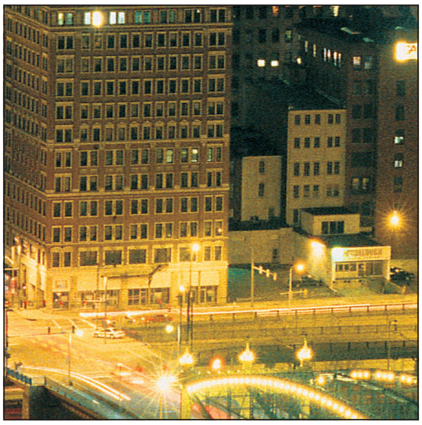
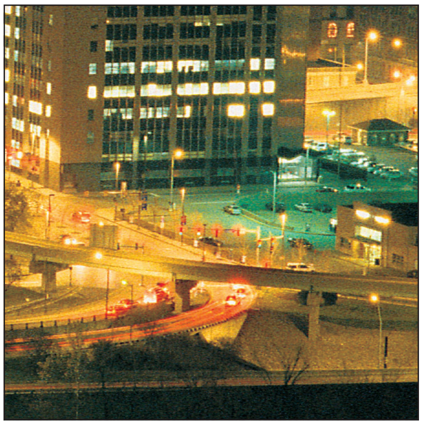
A New Lighting Experience





Compensation Capacitors

For Lamp Circuits using
Inductive Ballasts

Compensation Capacitors

Contents

1. Ballasts and Circuits

When connected to a supply network system, discharge lamps – owing to their unstable behaviour – require a ballast to stabilise the operating point, for which two basic technologies are in current use: magnetic (inductive) ballasts, also called inductors, and electronic ballasts. Both technologies perform the same tasks: ensuring the lamp electrode is sufficiently preheated, providing the necessary voltage to ignite the lamp possibly with the help of a starter or ignitor and keeping the lamp current within prescribed limits.

A ballast serves to preheat the electrode, provide the ignition voltage and limit the lamp current.

The main advantages of **electronic ballasts** can be seen in their cost-effectiveness and greater convenience of operation, whereby **magnetic ballasts** are not sensitive to external overloads, ensure a long service life and suitable for universal use.

The simplest and most robust operating method for fluorescent lamps involves an inductive ballast plus a starter or an ignitor for high-pressure discharge lamps.

In the case of fluorescent lamps, once the starter contact has been made the preheat current flows through the lamp electrodes and causes them to heat up.

When the starter contact is interrupted, the ballast generates a sufficiently high inductive voltage to ignite the lamp once the electrodes have preheated. The inductive resistance of the ballast then keeps the lamp's operating current within permissible limits.

The electrodes of a high-pressure discharge lamp do not need to be preheated. For these lamps, a magnetic ballast combined with an ignitor provides the ignition voltage pulses required to ignite the lamp and then limits the operating current.

The generation of ignition voltage pulses is determined by various ignition methods. Superimposed ignitors generate the ignition voltage in the device itself whereas pulse ignitors produce the requisite voltage in combination with the ballast, which must be adequately insulated against the high-voltage ignition pulses.

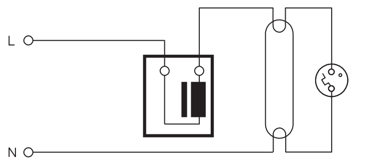


Figure 1
Circuit of a fluorescent lamp with a magnetic ballast

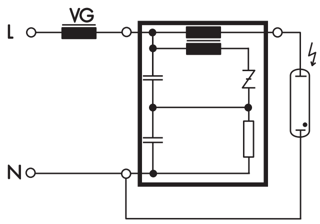


Figure 2
Circuit of a high-pressure discharge lamp with a magnetic ballast and a superimposed ignitor

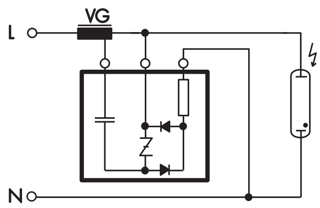


Figure 3
Circuit of a high-pressure discharge lamp with a magnetic ballast and a pulse ignitor

2. Compensation of Idle Current

When using magnetic ballasts a phase shift occurs between the mains voltage and the current drawn. This phase shift is expressed by the power factor λ, which generally ranges between a value of 0.3 and 0.7 with inductive circuits.

Power factor values range between 0.3 and 0.7 with inductive circuits.

As a result of this phase shift, reactive current, which does not boost the efficiency of the lighting unit, is also taken up from the power supply network in addition to real power. Power utility companies therefore require an increase of the power factor to values of over 0.85 for systems exceeding a certain size (usually upwards of 250 W per external conductor).

Compensation capacitors are used to counteract reactive current (increased power factor) and are basically either connected in parallel or in series. Compensation capacitors are not required when using electronic ballasts, whose power factor is generally in the region of 0.95.

2.1 Compensation using Series Capacitors

Series compensation employs a so-called dual circuit (two fluorescent lamp circuits connected in parallel), whereby the capacitor, which is connected in a branch of the circuit, overcompensates the inductive reactive current to such an extent that it covers the reactive current of both ballasts. This type of circuit is only used with fluorescent lamps. As series capacitors are dimensioned for nominal-voltage and ballast tolerances, the lamp in the capacitor branch of the dual circuit operates with a higher current and thus also with a higher rating. Apart from differences in brightness, power loss is also higher in the circuit branch with the capacitor.

Please note that series resonance between the ballast and the capacitor leads to a series capacitor operating at higher-than-mains voltage. The nominal voltage of a series capacitor is thus higher than mains voltage.

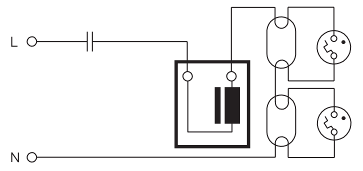


Figure 4
Series compensation in a branch of the dual circuit with a series capacitor, magnetic ballasts and starters

An advantage of the dual circuit is that it prevents the radiated light from flickering.

A little known fact is that a so-called capacitive lamp circuit operates with a high current, which can lead to a higher lamp rating (up to 14% increase) and a reduction of the lamp service lifetime (up to 20% shorter). This goes hand in hand with substantial technical, ecological and economic disadvantages.

Series capacitors have to meet very high technical requirements to suit various aspects like temperature, nominal voltage, tolerances of the capacitance values, etc.

Series capacitors have to meet very high technical requirements.

2.2 Parallel Compensation

During parallel compensation, each lamp circuit is assigned a capacitor connected in parallel to the mains. Only one capacitor providing sufficient capacitance is needed for luminaires with several lamps. Parallel compensation does not affect current flow through a discharge lamp. The requirements placed on parallel capacitors are clearly lower than those for series capacitors.

However, parallel compensation can be subject to limitations when using audio-frequency ripple control pulses if the system operates with a connected rating of over 5 kVA and ripple control frequencies of over 300 Hz are used. The respective power utility company should be consulted for advice in such cases.

Parallel compensation is used in fluorescent lamp and high-pressure discharge lamp circuits.

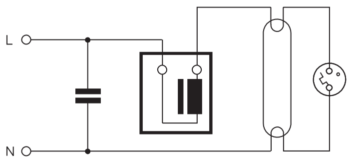


Figure 5
Parallel compensation
of a fluorescent lamp circuit

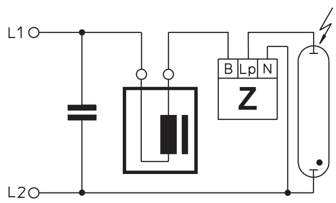


Figure 6
Parallel compensation
of a high-pressure discharge lamp circuit
with a superimposed ignitor

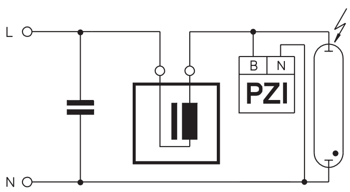


Figure 7
Parallel compensation of a high-pressure
discharge lamp circuit with a pulse ignitor

Advantages of parallel compensation for fluorescent lamp circuits:

- no additional noise suppression capacitor needed
- longer lamp service lifetime due to improved preheating
- lower lamp replacement and disposal costs
- longer service lifetime of lamp components due to lower thermal load
- quicker start
- energy savings due to lower system rating

2.3 Ballast Directive 2000/55/EC and Compensation of Lighting Systems

In accordance with the ballast directive 2000/55/EC, the total power consumption of lamp-ballast circuits must not exceed certain limits.

As defined by the directive (European Standard EN 50294 governing the measurement of total power consumption), a series capacitor is considered to be a part of the ballast. If the system rating of the capacitive circuit containing the lamps and ballasts is then determined in line with the above definition, rating increases of up to 14% will become apparent in comparison to operation without a series capacitor. Experience has shown that this increased power consumption often means devices fall in the directive's "banned" category. It is therefore strongly advised that due consideration be given to the elevated power consumption values common to using series capacitors for compensation purposes.

2.4 Uniform Compensation Method

In view of the increasing exchange of goods on the European and international markets, it would make sense to use a uniform method of compensation within the lighting industry.

Parallel compensation has become the accepted method in the last few years.

As parallel compensation offers substantial advantages, this has become the accepted method in the last few years.

While series compensation has been in common use in German-speaking countries up to now, parallel compensation is now being given increasing preference in these regions, too.

In addition to that, various European industrial associations recommend making parallel compensation the sole method of choice to ensure the limits specified by the ballast directive are safely observed, thus excluding any risk when retailing luminaires within the directive's area of validity.

3. Metallised Polypropylene Film Capacitors

Metallised polypropylene film capacitors are designed to compensate the inductive idle current drawn by discharge lamps (fluorescent lamps, high-pressure mercury vapour lamps, high-pressure sodium vapour lamps and metal halide lamps with a ceramic discharge tube) in 50 Hz and 60 Hz networks. All Vossloh-Schwabe compensation capacitors (series and parallel) for luminaires feature a metallised polypropylene film dielectric. Compensation capacitors help to increase the power factor to values of over 0.85 as required by power utility companies.

3.1 Construction of Metallised Polypropylene Film Capacitors

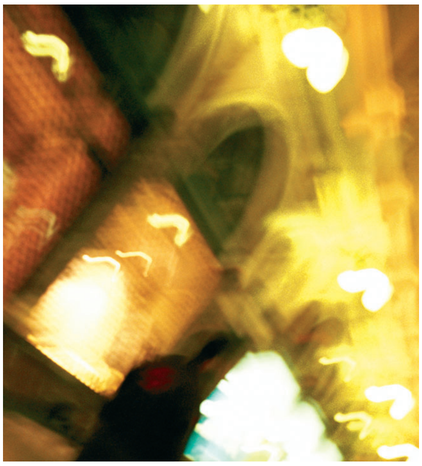
VS MKP capacitors contain a low-loss metallised polypropylene film dielectric, which is produced by vapour-depositing a thin layer of zinc and aluminium or pure aluminium onto one side of the polypropylene film. The contacts at either end of the capacitor elements are created by spraying on a layer of metal and thus guarantee a high current carrying capacity as well as a low-inductive connection between the terminals and the elements.

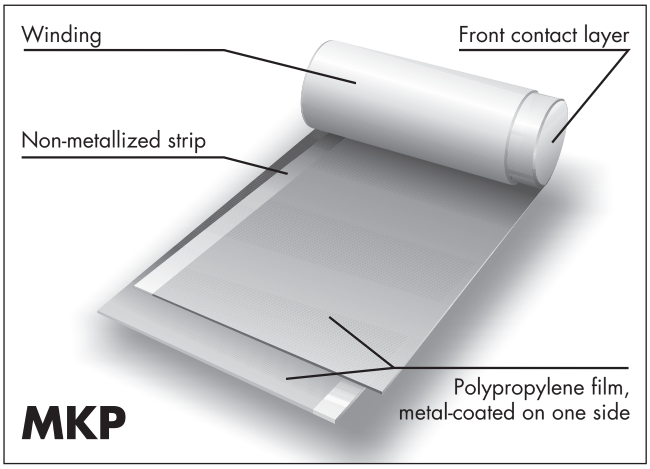
All capacitors with a nominal voltage upwards of 280 V are filled with oil or resin after the coils have been inserted and then hermetically sealed. This protects the elements from environmental influences and reduces partial discharge, which contributes to a long service lifetime and stable capacitance. Partial discharge effects only play a lesser role with capacitors with a nominal voltage of under 280 V so that these devices do not need to be filled.

In critical ambient conditions, hermetically sealed, filled capacitors with an overpressure break-action mechanism should always be used.

In critical ambient conditions (high humidity, aggressive atmospheres, high temperatures), if the workload and power supply conditions are unknown as well as in situations that demand increased attention to safety, hermetically sealed, filled capacitors with an overpressure break-action mechanism should always be used

All VS metallised polypropylene film capacitors are absolutely free of PCBs (polychlorinated biphenyls).





VS MKP capacitors feature a self-healing dielectric. In the event of a dielectric breakdown in the coil (short circuit), the metal coating vaporises around the breakdown site owing to the high temperature of the transient arc that is produced. Owing to the excess pressure generated during such a breakdown, the metal vapour is pushed outwards away from the centre of the site within the space of just a few microseconds. This creates a coating-free corona around the breakdown site that completely isolates it and means the capacitor remains fully functional during a dielectric breakdown.

The self-healing properties of a capacitor can decrease with time and with constant overloading. This bears the risk of a non-healing breakdown with a permanent short circuit. Therefore "self-healing" must not be confused with "failsafe".

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Compensation capacitors are divided into two type families (A and B) in accordance with IEC 61048 A2.

- Type A capacitors are defined as: "Self-healing parallel capacitors; without an (overpressure) break-action mechanism in the event of failure". They are referred to as unsecured capacitors.

- Type B capacitors are defined as: "Self-healing capacitors for series connection in lighting circuits or self-healing parallel capacitors; with an (overpressure) break-action mechanism in the event of failure". These are referred to as hermetically sealed, secured capacitors.

In accordance with the standard, the dis-charge resistor of both capacitor families must be capable of reducing capacitor voltage to a value of under 50 V within of 60 seconds.

The integrated discharge resistor of a capacitor must be capable of reducing capacitor voltage to a value of under 50 V in 60 seconds.

3.2 Capacitors with an Automatic Cut-Out, secured Type B Capacitors in accordance with IEC 61048 A2

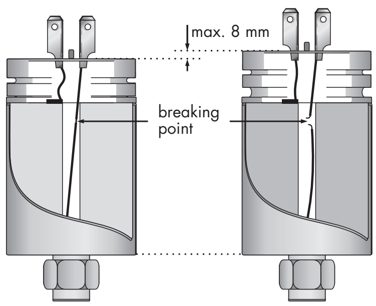
Self-healing capacitors do not require short-circuit protection for normal operation as they automatically regenerate after a dielectric breakdown. However, as a result of frequent self-healing caused by overloading (voltage, current, temperature) or towards the end of the capacitor's service lifetime, overpressure can build up in the capacitor (due to the decomposition products of the vaporised polypropylene).

In order to prevent the capacitor casing from exploding in such cases, hermetically sealed capacitors in accordance with IEC 61048 A2 (Type B capacitors) are fitted with an overpressure break-action mechanism. If excess pressure builds up within these capacitors, e.g. due to overload thermal or excessive voltages or at the end of the capacitor's service lifetime, a concertina section opens out that causes the casing to expand lengthways. As a result, the wire ruptures at a predetermined breaking point, which irreversibly interrupts the current.

This type of overpressure-protected capacitor with contact breaker is also referred to as a flame- and explosion-proof capacitor with a break-action mechanism.

Type B capacitors with a break-action mechanism are available in an aluminium casing.

Contact breaker



3.3 Capacitors without a Break-Action Mechanism, unsecured, Type A Capacitors in accordance with IEC 61048 A2

IEC 61048 A2-compliant Type A capacitors are also self-healing and require no short-circuit protection for normal operation.

However, in contrast to Type B capacitors, Type A capacitors are not fitted with a specific failsafe mechanism as prescribed by the standards for Type B capacitors. Nevertheless, the requirements laid down in the standard for Type A capacitors, especially with regard to temperature and service lifetime tests, are designed to ensure a sufficient degree of device safety and **availability provided the device was correctly installed and operated under calculable and known ambient operating conditions**.

Even so, in rare cases these capacitors can still develop erratic behaviour due to overloading or at the end of the device's service lifetime.

Type A capacitors should only be integrated into luminaires due for operation in uncritical ambient conditions.

For that reason, Type A capacitors should only be integrated into luminaires for operation in ambient conditions that are uncritical with regard to flammable materials. Luminaires should feature protection against secondary damage inside and outside the luminaire in the event of a defect.

Temperature-protected capacitors are a further development of Type A capacitors and are fitted with a thermal fuse that is triggered by overheating as a result of electrical or thermal overloading. They are tested in accordance with EN 61048 A2 and comply with Type A requirements. Excess temperatures cause the two wire ends of the element inside the fuse to melt into bead shapes that are fully isolated from each other by special insulation. In 99% of all the rare cases of critical capacitor failure, this is preceded by a gradual increase in the loss factor, which is in turn always accompanied by an increase in the winding temperature.

By disconnecting the device from the mains, the fuse thus provides effective thermal protection in most cases of capacitor failure.

Vossloh-Schwabe recommends that preference be given to Type A capacitors with a thermal fuse as a matter of course for reasons of safety.

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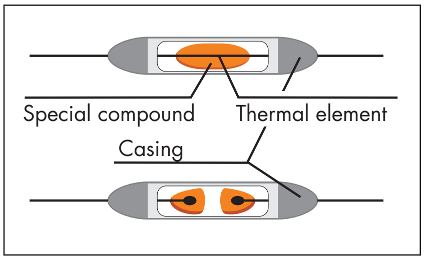
Type A capacitors normally feature a plastic casing.



4. Requirements for Installing Capacitors in Luminaires

Luminaire safety is tested in accordance with the luminaire standard IEC 60598-1, which therefore also includes the requirements placed on capacitors destined for installation in luminaires. Section 12 of IEC 60598-1 specifies endurance and temperature tests, which also take consideration of the ambient temperature when the luminaire is in use (application temperature). If a luminaire is not marked to the contrary, it will have been designed for operation at an ambient temperature of 25° C. Temperature readings at the capacitor within a luminaire are therefore also taken on the basis of this standard ambient temperature for luminaires.

If a luminaire is not marked to the contrary, it will have been designed for operation at an ambient temperature of 25° C.

Table 12.1 of IEC 60598-1 specifies the maximum permissible temperatures for luminaire components. In accordance with this table, components with a t_c marking like capacitors, starters, electronic ballasts or converters, etc. must comply with these t_c values during lamp operation. t_c values can be exceeded by a maximum of 5 K.

The test voltage applied when reading the temperature at the t_c point of a capacitor must equal 1.06 times the nominal voltage. Thus, a test voltage of 243.8 V test voltage needs to be applied given a 230 V power supply and a 230 V ballast and a test voltage of 254.4 V given a 240 V power supply. The maximum permissible temperature at a capacitor's tc point (surface of the capacitor) must not be exceeded at these test voltages. The best place to install a capacitor in a luminaire must be determined under these thermal conditions. Ballasts and lamps, in the latter case especially the regions around the lamp electrodes, can have an unfavourable effect on the capacitor's thermal load, which is made up of its inherent heating, the ambient temperature and any heat possibly radiated by the lamp.

When determining where to install a compensation capacitor in a luminaire (based on measurements of the thermal load) it must be remembered that the thermal balance within the luminaire can change as the lamp's rating will change in the course of its service lifetime.

Apart from the normal effects associated with an ageing lamp, like a drop in efficiency with higher lamp temperatures within the luminaire, the rectifier effect and bulb blackening towards the end of the lamp's service lifetime can lead to a clear increase in temperature within the luminaire, in particular with high-pressure discharge lamps.

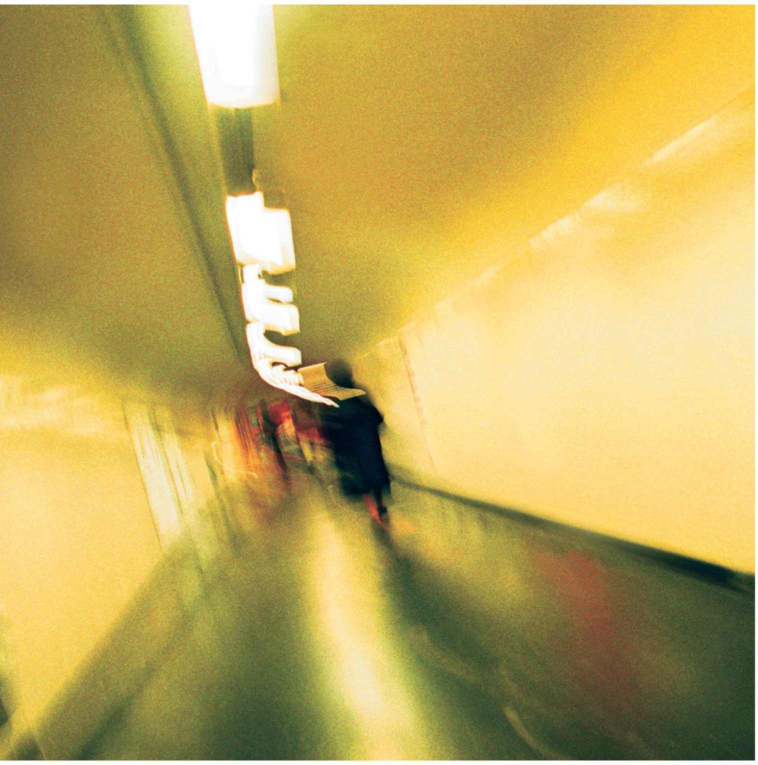
The built-in thermal fuses or temperature switches are only triggered to interrupt the lamp circuit when maximum temperature limits are reached. Operation under such circumstances exerts substantial thermal stress on the capacitor. Temperature increases of 10° C, caused by bulb blackening, are not uncommon and are still normal occurrences. The rectifier effect can even cause substantially higher temperatures.

Against this background in particular, capacitors installed in luminaires should remain well within the set temperature limits. A safe margin up to the maximum capacitor temperature is a further indicator of luminaire quality.

To avoid critical temperatures lamps should therefore be exchanged at the first sign of having reached the end of their service lifetime.

Lamp manufacturers list the following signs of a lamp having reached the end of its service lifetime:

- major change in light colour
- major reduction in brightness
- cyclic starting behaviour
- failure to start



Exceeding the nominal voltage of the capacitor is only permissible within the framework of the stipulated maximum values (in accordance with the standard):

Excess Voltage	Service Lifetime
1.0 x U_n	100 %
1.1 x U_n	42 %
1.15 x U_n	28 %
1.2 x U_n	19 %
1.3 x U_n	9 %

The table shows how sensitive capacitors are to excess voltage. The following formula (as used for the figures in the table) can be used to calculate service lifetime in the event of excess voltage:

$$\text{Service lifetime at excess voltage} = \left(\frac{\text{Nominal Voltage}}{\text{Excess Voltage}}\right)^9 \times \text{Service lifetime at nominal voltage}$$

This means that increasing the operating voltage of a capacitor rated for a nominal voltage of 250 V by just 10 V to 260 V will shorten its service lifetime by 30%. The expected service lifetime will thus only attain 70% of its potential.

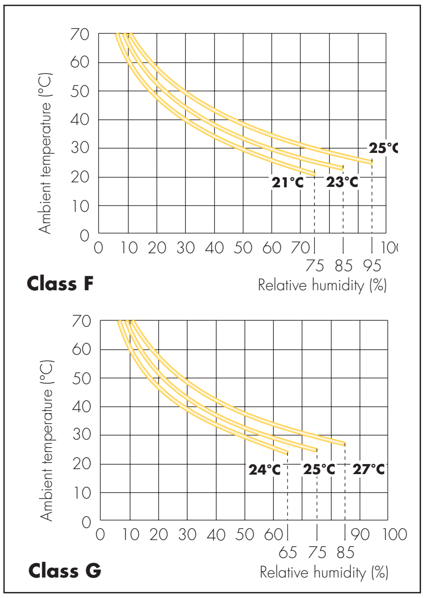
5. Practical Notes on Using Compensation Capacitors

Capacitors can be installed any way up and are fixed using M8 screws or M12 base screws. In addition, in plastic casing capacitors are also available with a side clip. However, capacitors fitted with overpressure protection require clearance of at least 10 mm above the contacts so ensure the casing can expand unhindered if the contact breaker is triggered.

Next to the installation conditions, special attention needs to be paid to the capacitor's voltage and temperature. VS capacitors are designed for continuous operation at the specified nominal voltage and temperature, whereby IEC 61048 A2 provides for a permissible failure rate of 3% over the capacitor's service lifetime of 30,000 hours. Exceeding either the nominal voltage or temperature will shorten the capacitor's service life. The specified maximum temperature refers to the permissible temperature (t_c point) at the surface of the capacitor.

Capacitors must not be subjected to condensation. The specified humidity levels must not be exceeded, even during storage as this also bears the risk of impairing the device's capacitance and shortening its service lifetime.

Capacitors must not be subjected to condensation.



Maximum Relative Humidity Values of the Component's Ambient Atmosphere as determined by the Ambient Temperature for Classes F and G (in accordance with IEC 60068-2-3)

The following table provides experience values regarding the service lifetime of capacitors. A 3% to 10% reduction in capacitance and a failure rate of 1‰ per 1,000 hours of operation can be expected over a capacitor's service lifetime. Overheating, voltage overloads, mains harmonics and high humidity levels all go to shorten the service lifetime of a capacitor.

Capacitor Type	Expected Service Lifetime (hrs)
Parallel capacitors with overpressure protection	approx. 75000
Parallel capacitors without overpressure protection with a plastic or aluminium casing	approx. 50000
Series capacitors with overpressure protection	approx. 50000

All of Vossloh-Schwabe's plastic capacitor casings are made of flame-retardant materials. The fire load of an MKP capacitor amounts to approx. 40 MJ/kg.

Next to overheating, excess operating voltages or high humidity levels and unduly high mains harmonics levels can also shorten a device's service lifetime or increase its failure rate.

All of Vossloh-Schwabe's plastic capacitor casings are made of flame-retardant (self-extinguishing) materials. The fire load of an MKP capacitor amounts to approx. 40 MJ/kg.

VS capacitors are free of PCBs, solvents and other hazardous or banned substances and therefore do not need to be marked in accordance with the directive on hazardous substances. The requirements of the RoHS Directive 2002/95/EG (Restriction of the Use of Hazardous Substances) have been complied with by Type B capacitors produced since May 2005 and by Type A capacitors produced since November 2005.

6. Impact of Voltage Overloads and Mains Harmonics on Parallel Compensation Capacitors

6.1 Impact of Voltage Overloads

Most luminaire capacitors rated for a nominal voltage of 250 V are operated at a nominal mains voltage of 230 V. In some countries, like the UK, the nominal mains voltage is 240 V. Taking account of permissible tolerances, voltages can range between 210 V and 264 V. However, practical experience has shown that some power supply networks can achieve voltages of more than 275 V for a variety of reasons (capacitive overload, stepped-up transformers and low-load operation).

Brief periods of substantially higher voltages are conceivable and must be expected should lightning strike or in the event of short interruptions, uncontrolled switching operations, sudden load variations and mains supply problems.

The original safety margin of a 250 V capacitor has long been exhausted as a result of deteriorating mains power quality.

The safety margin of a 250 V capacitor has long been exhausted as a result of deteriorating mains power quality.

6.2 Impact of Mains Harmonics

There is no doubt that the impact of mains harmonics on electrical systems, devices and components has steadily increased in the last few years. In many regions and consumer systems the tolerable limits are not only not observed, but are in part considerably exceeded, particularly during low-load periods. There is a general increase in damage resulting from mains harmonics, a problem that particularly affects parallel compensation capacitors.

In many European power supply regions it is therefore mandatory to fit larger compensation capacitors and central compensation systems with harmonic filter reactors in order to protect capacitors.

6.3 Special Protective Measures against Voltage Overloads and Mains Harmonics

The special conditions affecting the subsequent on-site operation of a lighting system, e.g. ambient temperatures, humidity, possibly chemical influences or radiation, overloads and mains harmonics, are unknown during the planning stage.

Often enough, capacitors already come close to their thermal limits during normal operation. If voltage overloads or increased mains harmonics are then added at the actual place of operation, a capacitor can overheat and in the case of unsecured Type A capacitors can even catch fire as this type of capacitor is not disconnected from the mains when it reaches this critical overheating point.

This constant rise in mains harmonics is particularly responsible for causing increasingly frequent problems with electrical appliances and components.

As mains-parallel capacitors are at special risk from voltage overloads and mains harmonics, every Vossloh-Schwabe luminaire capacitor is subjected to special testing that largely takes account of the additional stress caused by the altered power supply conditions. These tests attach special importance to increased current and pulse carrying capacity. These measures, which far exceed the requirements of IEC 61048 A2, ensure a high degree of safety, quality and availability.

Any residual risk can be nearly completely eliminated by integrating a fuse into the electrical circuit to protect against overloading.

However, although a residual risk remains, this can be nearly completely eliminated by integrating a fuse into the electrical circuit to protect against overloading.

Type A capacitors should also be fitted with an "emergency brake" of this kind. The VS product range therefore includes a favourably priced Type A capacitor with a thermal fuse that has been shown to prevent the capacitor from overheating with a 99% degree of certainty and thus to exclude any danger to the environment.

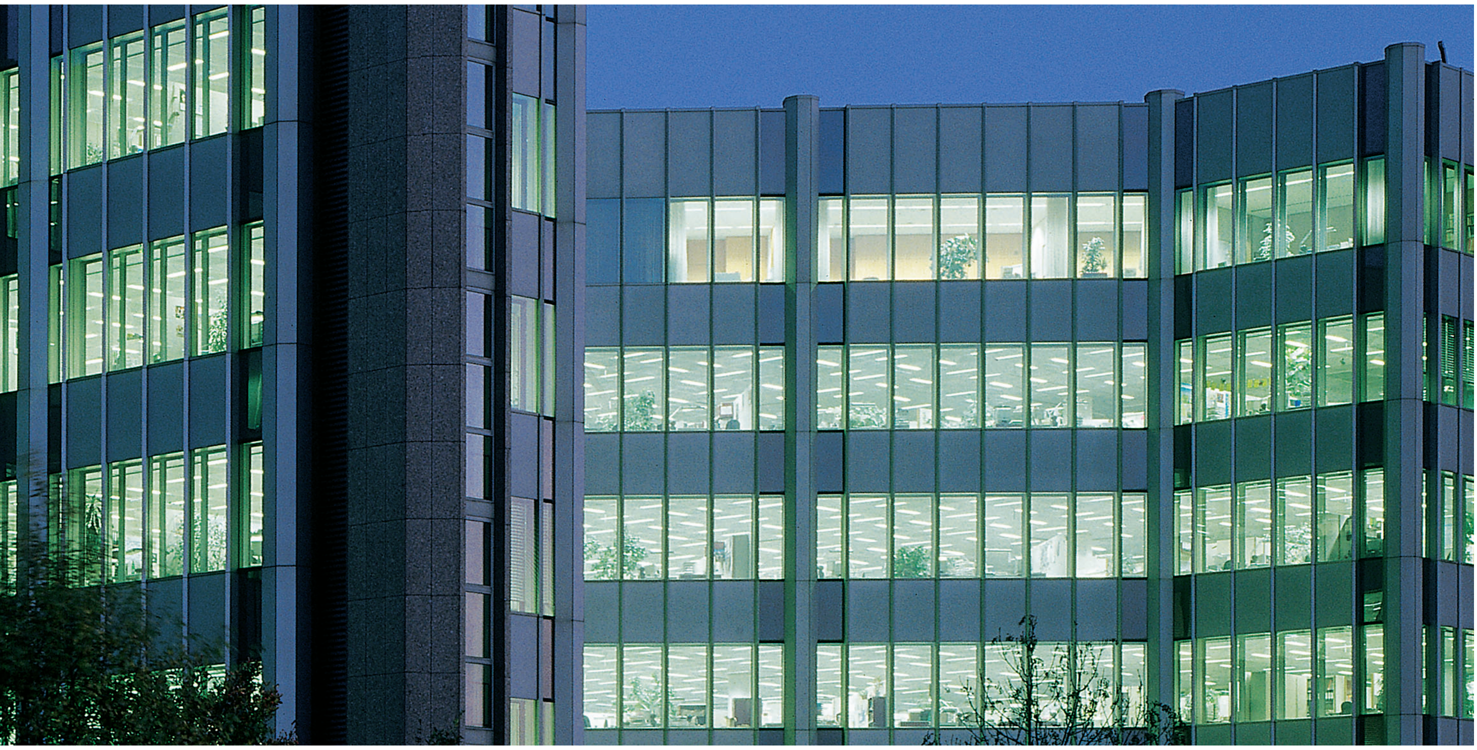
7. Application Notes on Luminaire Capacitors

The capacitance required to compensate for the inductive reactive current of a magnetic ballast is specified by the ballast manufacturer and can be taken from the technical documentation of the ballast. The recommended capacitances for standard VS ballasts are also detailed in Section 8 of this information brochure.

The technical and constructive selection criteria for compensation capacitors for luminaires are:

- **Type of circuit**
  Parallel/Series
- **Mains Voltage/Mains Conditions**
  Consideration is taken of external influences like voltage overloads and mains harmonics
- **Thermal Load**
  Due to inherent heating in the luminaire but also due to external influences at the place of installation
- **Environmental Influences**
  Major temperature changes, e.g. outdoor luminaires, extreme humidity, e.g. in greenhouses, impact of chemicals, etc.
- **Luminaire Construction**
  Construction to protect against external secondary damage in the event of capacitor damage
- **Place of Operation**
  Special risks for luminaire components, e.g. due to shock and impact in gymnasiums; equally, danger to the public in the event of a fault, e.g. when operated in sensitive environment conditions

The above criteria are designed to help luminaire manufacturers make a targeted and critical choice with regard to an application-relevant capacitor. Luminaire construction and on-site operational loading determine the resulting requirements and the risk potential.



If in doubt, a secured capacitor should always be given preference.

Choosing a luminaire capacitor should always be determined by the capacitor's technical suitability for its intended purpose. However, this golden rule is not always followed in practice owing to constantly rising price pressure and also due to increasing carelessness because of low component failure rates. Unsecured Type A capacitors should only be used after carefully weighing the possible risks. If in doubt, a secured capacitor should always be given preference.

Typical Applications

Typical Applications/Special Factors	Recommended Capacitor Type
Luminaires operated with series compensation at 230...240 V mains	Type B series capacitor, 480 V
Luminaires for greenhouse use (extreme humidity)	Filled Type B capacitor, filled Type A capacitor with a thermal fuse (e.g. VS Q102 attachment for 250 W, 400 W und 600 W luminaires)
Luminaires for outdoor installation (temperature changes, humidity)	Type B capacitor
Recess-mounted ceiling luminaires, open to the bottom, and comparable constructions (without constructive protection against secondary damage inside and outside of the luminaire in the event of capacitor damage)	Type B capacitor, Type A capacitor with a thermal fuse
Luminaires exposed to high thermal loads	Type B capacitor (t_c max. 100 °C)Type A capacitor with a thermal fuse (t_c max. 85 °C, possibly with an aluminium can)
Luminaires for highly stressed mains conditions (poor mains quality with overloads and mains harmonics and if the mains quality is unknown)	Type B capacitors (possibly rated for a higher nominal voltage than 250 V) Type A capacitor with a thermal fuse (max. available nominal capacitor voltage = 250 V)
Luminaires for sensitive environments (critical in the case of fire: hospitals, schools, department stores, etc. and in cases where liquid fillings are not desired)	Dry Type B capacitor (max. available nominal capacitor voltage = 250 V) Type A capacitors with a thermal fuse
Interior lighting with a moderate thermal load and constructive protection against secondary damage inside and outside of the luminaire in the event of capacitor damage	Type A capacitor with a thermal fuse, Type A capacitor without a thermal fuse (for use in non-critical environments and under normal mains conditions)

The above table can only sketch out the various factors and influences that must be taken into consideration when selecting a capacitor. It is not exhaustive and serves only as a recommendation.

If there is any uncertainty as to loading conditions, a capacitor should always be selected in line with the principle of "safety first". A Type B capacitor will thus always be the No. 1 choice and can safely replace any Type A capacitor from a technical point of view. In the event of a voltage overload or a defect, regardless of whether this occurs externally or internally, a Type B capacitor will be permanently disconnected from the mains. The basic function of the luminaire will remain unaffected and there will be no risk for third parties.

For functional and manufacturing reasons, aluminium can capacitors (all Type B capacitors) cannot be provided with an ALF terminal or with a side clip.

8. Selection Tables for Capacitors

The capacitance values assigned to the individual luminaires are detailed in the following tables, whereby the capacitance values required to compensate reactive current are dependent on the induction values of the respective ballast. Changes to the ballasts can lead to necessary changes in the capacitance values of the compensation capacitors.

Owing to the advantages of parallel compensation and the widespread use of this type of circuit, Vossloh-Schwabe's range mainly comprises capacitors suitable for parallel compensation circuits.

The range includes Type A parallel capacitors in plastic and aluminium casings with an integrated discharge resistor. These devices can be provided with push-in as well as IDC terminals for automatic luminaire wiring.

Type A capacitors can also be as on option provided with an integrated thermal fuse.

In addition, Type B parallel capacitors are also available with an aluminium casing with an integrated discharge resistor and push-in terminals or flat connectors.

8.1 Capacitors for Fluorescent Lamp Circuits

Lamp		Parallel Compensation Capacitor (µF ±10% at 250 V)		Series Compensation Capacitor (µF ±4%)		
Output W	Type	220–240 V/50 Hz µF	220–230 V/60 Hz µF	220 V/50 Hz µF	230 V/50 Hz µF	220 V/60 Hz µF
4	T	2**	2**	–	–	–
6	T	2**	2**	–	–	–
8	T	2**	2**	–	–	–
10	T	2	2	–	–	–
13	T	2	2	–	–	–
14	T	4.5	4.5	–	–	–
15	T	3.5 or 4*	3 or 4*	–	–	–
16	T	2	2	–	–	–
18	T	4.5 or 4*	4**	2.9/440 V	2.8/480 V	2.4/440 V
20	T	4.5 or 4*	4**	2.9/440 V	2.8/480 V	2.4/440 V
23	T	3.5	3	–	–	–
25	T	3.5	3	–	2.3/450 V	–
30	T	4.5	4	3/420 V	2.9/450 V	–
36	T	4.5	4	3.6/420 V	3.4/450 V	3/420 V
36-1m	T	6.5	–	–	–	–
38	T	4.5	4	–	–	–
40	T	4.5	4	3.6/420 V	3.4/450 V	3/420 V
42	T	6.5	–	–	–	–
58	T	7	6	5.7/450 V	5.3/450 V	4.8/420 V
65	T	7	6	5.7/450 V	5.3/450 V	4.8/420 V
70	T	6	–	–	–	–
75	T	6	–	–	–	–
80	T	9	8	–	7.2/420 V	–
85	T	8	6.5	–	8.4/420 V	–
100	T	10	9	–	–	–
115	T	18	16	–	–	–
140	T	14	14	–	–	–
160	T	14	14	–	–	–
16	T-U	2	2	–	–	–
18/20	T-U	4.5 or 4*	4**	2.9/440 V	2.8/480 V	2.4/440 V
36/40	T-U	4.5	4	3.6/420 V	3.4/450 V	3/420 V
58/65	T-U	7	6	–	–	–
22	T-R	5	4.5	–	3.2/440 V	–
32	T-R	5	4.5	–	3.4/450 V	–
40	T-R	4.5	4	3,6/420 V	3.4/450 V	3/420 V
5	TC-S	2**	2**	–	–	–
7	TC-S	2**	2**	–	–	–
9	TC-S	2**	2**	–	–	–
11	TC-S	2	2	–	–	–
10	TC-D/TC-T	2	2	–	–	–
13	TC-D/TC-T	2	2	–	–	–
18	TC-D/TC-T	2	2	–	–	–
26	TC-D/TC-T	3.5	3	–	–	–
10	TC-DD	2	2	–	–	–
16	TC-DD	2	2	–	–	–
21	TC-DD	3	3	–	–	–
28	TC-DD	3.5	3	–	–	–
38	TC-DD	4.5	4	–	–	–
18	TC-L/TC-F	4.5 or 4*	4**	–	–	–
24	TC-L/TC-F	4.5	4	–	–	–
34	TC-L/TC-F	4.5	4	–	–	–
36	TC-L/TC-F	4.5	4	–	–	–

*) Two lamps connected to a ballast in series **) Applies to one lamp connected to a ballast or two lamps connected in series

8.2 Capacitors for High-Pressure Mercury Vapour Lamp Circuits

Lamp		Compensation Capacitor (µF ±10%)			
Output W	Type	220 V/50 Hz µF	230 V/50 Hz µF	240/252 V/50 Hz µF	220 V/60 Hz µF
50	HM	7	7	7	6
80	HM	8	8	8	7
125	HM	10	10	10	10
250	HM	18	18	18	15
400	HM	25	25	25	25
700	HM	40	40	40	35
1000	HM	60	60	60	50

8.3 Capacitors for High-Pressure Sodium Vapour Lamp Circuits

Lamp		Compensation Capacitor (µF ±10%)			
Output W	Type	220 V/50 Hz µF	230 V/50 Hz µF	240/252 V/50 Hz µF	220 V/60 Hz µF
35	HS	6	6	6	5
50	HS	8	8	8	8
70	HS	12	12	12	10
100	HS	12	12	12	10
150	HS	20	20	20	16
250	HS	32	32	32	25
400	HS	50	50	50	40
600	HS	65	65	65	55
1000	HS	100	100	100	85

8.4 Capacitors for Low-Pressure Discharge Lamp Circuits

Lamp		Compensation Capacitor (µF ±10%)
Output W	Type	230 V/50 Hz µF
35	LS	20
55	LS	20
90	LS	26
135	LS	40
180	LS	40

8.5 Capacitors for Metal Halide Lamp Circuits

Lamp			Compensation Capacitor (µF ±10%)			
Output W	Current A	Type	220 V/50 Hz µF	230 V/50 Hz µF	240/252 V/50 Hz µF	220 V/60 Hz µF
35		HI	6	6	6	5
70		HI	12	12	12	10
100		HI	12	12	12	10
150		HI	20	20	20	16
250		HI	32	32	32	25
400		HI	35/45	35/45	35/45	35/45
1000		HI	85	85	85	75
2000	16.5	HI	125	125	125	125
			380 V/50 Hz	400 V/50 Hz	420 V/50 Hz	380 V/60 Hz
2000	8.8	HI	37	37	37	37
2000	10.3	HI	60	60	60	60
2000	11.3	HI	60	60	60	60
2000	18	HI	100	100	100	100

9. Technical Details of Vossloh-Schwabe Parallel Capacitors

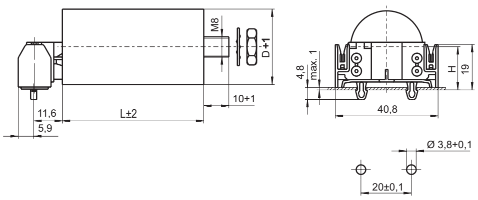
All VS capacitors comply with IEC 61048 A2 (Safety) and IEC 61049 (Operation). Capacitors rated 250 V and 280 V also bear the ENEC mark.

- Nominal voltage
  250 V, 50/60 Hz;
  280 V, 50/60 Hz;
  450 V, 50/60 Hz (dependent on type)
- Capacitance tolerance: ±10 %; ±5 %
- Temperature range: –40 to +85 °C
- Relative humidity load:
  Class F for Type B capacitors
  75 % annual mean
  95 % peak value on 30 days
  Class G for Type A capacitors
  65 % annual mean
  85 % peak value on 30 days
- Capacitors must not be subjected to condensation
- Failure rates it maximum voltage, current and temperature values are complied with = 1 ‰ per 1000 operating hours
- Permissible torque on the base screw:
  M8x10 – 5.0 Nm (aluminium casing)
  M8x10 – 2.2 Nm (plastic casing)
- Split fixing pins with a clearance of 20 mm for plastic casings (side clip)
- Optional thermal fuse
  (Type A capacitors)
- Connecting wires:
  parallel capacitors for fluorescent lamps
  - Casing diameter 25–30 mm:
    0.5—1 mm^2 and IDC terminals for H05V-U 0.5 conductors
  - Casing diameter >30 mm:
    0.5–1 mm^2

  parallel capacitors
  for high-pressure lamps
  - Casing diameter 25–30 mm:
    0,5–1 mm^2 and IDC terminals for H05V-U 0.5 conductors
  - Casing diameter >30 mm:
    0.5–1.5 mm^2

Type A Capacitors

1



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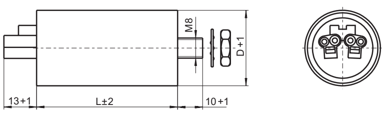

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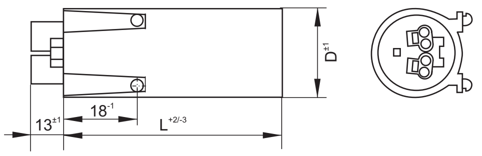

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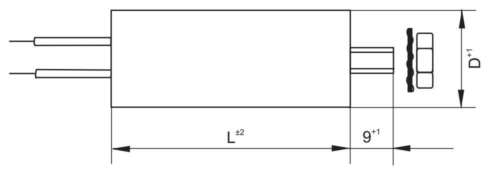

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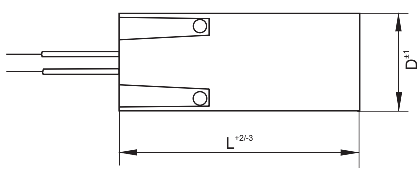

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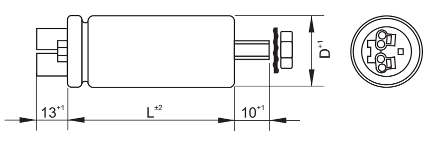
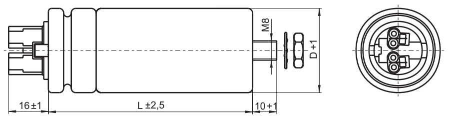


Type B Capacitors

7



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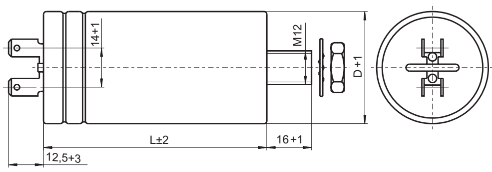

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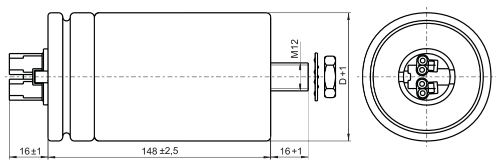

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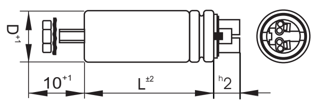

9.1 Type A Capacitors with a Plastic Casing – 250 V

Capacitance μF	**Ref. No.**	Type	Drawing s. p. 18	Dimension Ø/Length mm	Mounting	Filled/ Dry	Terminal	Thermal Fuse	Approval Mark	Unit pcs.	Quantity/ Pallet pcs.
For T/TC Fluorescent Lamps											
2	**500296.03**	40930	1	25/57	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
2	**500296.05**	40930	2	25/57	M8x10 bolt	Dry	Push-in terminal	–	I	530	15900
2	**508397.05**	40954	3	25/57	Side clip	Dry	Push-in terminal	–	I	530	15900
2.5	**500299.03**	40931	1	25/57	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
2.5	**500299.05**	40931	2	25/57	M8x10 bolt	Dry	Push-in terminal	–	I	530	15900
2.5	**525659.05**	41019	2	25/57	M8x10 bolt	Dry	Push-in terminal	yes	I	530	15900
2.5	**529014.05**	41111	2	25/57	M8 bolt without a nut	Dry	Push-in terminal	–	I	530	15900
2.5	**529015.05**	41110	3	25/57	Side clip	Dry	Push-in terminal	–	I	530	15900
3	**500300.03**	40932	1	25/57	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
3	**500300.05**	40932	2	25/57	M8x10 bolt	Dry	Push-in terminal	–	I	530	15900
3.5	**500301.03**	40933	1	25/57	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
3.5	**500301.05**	40933	2	25/57	M8x10 bolt	Dry	Push-in terminal	–	I	530	15900
4	**500302.03**	40934	1	25/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
4	**500302.05**	40934	2	25/70	M8x10 bolt	Dry	Push-in terminal	–	I	450	13500
4	**504367.03**	40980	1	30/55	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
4	**506214.05**	40953	3	25/68	Side clip	Dry	Push-in terminal	–	I	450	13500
4	**526169.01**	40969	4	30/57	M8x10 bolt	Dry	250 mm wire	–	I	300	9000
4.5	**500303.03**	40935	1	25/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
4.5	**500303.05**	40935	2	25/70	M8x10 bolt	Dry	Push-in terminal	–	I	450	13500
4.5	**508672.05**	41014	2	25/70	M8x10 bolt	Dry	Push-in terminal	yes	I	450	13500
4.5	**529012.05**	41113	2	25/70	M8 bolt without a nut	Dry	Push-in terminal	–	I	450	13500
4.5	**529013.05**	41112	3	25/70	Side clip	Dry	Push-in terminal	–	I	450	13500
6	**529296.05**	40978	3	25/70	Side clip	Dry	Push-in terminal	–	I	450	13500
7	**529009.05**	41115	2	30/70	M8 bolt without a nut	Dry	Push-in terminal	–	I	320	9600
7	**529011.05**	41114	3	30/70	Side clip	Dry	Push-in terminal	–	I	320	9600
9	**529007.05**	41117	2	30/70	M8 bolt without a nut	Dry	Push-in terminal	–	I	320	9600
9	**529008.05**	41116	3	30/70	Side clip	Dry	Push-in terminal	–	I	320	9600
12	**529005.05**	41119	2	35/70	M8 bolt without a nut	Dry	Push-in terminal	–	I	250	7500
12	**529006.05**	41118	3	30/95	Side clip	Dry	Push-in terminal	–	I	250	7500

I: ENEC, KEMA 0029985.02 (MKP E01/05)
*capacitors marked with "–" in the "Thermal Fuse" column can also be ordered with a thermal fuse (new reference number).

9.1 Type A Capacitors with a Plastic Casing – 250 V

Capacitance µF	**Ref. No.**	Type	Drawing s. p. 18	Dimension Ø/Length mm	Mounting	Filled/ Dry	Terminal	Thermal Fuse	Approval Mark	Unit pcs.	Quantity/ Pallet pcs.
For T/TC Fluorescent Lamps and HS/HI/HM/LS Discharge Lamps											
5	**500304.03**	40936	1	25/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
5	**500304.05**	40936	2	25/70	M8x10 bolt	Dry	Push-in terminal	–	I	450	13500
6	**500305.03**	40937	1	25/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
6	**500305.05**	40937	2	25/70	M8x10 bolt	Dry	Push-in terminal	–	I	450	13500
6	**504363.05**	40981	1	30/55	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	360	10800
6	**526170.01**	40970	4	25/70	M8x10 bolt	Dry	250 mm wire	–	I	320	9600
6.5	**500306.03**	40938	1	30/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
6.5	**508673.05**	41015	2	30/70	M8x10 bolt	Dry	Push-in terminal	yes	I	320	9600
7	**500307.03**	40939	1	30/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
7	**506495.05**	41009	2	30/70	M8x10 bolt	Dry	Push-in terminal	–	I	320	9600
7	**526852.05**	40973	2	35/57	M8x10 bolt	Dry	Push-in terminal	–	I	280	8400
7.5	**500308.03**	40940	1	30/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
8	**500309.03**	40941	1	30/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
8	**502783.05**	41041	2	30/70	M8x10 bolt	Dry	Push-in terminal	–	I	320	9600
8	**504364.03**	40982	1	30/68	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	9360
8	**505891.05**	40950	3	30/68	Side clip	Dry	Push-in terminal	–	I	320	9600
8	**526171.01**	40971	4	35/57	M8x10 bolt	Dry	250 mm wire	–	I	220	6600
9	**500310.03**	40942	1	30/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
9	**504351.05**	41007	2	30/70	M8x10 bolt	Dry	Push-in terminal	–	I	320	9600
9	**508674.05**	41016	2	30/70	M8x10 bolt	Dry	Push-in terminal	yes	I	320	9600
10	**500311.03**	40943	1	30/70	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
10	**508667.05**	40956	2	30/70	M8x10 bolt	Dry	Push-in terminal	–	I	320	9600
12	**500312.03**	40944	1	30/94	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	6480
12	**502375.05**	41006	2	35/70	M8x10 bolt	Dry	Push-in terminal	–	I	250	7500
12	**504366.03**	40983	1	30/92	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
12	**505818.05**	40951	3	30/92	Side clip	Dry	Push-in terminal	–	I	260	7800
12	**506366.05**	41008	2	30/93	M8x10 bolt	Dry	Push-in terminal	–	I	260	7800
12	**508675.05**	41017	2	30/94	M8x10 bolt	Dry	Push-in terminal	yes	I	260	7800
12	**509286.05**	41018	2	30/70	M8x10 bolt	Dry	Push-in terminal	yes	I	320	9600
12	**509585.01**	40944	5	30/94	Side clip	Dry	300 mm wire	–	I		
12	**526172.01**	40972	4	35/70	M8x10 bolt	Dry	250 mm wire	–	I	200	6000
13	**508669.05**	40958	3	30/95	Side clip	Dry	Push-in terminal	–	I	260	7800
13.5	**526247.05**	41042	2	30/94	M8x10 bolt	Dry	Push-in terminal	–	I	260	7800
15	**500313.03**	40945	1	30/94	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	6480
15	**508468.05**	41013	2	30/94	M8x10 bolt	Dry	Push-in terminal	–	I	260	7800
16	**500314.03**	40946	1	30/94	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	6480
16	**504365.03**	40984	1	30/92	M8x10 bolt	Dry	IDC/Push-in terminal	–	I	72	7920
16	**508668.05**	40957	2	30/95	M8x10 bolt	Dry	Push-in terminal	–	I	260	7800
18	**500315.05**	41000	2	35/94	M8x10 bolt	Dry	Push-in terminal	–	I	190	5700
18	**508670.01**	40959	3	35/95	Side clip	Dry	Push-in terminal	–	I	50	
20	**500316.05**	41001	2	35/94	M8x10 bolt	Dry	Push-in terminal	–	I	190	5700
20	**500808.05**	41005	2	40/70	M8x10 bolt	Dry	Push-in terminal	–	I	170	5100

I: ENEC, KEMA 0029985.02 (MKP E01/05)
*capacitors marked with "–" in the "Thermal Fuse" column can also be ordered with a thermal fuse (new reference number).

9.1 Type A Capacitors with a Plastic Casing – 250 V

Capacitance µF	**Ref. No.**	Type	Drawing s. p. 18	Dimension Ø/Length mm	Mounting	Filled/Dry	Terminal	Thermal Fuse	Approval Mark	Unit pcs.	Quantity/Pallet pcs.
For T/TC Fluorescent Lamps and HS/HI/HM/LS Discharge Lamps											
20	**508671.05**	40960	3	35/95	Side clip	Dry	Push-in terminal	–	I	190	5700
20	**520891.01**	40965	5	35/95	Side clip	Dry	300 mm wire	–	I	50	3500
20	**520969.01**	40967	4	35/95	M8x10 bolt	Dry	300 mm wire	–	I	50	4500
20	**527366.05**	41020	2	35/94	M8x10 bolt	Dry	Push-in terminal	yes	I	190	5700
20	**528552.01**	40974	4	40/70	M8x10 bolt	Dry	250 mm wire	–	I	130	3900
25	**500317.01**	41002	2	40/94	M8x10 bolt	Dry	Push-in terminal	–	I	36	3240
25	**507859.05**	41011	2	40/94	M8x10 bolt	Dry	Push-in terminal	–	I	130	3900
25	**508484.05**	40955	4	40/70	M8x10 bolt	Dry	250 mm wire	–	I	130	3900
25	**527368.01**	41021	2	40/94	M8x10 bolt	Dry	Push-in terminal	yes	I	36	3240
30	**500318.01**	41003	2	40/94	M8x10 bolt	Dry	Push-in terminal	–	I	36	3240
30	**527369.01**	41022	2	40/94	M8x10 bolt	Dry	Push-in terminal	yes	I	36	3240
30	**528553.01**	40975	4	40/94	M8x10 bolt	Dry	250 mm wire	–	I	36	3600
32	**525630.01**	40968	2	45/95	M8x10 bolt	Dry	Push-in terminal	yes	I	32	2880
35	**528554.01**	40976	4	45/95	M8x10 bolt	Dry	250 mm wire	–	I	32	3200
45	**528555.01**	40977	4	50/95	M8x10 bolt	Dry	250 mm wire	–	I	21	2100
For HS/HI/HM/LS Discharge Lamps											
50	**500699.01**	41004	2	55/95	M8x10 bolt	Dry	Push-in terminal	–	I	18	1260

I: ENEC, KEMA 0029985.02 (MKP E01/05)
*capacitors marked with "–" in the "Thermal Fuse" column can also be ordered with a thermal fuse (new reference number).

9.2 Type A Capacitors with an Aluminium Casing – 250 V

Capacitance µF	**Ref. No.**	Type	Drawing s. p. 18	Dimension Ø/Length mm	Mounting	Filled/Dry	Terminal	Thermal Fuse	Approval Mark	Unit pcs.	Quantity/Pallet pcs.
For HS/HI/HM/LS Discharge Lamps											
2	**504243.01**	41064	6	25/47	M8x10 bolt	Dry	Push-in terminal	–	II	98	10780
4	**504242.01**	41065	6	25/54	M8x10 bolt	Dry	Push-in terminal	–	II	98	10780
12	**503255.01**	41055	6	30/70	M8x10 bolt	Dry	Push-in terminal	–	II	72	7920
20	**503256.01**	41056	6	40/70	M8x10 bolt	Dry	Push-in terminal	–	II	36	3960
25	**503257.01**	41057	6	45/70	M8x10 bolt	Dry	Push-in terminal	–	II	32	2880
32	**500319.01**	41050	6	35/135	M8x10 bolt	Dry	Push-in terminal	–	II	50	3500
32	**503258.01**	41058	6	45/90	M8x10 bolt	Dry	Push-in terminal	–	II	32	2880
32	**525548.01**	41075	6	35/135	M8x10 bolt	Dry	Push-in terminal	yes	II	50	4500
35	**500320.01**	41051	6	40/135	M8x10 bolt	Dry	Push-in terminal	–	II	36	2520
40	**500321.01**	41052	6	40/135	M8x10 bolt	Dry	Push-in terminal	–	II	36	2520
40	**504543.01**	41061	6	45/90	M8x10 bolt	Dry	Push-in terminal	–	II	32	2560
40	**527367.01**	41076	6	45/90	M8x10 bolt	Dry	Push-in terminal	yes	II	32	2880
45	**527674.01**	41077	6	40/135	M8x10 bolt	Dry	Push-in terminal	yes	II	36	3600
50	**500322.01**	41053	6	45/135	M8x10 bolt	Dry	Push-in terminal	–	II	32	2240
50	**503259.01**	41059	6	55/95	M8x10 bolt	Dry	Push-in terminal	–	II	18	1260
55	**500323.01**	41054	6	45/135	M8x10 bolt	Dry	Push-in terminal	–	II	32	2240
55	**527673.01**	41078	6	45/135	M8x10 bolt	Dry	Push-in terminal	yes	II	32	3200
60	**503260.01**	41060	6	55/119	M8x10 bolt	Dry	Push-in terminal	–	II	18	1260

II: ENEC, KEMA 2029985.04 (MKP E02/06)

9.3 Type B Capacitors with an Aluminium Casing

Capaci-tance µF	**Ref. No.**	Type	Drawing s. p. 18	Dimension Ø/Length mm	Mounting	Filled/ Dry	Terminal	Protection Device	Approval Mark	Unit pcs.	Quantity/ Pallet pcs.
For T/TC Fluorescent Lamps – 250 V, flame- and explosion-proof with break-action mechanism											
2	**526324.01**	41043	7	25/55	M8x10 bolt	Dry	Push-in terminal	FPU	VI	98	
4	**526325.01**	41044	7	25/73	M8x10 bolt	Dry	Push-in terminal	FPU	VI	98	
6	**526326.01**	41045	7	30/55	M8x10 bolt	Dry	Push-in terminal	FPU	VI	72	
7	**526862.01**	41039	7	25/73	M8x10 bolt	Dry	Push-in terminal	FPU	VI	98	11760
8	**526327.01**	41046	7	25/81	M8x10 bolt	Dry	Push-in terminal	FPU	VI	98	
10	**526328.01**	41047	7	25/93	M8x10 bolt	Dry	Push-in terminal	FPU	VI	98	
12	**526330.01**	41049	7	30/81	M8x10 bolt	Dry	Push-in terminal	FPU	VI	72	
13.5	**529016.01**	41038	7	30/81	M8x10 bolt	Dry	Push-in terminal	FPU	VI	72	6480
16	**526329.01**	41048	7	35/81	M8x10 bolt	Dry	Push-in terminal	FPU	VI	50	
18	**526861.01**	41040	7	35/81	M8x10 bolt	Dry	Push-in terminal	FPU	VI	50	6000
30	**509562.01**	41012	7	40/93	M8x10 bolt	Dry	Push-in terminal	FPU	VI	50	
For T/TC Fluorescent Lamps – 280/300 V, flame- and explosion-proof with break-action mechanism											
60	**505871.01**	41068	7	45/148	M8x10 bolt	Vegetable oil	Push-in terminal	FPU	III	32	1920
65	**505872.01**	41069	7	45/148	M8x10 bolt	Vegetable oil	Push-in terminal	FPU	III	32	1920
75	**506359.01**	41070	9	50/148	M12x16 bolt	Vegetable oil	Push-in terminal	FPU	III	21	1260
85	**506360.01**	41071	9	55/148	M12x16 bolt	Vegetable oil	Push-in terminal	FPU	III	18	1080
90	**506362.01**	41072	9	55/148	M12x16 bolt	Vegetable oil	Push-in terminal	FPU	III	18	1080
100	**506363.01**	41073	9	55/148	M12x16 bolt	Vegetable oil	Push-in terminal	FPU	III	18	1080
125	**500330.01**	41106	8	60/148	M12x16 bolt	Vegetable oil	Blade connector	FPU	III	18	1080
For T/TC Fluorescent Lamps – 450 V, flame- and explosion-proof with break-action mechanism											
13	**505831.01**	41062	7	35/85	M8x10 bolt	Vegetable oil	Push-in terminal	FPU	V	50	4500
18	**505866.01**	41063	7	40/85	M8x10 bolt	Vegetable oil	Push-in terminal	FPU	V	36	3240
28	**505869.01**	41066	7	40/124	M8x10 bolt	Vegetable oil	Push-in terminal	FPU	V	36	2160
32	**505870.01**	41067	7	45/124	M8x10 bolt	Vegetable oil	Push-in terminal	FPU	V	32	1920
37	**500335.01**	41204	10	45/124	M8x10 bolt	Vegetable oil	Blade connector	FPU	V	32	1920
50	**500336.01**	41205	8	50/124	M12x16 bolt	Vegetable oil	Blade connector	FPU	V	21	1470
55	**500337.01**	41206	8	55/124	M12x16 bolt	Vegetable oil	Blade connector	FPU	V	18	1080
60	**500338.01**	41207	8	60/124	M12x16 bolt	Vegetable oil	Blade connector	FPU	V	18	1260
85	**500339.01**	41208	8	60/148	M12x16 bolt	Vegetable oil	Blade connector	FPU	V	18	1080
100	**500340.01**	41209	8	65/148	M12x16 bolt	Vegetable oil	Blade connector	FPU	V	10	600
For T/TC Fluorescent Lamps – 480 V, series, flame- and explosion-proof with break-action mechanism											
3.4	**526096.01**	41029	7	25/68	M8x10 bolt	Vegetable oil	Push-in terminal	FPU	IV	98	10780

III: ENEC, VDE 40001220 (E12)
IV: ENEC, VDE 40000218 (E13)
V: VDE, VDE 40001461 (E33)
VI: ENEC, VDE 40001178 (E11)

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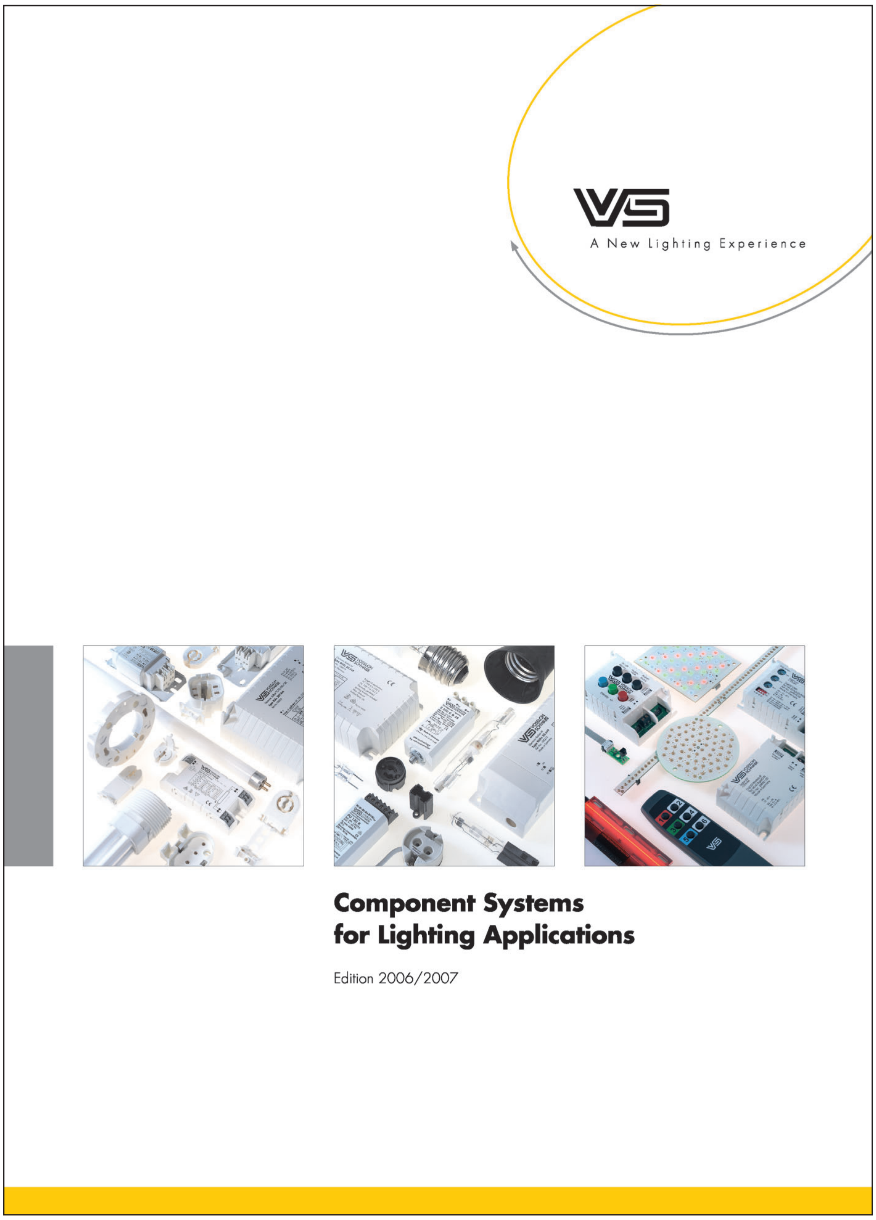

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