Motors | Automation | Energy | Transmission & Distribution | Coatings

AC Capacitors

Safety and Application Manual

Safety and Application Manual

Serie: AC Capacitors

Language: English

Document nº: 10005056250 / 02

Publishing date: 07/2017

SUMMARY

1 SAFETY IN THE APPLICATION OF CAPACITORS 6

2 STORAGE CONDITIONS 7

3 SAFETY CONDITIONS FOR INSTALLATION AND OPERATION OF CAPACITORS 8

4 PRODUCT INFORMATION 9

5 CAPACITOR INTERNAL SAFETY AND PROTECTION DEVICES 10

5.1 SELF-HEALING METALLIZED POLYPROPYLENE FILM 10
5.2 SEGMENTED FILM 10
5.3 INTERNAL OVERPRESSURE SAFETY DEVICE 11

6 POWER FACTOR CORRECTION CAPACITORS (P.F.C.) 12

6.1 INSTALLATION IN THE PRESENCE OF HARMONICS 13
6.1.1 Detuning reactor 14
6.2 ASSEMBLY POSITION AND SPACING BETWEEN CAPACITORS 15
6.3 AMBIENT TEMPERATURE 17
6.4 VOLTAGE LEVELS ACCEPTED IN OPERATION 17
6.5 CONNECTION OF CAPACITORS 18
6.6 GROUNDING 19
6.7 DISCHARGE OF CAPACITORS 19
6.8 SELECTION OF CONTACTORS 19
6.9 SELECTION OF CIRCUIT BREAKERS 20
6.10 ELECTION OF FUSES 20
6.11 PREVENTIVE MAINTENANCE 21
6.11.1 Monthly 21
6.11.2 Six-monthly 21

7 MOTOR CAPACITORS (MOTOR RUN) 22

7.1 MOUNTING POSITION OF CAPACITORS 23
7.2 OPERATING TEMPERATURE 24
7.3 CONNECTION OF CAPACITORS 24
7.4 DISCHARGE OF CAPACITORS 24

8 LIGHTING CAPACITORS 25

8.1 MOUNTING POSITION OF CAPACITORS 25
8.2 OPERATING TEMPERATURE 26
8.3 CONNECTION OF CAPACITORS 26
8.4 DISCHARGE OF CAPACITORS 26

9 POSSIBLE PROBLEM CAUSES AND TROUBLESHOOTING 27

9.1 ANNEX A - CHECKLIST 29

1 SAFETY IN THE APPLICATION OF CAPACITORS

It is necessary to read this manual before performing the installation or maintenance of AC capacitors. Failure to comply with the directions contained in this manual may result in reduction of the product useful life, operating fault, disabling of the capacitor safety system and, consequently, risk of fire. If you need any further explanation, please contact WEG

FOR YOUR SAFETY!
Capacitors are passive system components which have the capacity to store electric energy. Even after being de-energized, they must be handled with care, because they may contain high levels of voltage, putting human life at risk. Therefore, always discharge and short circuit the capacitor terminals before handling it. This rule is also valid for all components and devices that have some electrical connection to the capacitors.

International, national, state and local standards must always be observed when servicing equipment and components in electrical systems.

2 STORAGE CONDITIONS

- Capacitors must never be stored in places with temperatures exceeding the specified limits.
- Capacitor condensation must not occur. The average relative humidity during the year must not exceed 75%, with a maximum value of 95%.
- Capacitors must not be stored in corrosive environments, especially in the presence of hydrochloric gas, hydrogen sulfide, acids, organic solvents or similar substances.
- Capacitors stored in dusty environments must be cleaned before the installation, especially in the area near the terminals so as to ensure electrical insulation between phases and/or phases and enclosure.
- If the capacitors remain stored for more than three years, it is suggested to perform a visual inspection to check the integrity of the enclosure (no corrosions, leakages, deformations, etc.) and measure the capacitance values. If the values are within the limits indicated on the nameplate and the enclosure is intact, the product can be used. In case of non-compliance, the capacitor must be disposed.

3 SAFETY CONDITIONS FOR INSTALLATION AND OPERATION OF CAPACITORS

Do not perform any type of weld on the capacitor terminals, under the risk of causing deterioration of the sealing materials and disabling the capacitor safety system.

Capacitors must not be used in corrosive environments, especially in the presence of hydrochloric gas, hydrogen sulfide, acids, organic solvents or similar substances.

Capacitors used in dusty environments must undergo regular maintenance so as to ensure electrical insulation between phases and/or phases and enclosure.

The distance between capacitors must always be in compliance with the product specifications.

The maximum values of temperature, voltage, reactive power, frequency, discharge times and number of switches in the application must always be in compliance with the product specifications and applicable standards.

Sufficient means of heat dissipation must be provided so that the maximum temperature of the capacitor is not exceeded.

AMBIENT TEMPERATURE!
The operating temperature is one of the main factors that influence the capacitor useful life; therefore, it is directly related to the length of the useful life. In case of temperatures exceeding values mentioned below, provide forced ventilation or contact WEG for the supply of special capacitors.

1. P.F.C. Capacitors
   The temperature category of WEG Power Factor Correction capacitors is -25/D. This designation corresponds to the maximum operating temperature of 55° C where the highest average in 24 hours must not exceed 45° C, and the average temperature during one year must not exceed 35° C.

2. Capacitors for single-phase motors
   Capacitors for single-phase motors are classified into a climatic category defined by the minimum and maximum operating temperature and severity to humid heat. CMRW, CMRW-S, UCW--M and CDW lines are identified with 25/85/21, which indicates the minimum operating temperature of-25 ºC, maximum of 85 ºC and 21 severity days to humid heat. The CMLW and CDWV capacitors are identified with 25/70/21; therefore, the maximum temperature must not exceed 70 ºC.

3. Lighting capacitors
   The CLAW, CILW and CLAW-S capacitors belong to the temperature category -25 ºC / +85 ºC; thus, the minimum operating temperature must be above -25 °C and the maximum must be below 85 °C.

4 PRODUCT INFORMATION

The lines of AC capacitor produced by WEG are divided into three application fields: Power Factor Correction (P.F.C.), single-phase motors (motor run) and lighting. Table 01 lists the products offered by WEG.

Family	Line	Description	Enclosure	Application	Reference standard
P.F.C.	UCW	Single-phase Capacitive Unit	Aluminum Housing	P.F.C.	IEC 60831-1/2 UL 810
	UCW-T	Three-phase Capacitive Unit	Aluminum Housing	P.F.C.	IEC 60831-1/2 UL 810
	MCW	Three-phase Capacitive Module	Aluminum housing and plastic cover	P.F.C.	IEC 60831-1/2 UL 810
	BCW	Three-phase Capacitor Bank	Metallic Box	P.F.C.	IEC 60831-1/2 IEC 61921
	BCWP	Three-phase Capacitor Bank with Protection	Metallic Box	P.F.C.	IEC 60831-1/2 IEC 61921
Motor run	CMRW	Permanent capacitor	Plastic Housing	Single-phase motors	IEC 60252-1 UL 810
	CMLW	Permanent capacitor	Plastic Housing	Single-phase motors	IEC 60252-1
	CMRW-S	Permanent capacitor with segmented film	Plastic Housing	Single-phase motors	IEC 60252-1 UL 810
	UCW-M	Permanent capacitor with aluminum housing	Aluminum Housing	Single-phase motors	IEC 60252-1 UL 810
	CDWV	Permanent capacitor with double capacitance	Aluminum Housing	Ceiling fan	IEC 60252-1
	CDW	Permanent capacitor with double capacitance	Aluminum Housing	Air conditioning	IEC 60252-1 UL 810
Lighting	CLAW	Type A capacitor for lighting	Plastic Housing	Lighting	IEC 61048 IEC 61049
	CILW	Type A capacitor for lighting	Plastic Housing	Lighting	IEC 61048
	CLAW-S	Type A capacitor for lighting with segmented film	Plastic Housing	Lighting	IEC 61048

Table 4.1: Product information

5 CAPACITOR INTERNAL SAFETY AND PROTECTION DEVICES

Table 02 lists which product lines contain safety devices and specifies each type.

Family	Line	Segmented film	Internal overpressure safety device	No safety device
P.F.C	UCW		√	
	UCW-T		√	
	MCW		√	
	BCW		√	
	BCWP		√	
Motor run	CMRW			√
	CMLW			√
	CMRW-S	√		
	UCW-M		√	
	CDWV			√
	CDW		√	
Lighting	CLAW			√
	CILW			√
	CLAW-S	√		

Table 5.1: Capacitor internal safety devices

5.1 SELF-HEALING METALLIZED POLYPROPYLENE FILM

The metallized polypropylene film has the self-healing characteristic; therefore, the electrical properties are rapidly restored after a local perforation of the dielectric. As you can see in figure 01, at the moment the dielectric breaks, the metal layer (electrodes) around the perforation is vaporized and the short circuit is insulated.

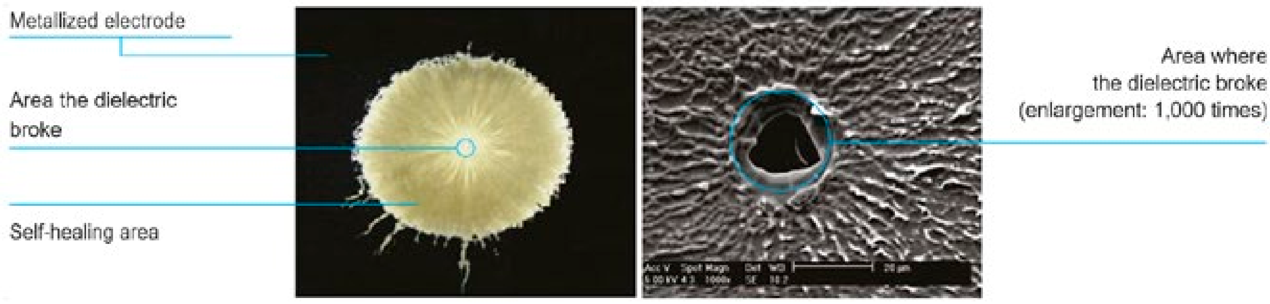
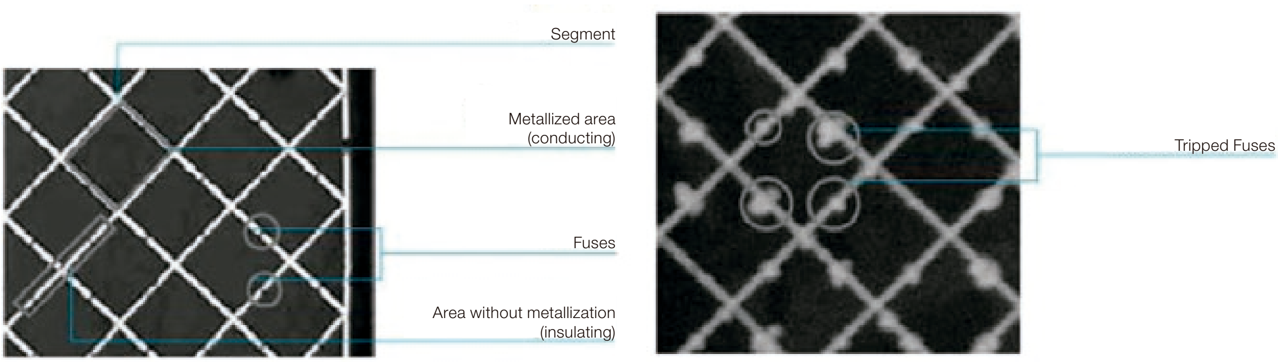


Figure 5.1: Self-healing metallized polypropylene film

5.2 SEGMENTED FILM

In capacitors that use such technology, the protection is in the segmentation of the metallization (electrodes) of the polypropylene film. Those segments, or small metallized areas, are interconnected by fuses, as shown in figure 02 (a).

The operation of the device occurs in case the dielectric breaks in a segment, tripping the fuses, as shown in figure 02 (b), and isolating the segment that presented the fault. Therefore, the safety of this device lies in limiting the energy released during regeneration, which is proportional to the area of the segment.



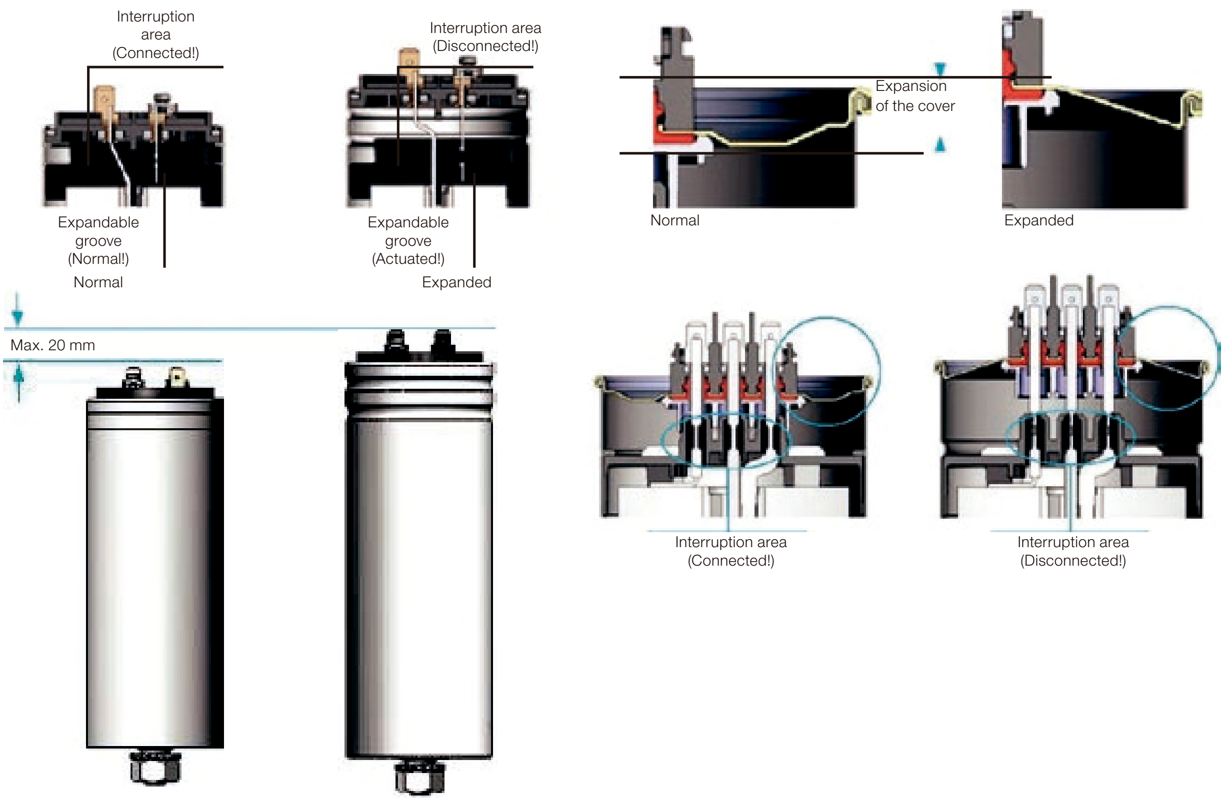
(a) No fuses tripped

(b) After the fuses tripped

Figure 5.2: Film segmentado

5.3 INTERNAL OVERPRESSURE SAFETY DEVICE

This device is connected inside the capacitive unit, in series with the capacitive element, and its function is to interrupt the electric current in the capacitor in case of abnormal increase of the internal pressure. Actuation of this device occurs at the end of the product useful life or in case of fault.
According to the cover material, the safety device can actuate in two different ways.
Plastic cover: the internal pressure caused by the film regeneration will force the capacitor walls. Such force will act on the expandable grooves, causing the interruption of the mechanical fuse and, consequently, of the power supply to the capacitive element (figure 3 (a)).
Aluminum cover: the internal pressure caused by the film regeneration will force the capacitor walls. That force will act on the metallic cover and on the expandable groove. In this way, the cover expands, causing the interruption of the mechanical fuse and, consequently, of the power supply to the capacitive element.



(a) Plastic cover

(b) Metallic cover

Figure 5.3: Safety device

ATTENTION!
Capacitors that have internal overpressure safety device must not leak. Presence of leakage indicates that the capacitor is no longer sealed; therefore, the housing may no longer have internal pressure, compromising the product safety.

6 POWER FACTOR CORRECTION CAPACITORS (P.F.C.)

Power factor correction capacitors are manufactured in compliance with IEC 60831-1/2 and UL 810 with 5 product lines that are used according to the user's final application. Table 3 describes the relationship between the line (considering technical, practical and economic aspects) with the product application, which is guiding and not mandatory information. It's important to note that, if there is voltage harmonics distortion (THDV) above 3% and/or current harmonics distortion (TDHi) above 10%, it is necessary to use a detuning reactor in series with the capacitors.

Line	Picture	Referential use
UCW		Correction at the low-voltage energy input. Correction by load groups.
UCWT		Correction at the low-voltage energy input. Correction by load groups. Localized correction.
MCW		Localized correction.

Line	Picture	Referential use
BCW		Localized correction.
BCWP		Localized correction.

Table 6.1: Selection of the product lines

CARE IN THE LOCALIZED INSTALLATION!
Some care must be taken when a localized power factor correction is to be done:

a. Loads with high inertia
Contactors must be installed for capacitor switching. If the capacitor is permanently connected to a motor, problems may arise at the moment the motor is disconnected from the power supply. The motor still spinning will work as a generator by self-excitation and cause overvoltage at the capacitor terminals.

b. Variable speed drives
Power factor correction capacitors must not be installed in variable speed drives.

c. Soft-starter
A contactor protected by time-delay fuses (gL-gG) must be used to switch the capacitor, which must go into operation only after the soft-starter goes into service duty (bypass). If there is more than one soft-starter on the same bus, an auxiliary circuit must be provided in order to prevent the capacitor from being turned on during the start of any soft-starter.
Important: the capacitor must be energized at the energy input where the soft-starter is connected. Never at the output of the soft-starter.

6.1 INSTALLATION IN THE PRESENCE OF HARMONICS

When there is distortion in the voltage wave form that feeds an electrical plant caused by non-linear loads (inverters, rectifiers, induction furnaces, lighting with reactors, etc.), correction by means of capacitors may make the electrical system vulnerable to resonance.

The use of an appropriate detuning reactor eliminates the risk of resonance and avoids the reduction of the capacitor useful life, since the reactor functions as a harmonic current blocker for the capacitor.

6.1.1 Detuning reactor

DRW detuning reactors are made from special silicon steel plate, which ensures excellent magnetic properties in all directions. All reactors are vacuum impregnated ensuring a low noise level and long useful life.

The winding is made of electrolytic copper with a high degree of purity and insulation that ensures H temperature class H (180 °C). In addition, a thermal protector is integrated to the central winding, which allows temperature monitoring and disconnection in case of overtemperature. Figure 4 shows the main mounting characteristics of the detuning reactor.

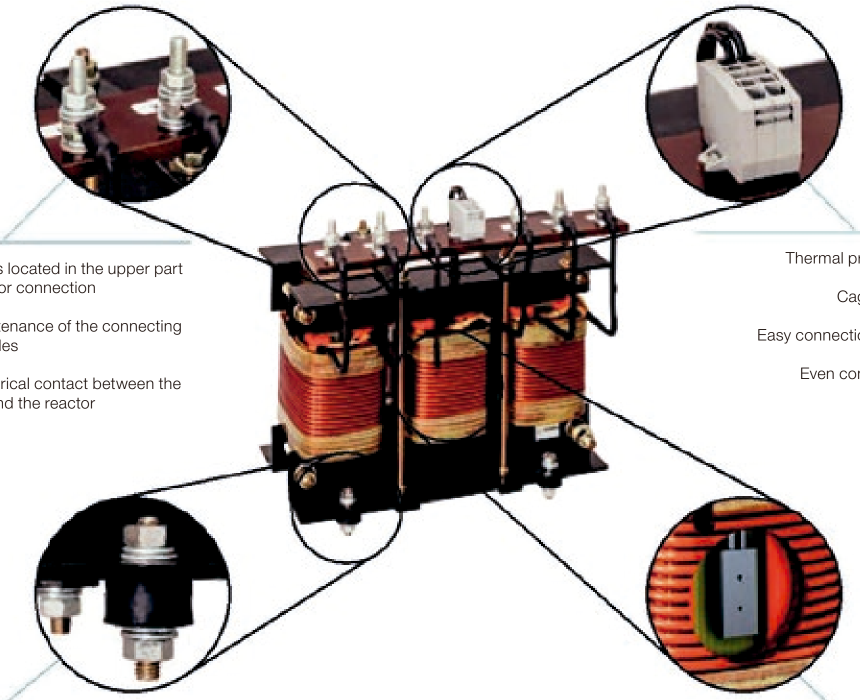


Figure 6.1: Detuning reactor

Figure 6.2 shows the mounting position of the capacitors and reactors. In order to avoid overheating, it is mandatory to install fans and exhaust fans in panels with reactors installed.

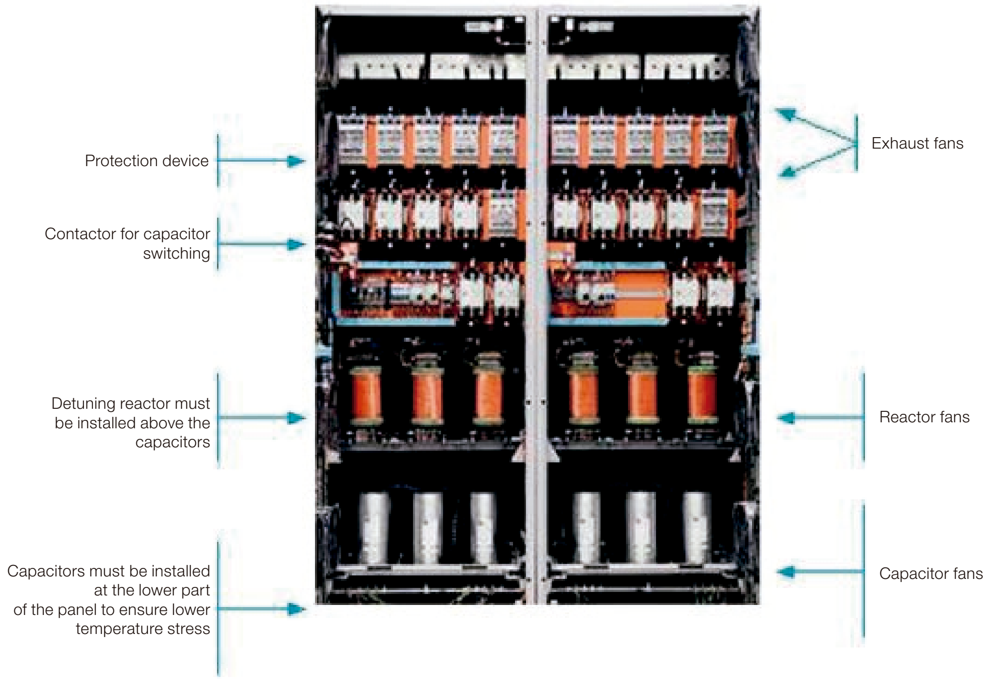


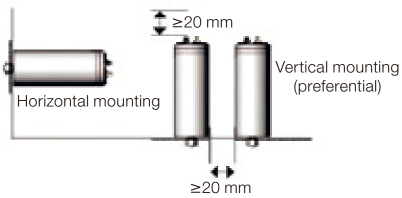
Figure 6.2: Panel mounting position / panel cooling

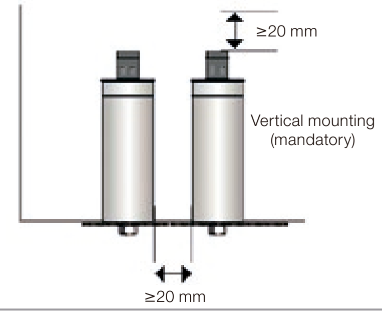
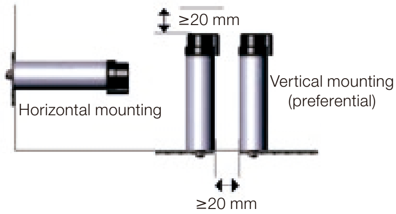
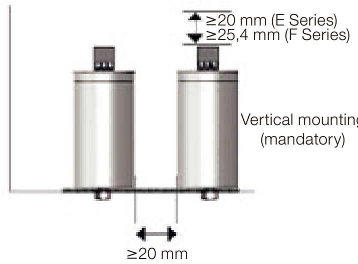
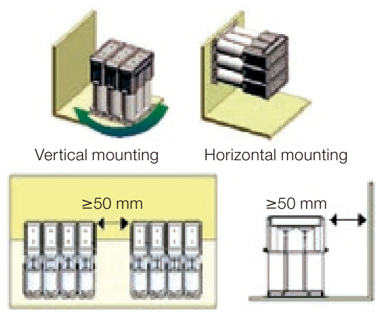
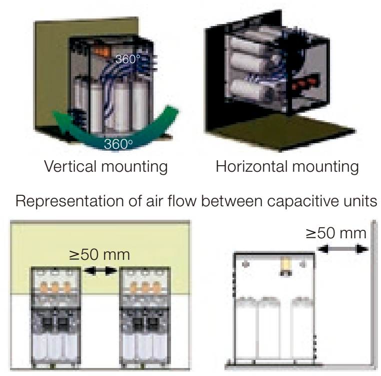
> **HARMONIC DISTORTION!**
> When there is distortion in the voltage wave form that feeds an electric plant caused by non-linear loads (inverters, rectifiers, induction furnaces, etc.), correction by means of capacitors may make the electrical system vulnerable to resonance.
>
> The use of an appropriate detuning reactor eliminates the risk of resonance and avoids the reduction of the capacitor useful life, since the reactor functions as a harmonic current blocker for the capacitor.

6.2 ASSEMBLY POSITION AND SPACING BETWEEN CAPACITORS

The capacitors must be installed in a place with proper dissipation by convection and irradiation of the heat produced by the capacitor joule losses.

Cooling of the installation place and the arrangement of the capacitors must provide good air circulation between them. Table 6.2 shows the minimum spacing and mounting position for each product line.

Line	Series / Reactive power	Mounting
UCW	A Series 0,83 kvar - 380...480 V	
	B Series 0,83...3,33 kvar - 220 V 0,83...6,67 kvar - 380...535 V	

Line	Series / Reactive power	Mounting
UCW	C Series 5...6,67 kvar - 220 V 6,67...10,0 kvar - 380...535 V	
UCWT	D Series 0,5... 3,0 kvar - 220 V 0,5...5,0 kvar - 380...535 V	
	E Series 5,0...10,0 kvar - 220 V 7,5...15,0 kvar - 380...535 V	
	F Series 12,5...30,0 kvar - 220 V 17,5...50,0 kvar - 380...535 V	
MCW	2,5...30,0 kvar - 220 V 2,5...60,0 kvar - 380...480 V	
BCW	10,0...50,0 kvar - 220 V 17,5 75,0 kvar - 380 480 V	

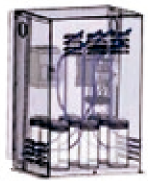
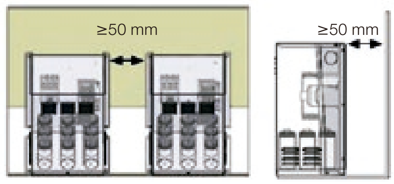
Line	Series / Reactive power	Mounting
BCWP	10,0...35,0 kvar - 220 V 20,0 75,0 kvar - 380 480 V	 Vertical mounting
		

Table 6.2: Mounting position and spacing between capacitors

6.3 AMBIENT TEMPERATURE

Power factor correction capacitors are classified in temperature categories, specified by a number followed by a letter. The number represents the lowest ambient temperature at which the capacitor can operate. The letter represents the upper limit of the temperature variation ranges, with the maximum values indicated in table 05. The temperature category of WEG capacitors is -25/D. Therefore, the maximum temperature is 55 °C, the highest average in 24 hours must not exceed 45° C, and the average temperature during one year must not exceed 35 °C.

Symbol	Ambient temperature (°C)		
	Maximum	Highest average in a period of	
		24 h	1 year
A	40	30	20
B	45	35	25
C	50	40	30
D	55	45	35

Table 6.3: Upper limit of the capacitor temperature range

AMBIENT TEMPERATURE
If it is not possible to meet the temperature values indicated in table 05, forced ventilation or air conditioning must be provided at the place where the capacitor will be installed.

6.4 VOLTAGE LEVELS ACCEPTED IN OPERATION

The rated voltage of the capacitor must be at least equal to the operating voltage of the supply line to which it is connected, taking into account the influence of the presence of the capacitor itself. Table 06 lists the permitted voltage levels in operation.

Voltage factor x rated voltage	Maximum duration	Notes
1,00	Continuous	Average value during any capacitor power-up period
1,10	8 h every 24 h	Fluctuations of the supply line
1,15	30 min every 24 h	Fluctuations of the supply line
1,20	5 min every 24 h	Voltage increase under low load conditions
1,30	1 min every 24 h	Voltage increase under low load conditions

Table 6.4: Voltage levels accepted in operation

If it is not possible to meet the values mentioned in table 06, the capacitor dielectric voltage must be reinforced. In this case, the reactive power and the rated current must be recalculated according to the equations below:

$$Q_{eq} = Q_{nameplate}\left(\frac{V_{line}}{V_{nameplate}}\right)^2$$

$$I_{eq} = I_n \left(\frac{V_{line}}{V_{nameplate}}\right)$$

Where:
Q_{eq} Capacitor equivalent reactive power in the line voltage
I_{eq} - Capacitor equivalent current in the line voltage
I_n - Capacitor rated current
V_{line} - Line voltage
$V_{nameplate}$ - Capacitor nameplate voltage
$Q_{nameplate}$ - Capacitor nameplate reactive power

6.5 CONNECTION OF CAPACITORS

The quality of the installation is directly related to the correct choice of the connection between the capacitor and the supply line. Poor, improperly made or undersized connections may generate heat and consequently reduce the useful life and/or disable the capacitor internal safety device. The power cables and connections must be sized according to the selected protection device.

Capacitors are not allowed to be powered by means of busbars. Therefore, connections must be made with flexible cables to allow the expansion and actuation of the capacitor safety device.
As shown in figure 06, it is not allowed to make parallel connection through the interconnection of the capacitor terminals. If that occurs, the current increases and causes the heating of the capacitor, which may reduce its useful life and/or disable the internal protection device. The maximum conductor cross-section values and the tightening torque of the capacitor terminals must be observed according to the product catalog information.

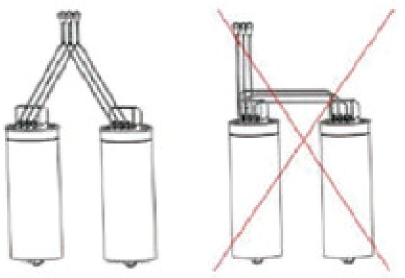


Figure 6.3: Connection of capacitors

For the UCW and UCWT lines with plastic cover, the connections of the power cables must be made according to the following figure:

Figure 6.4: Connection of capacitors with plastic cover

CONNECTION OF CAPACITORS
The power cables must be flexible. Capacitors are not allowed to be powered by means of busbars. This condition is required to ensure expansion of the capacitor and avoid stresses on the terminals.

6.6 GROUNDING

The ground cable must be fastened directly to the capacitor fixing screw or the capacitor must be fastened to a conductive surface connected to the ground.

For MCW, BCW and BCWP lines, the ground cable must be directly connected to the ground screw indicated on the product.

6.7 DISCHARGE OF CAPACITORS

Capacitors must always be discharged before putting them back into operation. The maximum residual value is 10% of the rated voltage; however, the recommendation is the full discharge of the capacitor. The full discharge of the capacitor prevents current peaks, ensuring the useful life of the capacitor and components connected to the system.

The UCW-T line (up to 20 kvar @ 220 V and 35 kvar @ 380, 440, 480, 535 V), MCW, BCW and BCW-P have resistors for discharge in 30s at 1/10 Un. For the UCWT line (above 20 kvar @ 220V and 35 kvar @ 380, 440, 480, 535V) the discharge resistor is sized so that the voltage at the capacitor terminals is 1/10 of the rated voltage in 120 s. For single-phase units of the UCW line (up to 5 kvar @ 220 V and 6.67 kvar @ 380, 440, 480, 535 V) the resistors are sold separately. Single-phase units (above 5 kvar @ 220 V and 6.67 kvar @ 380, 440, 480, 535 V) contain discharge resistors in 30s at 1/10 Un.

6.8 SELECTION OF CONTACTORS

In the switching of capacitors, the voltage associated with a low impedance of the line may cause high capacitor currents. This current may reach values of 100 x In, being one of the main causes of the reduction of the capacitor useful life. In order to avoid high transient currents, commonly referred to as "in rush currents", CWMC contactors (figure 07) must be installed for the switching of capacitor.
Those contactors contain pre-charge resistors that limit the "in rush current" at the moment the capacitors are switched. The resistors, mounted in series with the advanced contact blocks, are connected before the main contacts. After the main contacts are closed, the advanced contacts are disconnected, and only the capacitors in parallel remain with their inductive load for the proper power factor correction. Figure 08 shows the comparison between the switching with standard contactor and switching with CWMC contactor.

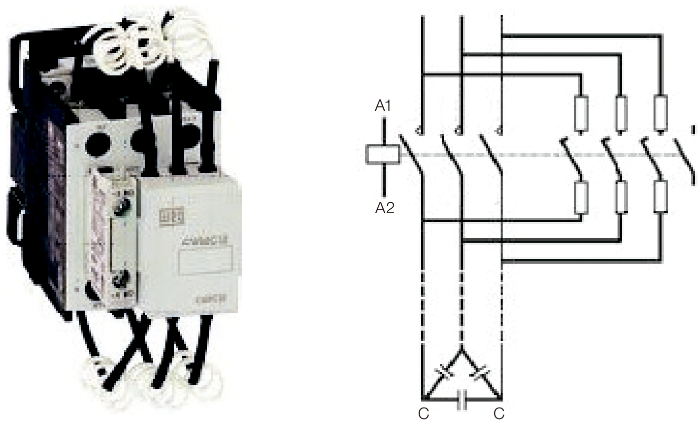
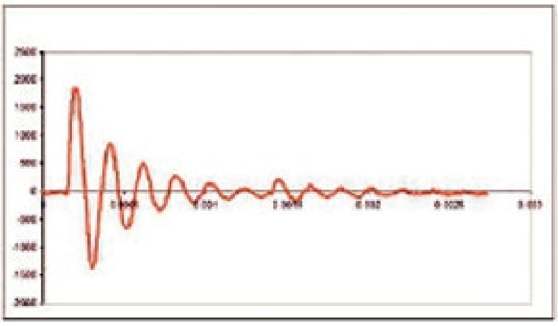
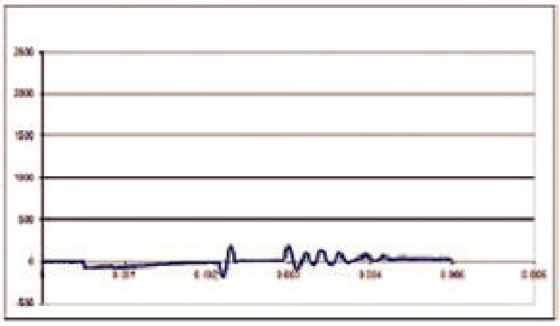


Figure 6.5: Contactor for the switching of capacitors (CWMC line)



Standard contactors



CWMC contactors

Figure 6.6: Comparison between switching with standard contactors and switching with CWMC contactors

6.9 SELECTION OF CIRCUIT BREAKERS

Capacitors must preferably be individually protected by means of molded case circuit breakers (suitable breaking capacity), which are set to operate when the current exceeds the permitted limit. The circuit-breaker must be designed to conduct a constant current of 1.3 times the current that will be obtained in the capacitor when operating with sinusoidal voltage of effective value and frequency equal to the rated values. Since the capacitor can have a voltage equal to 1.1 times the rated value, a maximum value of 1.43 (1.3 x 1.1) times the rated current can be reached. Therefore, the circuit-breaker must be sized according to the equation below:

$I_{CB} = 1,43\ I_n$

I_{CB} - Circuit breaker design current in (A)

I_n - Capacitor rated current in (A)

6.10 ELECTION OF FUSES

If you choose to use fuses, they must be time delayed NH type. The capacitors must have individual protection and the following equation must be used for sizing:

$I_{fuse} = 1,65\ I_n$

Donde:

I_{fuse} - Fuse design current in (A)

I_n - Capacitor rated current in (A)

6.11 PREVENTIVE MAINTENANCE

6.11.1 Monthly

Visual inspection of the capacitors
Check if the capacitor safety device (housing expansion) is actuated. If so, try to identify the cause before the replacement.
Check the integrity of the capacitors
Check the tightening of the connections.
Check the temperature and if the cooling is working properly.
Measurement of the operating voltage.
Measurement of the current
Measurement of the insulation between the terminals and the ground.
Thermographic analysis of the connections.

6.11.2 Six-monthly

Repeat all the procedures of the previous item (monthly).
Check the operation of the controller outputs.
Check if the discharge time of the capacitors is being observed.
Check the supply line harmonics with the capacitor bank turned on.
Clean all the panel or the place where the capacitors were installed.

ATTENTION
The bouncing (fast opening and closing of the output contacts), which may occur on the controller, causes the burn of the pre-charge resistors of the contactors and premature expansion of the capacitors.

7 MOTOR CAPACITORS (MOTOR RUN)

WEG Motor Run capacitors are intended to increase the efficiency, improve the torque and help the motor start. Each product line has a safety protection class in accordance with IEC 60252-1.

P2: it indicates that the capacitor is designed to fail in the open circuit mode, being protected against fire and electric shocks.
P1: it indicates that the capacitor may fail in the open circuit mode or "short circuit" mode, and it is protected against fire and electric shock.
P0: it indicates that the capacitor does not have a specific fault mode.

Table 07 lists the line, application, safety class and protection device.

Line	Application	Protection safety class	Protection device
CMRW	Single-phase motors in general, such as automatic washing machines, pumps, fans, electronic gates, etc.	P0	None
CMLW	Single-phase motors in general, such as small washing machines, fans, electronic gates, high pressure washers, etc.	P0	None
CMRW-S	Single-phase motors in general, such as automatic washing machines, refrigerators, air conditioners, pumps, etc.	P2	Segmented film
UCW-M	Motors in general, such as compressors, air conditioners, pumps, etc.	P2	Internal overpressure safety device
CDWV	Ceiling fan.	P0	None
CDW	Window air conditioner.	P2	Internal overpressure safety device

Table 7.1: Motor capacitors

ATTENTION
Capacitors with P0 safety protection class have no specific fault mode and no protection device.
In case of a fault or overload, the capacitive element may overheat, melt, produce smoke and even flames, damaging surrounding elements. Therefore, they must only be applied in non-critical environments or additional mounting measures must be applied (e.g.: metal encapsulation) to ensure the safety of people, installations and prevention of fire.

7.1 MOUNTING POSITION OF CAPACITORS

Motor Run capacitors may be fixed by means of fixing screw, plastic or metal clamps. Table 7.2 shows the mounting position for each product line.

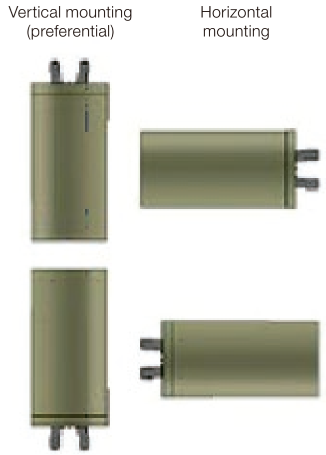
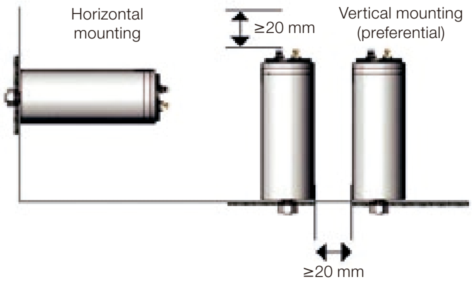
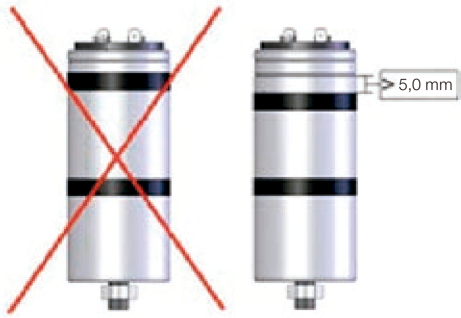
Line	Mounting	Mounting
CMRW		No restrictions.
CMLW		
CMRW-S		
CDWV		
UCW-M		
CDW		

Table 7.2: Mounting position of Motor Run capacitors

ATTENTION

a. Mounting in metallic housing
When the capacitors are mounted in a metallic housing with clamps, it must not prevent or hinder the expansion of the housing. Therefore, the minimum distance between the first expandable groove and the clamp is 5 mm.

b. Maximum operating temperature
The capacitor maximum operating temperature must be observed; therefore, the mounting must not be made too close to heat sources or equipment with high temperatures, such as motors and reactors. It is worth of notice that heat can be conducted from the heat source to the capacitor by means of the power cables.

7.2 OPERATING TEMPERATURE

Table 7.3 lists the minimum and maximum operating temperature for each product line of the Motor Run family.

Line	Minimum	Maximum
CMRW	-25 ºC	85 ºC
CMLW	-25 ºC	70 ºC
CMRW-S	-25 ºC	85 ºC
UCW-M	-25 ºC	85 ºC
CDW	-25 ºC	85 ºC
CDWV	-25 ºC	70 ºC

Table 7.3: Motor Run maximum temperature

ATTENTION
The capacitor maximum operating temperature must be observed; therefore, the mounting must not be made too close to heat sources or equipment with high temperatures, such as motors and reactors. It is worth of notice that heat can be conducted from the heat source to the capacitor by means of the power cables.

7.3 CONNECTION OF CAPACITORS

It is essential to choose the correct connection between the capacitor and the power supply. Poor, improperly made or undersized connections may generate heat and consequently reduce the useful life and/or disable the capacitor internal safety device.

The power cables and the connections must have a minimum capacity of 1.43 times the capacitor rated current so as to avoid their heating, and thus of the capacitor.

When using fast on terminals, the female connector must be appropriate and fasten the terminals securely. Never interconnect capacitors by means of their terminals. Bends or other mechanical stresses on the terminals are not allowed. When using wire terminals, the connection and/or splice must be appropriate.

7.4 DISCHARGE OF CAPACITORS

Permanent motor capacitors generally do not require discharge resistors, since the discharge of the capacitor is done via the motor windings. However, it must always be analyzed if the discharge time is sufficient, for instance, in case of single-phase motors with instantaneous reversal.

8 LIGHTING CAPACITORS

WEG lighting capacitors are used for the power factor correction of electromagnetic reactors and have the function of increasing the energy efficiency, reducing the consumption of electric energy. According to IEC 61048, there are two safety protection classes:

Type B: self-healing capacitor containing an internal protection device for use in series or parallel in lighting circuits.
Type A: self-healing capacitor that does not necessarily contain an internal protection device for use in parallel in lighting circuits.

Line	Application	Protection safety class	Protection device
CLAW	Used in parallel with the lighting circuit for power factor correction.	Type A	None
CILW	Used in parallel with the lighting circuit for power factor correction.	Type A	None
CLAW-S	Used in parallel with the lighting circuit for power factor correction.	Type A	Segmented film

Table 8.1: Lighting capacitors

ATTENTION
CLAW and CILW capacitors do not have a specific fault mode and a protection device. In case of a fault or overload, the capacitive element may overheat, melt, produce smoke and even flames, damaging surrounding elements. Therefore, they must only be applied in non-critical environments or additional mounting measures must be applied (e.g.: metal encapsulation) to ensure the safety of people, installations and prevention of fire.

8.1 MOUNTING POSITION OF CAPACITORS

Lighting capacitors can be fixed by means of the fixing screw, plastic or metal clamps. Table 11 shows the mounting position for each product line.

Line	Mounting	Mounting
CLAW	Vertical mounting (preferential) / Horizontal mounting 	No restrictions
CILW		
CLAW-S		

Table 8.2: Mounting position of lighting capacitors

8.2 OPERATING TEMPERATURE

Table 8.3 lists the minimum and maximum operating temperature for each product line of the lighting capacitor family.

Line	Minimum	Maximum
CLAW	-25 °C	85 °C
CILW	-25 °C	85 °C
CLAW-S	-25 °C	85 °C

Table 8.3: Minimum and maximum temperature of the family of lighting capacitors

ATTENTION
The maximum capacitor operating temperature must be observed; therefore, the mounting must not be made too close to heat sources or equipment with high temperatures, such as reactors. It is worth of notice that heat can be conducted from the heat source to the capacitor by means of the power cables.

8.3 CONNECTION OF CAPACITORS

It is essential to choose the correct connection between the capacitor and the power supply. Poor, improperly made or undersized connections may generate heat and consequently reduce the useful life and/or disable the capacitor internal safety device.

The power cables and the connections must have a minimum capacity of 1.43 times the capacitor rated current so as to avoid their heating, and thus of the capacitor.

When using fast on type terminals, the female connector must be suitable and provide a secure mounting of the terminals. Never interconnect capacitors by means of their terminals. Bends or other mechanical stresses on the terminals are not allowed.

When using wire terminals, the connection and/or splice must be appropriate.

8.4 DISCHARGE OF CAPACITORS

A way of discharging capacitors in lighting circuits must be provided. The discharge of capacitors is generally done using built-in discharge resistors or external discharge resistors. In order to ensure the discharge, WEG recommends the purchase of capacitors with built-in resistors.

ATTENTION
In lighting circuits, capacitors must always be discharged before being restarted. Otherwise, the capacitor useful life may drastically reduce and even put the installation at risk.

9 POSSIBLE PROBLEM CAUSES AND TROUBLESHOOTING

Index	Problem found	Possible cause	Possible solution
1.	Capacitor terminal is heating.	1. Improper supply terminal for application. 2. Poor connection (improper torque). 3. Incorrect cable cross-section. 4. Terminals incorrectly crimped. 5. Overcurrent (harmonics). 6. Parallel connection through the interconnection of the capacitor terminals.	1. Check the terminal being used and change to the terminal indicated by the manufacturer. 2. Re-tighten the connections with the specified torque. 3. Resize the cable according to the product current. 4. Crimp the terminals again. 5. Analyze the energy quality. 6. Redo the connection according to the product specification.
2.	Expanded capacitor.	1. End of product useful life. 2. Overcurrent (harmonics) 3. Overvoltage. 4. Overtemperature. 5. Conventional contactor for the switching of capacitors.	1. Preventive maintenance of capacitive units. 2. Analyze the energy quality. 3. Maintain the voltage within the capacitor limits or change the capacitor so as to meet the operating voltage. 4. Ensure that the installation cooling meets the temperature requirements of each product line.
3.	Capacitor overheating.	1. Improper cooling. 2. Overcurrent (harmonics). 3. Overvoltage.	1. Ensure that the installation cooling meets the temperature requirements of each product line. 2. Analyze the energy quality. 3. Maintain the voltage within the capacitor limits or change the capacitor so as to meet the operating voltage.
4.	Current below the specified.	1. Low voltage. 2. Expanded capacitor or with high capacitance drop. 3. Improper actuation of the safety system.	1. Check if there is a problem with the distribution line. 2. Before replacement, check if the capacitor limits (temperature, voltage, current, etc.) are being observed or if it is at the end of useful life. 3. Check if the protection size is incorrect or if there is an external factor that is causing its improper actuation.

Index	Problem found	Possible cause	Possible solution
5.	The power factor is not being reached.	1. The controller is not operating properly. 2. The amount of kvar is smaller than the demand. 3. Expanded capacitor or with high capacitance drop. 4. Improper actuation of the safety system. 5. There is no compensation for the transformer with no load.	1. Check if there is an installation error or if the controller is not operating. 2. Carry out a more detailed study of the plant load behavior. 3. Before replacement, check if the capacitor limits (temperature, voltage, current, etc.) are being observed or if it is at the end of useful life. 4. Check if the protection size is incorrect or if there is an external factor that is causing its improper actuation. 5. Install capacitors to correct the transformer with no charge.
6.	Capacitor leakage.	1. Conventional contactor for the switching of capacitors. 2. The controller is not observing the capacitor discharge time. 3. Improper cooling. 4. Improper power cable terminal for application. 5. Poor connection (improper torque). 6. Incorrect cable cross-section. 7. Terminals incorrectly crimped. 8. Overcurrent (harmonics). 9. Parallel connection through the interconnection of the capacitor terminals.	1. Install contactor for the switching of capacitors. 2. Set the controller time according to the capacitor discharge time. 3. Ensure that the installation cooling meets the temperature requirements of each product line. 4. Check the terminal being used and change to the terminal indicated by the manufacturer. 5. Re-tighten the connections with the specified torque. 6. Resize the cable according to the product current. 7. Crimp the terminals again. 8. Analyze the energy quality. 9. Redo the connection according to the product specification.

Table 9.1: Possible problem causes and troubleshooting

RISK ASSESSMENT
In the development of projects using capacitors, it must be evaluated if the chosen capacitor is the most appropriate for the desired application.
It is not possible to predict all possible "stress" causes that the capacitor may undergo, so all possible influences must be considered in advance.
When using capacitors without any internal safety device, mechanisms or means to eliminate possible risks to people and installations must be provided.

9.1 ANNEX A - CHECKLIST

Power factor correction project checklist (sheet 1)				
Customer			Inspection date	
Invoice			Capacitor (model / item / batch)	
Total power			Contactor (model / item / batch)	
Serial number			Stage protection (model / item / batch)	
Number and power of the stages			Panel protection (model / item / batch)	
			Controller (model / item / batch)	

Item	Description	Notes
1	Is the capacitor rated voltage smaller or equal to the line voltage?	
2	Is the capacitor mounting position being observed?	
3	Is the minimum distance between capacitors being observed?	
4	Have all capacitors been grounded?	
5	Are the terminals appropriate to connect the capacitors?	
6	Are the cables sized correctly (min. 1.43 x I_n)?	
7	Is the protection and control size correct?	
8	Are contactors being used to switch the capacitors?	
9	Is the capacitor installed near some heat source?	
10	Is there forced ventilation?	
11	Is the installation place free of dust, chemical soot or water contact?	
12	Are all controller outputs working?	
13	Is the controller observing the discharge time of the capacitors?	
14	Are there harmonics in the supply line (without capacitors installed)? What are the values (THDV and THDi)?	

Comments:

____

____

	Name	Signature	Date
Executed by			
Checked			
Released			

Power-factor correction maintenance checklist (sheet 1)				
Customer			Inspection date	
Invoice			Capacitor (model / item / batch)	
Total power			Contactor (model / item / batch)	
Serial number			Stage protection (model / item / batch)	
Number and power of the stages			Panel protection (model / item / batch)	
			Controller (model / item / batch)	

Item	Description	Notes
1	Are there expanded capacitors? If so, identify them and replace them.	
2	Are there blown fuses or tripped circuit breakers?	
3	Are the contactors intact?	
4	Measure the current and voltage, and check the capacitance drop.	
5	Is the maximum capacitor temperature being observed?	
6	Is there forced ventilation? If so, check thermostat and fan operation.	
7	Have any changes been made to the installation?	
8	Is the grounding effective? Is the resistance between capacitor and ground below 1Ω?	
9	Is there grounding for all capacitors?	
10	Are there any overheating signs on the connections of capacitors, contactors, fuses/circuit breakers?	
11	Are the connections properly tightened?	
12	What is the capacitor situation? Are there dust, chemical soot or water traces? If so, installation must be re-evaluated.	
13	Is the protection and control size correct?	
14	¿Están siendo utilizados contactores para maniobra de condensadores?	
15	Are contactors being used to switch the capacitors?	
16	Is the controller observing the discharge time of the capacitors?	
17	Are there harmonics in the supply line (with the bank turned on)? What are the values (THDV and THDi)?	

Comments:

____

____

	Name	Signature	Date
Executed by			
Checked			
Released			

Power-factor correction installation checklist / maintenance (sheet 2)				
Customer			Installation or maintenance?	
Invoice			Inspection date	
Total power			Capacitor (model / item / batch)	
Serial number			Contactor (model / item / batch)	
Number and output of the stages			Stage protection (model / item / batch)	
			Panel protection (model item / batch)	
			Controller (model / item / batch)	

Stage No.	Voltage measurement			Current measurement			Capacitance per phase	Reactive power	Insulation between terminals and ground
	RS	ST	RT	R	S	T			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									

Comments:

____

____

	Name	Signature	Date
Executed by			
Checked			
Released			

WEG Group - Automation Business Unit
Jaraguá do Sul - SC - Brazil
Phone: +55 47 3276 4000
automacao@weg.net
www.weg.net