

SIEMENS

SIVACON

Distribution systems Installation and maintenance instructions for Power Factor Correction (PFC) capacitors




Installation Manual

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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

 DANGER
indicates that death or severe personal injury will result if proper precautions are not taken.
 WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.
 CAUTION
indicates that minor personal injury can result if proper precautions are not taken.
NOTICE
indicates that property damage can result if proper precautions are not taken.


If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

 WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Introduction

1.1 About this manual

Overview

PhaseCap Energy+	4RB8
DeltaCap	4RB7
PhaseCap HD	4RB6
PhaseCap Premium	4RB5
PhaseCap Compact	4RB4
PhiCap	4RB2

Note

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

Note

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.

Note

These operating instructions do not purport to cover all details or variations in equipment, or to provide for every possible contingency in connection with installation, operation or maintenance.

Should additional information be desired, or should particular problems arise that are not discussed in enough detail in the operating instructions, please contact Technical Support (<https://www.siemens.com/support-request>) for the information you require.

Note

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

1.2 Technical Support

You can find further support on the Internet at:

TechnicalSupport (<https://www.siemens.com/support-request>)

Safety notes

2.1 General safety notes for installation and operation

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

2.2 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.

2.3 Ambient temperature

The ambient temperature category for most standard types is -40 / D. This means a max. temperature of 55 °C, an average temperature over 24 hours of 45 °C, and the average temperature in one year should not exceed 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. Temperature has a major influence on the useful life expectancy of the capacitor.

WARNING

The use of damaged devices may result in death, serious injury, or property damage.

Capacitors should not be used in cases of dents or any other kind of mechanical damage.

Check the integrity of discharge resistors before installation.

WARNING

Exceeding the maximum allowable temperature may disable the device which could result in death, serious injury, or property damage.

The maximum allowed temperature must not be exceeded.

DANGER

Hazardous voltage will cause death, serious personal injury, or equipment damage.

Turn off and lock out all power supplying this equipment before working on this device.

Note

Only qualified personnel are permitted to install, commission or service this device.

Wear the prescribed protective clothing. Observe the general equipment regulations and safety regulations for working with high-voltage installations (e.g. DIN VDE, NFPA 70E as well as national or international regulations).

The limits given in the technical data must not be exceeded even during startup or testing of the device.

Before connecting the device, make sure that the line voltage matches the specifications on the rating plate.

Before you start up the device, check that all connections are correct.

Before power is applied to the device for the first time, it must have been located in the operating area for at least two hours in order to reach temperature balance and avoid humidity and condensation.

Condensation on the device is not permissible during operation.

Mounting

3.1 Mounting the capacitors

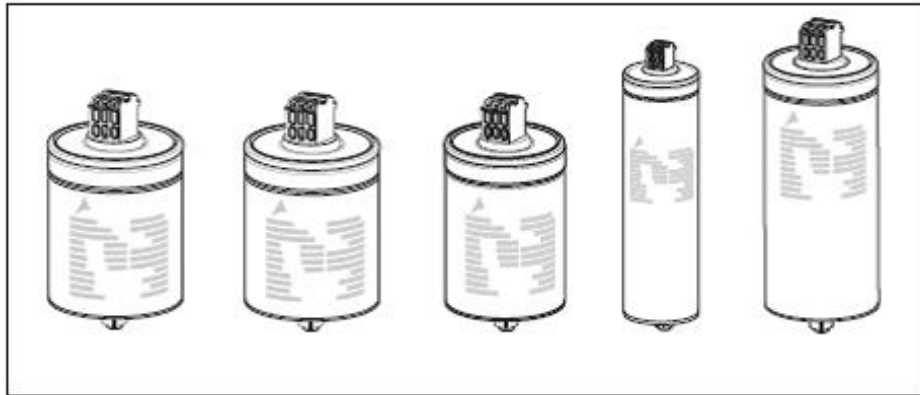


Figure 3-1 Capacitor overview

Mounting positions

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

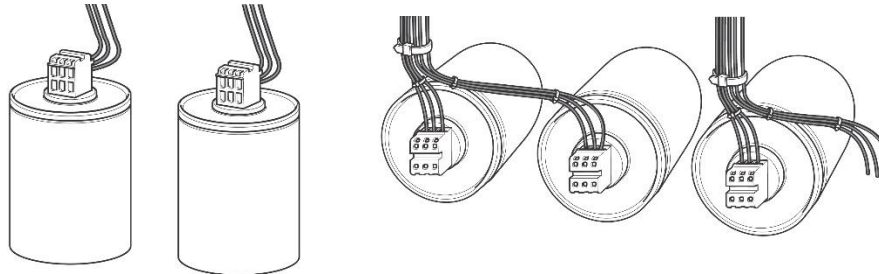
! WARNING

The use of damaged devices may result in death, serious injury, or property damage.

Do not install the capacitor with dents deeper than 0.5 mm. Disregarding can lead to malfunction or rupturing.

3.1 Mounting the capacitors

The **PhaseCap Premium, PhaseCap Compact and PhaseCap Energy+** (Height of capacitor ≤ 224 mm) capacitor series may be mounted in the vertical or horizontal position.

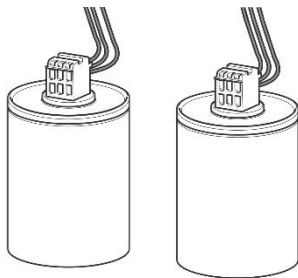


Note

The pictures depicted above are for illustration purposes only. Actual sample will be as per MLFB type.

When mounting in horizontal position, additional mechanical support is recommended to prevent breaking of the mounting bolt in case of mechanical shock or vibrations. This support should be placed at short distance below the bead at the top end of the capacitor.

The PhaseCap HD, PhiCap and PhaseCap Energy+ (Height of capacitor > 224 mm) and DeltaCap capacitors series may be mounted only in the vertical position:



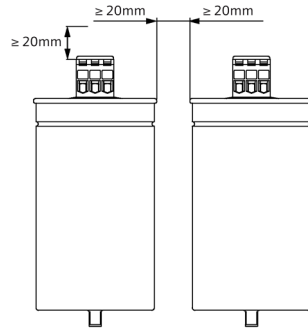
Mounting conditions

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.

3.2 Cooling space for capacitors

Make sure that sufficient cooling space is provided:

- 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.



Note

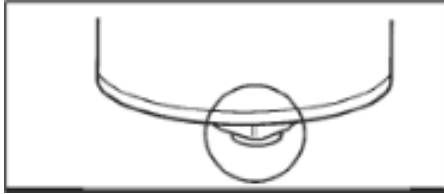
The pictures depicted above are for illustration purposes only. Actual sample will be as per MLFB type.

Using reactors: cooling space for cables

If reactors are used in an application, note that they operate at a much higher temperature. The distance between the reactor and capacitor must be large enough so that no reactor heat is conducted via the connection cable to the capacitor, or that heat radiation from the reactor to the capacitor causes overheating.

3.3 Fixing threaded bottom stud

The threaded mounting stud is at the bottom of the capacitor:



Fixing

The threaded bottom stud must be fastened with certain specified torques:



- PhaseCap, PhaseCap Compact, PhaseCap Energy +, PhaseCap HD, DeltaCap:
M12 bottom stud: torque 10 Nm.

- PhiCap:
M12 bottom stud for diameters > 53 mm: torque 10 Nm
M 8 bottom stud for diameters \pm 53 mm: torque 4 Nm

3.4 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

Connect the capacitor case to ground.

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.

3.5 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 (overpressure disconnecter).

Provide sufficient mechanical strain relief for the cable.

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.

3.5.1 Connecting the supply cable

Cable specification

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

Do not use solid core cables.

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

Product type	Screws	Maximum cable cross section	Maximum allowable RMS total current	Maximum permissible torque values
PhaseCap Premium	M5	25 mm ²	80 A	2,0 Nm
PhaseCap Compact:				
Terminal Type A	M4	16 mm ²	50 A	1,2 Nm
Terminal Type B	M5	25 mm ²	80 A	2,0 Nm
Terminal Type C	M5	25 mm ²	80 A	2,0 Nm
DeltaCap	M5	25 mm ²	55 A	2,0 Nm
PhaseCap Energy+:				
Terminal type A	M4	16 mm ²	50 A	1,2 Nm
Terminal type B	M5	25 mm ²	80 A	2,0 Nm
Terminal type C	M4	16 mm ²	50 A	1,2 Nm
Terminal type D, E	M5	25 mm ²	50 A	2,0 Nm
Terminal type F	M6	35 mm ²	130 A	2,5 Nm
PhaseCap HD	M6	35 mm ²	130 A	2,5 Nm
PhiCap	M4	16 mm ²	50 A	1,2 Nm

Further information can be found in the Appendix.

Note

Prevent heating the cables.

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

Note

Capacitor may be damaged.

Do not exceed the maximum allowable current.

Use an appropriate screw driver. Capacitors are supplied with partially engaged terminal screws.

- PhaseCap Premium, DeltaCap, PhaseCap Compact, PhaseCap Energy+ except terminal type F and PhiCap: 5.5 x 1/Ph2/Pz2 type
- PhaseCap HD, PhaseCap Energy+ with terminal type F: DIN 5264-B 1.2 x 6.5

3.6 Discharging of capacitors

3.6.1 Discharge the capacitor

Using discharge resistors

Discharge resistors are included in the delivery package, pre-mounted by the factory for PhaseCap Premium, DeltaCap, PhaseCap Compact, PhaseCap Energy+ and PhiCap E-series . PhaseCap Premium, PhaseCap Compact and PhaseCap Energy+ types with voltage from 600 V onwards, all PhaseCap HD-types and PhaseCap Energy+ with terminal type F are provided with external discharge module (see table 3-2).

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).

Siemens discharge resistors are designed to discharge capacitors down to 75 V or less within 180 seconds (some types within 90 seconds; please refer to the specific data sheet).

Make sure that the correct resistor is used for replacement, e.g. ohmic value and push-on connector diameter.

Discharge the capacitor

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

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


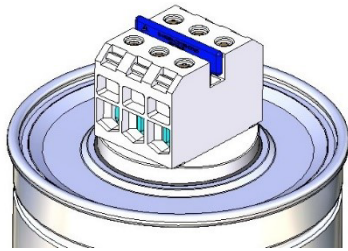
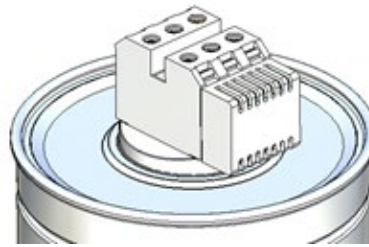
 DANGER
Hazardous voltage. Will cause death, serious personal injury, or equipment damage.
Discharge and short circuit the capacitor before handling.

Table 3-2 Discharge resistor and discharge module

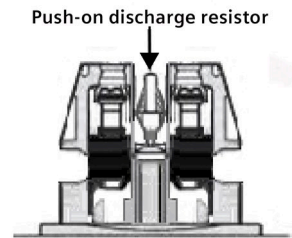
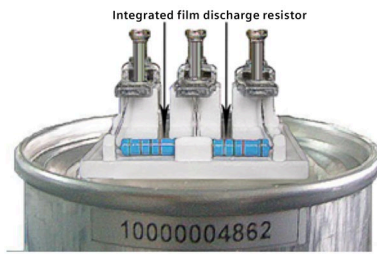


Push on discharge resistors



External discharge resistor

Table 3-3 Different discharge resistors



3.7 Inrush current limitation

Switching LV PFC capacitors can cause high inrush currents of more than 200 times the rated current, especially when they are connected in parallel to others that are already energized. This may cause additional stress to contactors as well as to capacitors and reduce their life cycle.

Inrush currents have a negative effect on power quality, e.g. transients, voltage drop. MKK- and MKP-designs feature high impulse handling capability, inrush current limitation is required, e.g. contactors with pre-charging resistors for pre-loading of capacitors.

Standards and references

4.1 IEC 60831 Standard and Reference

Following maximum switching operations per year are acceptable:

PhaseCap Premium	up to 7500 switching operations
DeltaCap	up to 5000 switching operations
PhaseCap HD and PhiCap	up to 5000 switching operations
PhaseCap Compact	up to 10000 switching operations
PhaseCap Energy+	up to 15000 switching operations

Before considering a higher number of switching operations, please contact Siemens.

4.1 IEC 60831 Standard and Reference

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 operated 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 VR and the peak voltage doesn't exceed 1.6 VR. Use a true rms and peak voltmeter or oscilloscope to check it.

Note

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 operation of other loads.

Note

Avoid resonance conditions

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. Total RMS capacitor current (incl. fundamental and harmonic currents) specified in the technical data of the specific series must never be exceeded.

Overpressure disconnecter

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.

All capacitors of the PhaseCap Premium, PhaseCap Compact, PhaseCap Energy+, PhaseCap HD, DeltaCap and PhiCap series are consequently fitted with a disconnecter that responds to overpressure. If numerous electric breakdowns occur at the end of 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.



CAUTION

The function of an overpressure disconnecter can be affected.

To ensure full functionality of an overpressure disconnecter, 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 IEC 60831 specification.

Overcurrent / short circuit protection

7.1 Overcurrent / short circuit protection

HRC fuses or moulded case circuit breakers for short circuit protection have to be used. Short circuit protection equipment and connection cable should be dimensioned to handle the 1.5 times rated current of the capacitor permanently.

- Selection of connection cables should be dimensioned according to handling of current (for recommendations, refer to the appendix).
- HRC fuses do not protect the capacitor against overload. They are only a short circuit protection.
- MCCBs and HRC fuse rating has to be 1,6 ... 1,8 times nominal capacitor current.
- Do not use HRC fuses for switching capacitors (electrical arcing).
- Use thermal / magnetic overcurrent relays for overload protection.

 CAUTION
Maintenance <p>Disregarding the following measures may result in severe operation failures, bursting and fire.</p> <ul style="list-style-type: none">• 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 nominal current. 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:<ol style="list-style-type: none">1. Power the capacitor up and down.2. After 60 seconds the voltage between the terminals must decline to less than 75 V. Please note that for specific types discharge time is 180 seconds.• Check the temperature of energized capacitors. 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.

8.1 Disposal of waste electronic equipment

Disposal of waste electronic equipment



Waste electronic equipment must not be disposed of as unsorted municipal waste, e.g. household waste. When disposing of waste electronic equipment, the current local national/international regulations must be observed.

Appendix

Connection cable cross section, HRC fuse rating

Recommendations to VDE 0100 for fusing and cable cross sections for three phase power capacitors are listed below.

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 ²
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

Other voltage ratings	
230 V	table figure x 1,74
440 V	table figure x 0,91
480 V	table figure x 0,83
525 V	table figure x 0,76
690 V	table figure x 0,58
800 V	table figure x 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.

Important notes

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 Siemens 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)**. Useful information on this will be found on the Internet (<https://support.industry.siemens.com/cs/us/en/>). 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.
6. Unless otherwise agreed in individual contracts, **all orders are subject to the current version of the "General Terms of Delivery for Products and Services in the Electrical Industry" published by the German Electrical and Electronics Industry Association (ZVEI)**.
7. The trade names DeltaCap, MKD, MKK, PhaseCap, PhiCap are **trademarks registered or pending** in Europe and in other countries.