Attaching the supply cable

Attach the supply cable only with the maximum permissible torque values:

- **SCap:** 1.2 Nm

### Supply cable with lug crimped

Use an appropriate wire as specified for the connection in the appendix and fix it onto the fast-on terminal on top of the capacitor.

### Using discharge resistors

Discharge resistors are included in the delivery package, pre-mounted by the factory for SCap with voltage from 600 V. Please note that regarding the ceramic discharge resistors necessary care should be taken during the maintenance and the resistors should be replaced in case of cracks. While plugging or unplugging the resistors adequate care is necessary. Discharge resistors are required for discharging of capacitors to protect operating personal (risk of electric shock hazard) and for re-switching capacitors in automatic PFC equipment (phase opposition!).

According to the IEC 60831 standard the capacitor must discharge to less than 75V within 180 seconds. Make sure that the correct resistor is used for replacement, e.g. ohmic value and push-on connector diameter.

Before re-switching, capacitors must be discharged to 10% of the nominal voltage or below.

A discharge resistor can be easily replaced by pushing it onto the exposed top on the terminal.

Discharge and short circuit the capacitor before handling!

Push on discharge resistors    External discharge resistor

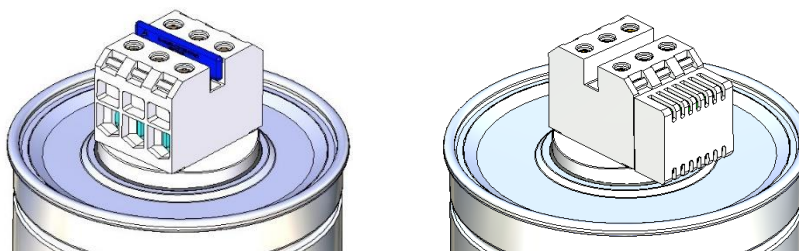


Figure 5: Discharge resistor and discharge module

## IEC 60831 Standard and Reference

Following maximum switching operations per year are acceptable:

SCap                      up to 5000 switching operations

## Harmonics

Harmonics are voltages and currents with frequencies that are different from a 50 Hz or 60 Hz power supply frequency.

Harmonics result from the operation of electrical loads with non-linear voltage-current characteristics.

They are mainly caused by loads operating with modern electronic devices, such as converters, electrical drives, welding machines and uninterruptible power supplies (UPS).

Ensure that the current through the capacitor doesn't exceed the limits given in the specific data sheets.

Ensure that the voltage doesn't exceed  $1.1 \cdot V_R$  and the peak voltage doesn't exceed  $1.6 \cdot V_R$ . Use a true rms and peak voltmeter or oscilloscope to check it.

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Attention!</b>                 | <p>Only power capacitors with reactors – namely de-tuned capacitor banks – should be used in applications with harmonic distortion. Depending on the chosen series resonance frequency, a part of the harmonic current will be absorbed by the power capacitor. The rest of the harmonic current will flow into the grid. The use of power capacitors with reactors reduces harmonic distortion and minimizes the disturbing effects on the operation of other loads.</p>                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Avoid resonance conditions</b> | <p>The most important reason for installing de-tuned capacitor banks is to avoid resonance conditions. Resonance conditions may multiply existing harmonics, create power quality problems and damage distribution equipment. Occurrences of resonance should by all means be avoided by appropriate application design!</p> <p>Total RMS capacitor current (incl. fundamental and harmonic currents) specified in the technical data of the specific series must never be exceeded.</p>                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Overpressure disconnect</b>    | <p>Electrical components do not have unlimited life expectancies; this also applies to self-healing capacitors. As polypropylene-type capacitors seldom produce a pronounced short circuit, HRC fuses or circuit breakers alone do not offer sufficient protection.</p> <p>All capacitors of the SCap series are consequently fitted with a disconnect that responds to overpressure. If numerous electric breakdowns occur at the end of its life or as the result of thermal or electric overload (within IEC 60831 specification), the formation of gas causes the pressure inside the capacitor case to rise. This causes a change in length because of curvature of the lid or stretching of the expansion bead. Expansion beyond a certain degree will separate the internal wires (tear-off fuses) and disconnect the capacitor from the line.</p> |

**Caution!**

To ensure full functionality of an overpressure disconnect, observe the following requirements:

1) The elastic metal top must not be impaired:

- The connecting lines must be flexible leads (cables).
- There must be sufficient space for expansion above the connections (stated for the different models).
- The folding groove must not be retained by clamps.

2) The maximum allowed fault current of 10000 A to the UL 810-standard must not be exceeded.

3) Stress parameters of the capacitor must be within the IEC60831 specification.

**Overcurrent / short circuit protection**

HRC fuses or molded case circuit breakers for short circuit protection must be used. Short circuit protection equipment and connecting cables should be dimensioned to permanently handle 1.5 times the rated current of the capacitor.

- HRC fuses do not protect the capacitor against overload. They only offer short-circuit protection!
- HRC fuse rating must be 1.6 ... 1.8 times the nominal capacitor current.
- Do not use HCR fuses for switching capacitors (lightning arc!).
- Use thermal/magnetic overcurrent relays for overload protection.

## Maintenance

### Caution!

Disregarding the following measures may result in severe operation failures, bursting and fire.

- Check tightness of the connections/terminals periodically, two weeks after installation at the latest, and then once every month.
- Clean the terminals/bushings periodically to avoid short circuits due dust or other contamination.
- Check the short circuit protection fuses.
- Take current reading twice a year and compare with capacitor current at operating voltage. Use a harmonic analyzer or true effective RMS-meter.
- In case of a current above the nominal current check your application for modifications.
- If a significant increase in the amount of non-linear loads is detected, a consultant has to be called in for a harmonic study.
- In cases of the presence of harmonics, the installation of a de-tuned capacitor bank (reactors) must be considered.
- Check the discharge resistors/reactors and in case of doubt check their function:
  - (1) Power the capacitor up and down.
  - (2) According to the IEC 60831 standard the capacitor must discharge to less than 75V within 180 seconds. Please regularly check and record the discharge time. In case the capacitors are not discharging properly, please replace the resistor or/and the capacitor.
- We recommend to measure and record capacitance, ambient temperature near capacitor and energized capacitor case temperature once a year for the first 7 years and after 7 years twice per year for evaluating performance. Capacitors need to be replaced if capacitance drops significantly. In case of excessive temperature of individual capacitors, it is recommended to replace this capacitor, as this could be an indication for loss factor increase which is a sign for reaching end of life.

**Note!**

Please note again that these »Installation and Maintenance Instructions« apply to typical specifications. Refer to our product specifications, or request our approval for your specification before installing a capacitor

**Appendix**

**Connection cable cross section, HRC fuse rating**
**VDE 0100 recommendations**

Cross-section values mentioned below are guideline values valid for operation under normal conditions and at an ambient temperature of 40 °C. Higher values should be selected if conditions differ from the norm, such as higher temperatures or harmonic distortion.

| kvar rating at 400 V kvar | Nominal current A | HRC fuse rating A | Cross section of supply cable mm <sup>2</sup> |
|---------------------------|-------------------|-------------------|-----------------------------------------------|
| 5                         | 7.2               | 16                | 1.5                                           |
| 6.3                       | 9                 | 16                | 2.5                                           |
| 7.5                       | 10.8              | 20                | 2.5                                           |
| 8.3                       | 12                | 20                | 2,5                                           |
| 10                        | 14.4              | 25                | 4                                             |
| 12.5                      | 18                | 35                | 4                                             |
| 15                        | 21.6              | 35                | 6                                             |
| 20                        | 29                | 50                | 10                                            |
| 25                        | 36                | 63                | 16                                            |
| 30                        | 43                | 80                | 25                                            |
| 40                        | 58                | 100               | 35                                            |
| 50                        | 72                | 125               | 35                                            |
| 56 kvar, 440 V            | 73.5              | 125               | 35                                            |
| 60 kvar, 440 V            | 78.7              | 160               | 35                                            |

For other voltage ratings:

230 V table figure \* 1.74

440 V table figure \* 0.91

480 V table figure \* 0.83

525 V table figure \* 0.76

690 V table figure \* 0.58

800 V table figure \* 0.50

The internal wiring of a capacitor bank can be normally done with a lower cross section. Various parameters such as temperature inside cabinet, quality of cable, maximum

cable isolation temperature, single or multicore cable and length of cable have to be taken into consideration when selecting the appropriate value.

### Vibration resistance

The capacitor resistance to vibration corresponds to IEC 68, part 2-6. The following values apply to the capacitor alone.

### Test Conditions

Max. test conditions:

|                          |              |              |
|--------------------------|--------------|--------------|
| ■ Test duration          | 2 h          | } max. 0.7 g |
| ■ Frequency range        | 10 ... 55 Hz |              |
| ■ Displacement amplitude | 0.75 mm      |              |

The connections and the terminals may influence the vibration properties. It is necessary to check the stability when an installed capacitor is exposed to vibration. Irrespective of this, it is not advised to locate capacitors where vibration amplitude could reach maximum levels in strongly vibrating appliances.

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, we are either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether a product with the properties described in the product specification is suitable for use in a particular customer application.

2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified.**

In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or life-saving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.

3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous).** Should you have any more detailed questions, please contact our sales offices.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time.** The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order.

We also **reserve the right to discontinue production and delivery of products.** Consequently, we cannot guarantee that all products named in this publication will always be available. The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

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