



# Technical Application Guide POWERTRONIC®

SEE THE WORLD IN A NEW LIGHT



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Electronic control gear for metal halide lamps and high-pressure sodium vapor lamps have increased substantially in importance in the last few years and now represent the current state of technology.

This technical guide highlights the properties of the electronic control gear and their differences from the conventional magnetic control gear when in operation. It also provides hints and tips for the correct installation and operation of the devices according to the applicable standards. Furthermore, it offers guidelines to the luminaire design, an overview of the important standards and certifications, as well as the links to the relevant OSRAM websites for electronic control gear. This guide is meant to provide a first orientation and not to replace one's own expert check.



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# 1. The system HID lamp and ECG

## 1.1. High-pressure discharge lamps

Metal halide lamps and high-pressure sodium vapor lamps both belong to a group referred to as high-pressure discharge lamps. In contrast to what happens in low-pressure discharge, the discharge tube in such lamps operates at high temperatures and pressures. The light in discharge lamps is generated in a gas discharge that takes place in the arc tube between two electrodes after ignition. In the case of high-intensity discharge lamps, the arc tube is generally housed in an evacuated outer bulb, which thermally insulates the hot arc from the environment in a similar way to the principle used in a thermos flask. However, there are also discharge lamps that do not have any outer bulb, and also ones with an outer bulb filled with gas.

During gas discharge, the metal halide additives and mercury or calcium amalgam are excited by the flow of current and emit excitation energy in the form of the radiation characteristic of each of the elements it contains. The mixture of different radiation components produces the desired color temperature and color rendering properties.

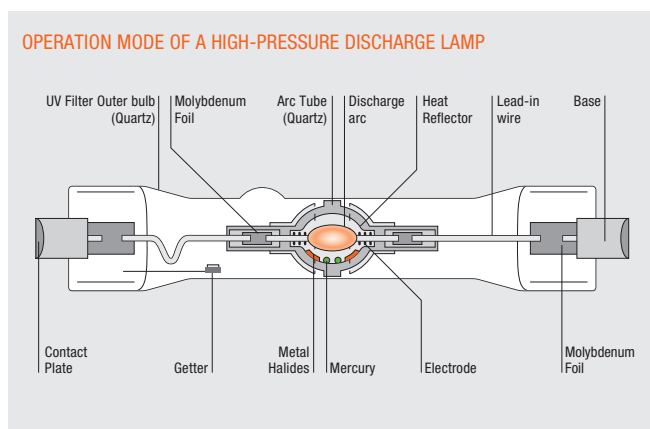


Figure 1: Structure of a quartz burner

The illustration above shows the structure of a metal halide lamp as an example of a double-ended lamp with a quartz burner.

Metal halide lamps and high-pressure sodium vapor lamps are also referred to as HID lamps, which stands for **H**igh **I**ntensity **D**ischarge lamps.

Metal halide lamps can also be referred to as HIT lamps (using the "LBS" lamp designation system):

- H:** High-pressure
- I:** Iodide
- T:** Tubular

They are also often called MH (Metal Halide) lamps. Metal halide lamps are principally characterized by the following properties:

- Good luminous efficacy
- Long service life
- Very good color quality
- Good to very good color rendering
- Point light source, with benefits in light control and lighting brilliance



More detailed information on metal halide lamps can be found in the following application guide: "Metal halide lamps – hints on application and use"

Sodium vapor lamps are also referred to as HS ("High-pressure Sodium") lamps. They are principally characterized by the following properties:

- Optimal energy efficiency
- Long service life
- Good reliability
- Very high luminous efficacy
- Very good lumen maintenance
- Good dimming behavior



More information on sodium vapor lamps can be found in the following application guide: "High Intensity Discharge lamps"

## 1.2. The POWERTRONIC® ECG

Electronic control gear (ECGs) for the operation of metal halide lamps with ceramic (HCl) or quartz burners (HQI) or sodium vapor lamps (NAV) are all referred to using the term POWERTRONIC® at OSRAM.

POWERTRONIC® ECGs replace all the conventional system components of a luminaire (choke, ignition unit and correction capacitor), thus making the assembly substantially simpler. Other benefits include the ability to optimally operate the lamp so as to maximize the lamp service life and minimize the lumen loss.

Electronic control gear has become the right choice for operating metal halide lamps with ceramic burners, as its technical properties are able to make the most of the full potential of such lamps.

**1.2.1. Product range**

POWERTRONIC® ECGs are available in a variety of wattages. For indoor applications, the PTi and PT-FIT control gear (POWERTRONIC® indoor) have been developed for operation of HCI and HQI lamps. For this area of application there are ECGs available that are capable of being connected to one or two lamps. PTo control gear (POWERTRONIC® outdoor) have been developed for outdoor operation of HCI, HQI and NAV lamps.

**1.2.2. Operating principle**

In POWERTRONIC® ECGs for high-pressure discharge lamps, all functions for lamp ignition, lamp operation, including monitoring and lamp shutdown are controlled by a single device.

In order to achieve optimal lamp operation, POWERTRONIC® ECGs convert the sinusoidal alternating voltage from the mains supply into a square-wave voltage with an operating frequency of between 100 and 240Hz. For optimal lamp ignition, up to 4.5kV is supplied by the ECG. But that will not allow the restrike of hot lamps.

The following diagram shows the current and voltage curves at the output end of a 150-W POWERTRONIC® square wave ECG:

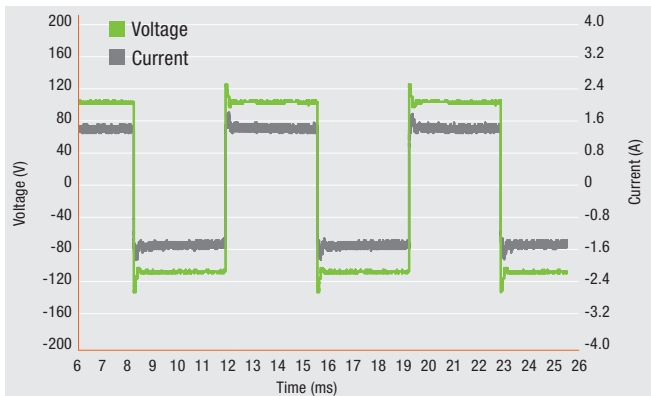


Figure 2: 150 W POWERTRONIC® square-wave ECG

**1.2.3. Benefits of the intelligent POWERTRONIC® ECG**

The following list shows the main benefits of using an intelligent OSRAM POWERTRONIC® ECG:

- Compact and lightweight
- Long service life of ECG at maximum permissible temperatures
- Good thermal behavior: High  $t_a$  and  $t_c$  temperatures for best possible ECG performance, even in luminaires where heat is a critical factor
- Micro-controller for fully digital lamp control, intelligent ignition management and safe shutdown at the end of the lamp life
- Power reduction control and reversible shutdown of the ECG in cases of unsuitably high ambient temperature for maximum light comfort
- Versions with cable clamp, with easy-to-install, two-piece cable clamp (applies to indoor ECGs).
- PCB models for installation with the smallest possible footprint and/or for thermally critical applications (applies to ECGs for indoors use)
- 3DIM function (DALI®, StepDIM and AstroDIM) for PTo (outdoor ECGs)
- Lightning strike protection up to 10kV (for outdoor ECGs)

**1.2.4. Advantages of electronic control gear over conventional gear**

In the past, HID lamps were operated almost exclusively using conventional, ferromagnetic control gear. These conventional devices are increasingly being replaced by electronic control gear.

The following table offers an overview of the characteristic properties of high-intensity discharge lamps and at the same time shows the substantial advantages of using electronic control gear for operating such lamps over using CCG.

In the comparison between CCG and ECG, the performance of the CCG is used as the reference, with a value of 100. This is also due to the fact that the parameters used to characterize lamps are largely fixed using CCGs as a reference.

The following block diagram shows the outline structure of a classic square-wave ECG in half-bridge topology.

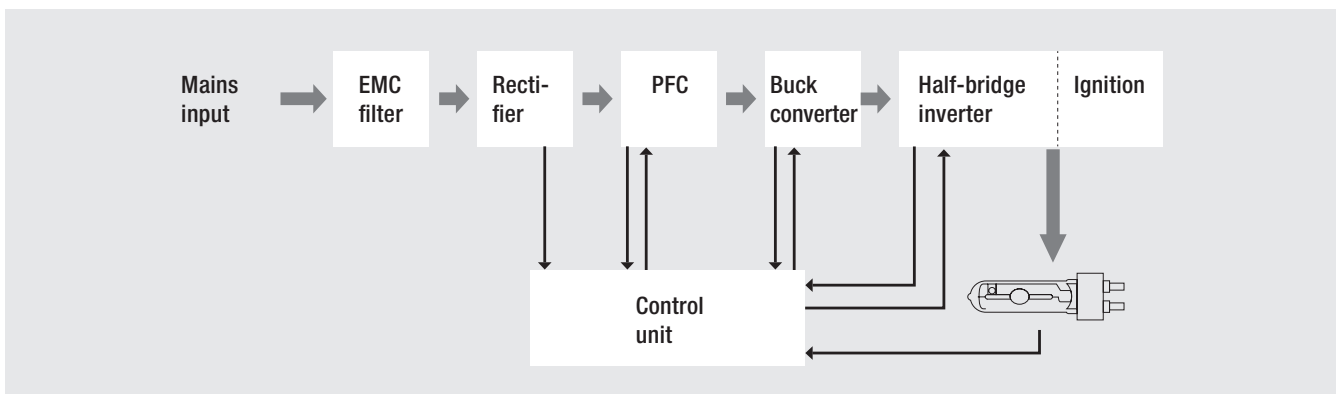


Figure 3: Block diagram of a square-wave ECG with half-bridge topology

| Comparison of CCG and POWERTRONIC®   |                                                                                                                                    |                                                                                                                                                                                         |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      | Magnetic control gear (CCG)                                                                                                        | POWERTRONIC® electronic control gear                                                                                                                                                    |
| <b>Energy consumption</b>            | 100                                                                                                                                | For indoor applications: 10 to 15 % savings over the whole service life<br><br>For outdoor applications: up to 30 % savings over the whole service life through dimming function (3DIM) |
| <b>Lamp life</b>                     | 100                                                                                                                                | Up to 30 % depending on lamp type and application                                                                                                                                       |
| <b>Lamp warm-up</b>                  | Depends on lamp type: generally approx. 60–90 sec, up to 90 % of nominal luminous flux                                             | Up to 50 % faster                                                                                                                                                                       |
| <b>Color stability (HCI/HQI)</b>     | Color variation possible                                                                                                           | Substantially improved color stability; both initially and over the whole service life                                                                                                  |
| <b>Shutdown at end of lamp life</b>  | None or only primitive shutdown mechanisms                                                                                         | Continuous parameter control, intelligent shutdown mechanisms                                                                                                                           |
| <b>Shutdown of ignition</b>          | Only with timer-based ignition devices                                                                                             | Default shutdown of ignition after 20 minutes                                                                                                                                           |
| <b>Light flicker</b>                 | Visible flicker                                                                                                                    | Flicker-free thanks to operation at 100–240 Hz                                                                                                                                          |
| <b>Power constancy</b>               | Increased wattage over the whole service life, wattage also depends on temperature and mains voltage fluctuations and cable length | ± 3 % over the whole service life, independent of temperature, mains voltage fluctuations and cable length                                                                              |
| <b>Usability</b>                     | 3 components, complex wiring                                                                                                       | 1 device, simple wiring                                                                                                                                                                 |
| <b>Size and weight</b>               | Heavy, more components, can be quite large                                                                                         | Lightweight and compact                                                                                                                                                                 |
| <b>Power factor correction (PFC)</b> | 0.5–0.95, substantial fluctuations due to age                                                                                      | ≥ 0.95                                                                                                                                                                                  |
| <b>Noise generation</b>              | Possible detectable humming                                                                                                        | Almost soundless                                                                                                                                                                        |
| <b>Bi-directional data exchange</b>  | Not possible                                                                                                                       | Generally possible (DALI®)                                                                                                                                                              |
| <b>Dimming</b>                       | Possible to a limited extent (additional components necessary)                                                                     | 3 different dimming modes possible for outdoor ECG (DALI®, StepDIM and AstroDIM)                                                                                                        |
| <b>Lightning protection</b>          | Not necessary                                                                                                                      | For outdoor ECG up to 10 kV                                                                                                                                                             |

The above values and statements are based on research and experience with OSRAM POWERTRONIC® devices and are therefore not transferable on a one-to-one basis to the devices made by other manufacturers.

### 1.2.5. Application areas

#### 1.2.5.1. Indoor, outdoor

POWERTRONIC® PTi and PT-FIT ECGs have been developed for indoor applications and for these they are suitable.

Any guarantee claims against OSRAM POWERTRONIC® PTi and PT-FIT ECGs are void if they are used in outdoor areas – no matter what the IP classification of the installed luminaires may be.

PTi and PT-FIT devices conform to the requirements of IEC/EN 61547: Resistance to interference under surge voltage between L and N 1 kV, between L/N and PE 2 kV for devices with input power > 25 W, with these values divided by two where power is < 25 W. These levels of test precision (test levels) comply with installation classes 2 (< 25 W) and 3 (> 25 W) in accordance with IEC/EN 61000-4-5 Annex A.

POWERTRONIC® PTo ECGs were developed for deployment in outdoor areas. Due to their robustness, they offer substantial improvements in the way they deal with outdoor weather conditions (e.g. moisture or temperature changes), vibrations or also transient power supply conditions (caused by switching or lightning (EN 61000-4-5 Section 1)). Besides street lighting, PTo ECGs can be used in industrial applications. Both areas of application make tough demands for surge voltage stability. PTo exceed the standards required for Installation Class 4, with test levels for L to N of 3 kV and for L/N to PE of 4 kV.

**1.2.5.2. Installation of devices in luminaires or mounting the types with cable clamp in suspended ceilings**

POWERTRONIC® ECGs are available in two different versions – each tailor-made for the requirements of the lighting application they are being used in. Thus there is a basic distinction between:

- ECG for (indoor and outdoor) installing in luminaires
- ECG with cable clamp for mounting independently, for example, in suspended ceilings (indoors)



Figure 4: PTi S or PT-FIT S for installation in luminaires



Figure 5: PTi I or PT-FIT I with cable clamp



Figure 6: PTi B or PT-FIT B for installation in luminaires



Figure 7: PTi SNAP with integrated plug-in system



Figure 8: PTo for installation in luminaires

HID ECGs for installation in luminaires are each given the abbreviation "S" in OSRAM terminology. The circuit-board versions are distinguished with a B (for "Board"). Devices equipped with a cable clamp are distinguished with an "I" (for "Independent"), and those with an integrated plug-in system are marked "SNAP".

ECGs for indoor installation generally have a metal casing (aluminum or sheet steel) to facilitate the best possible thermal coupling with the luminaire they are fitted into.

Devices with cable clamp for independent mounting must have the following properties:

- 1.) Protection against electric shock conforming to IEC/EN 60598-1. An effective option for fulfilling this requirement would be to use casings made of non-conducting materials, such as plastic (e.g. polyamide)
- 2.) Relief of push and pull strains on connection cable

It is possible to fasten all POWERTRONIC® PTis to wood, as it complies with the temperature requirements required for certification in accordance with VDE 0710-14 and DIN VDE 0100-559. The devices carry the MM mark.





## 2. The product in operation

### 2.1. Supply voltage

#### 2.1.1. Permissible voltage range

All POWERTRONIC® ECGs for the operation of high-pressure discharge lamps are designed for sinusoidal alternating voltages at 50 to 60 Hz in a nominal voltage range of 220–240 V. Deviations of -10 %/+6 % from each of the nominal voltage boundary values are permissible – even within such a range, thanks to the ECG, lamps will still remain within the optimal working range set for the relevant lamp type.

| Nominal voltage range and behavior in case of undervoltage or overvoltage    |                                                                                                                                                        |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Nominal voltage range</b>                                                 |                                                                                                                                                        |
| <b>AC voltage</b>                                                            | 220–240 V, 50/60 Hz                                                                                                                                    |
| <b>Permissible voltage range for continuous operation</b>                    |                                                                                                                                                        |
| <b>AC voltage</b>                                                            | 198–264 V, 50/60 Hz                                                                                                                                    |
| <b>Behavior with undervoltage</b>                                            |                                                                                                                                                        |
| <b>Lamp operation with undervoltage</b>                                      | 198–220 V → guaranteed lamp operation                                                                                                                  |
| <b>Voltage drop during operation</b>                                         | 198 V ≥ U ≥ 176 V → lamp start and operation usually possible, but not guaranteed<br>U < 176 V → unspecified range → continuous operation not possible |
| <b>Behavior with overvoltage</b>                                             |                                                                                                                                                        |
| <b>Lamp operation with overvoltage</b>                                       | U : 240–264 V → guaranteed lamp operation                                                                                                              |
| <b>Voltage peak during operation</b>                                         | U > 264 V → continuous operation not possible, ECG may be irreversibly damaged within seconds, depending on the height of the peak.                    |
| <b>Short transients or impulse voltages in accordance with EN/IEC 61547.</b> | POWERTRONIC® ECGs are protected                                                                                                                        |

Valid for: The POWERTRONIC® ECG

Operation outside of the permissible nominal voltage range can lead to the ECG being damaged. For this reason, the layout of the relevant network and its permitted values and tolerances should be considered when deploying electronic control gear.

#### 2.1.2. Overvoltage > 264 V

During operation above the nominal voltage range ("overvoltage"), a distinction is made between two forms of overvoltage which differ in terms of their duration:

Short-term surge voltages that are typically in the micro-second range (fast transient or impulse voltages).

Such surge voltages may be caused by:

- Switching inductive loads (e.g. welding devices, elevators, inverters, etc.) on or off
- Lightning strikes

POWERTRONIC® ECGs are protected against short-term mains voltage surges in accordance with EN/IEC 61547

Quasi-stationary overvoltage, which may last into the minutes to hours range.

Such overvoltage may be caused by:

- Imbalances in mains loads (interruption of the neutral conductor in three-phase networks plus additional asymmetrical load balancing)
- Unstable supply networks

The strain caused by overvoltage will always exert a heavier load on each individual component (part). This in turn leads to heavier thermal loads and can thus have a negative effect on the service life of the affected ECG.

POWERTRONIC® ECGs are not suitable for operation where loading is unbalanced. In extreme cases, overvoltage can lead to the destruction of the affected ECG. There are, however, exceptions from these remarks, such as the PTi SNAP devices (you can obtain details on them in their various technical datasheets) which exhibit a high level of stability in load imbalances. Such devices can withstand overvoltage of up to 300 V for 48 hours and of up to 320 V for two hours. In the range from 275 < V < 320, these ECGs shut down after 40 seconds in order to protect their own circuits from destruction. With mains voltages of over 320 V they shut down immediately. Extended periods with mains voltages > 320 V may lead to the destruction of the device.

**2.1.3. Undervoltage > 198V**

The operation of ECGs below the permissible nominal voltage range ("undervoltage") is not permitted and may lead to the following effects:

- Lamp operation outside nominal values → Effect on lamp life
- Uncertain lamp ignition, as ignition is guaranteed only above 198V.
- Unstable behavior of lamp, up to and including the lamp being extinguished
- Overload on the electronic control gear, as the lamp's own correction mechanisms in low voltages may give rise to substantially higher operating current.

In extreme cases this may lead to overloading of components and to the device failing. The following causes may lead to undervoltage:

- Imbalances in mains loading
- Incorrect electrical installation
- Unstable supply networks
- Transition resistance at electrical connections

**2.1.4. DC voltage**

DC-capable ECGs are marked with "0Hz" in technical information sheets. At present there are no devices in the POWERTRONIC® ECG product range that fulfill the requirements of DC compatibility.

**2.1.5. ECG for networks with 120V/277V**

Electronic control gear units for metal halide lamps are now being increasingly used in North America (the USA and Canada). OSRAM SYLVANIA supplies a growing number of devices that are usable in North American networks with 120V/277V and 60Hz mains frequency.



Further information on this topic is available at: <http://www.sylvania.com/en-us/products/ballasts>

**Note:** The HID ECG family is referred to using the abbreviation QT xxx MH (for Metal Halide) on the North American market.

**2.1.6. Operation on a 3-phase network**

Luminaires and groups of luminaires can be operated in a 3-phase network using a shared N (neutral) conductor. This graphic shows both the correct (left) and incorrect (right) wiring and its consequences.

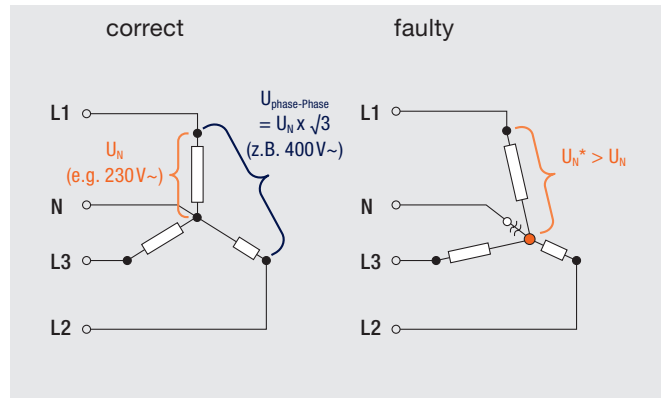


Figure 9: 3-phase network

$U_N^* > U_N$

Theoretical maximum value:

$U_N^* \text{ max} = U_N \times \sqrt{3} (= 400 \text{ V AC @ } U_N = 230 \text{ V AC})$

In practice:

$U_N^* < 350 \text{ V}$  in most cases

(without fully asymmetrical load balancing)

If the shared neutral conductor is interrupted in an ECG installation in star configuration while voltage is present, then ECG luminaires or groups of luminaires may be exposed to unacceptably high voltages (load imbalances) and the electronic control gear may be destroyed as a result.

The following points should be observed for electronic control gear used in 3-phase networks.

1. Check whether the mains voltage is within the permissible nominal voltage range for the ECG
2. Make absolutely sure that the neutral conductor is correctly connected to all the ECG fixtures and that it is making proper contact.
3. Cables should only be connected or disconnected when no voltage is present
4. For 3 x 230/240V supply networks in triangular circuit arrangements, protection by way of common disconnection of the phase conductor will be required

**Important:**

In new systems, users should not connect to the network when the insulation resistance is being measured at 500V DC since, according to IEC 0100 6 Section 9.3, the test voltage is also applied between the neutral conductor (N) and all three external lines (L1, L2, L3). In existing systems it is sufficient to conduct an insulation test between the external conductors (L1, L2, L3) and the protective earth (PE) without disconnecting from the network. The neutral conductor (N) and the protective earth (PE) must not be electrically connected in any way while this is being done. For the insulation measurement (500V DC to Earth) the neutral conductor terminal may only be opened after the mains voltage has been switched off.

Make sure that the N conductor is correctly connected before putting the equipment into service.

The neutral conductor should never be interrupted during the operation of the lighting installation.

### 2.1.7. Overvoltage protection

In conventional three-phase installations, electronic control gears are generally suited to an input voltage of between 220 and 240 V.

Depending on the load balance, this value may rise in case of the missing or unsatisfactory contact of the neutral conductor to a maximum value of  $\sqrt{3} \times 230 \text{ V} = 400 \text{ V}$ :

POWERTRONIC® ECGs are not suitable for operation where loading is unbalanced. In extreme cases, overvoltage can lead to the destruction of the affected ECG.

There are, however, exceptions from these remarks, such as the PTi SNAP devices (you can obtain details on these in their various technical datasheets) which exhibit good surge protection capability (see also chapter 2.1.2).

## 2.2. Installation

### 2.2.1. ECG operation for luminaires with protection Class I and II

Luminaires are classified according to the level of protection against electric shock according to EN 60598-1.

#### Protection Class I

For luminaires under Protection Class I, all touchable conducting parts that might become "live" in the event of a failure must be properly connected with the protective earth.

POWERTRONIC® ECGs are generally suitable for use in PC I luminaires. To conform to the specification you must make a correct connection of the PE terminal to the ECG via the PE connection.

#### Protection Class II

For Protection Class II luminaires, protection against electric shock does not depend only on basic insulation, but also on additional precautions such as additional insulation or improvements to existing insulation. Protection Class II luminaires therefore have no protective earth (PE) connection.

POWERTRONIC® ECGs have been certified in accordance with safety standards EN 61347-1 (General safety requirements) and EN 61347-2-12 (Particular requirements) as PC I ECG (carrying the protective earth symbol). In addition, EMC approval is also granted at PC I level for ECGs.

However, under certain conditions, these ECGs can also be used in PC II luminaires (without any PE connection). The following preconditions must be fulfilled in such cases:

- Only L and N terminals are available as electrical connection terminals for the luminaire. There is no PE connection for the luminaire.  
=> No protective earth is connected either to the luminaire or the ECG.
- The ECG is installed in such a way that either the PE ECG terminal (marked with the Protective Earth symbol) or the ECG is not visible and thus cannot be connected with PE accidentally.

- The requirements in relation to additional or improved insulation, creep distances and clearances are fulfilled for ECGs with cable clamp or ensured using other appropriate precautions (adding separations, increasing distances, etc.) when installing the ECG in the luminaire.
- The EMC requirements are also fulfilled without connecting the PE or ensured by taking appropriate precautions (using ferrites, etc.).

### 2.2.2. Insulation

#### 2.2.2.1. Insulation distances in luminaires

When constructing luminaires, the EN 60598-1/IEC 60598-1 standard is decisive in relation to the topic of electrical safety (especially in terms of contact safety).

In order to ensure the electrical safety of a luminaire creep distances and clearances between electrical connections must be considered. These terms are described in EN 60598-1 Section 11 for the supply terminal of the luminaire.

"Creep distances at a supply terminal shall be measured from the live part in the terminal to any accessible metal parts". The clearance shall be measured between incoming supply wiring and accessible metal parts, i.e. from a bare conductor of the largest section to the metal parts which can be accessible. At the internal wiring side of the terminal the clearance shall be measured between live parts of the terminal and accessible metal parts."

Further information on this topic is available in the EN 60598-1 luminaire standard.

#### 2.2.2.2. Insulation testing in luminaires

Luminaires must be subjected to an insulation and high-voltage test (according to EN 60598-1). This test should be carried out as follows:

- The supply terminal and all lamp cabling for the luminaire – except the protective earth terminal – should be connected together conductively.
- Apply a test voltage between the connected mains and lamp cable and the earthed metal parts.
  - Test insulation with 500 V DC min. 2 MΩ (corresponding to a max. 0.25 mA leakage current) will be necessary.
  - High-voltage test with 1.5 kV, AC/50 Hz: 1 sec without flashover (e.g. leakage current < 10 mA)

Permissible alternatives in luminaire manufacture are (PM 333, PM 395)

- 100 % high-voltage test (insulation testing may be dispensed with) or
- 100 % insulation test and 1–2 % high-voltage test or
- Alternative testing in consultation with the test center (e.g. VDE)

### 2.2.2.3. Insulation resistance in lighting installations

The insulation resistance in lighting installation ( $> 1.0\text{ M}\Omega$ ) must be measured in accordance with IEC 60364-6 Section 61.3.3 between:

- The outside cables (L1, L2, L3) and the protective earth (PE)
- The neutral cable (N) and the protective earth (PE)

In spaces with a higher threat of fire the insulation resistance should also be measured between:

- The outside cables (L1, L2, L3) in relation to each other
- The outside cables (L1, L2, L3) and the neutral cable (N)

The insulation testing should be done at 500V DC.

### Insulation measurement between N/L and PE

The tests should be made both in new and in existing systems. The test intervals for existing systems should be set out in the relevant workplace or operational safety regulations.

Insulation measurements should be made without the user disconnecting any connection. The neutral conductor (N) and the protective earth must not be electrically connected in any way. For the insulation measurement (500V DC to PE) the neutral conductor terminal may only be opened after the mains voltage has been switched off. It is essential that the connection is reestablished securely before switching the mains voltage back on. Otherwise, load imbalance and the consequent surge voltage may lead to the destruction of all ECGs in the system.

Permissible: 500V = max. 1 mA measured current

Testing procedure:

The ECG first appears to show low impedance (due to loading of the capacitors in the interference suppression filters). The ECG then shows high impedance. A short circuit between the lamp wires does not affect the ECG.

The ECG is not destroyed by the insulation test! A precondition for this is that a maximum current value of 1 mA is not exceeded.

### Caution:

Before commissioning the lighting installation, check that N cable connections are in order! The neutral conductor should never be interrupted while the lighting system is operating.

### 2.2.3. Output voltage

During the operation of a high-pressure discharge lamp, a general distinction is made between the ignition phase and the normal operation of the ECG. During the ignition phase some very high ignition voltages up to 4.5 kV may occur temporarily at the outlet connection. In contrast, the output voltage, which is measured during normal operation of a high-pressure discharge lamp at both output terminals, is never higher than the U-OUT working voltage.

### 2.2.3.1. Lamp ignition voltage

POWERTRONIC® ECGs use asymmetric ignition. For this reason it is important to mark each lamp connection clearly. A distinction should be made between the cable carrying the high-voltage potential (25 kV), which is referred to as the Lamp High (LH) and the second cable, also known as the Lamp Low (LL), which has a substantially lower potential (U-OUT) in comparison with the PE.

LH and LL are marked clearly on the device label.

LH should be kept as short as possible. In addition, with Edison fittings it may be necessary to check that the potential carrying cable is connected correctly.

### 2.2.3.2. Operating voltage (U-OUT)

U-OUT is a compulsory ECG marking according to Safety Standard EN 61347-2-12.

In this context U-OUT indicates the largest effective working voltage between

- The output terminals
  - Each output terminal and the PE
- in the normal operation of a high-pressure discharge lamp. The output working voltage U-OUT is often designated open circuit voltage.

The above information is important for all components that are electrically wired or connected between the ECG and the lamp.

The components such as lamp cables, lamp sockets (EN 60061-2), insulation parts and all other components that may come into contact with the ECG output terminals must be designed for the following voltages:

- For the LL connection the U-OUT working voltage
- For the LH connection the ignition voltage

As an ECG manufacturer, OSRAM ensures that no higher voltage is to be expected at the output terminals than the ones described above against any other potentials or against the PE; e.g. at the reflector. For this reason, no additional voltage reserve need be considered.

### 2.2.4. Wiring

#### 2.2.4.1. Wire and cabling types

When wiring luminaires in order to use high-pressure discharge lamps, it is important to consider the U-OUT voltage on the ECG's label. The U-OUT value gives information on the types of wiring to be used.

OSRAM POWERTRONIC® ECG values indicate a U-OUT voltage of < 430 V. H05 cables for luminaire wiring (on both the mains and the lamp side) are thus suitable.

If high temperatures are to be expected in the vicinity of the luminaire, then cabling with silicon insulation is recommended.

As heavy pulse loads of up to 4.5 kV occur during lamp ignition, high-voltage capable, double insulated cable should be used on the lamp side.

The capacity of particular types of cabling to deal with short voltage peaks should be checked with cable manufacturers. For example cables marked with SiHF J 3x1.5 have been tried and tested positively for lamp side connection.

It is not recommended to use simple standard or Teflon cables without any additional insulation protection, as sufficient insulation between each individual cable strand cannot be assured over the entire service life of the luminaire, thus leaving open the risk of damage to the ECG or luminaire.

#### 2.2.4.2. Cable cross-section

The cable cross-sections to be used are shown on the label of the electronic control gear. In general, the following values apply.

Solid and multi-wire cables:

Wire cross section of 0.5 mm<sup>2</sup> to max. 2.5 mm<sup>2</sup> (see technical datasheet for individual sample types)

The use of cable end sleeves is permissible but not absolutely necessary. It should be noted that maximum cross section applies to wires without cable end sleeves.

The brazing (tin plating) of cable ends has not proved successful, as a durable stable contact between terminal and cable cannot be guaranteed if this is done. For this reason this method is not recommended.

Solid cables can be inserted into the terminal directly, with flexible cables you should use the push buttons for connecting and disconnecting cable strands.

Note on mains connection with flexible connection cables (according to EN 60598-1):

In order to ensure sufficient mechanical stability the nominal cross section of the cable should not be less than:

- 0.75 mm<sup>2</sup> for ordinary luminaires
- 1 mm<sup>2</sup> for other luminaires

#### 2.2.4.3. Cable length between ECG and lamp

The length of cables between the POWERTRONIC® and the lamp/luminaire is of decisive importance to:

- The ignition reliability of the system
- Conformity to the EMC limits for the relevant lighting installation

A reliable lamp ignition must be ensured even in such unfavorable conditions as low ambient temperature or high humidity. Naturally, it should also be ensured for older lamps.

A decisive factor in the allowable length of the cable is the load capacitance of the cable being used. A load capacitance of about 80 pF/m may be considered a good rule of thumb for a standard cable. The exact values should be obtained from the relevant cable manufacturers.

In cases where longer cabling is required, the following is recommended:

- Use cables with particularly low capacitance
- Selecting a luminaire structure in which the wiring on the lamp side exhibits restricted coupling capacitance with the PE

An overview of the maximum possible load capacitance for each ECG can be found on its technical datasheet.

Besides reliable ignition, the cable length will have a decisive influence on the EMC behavior of the lighting installation. Detailed information on this topic can be found in chapter 2.2.4.4 Wiring.



## THE PRODUCT IN OPERATION

### 2.2.4.4. Cable layout

In order to achieve good radio interference suppression and the greatest possible degree of operational safety, attention should be paid to the following points for wiring:

1. Keep the cable between ECG and lamp as short as possible.
2. In order to prevent coupling of lamp lines with mains lines, avoid laying them parallel to each other. The distance between such cabling should be at least 5 cm. Where a crossover is unavoidable, it must be done at right angles.
3. Where it is impossible to avoid laying longer lamp cabling, the two strands (LH and LL) must be twisted.
4. Keep mains cables inside the luminaire short and as far away as possible from the ECG.
5. Very short low-inductive connection of the protective earth to the ECG and to all metallic parts of the luminaire (e.g. its reflector).
6. For luminaires that do not conform to EMC limits it may be necessary to add a ferrite to both lamp cables. The impedance of the ferrite will depend on the wattage of the device and the luminaire. The higher the wattage, the larger impedance you will need to select. The impedance can be varied by changing the number of twists. Typical ferrite values: 20–70 W → 250 Ω; 100 W–150 W → 400 Ω
7. Unprotected cable transition through metal parts should never be used. They should always be made using additional insulation (insulation tubing, cable-entry grommet, edge protection, etc.).

During wiring you should observe the rules set out in the EN 60598-1 standard for luminaires, and also any country-specific regulations in their version currently in force.

The luminaire housing or any part of it must never be "abused" as a conductor or in any other way have contact with the mains or lamp conductors (e.g. via bare wires, excessively long stripping lengths, screws projecting from the insulation or by excessively sharp edges on sheet metal). Any such contact is dangerous for people and can lead to the destruction of the control gear.

Question: Are L and N swappable (e.g. for portable luminaires)?

- Yes** on labeling on the casing ~
- Yes** on labeling on the casing L, N (applies to Class II luminaires only)
- No** on labeling on the casing L, N (applies to Class I portable luminaires)

### 2.2.4.5. Wiring diagrams for integration of POWERTRONIC® ECG PTi and PT-FIT

Below you will find the wiring diagrams for the one and two-lamp PTi and PT-FIT ECG.

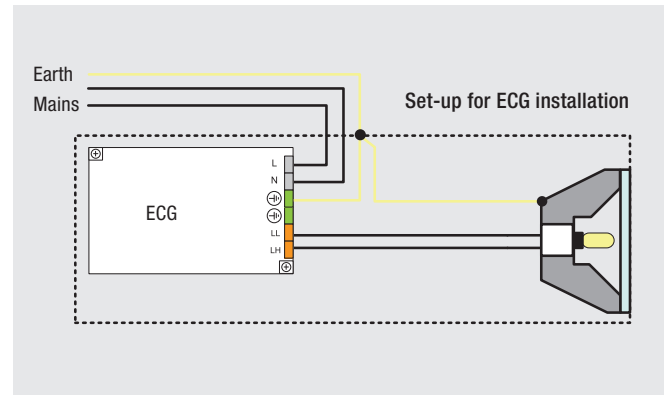


Figure 10: PTi and PT-FIT 35 to 150 S and B wiring plan

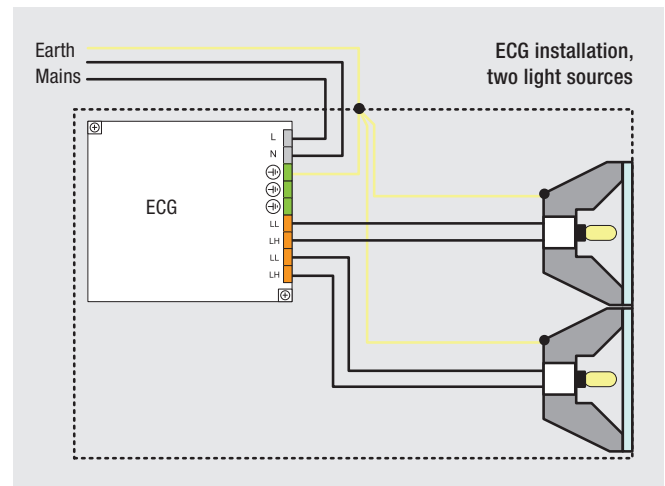


Figure 11: PTi 2x35 and 2x70 S wiring plan

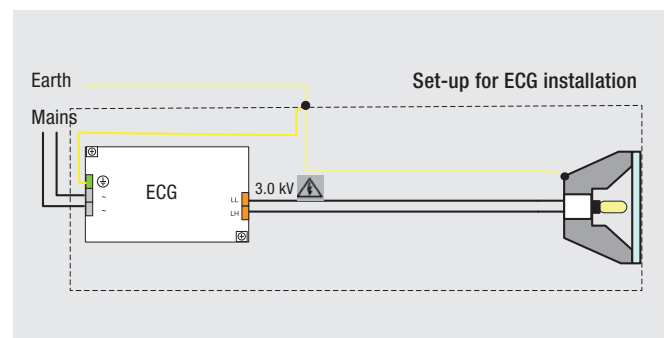


Figure 12: PTi 20 S and B, 35 S mini or 35 B mini wiring plan

**2.2.4.6. Wiring plans for downlights with POWERTRONIC® ECG with cable clamp**

The wiring of independent devices has particular requirements, particularly from the point of view of the EMC. For this reason the following section is dedicated to dealing with such applications.

**Notes:**

- Use short lamp cabling: approx. 0.5 m
- The PE-LUM connection may only be used for earthing the luminaire.

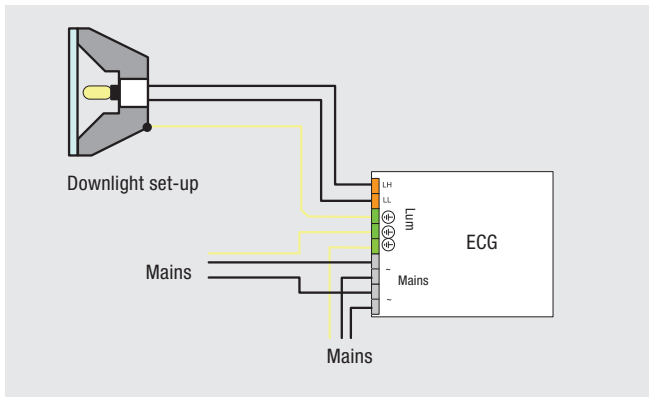


Figure 13: Wiring plan PTi 35 to 70 I with mains looping

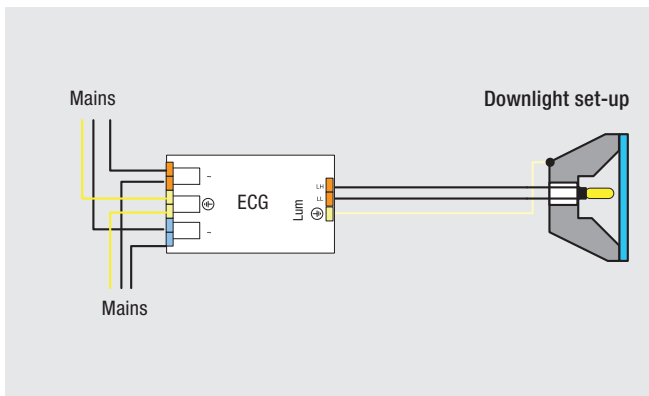


Figure 14: Wiring plan PTi 20 I with mains looping

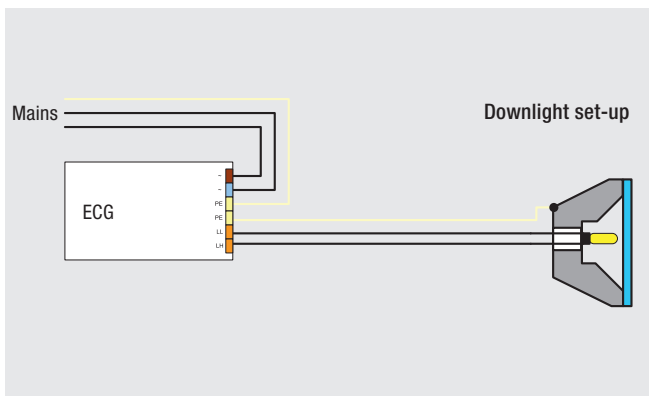


Figure 15: PTi 100 and 150 I as well as PT-FIT 35 to 70 I wiring plan

Where longer cables (<1.5 m) are necessary, the PE should be connected to the ECG and from the ECG to the luminaire; the lamp cables must be twisted; ferrites must be installed on the lamp cables.

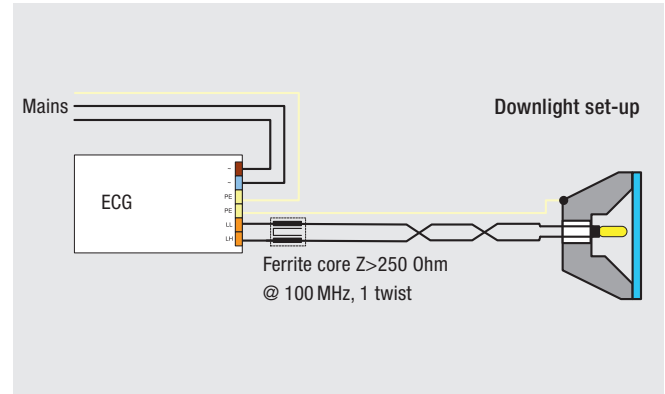


Figure 16: (Sample) Wiring plan for improved EMC behavior

Example of looping in a ferrite in order to reduce EMC emissions

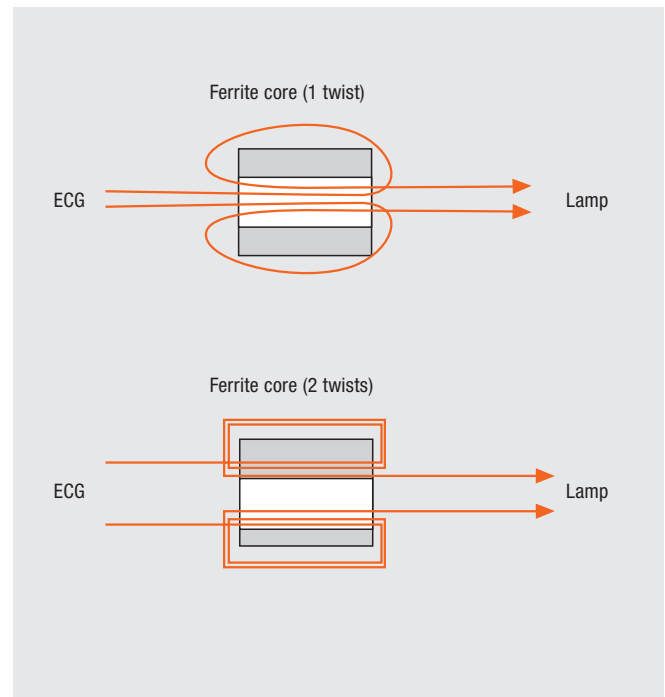


Figure 17: Looping in ferrite cores to reduce EMC emissions

**2.2.4.7. Wiring plans for POWERTRONIC® ECG PTo**  
 The PTo devices<sup>1</sup> provide 3 different dimming modes; these are provided under the 3DIM feature.

# 3DIM

DALI  
StepDIM  
AstroDIM

<sup>1</sup> With the exception of the PTo 35

The ECG must be appropriately wired depending on the dimming mode:

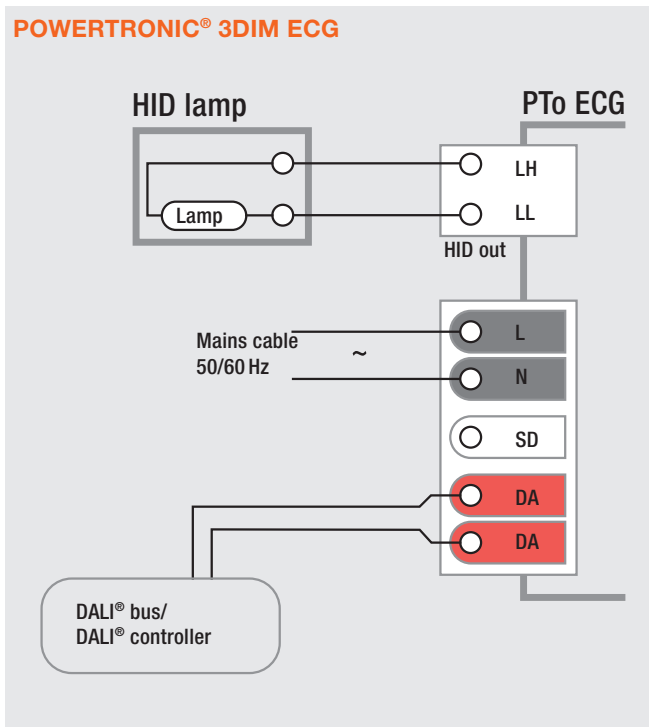


Figure 18: 3DIM – wiring in DALI® mode

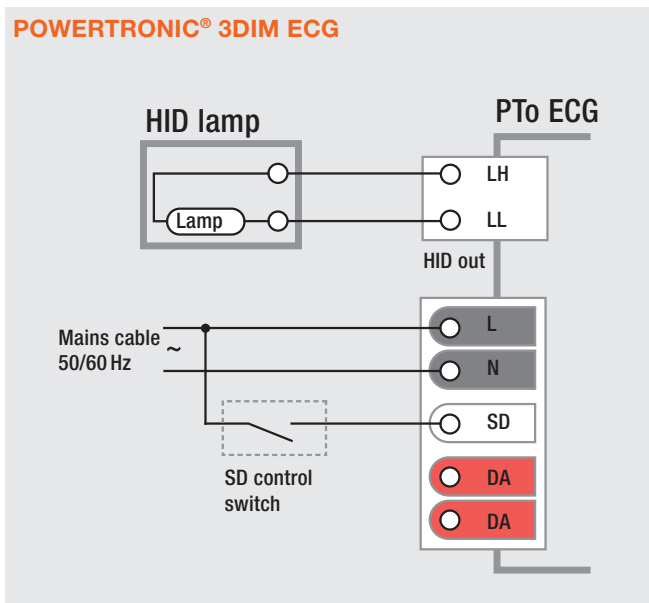


Figure 19: 3DIM – wiring in StepDIM mode

**POWERTRONIC® 3DIM ECG**

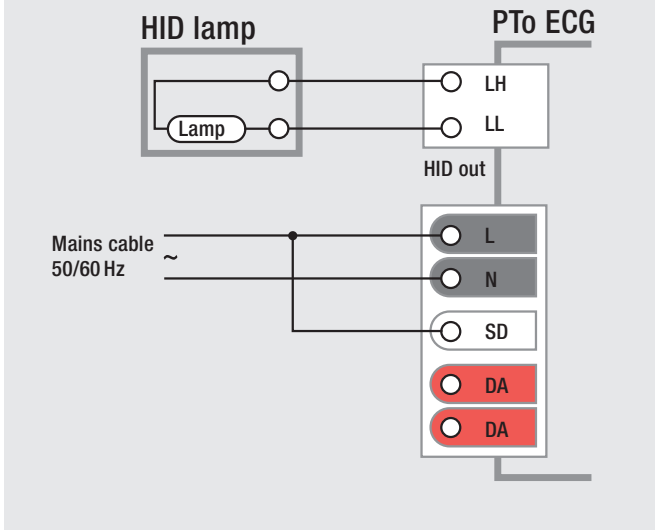


Figure 20: 3DIM – wiring in AstroDIM mode



Further information on the 3DIM functionality can be found in the 3DIM application guide.

**2.2.4.8. Stripping length**

The required stripping length of wiring depends on the terminal type used by the ECG. A length of 8.5 to 9 mm or 10 to 11 mm is appropriate, depending on the terminal version. The exact stripping length is given on each ECG.

**2.2.5. Inrush current limiter**

Due to the initial charging of the storage capacitor responsible for internal power supply, a strong pulse of inrush current occurs on switching on an ECG. This pulse lasts for a very short time (< 1 ms). For this reason, if very many ECGs are switched on at the same time (especially when switching on at a peak in mains voltage) a substantially stronger overall current flows for a short time. Therefore appropriate switching and protective devices are necessary to ensure sufficient current. The maximum number of ECGs allowed per circuit breaker can therefore be calculated by observing the total maximum inrush current impulse per device and its duration. This value is to be found in the datasheet for each individual POWERTRONIC® ECG. Further information:



[www.osram.com/powertronic](http://www.osram.com/powertronic)

Easy ways of increasing the number of ECGs per circuit breaker:

- Use of the EBN-OS inrush current limiter
- The use of AC relays for each group with the maximum permissible number of ECGs. These relays should be connected so that they close as soon as mains voltage is applied. The retardation of the relays will cause the inrush current for the 2nd group to occur with a delay as compared to the 1st group. The switch-on peak current value is thus effectively reduced into a number of smaller successive flows.

### 2.2.6. Leakage current, protective current, contact current, earth leakage circuit breaker (ELCB)

According to current luminaire standards, the term leakage current includes both the concept of contact current and protective current.

The internal interference suppression filter in the ECG and the lamp cable near earthed surfaces cause a leakage current through the earth protection cable in Class I luminaires. The strength of this leakage will depend on the type of the affected device.

All POWERTRONIC® ECGs with a consumption of < 4 A have a substantially lower protective current than the maximum permissible value of 2 mA (rms).

Just like in the case of the inrush current, the protective current limits the number of ECGs to the number that can be operated on a leakage current circuit breaker.

The following solutions can be suggested in order to increase the number of devices:

- Distribute luminaires across 3 phases and use 3-phase RCDs
- Use surge-current-resistant short-delay RCDs
- Use RCDs with 30 mA (where permissible)
- Connect max. 30 ECGs per phase and RCD

The contact current is restricted for all POWERTRONIC® ECGs to  $0.7 \text{ mA}_{\text{peak}}$ , or  $0.5 \text{ mA}_{\text{rms}}$ .

## 2.3. Behavior in operation

### 2.3.1. Lamp ignition and lamp operation

The operation of high-pressure discharge lamps is divided into a start-up phase and a running phase, each of which involve very different behaviors. During the start-up phase a voltage range of 1,800 to 4,000 V (depending on the type of lamp) is required for the initial ignition of a high-pressure discharge lamp. During normal running, voltages of 80 to 140 V are required, depending on lamp type and age.

In order to enable the safe and reliable start-up of the lamp, POWERTRONIC® ECGs provide a short burst of ignition voltage of up to 4.5 kV for lamp start. As the ignition process is asymmetric in structure, the strong potential is supplied through the LH terminal marked with the lightning bolt inside a triangle.

The intelligent POWERTRONIC® ECG monitors each phase of the start-up process and, as soon as the lamp has reached stable operating mode after going through what is referred to as the "breakthrough" stage, reduces the voltage to the required value for normal lamp working.

### 2.3.2. Hot restrike of lamp

POWERTRONIC® ECGs are not capable of igniting high-pressure discharge lamps when they are hot.

For example, for a metal halide lamp that requires an ignition voltage of up to 4.5 kV cold, the required voltage will increase to 30 kV in a hot state.

Progressive cooling of the lamp will bring this value back down. Depending on the lamp's wattage, the luminaire structure and the cooling conditions for the lamp inside the luminaire, high-pressure discharge lamps return to a level in between 3 and 20 minutes in which they can be ignited once more by the ECG, with the maximum of 4.5 kV available to it.

In order to re-ignite double-ended metal halide and NAV lamps from a hot state, special hot restrike devices and special socket designs are required. In addition to this, the approval of the lamp manufacturer confirming the suitability of the lamp is also a precondition for this.

### 2.3.3. ECG reset, restart

If a POWERTRONIC® ECG should switch off (e.g. due to an ignition timeout, temperature-related cutoff, etc.) then it must be disconnected from mains power for at least 0.5 seconds before it can be switched on again.

### 2.3.4. Constant lamp wattage

As compared with conventional control gear, a POWERTRONIC® ECG supplies its high-pressure discharge lamp with constant wattage over the whole of the lamp's service life. The fluctuation range is within a maximum of 5%. The increase in the lamp working voltage over the service life of the lamp is regulated via the lamp current supplied by the ECG.

In contrast, with a conventional control gear the system wattage may fluctuate quite substantially, as it is not possible to regulate the lamp voltage.

For more information on this topic, see also the application paper:



"Metal halide lamps" – hints on application and use"

**2.3.5. Power factor, compensation**

For all devices that consume electricity, the power factor  $\lambda$  is the ratio of effective power ( $P_{\text{Effect}} = U \times I_{\text{Effect}}$ ) to apparent power ( $P_{\text{Appar}} = U \times I$ ). This value is affected both by the phase displacement  $\cos \varphi$  between the current and the voltage and by the current distortion  $\varepsilon$  (deviation from the sinusoidal shape).

$$\lambda = P_{\text{Effect}} / P_{\text{Appar}} = \varepsilon \cos \varphi$$

In contrast to conventional control gear (CCG: inductive, 50Hz), with electronic control gear there is practically no phase displacement present. There is therefore no need for any compensation. However, during the operation of electronic control gear small distortions in the sinusoidal mains current may appear. In general, these distortions are also described by harmonics or overtones.

The harmonic content of the line current is strictly controlled by national and international standards (IEC 61000-3-2). In order to conform to these standards, OSRAM electronic control gear units have fully electronic harmonics filters built in, which ensure that  $\varepsilon > 0.95$  and thus that power factor  $\lambda \geq 0.95$ . From this point of view ECGs are significantly better than CCGs.

**Exception:**

For system wattages of less than 25W, there are simplified evaluation criteria for harmonic content, so that in such cases a power factor of  $\lambda \sim 0.6$ , for example, may be permissible.

All POWERTRONIC® devices have been tested in relation to mains current harmonics content in accordance with EN 61000-3-2 by VDE and carry the VDE EMC symbol:



**2.3.6. ECG temperatures and their effect on service life**

In evaluating the properties of an ECG, considerations relating to their thermal behavior in relation to maximum permissible temperatures are decisive. In this context one should always distinguish between the ambient temperature of the luminaire, the ambient temperature of the ECG and the temperature of the ECG casing.

The following diagram illustrates these temperatures:

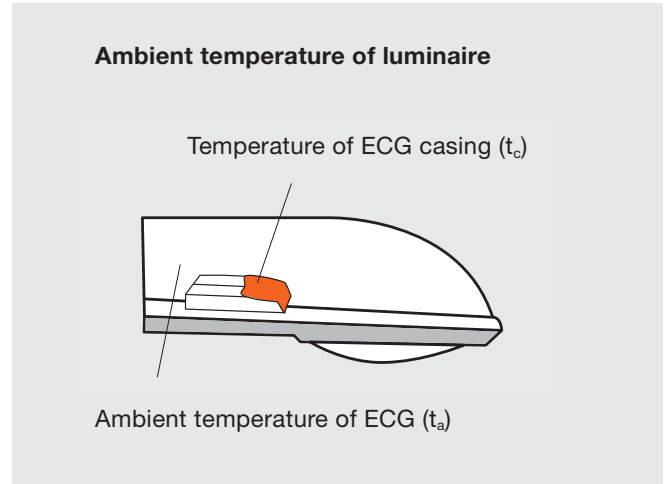


Figure 21: Schematic diagram of a luminaire's structure

The observations of temperature must be made separately for the two system components (ECG and lamp). For the lamp there are legal provisions that restrict the temperature range and the boundary temperatures to be respected for safety reasons.

For the ECG fixed restrictions must be defined for reasons of operational safety. Starting from the separate observation methods, there are outside influences on luminaire installation which play a substantial role in influencing the ECG, lamp and luminaire, as well as the choice of installation position.

**Complying with the required restrictions and thus ensuring operational safety is the responsibility of the manufacturer of the luminaire.**



### 2.3.6.1. Device temperature $t_c$

According to EN 60598-1  $t_c$  (temperature casing) is the highest permissible temperature that may occur during normal operation under the nominal voltage (or at the maximum value of a rated voltage range) on a particular marked point of the ECG (the  $t_c$  test point). It is thus a safety-relevant value.

In practice, the temperature measured at the  $t_c$  test point of the ECG will depend on a variety of factors:

- The ambient temperature of luminaire
- Losses and the resulting self-heating of the ECG
- Luminaire design and the thermal coupling of the ECG to the luminaire

In order to determine the life expectancy of an ECG, the temperature of the ECG at the  $t_c$  measuring point is compared against the values that appear on the datasheet. In order to reach the life expectancy that is reported in the datasheet, the  $t_c$  should never be exceeded.

It is possible for each ECG manufacturer to position the  $t_c$  test point where he or she likes on the ECG. It may be placed at a particularly hot point or at a cooler point, and thus has a direct influence on the real temperature measured for the device.

For OSRAM POWERTRONIC® ECGs the  $t_c$  point is always positioned so that there is a good correlation between the temperature measured at the  $t_c$  point and the real temperatures of the components decisive for the life expectancy of the ECG.

**It should be pointed out that the absolute value of the  $t_c$  value represents no indication of quality, as it is merely an individually placed test point used as described above for the measurement of the  $t_c$  value.**

### 2.3.6.2. Ambient temperature $t_a$ of ECG

According to EN 60598-1  $t_a$  (a=ambient) is the highest value of continuous temperature at which the luminaire (or ECG) may be operated appropriately. That means that this temperature may not exceed the  $t_c$  temperature described in section 2.3.6.1.

In the case of OSRAM POWERTRONIC® ECGs, the specified maximum value for  $t_a$  has a correlation with the value for  $t_c$ . This relationship applies to a reference measuring system in accordance with EN 61347-1 Annex D. In it the ECG is operated without any thermal connection to the luminaire.

**As the ECG ambient temperature  $t_a$  is determined under the reference conditions for all ECGs, it is also suitable for making a direct comparison of the thermal properties of different ECGs.**

It is therefore possible to compare ECGs using the  $t_a$  temperature, even where there is no other means of comparing them directly.

In practice the method used for the thermal design of luminaires and for predicting the service life of an ECG inside a luminaire is measuring the  $t_c$  temperature. However, in this context the details on expected service life must always be decided on the basis of the  $t_c$  temperature for each ECG separately.

Where ECG ambient temperatures ( $t_a$ ) are too low, then the ECG is not capable of ensuring reliable lamp ignition. In addition to this, at excessively low temperatures the properties of particular parts may change to such an extent that it leads to the failure of the ECG.

The ambient temperature should never fall below the minimum  $t_a$  marked on the ECG.

Where ECG ambient temperatures ( $t_a$ ) are too high the service life of the ECG may be foreshortened or the ECG may be destroyed. High ECG failure rates may occur.

Typical values for the storage of electronic control gear are the following:

**Storage temperature:** -40 °C to max. +80 °C

**Air humidity:** 5 % to max. 85 %, uncondensed

#### **It should be noted that:**

Before these devices are put into service they must be restored to the specified boundary temperatures for  $t_a$ .

The values for  $t_a$  temperatures for each device can be obtained from the technical datasheet of the specific device.

### 2.3.6.3. ECG self-heating

POWERTRONIC® ECGs have an efficiency of 90 to 92 %. The remaining wattage is lost energy which causes the self-heating of the devices. Typical values for the increase in temperature of ECG casings as compared to ambient temperature are between 10 and 30 °C. This allows for a very wide range of ambient temperatures within the relevant limits, which will be quite sufficient for the most common areas of application. In cases where this is not true, the thermal properties of the luminaire need to be improved by making changes to the luminaire or to the installation position.

### 2.3.6.4. Practical assessment of the service life and thermal properties of an ECG

There are two ways of clarifying the life expectancy of an ECG.

#### 1) Without any temperature measurement

Comparing the  $t_a$  values of the ECG with the  $t_a$  temperature data shown on its technical datasheet can give an indication of the ECG life expectancy

#### 2) With temperature measurement in a luminaire

Set an ambient temperature for the luminaire (e.g. + 25 °C)

→ Measure the temperature at the  $t_c$  test point of the ECG to be compared and conclude the life expectancy of the ECG using the data sheet applicable to it.

→ If you only compare nominal or catalog values, then the data on the  $t_a$  temperature should be preferred over those on  $t_c$  temperature.

→ However, real measurements of the  $t_c$  temperature of the ECG within a luminaire (not burning independently) and obtaining the ECG life expectancy via the indications in its data sheet, is a substantially more meaningful and realistic approach.

→ The contact of the ECG with the luminaire and the associated improvement in heat dissipation will have a decisive influence on its real life expectancy.

Real life measurement of the  $t_c$  temperature and comparison with the data specified on ECG life expectancy as a function of  $t_c$  temperature is the only reliable way of obtaining the life expectancy of an ECG.

#### CAUTION:

A simple comparison of the absolute nominal values for the  $t_c$  temperatures of ECGs produced by different manufacturers does not have any meaning in relation to their properties or life expectancy, as the point at which the  $t_c$  measurement is made can be chosen freely by the manufacturer.

Illustrative example of such a calculation:

#### ECG 1:

Nominal values:  $t_c = 80\text{ °C}$ ,  $t_a = +55\text{ °C}$ , 40,000 h service life at  $t_c = 80\text{ °C}$

→ With an ECG ambient temperature of 55 °C the max.  $t_c$  is reached, and thus a life expectancy of 40,000 h can be deduced.

#### ECG 2:

Nominal values:  $t_c = 80\text{ °C}$ ,  $t_a = +55\text{ °C}$ , 40,000 h service life at  $t_c$  life = 70 °C

→ With an ECG ambient temperature of 55 °C the max.  $t_c$  temperature is reached; however, the  $t_c$  life has been exceeded by 10 °C, which corresponds to a service life of approx. 20,000 h.

→ With an ECG ambient temperature of 55 °C - 10 °C = 45 °C a  $t_c$  temperature of 80 °C - 10 °C = 70 °C is obtained (corresponding to  $t_c$  life), leading to a service life of 40,000 h being obtained.

#### Conclusion:

In spite of having the same nominal and maximum  $t_c$  and  $t_a$  temperatures, ECG 1 reaches a service life of 40,000 h at its max. permitted ECG ambient temperature  $t_a$ .

In contrast, ECG 2 is only given a service life of half that duration; 20,000 h. In order to reach the same service life of 40,000 h, ECG 2 must operate at temperature  $t_c$  life = 70 °C. In this case it should be verified whether the ambient temperature would have to be reduced by 10 °C.

**2.3.6.5. Effect of temperature on service life**

The service life of an ECG is governed by the failure rate of the electronic parts used within it. The failure rates of these parts depend in turn on the particular properties of their components and the thermal and electrical loads that they are subjected to.

Extreme overheating can destroy components very quickly. Long-lasting high temperatures can also lead to premature failure. In some areas there may be an almost exponential relationship between the failure rate of an electronic component and the thermal load it is subjected to.

Due to this exponential relationship, exceeding the permissible  $t_c$  temperature can drastically reduce the service life of an ECG. Conversely, where this temperature limit is not reached, the service life of the device increases disproportionately. The following graphics show the life expectancy of the various types of ECGs at a variety of  $t_c$  temperatures:

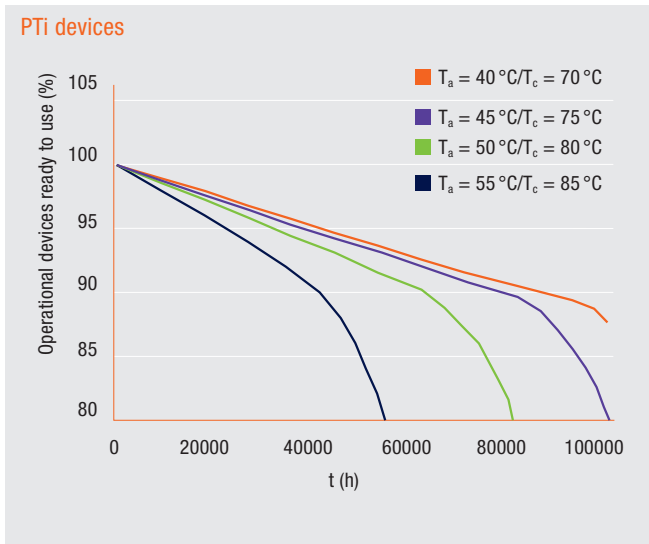


Figure 22: Life expectancy of PTi devices

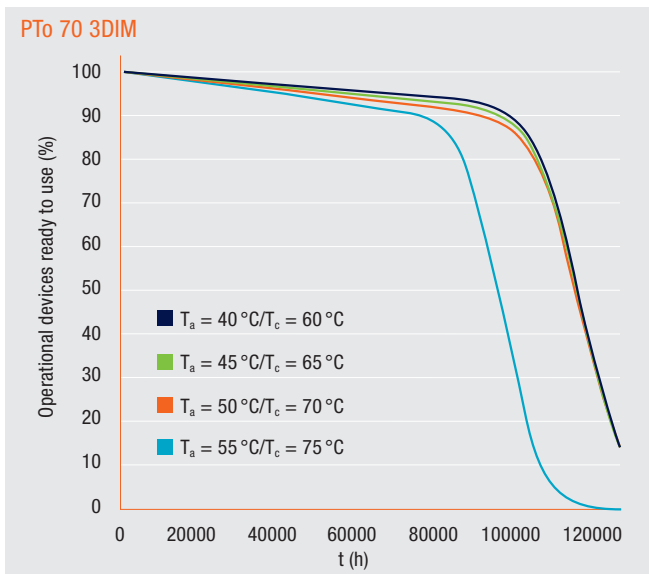


Figure 23: Life expectancy of PTo 70/220-240 3DIM

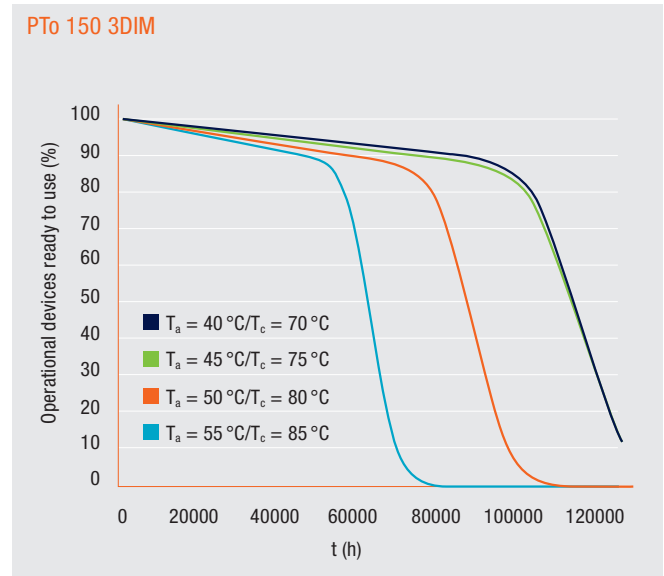


Figure 24: Life expectancy of PTo 150/220-240 3DIM

**Note:**

As a rule of thumb, one may expect a doubling of service life of POWERTRONIC® devices where there is a long-term reduction in the  $t_c$  temperature of 10°C. **When the ECG temperature exceeds the  $t_c$  max limit, then the POWERTRONIC® protects itself through power reduction or shutdown (see also 2.3.7.1).**

At OSRAM the  $t_c$  temperature has a direct relationship with the service life of the ECG. In the case of the PT-FIT ECG the maximum permissible temperature at the  $t_c$  meter point correlates to a life expectation of 30,000 h.

The  $t_c$  temperature is thus an essential limit, for one thing because of its importance for safety approval of luminaires in accordance with EN 60598-1 and, for another, because of its influence on the ECG's expected service life given by the manufacturer due to the thermal load to which the components are subjected.

**2.3.6.6. Failure rate**

The failure rate of electronic components depends not only on the component specification and quality, but also strongly on the operating temperature. POWERTRONIC® devices are designed so that at the maximum permissible device temperature ( $t_c$  max.) a failure rate of fewer than 2.5‰ per 1000 hours of operation can be expected. Given a service life of up to 60,000 hours (depending on ECG type), this corresponds to a failure rate for devices of less than 10%. You can get more information on the failure rate in the technical datasheets.

### 2.3.7. General hints on installation in relation to temperature

It is essential to ensure that lamp and ECG do not heat up each other in the luminaire and that the ECG power loss can be safely dissipated even at the maximum expected ambient temperatures and/or supply voltage.

The temperature at the  $t_c$  test point of the ECG may not be exceeded even at the maximum expected ambient temperature and/or supply voltage. When measuring temperatures under "normal" operating conditions at the  $t_c$  test point a temperature should be obtained that is at least 5 to 10 °C below the maximum value indicated, in order to be sure of enough safety buffer for extreme situations.

To achieve an optimal temperature situation it may be necessary to decouple the system (e.g. putting the lamp in the luminaire head and the ECG in the base or light support) as the lamp and ECG will always warm each other up if positioned too close together, leading to excessive temperatures in the ECG. Such a separation of the parts of the system must respect the maximum permissible cable lengths between ECG and lamp(s).

→ See also wiring notes (Section 2.2.4)

→ See also the notes on luminaire structure and thermal coupling (Sections 2.4 and 2.4.1)

#### 2.3.7.1. Power reduction control due to overtemperature

It may occur that, due to suboptimal luminaire construction or by external heat sources (e.g. direct sunlight), an ECG may operate at a too high temperature; i.e. at a temperature outside the specified range. In order to protect the device from damage, the POWERTRONIC® will automatically reduce the output wattage. This reduction has the same effect as relieving the thermal load of the device and should protect it from irreversible damage. The reduction is limited to a maximum of 40 % of the nominal wattage. Once the device is back within the specified temperature range the wattage is reset. Users will notice any such power reduction control through a reduction in the luminous flux of the affected lamps. If this is not sufficient the ECG will shut down to protect itself.

Power reduction control due to overtemperature is the "last exit" before the shutdown or destruction of the device. For this reason when designing luminaires, one should be careful that there are enough thermal reserves for the ECG at normal ambient temperatures and that the device is not already operating close to the limits.

Permanent power reduction with negative effect on light quality, on efficiency and possibly even on the service life of the lamp, as well as frequent shutdown or premature aging and failure of the ECG will be logical consequences in such cases.

#### 2.3.7.2. ECG temperature measurement in the luminaire

According to EN 60598-1 there are precisely defined test and measurement preconditions both for surface-mounted luminaires (fixed: e.g. downlights, and portable ones: e.g. free-standing luminaires) and for recessed luminaires.

The relevant temperatures of the ECG (at the  $t_c$  test point) can be best determined using stick-on thermocouples or using a suitable measurement device. You must make sure that the adhesive/glue is thermally neutral.

For ECG measurement it is generally sufficient to equip the casing cover with a thermocouple. The temperature values should only be determined when the steady state temperature of the system has been reached; i.e. when no significant change in temperature occurs over a longer period.

In accordance with the standards, this measurement should be done at the highest value of the rated voltage range. It makes sense, however, to get the measurements at the most unfavorable voltage in the rated voltage range, which is generally the lower limit of the range, since this voltage will require the highest current and thus the heaviest possible thermal load.

When assessing the thermal properties of the luminaire it is recommended to use the following procedure for the measuring system specified in EN 60598-1:

1. Thermal situation in the luminaire without any heating by the control gear.  
Luminaire in measuring system according to EN 60598-1 in nominal mounting position equipped with lamp connected to ECG and thermal elements. However, the lamp is not operated by the built-in ECG, but by an externally wired control gear. In this way it is possible to determine only the heat generated by the lamp on the whole system and to optimize the thermal "coupling" to the environment.
2. Thermal situation in the luminaire including warming by the control gear.  
Arrangement as described in point 1, but with the lamp being supplied by the built-in control gear. Taking the previously obtained values into account the additional heating generated by the ECG can now be determined.

### 2.3.8. ECG's ability to withstand frequent on/off switching

The ability of electronic control gears to withstand on/off switching is always determined in the form of the number of possible lamp starts per day. By multiplying this number with the expected service life of the gear, the total number of switchings for professional electronic control gear can be calculated.

For HID-ECGs, however, there are a number of special factors:

- High-pressure discharge lamps, due to the physics of their lamp technology are not designed for frequent switching, since, after being switched off a cooling time of roughly between 3 and 15 minutes is necessary before switching on again.
- In typical HID applications, therefore, there is only a small number of switches per day.
- Due to the ignition time limit in the ECG, after a particular number and duration of unsuccessful attempts at starting up the lamp, the ECG is shut down.

Switching rhythm tests have shown that POWERTRONIC® ECGs can execute 40,000 lamp starts, which corresponds to one lamp start per hour over a service life of 40,000 hours.

### 2.3.9. Short-circuit strength

With POWERTRONIC® ECGs, the secondary outputs are short-circuit-proof for approx. 5 minutes. However, any short circuit between a lamp connection and the casing/protective earth should be prevented at all costs, since such an accidental fault to ground will lead to the certain destruction of the ECG.

### 2.3.10. Switch-off criteria and mechanisms

One of the decisive advantages of lamp operation using an ECG over a CCG is the active and intelligent protection mechanisms provided by the ECG in order to ensure safe and reliable lamp operation. Below we list the most important causes of failure of high-pressure discharge lamps along with the corresponding shutdown mechanisms provided by the ECG.

#### 2.3.10.1. Monitoring lamp voltage

One decisive parameter for ensuring safe and reliable operation of your lamp is its lamp operating voltage. POWERTRONIC® ECGs therefore carry out permanent monitoring of the lamp's operating voltage. If the lamp voltage exceeds or falls below the limits defined for it, then the device switches off, as proper operation of the lamp can no longer be guaranteed and there is a strong probability that the lamp may be running outside its required specifications.

### 2.3.10.2. Ignition time limitation

The EN 61347-2-12 safety standard requires that ECGs for high-pressure discharge lamps with ignition voltages of above 5 kV provide a defined shutdown of ignition voltage after a particular length of time. POWERTRONIC® ECGs – despite having ignition voltages of less than 5 kV – are fitted as standard with an ignition time limit. That means that the ECG will shut down after a defined time period without successful ignition of the lamp. In order to allow a re-ignition of the lamp with ECG after a cooling period, the shutdown of the ECG happens after 20 minutes. It will once more become possible to ignite the lamp after a short mains interruption ( $t > 0.5$  seconds). According to the above-mentioned standard, an independent autostart function by the ECG after a defined time period (e.g. 3 hours) is not permitted.

### 2.3.11. Lamp shutdown at end of life

The end of the service life of a high-pressure discharge lamp may occur for a number of reasons.

Possible reasons for this might be:

- Leaky arc tube or outer bulb
- Increase of the re-ignition peak
- Breakage of the leads or electrodes in the arc tube
- Oxidation of the base contacts due to arcing in the socket
- Explosion of the lamp (HCI and HQI lamps only)

POWERTRONIC® ECGs generally operate metal halide lamps and high-pressure sodium vapor lamps safely and reliably. Of particular interest in this regard is their ability to recognize and control End of Life effects (EoL effects) of the lamps.

The intelligent ECGs are capable of detecting a variety of EoL modes in the lamps and to shut them down accordingly.

The following operating situations and discharges in the outer bulb are detected by PTi and PTo and shut down:

- Glow discharge
- Arc discharge
- Incandescent mode



Details on the above mentioned EoL cases can be found in the application guide: "Metal halide lamps" – hints on application and use"



### 1) Shutdown mechanism – increase in the re-ignition peak

In conventional operation the re-ignition peak is a peak in the lamp's operating voltage, after current and voltage pass through zero. With sinusoidal lamp current, the current decreases little by little, before reaching zero. As a result of the continuously decreasing current the lamp plasma cools down. This reduces further its conductivity until the supply voltage is no longer capable of re-igniting the plasma and the lamp finally goes out.

One of the main advantages of operation using POWERTRONIC® ECGs lies in the reduced occurrence of re-ignition peaks. Since the zero crossing of the current is very steep in these devices, the times in which little or no current flows are very short, and the plasma has less chance of cooling down.

Finally, a high-pressure discharge lamp using an ECG can be operated for longer. The smaller re-ignition peaks are to a large extent responsible for the longer service life through ECG operation as compared to conventional choke operation.

### 2) Shutdown mechanism – rectifying effect

Uneven heated electrodes, the malfunction of an electrode or discharge in the outer bulb are all possible causes of asymmetric operating mode (rectifying operation) of high-pressure discharge lamps. The rectifying effect causes a high DC voltage component. As a result, a conventional choke will go into saturation, which will drastically reduce choke impedance. In extreme cases the lamp current will be restricted only by the ohmic resistance of the choke. This may result in the choke and ignitor overheating.

With POWERTRONIC® ECGs, current and voltage are constantly monitored and adjusted by a microcontroller. POWERTRONIC® ECGs shut down before rectifying effects can lead to damage of the ECG thus allowing them to offer a clear plus in terms of safety over conventional control gears.

#### 2.3.12. Noise levels

POWERTRONIC® ECGs are so quiet in operation that even in a quiet environment they can hardly be detected. Their limit is generally < 30 dB(A).

In comparison to this, here are guideline values for acceptable room noise intensity:

- For an office: 35 dB(A)
- In a shop: 35 dB(A)

Factors that influence the noise intensity levels are the noise emitted by each separate electronic control gear, the acoustic properties of the luminaires in which they are fitted, the way the ECGs are mechanically attached into the luminaires, the sound absorption properties of the room, as characterized by volume and reverberation time, as well as the total number of electronic control gear units.

#### Tip:

In order to develop a luminaire that makes as little noise as possible, a sufficient decoupling of the ECG and the luminaire body is essential; i.e. the ECG should not have full contact with the luminaire chassis, but it should be only connected at points or mounted using the rubber absorbers that are also used for CCGs.

This method of mounting may under some circumstances lead to thermal problems (the maximum permissible temperature at the  $t_c$  point may be exceeded due to the bad thermal coupling), as the heat may be best dissipated with full-surface mounting. Solving this problem with an appropriate casing construction and/or method of mounting the luminaire (with forced ventilation or cooling, or enhanced convection) has the advantage of reducing the operating sound and therefore it should be taken into consideration.

Tests have shown that noise levels depend on the operating temperature of the electronic control gear. This factor has a particular role if the ECG has been mounted according to the above-mentioned recommendations. In extreme cases it may not be possible to do without an additional heat sink.

In addition, noise levels rise disproportionately with increasing temperatures in the ECG. For this reason it is recommended to run the ECG at a temperature lower than the maximum permissible operating temperature. In practice, this means that the lower the temperature at the  $t_c$  test point, the lower the noise level. The ideal solution would be to use the double strategy of mounting the ECG in an acoustically decoupled manner and running it at a lower temperature.

#### 2.3.13. Dimming

High-pressure discharge lamp systems based on high-pressure sodium vapor or metal halide lamps can generally be operated at reduced power. However, it should be kept in mind that dimmed operation will bring with it losses in light quality and efficiency (lm/W). For this reason dimming of HID lamps can only be recommended for outdoor lighting applications. Therefore, POWERTRONIC® PTi and PT-FIT devices do not provide any dimming function.

In the interests of energy savings and CO<sub>2</sub> reduction, there is now a demand for dimming capacity of lighting installations used for outdoor applications. The loss of light quality can be tolerated late at night, as the number of motorists reduces rapidly during the course of the night. For this reason, OSRAM has developed the ideal ECG solution with the PTo family, which has been fitted out with the 3DIM feature. 3DIM stands for DALI®, StepDIM and AstroDIM.

## THE PRODUCT IN OPERATION

The user can choose here between three different dimming modes:

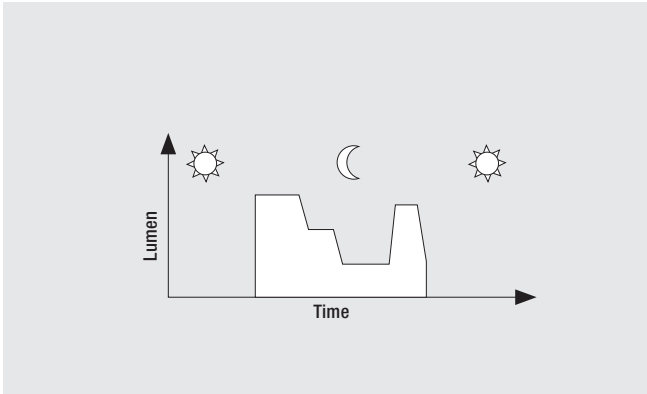


Figure 25: DALI® – Digital Addressable Lighting Interface

DALI® is a communication standard that is widely used by luminaire manufacturers. DALI® works bidirectionally as part of a tele-management system, and offers the user a number of control and settings options for each light source.

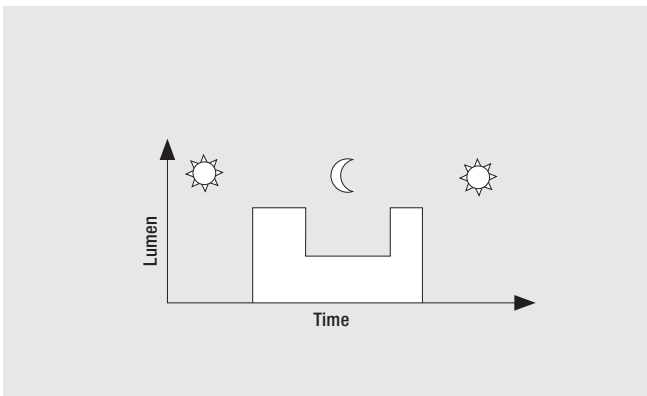


Figure 26: StepDIM

StepDIM is the possibility to regulate a luminaire in a single step via a control cable to a particular dimming factor (e.g. from 100 to 60%).

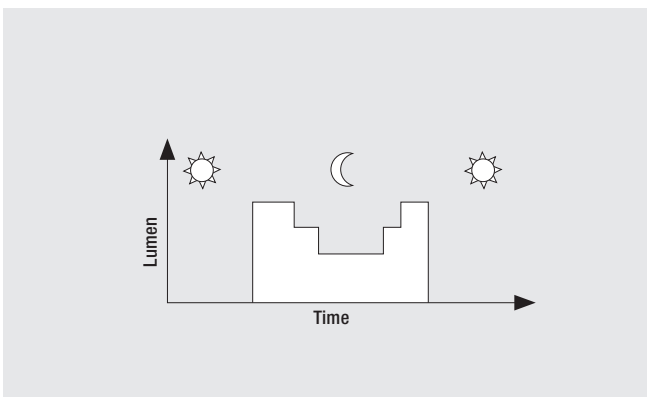


Figure 27: AstroDIM

Where no control line exists in the system the user can use the AstroDIM function. Using it one can dim the luminaire without an external control by defining a time window (e.g. within six hours) within which the lamp is dimmed from 100 to 60% and is then turned back up again.

All three dimming settings can be adjusted using a software tool and can be changed back again at any time. For this purpose OSRAM provides the DALI magic interface standard and the 3DIM Tool software package as a download.



More detailed information on the 3DIM topic can be found in [www.osram.com/3dim](http://www.osram.com/3dim).

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Dimming means reducing wattage to save energy.  
The following values emerge per DIM level, lamp type and wattage for each system.

### Light and wattage details for a PTo 50 3DIM system

| PTo 50 3DIM   |        |        | HCI-TT 50W WDL                |            |                |        |    | NAV-T 50W Super |            |                |
|---------------|--------|--------|-------------------------------|------------|----------------|--------|----|-----------------|------------|----------------|
| DIM-Level [%] | PL [W] | PS [W] | PHI [lm]                      | ETA [lm/W] | ETA sys [lm/W] | CT [K] | Ra | PHI [lm]        | ETA [lm/W] | ETA sys [lm/W] |
| 100           | 50.5   | 56.4   | 4960                          | 98.1       | 87.9           | 3041   | 79 | 4005            | 79.3       | 71.0           |
| 90            | 45.7   | 51.2   | 4375                          | 95.7       | 85.5           | 3183   | 75 | 3380            | 73.9       | 66.0           |
| 80            | 40.6   | 45.6   | 3725                          | 91.8       | 81.7           | 3389   | 71 | 2715            | 66.8       | 59.5           |
| 75            | 37.9   | 42.7   | 3375                          | 89.1       | 79.0           | 3521   | 69 | 2380            | 62.7       | 55.7           |
| 70            | 36.0   | 40.6   | 3115                          | 86.6       | 76.7           | 3634   | 67 | 2140            | 59.4       | 52.7           |
| 60            | 33.6   | 38.1   | Not released, dimming to 60 % |            |                |        |    | 1890            | 56.3       | 49.6           |

### Light and wattage details for a PTo 70 3DIM system

| PTo 70 3DIM   |        |        | HCI-TT 70W WDL |            |                |        |    | NAV-T 70W Super |            |                |
|---------------|--------|--------|----------------|------------|----------------|--------|----|-----------------|------------|----------------|
| DIM-Level [%] | PL [W] | PS [W] | PHI [lm]       | ETA [lm/W] | ETA sys [lm/W] | CT [K] | Ra | PHI [lm]        | ETA [lm/W] | ETA sys [lm/W] |
| 100           | 73.3   | 80.9   | 7150           | 97.5       | 88.4           | 3003   | 89 | 6810            | 92.9       | 84.2           |
| 90            | 64.5   | 71.4   | 6280           | 97.4       | 88.0           | 3056   | 84 | 5675            | 88.0       | 79.5           |
| 80            | 56.6   | 62.8   | 5435           | 96.1       | 86.5           | 3141   | 80 | 4595            | 81.2       | 73.1           |
| 75            | 51.8   | 57.8   | 4890           | 94.4       | 84.7           | 3225   | 78 | 3940            | 76.0       | 68.2           |
| 70            | 47.8   | 53.4   | 4430           | 92.7       | 82.9           | 3322   | 75 | 3400            | 71.2       | 63.7           |
| 60            | 46.1   | 51.8   | 4175           | 90.5       | 80.6           | 3439   | 73 | 3150            | 68.3       | 60.8           |

## THE PRODUCT IN OPERATION

### Light and wattage details for a PTo 100 3DIM system

| PTo 100 3DIM  |        |        | HCI-TT 100W WDL |            |                |        |    | NAV-T 100W Super |            |                |
|---------------|--------|--------|-----------------|------------|----------------|--------|----|------------------|------------|----------------|
| DIM-Level [%] | PL [W] | PS [W] | PHI [lm]        | ETA [lm/W] | ETA sys [lm/W] | CT [K] | Ra | PHI [lm]         | ETA [lm/W] | ETA sys [lm/W] |
| 100           | 98.0   | 106.1  | 10695           | 109.1      | 100.8          | 3009   | 86 | 10670            | 108.8      | 100.5          |
| 90            | 85.0   | 92.3   | 9215            | 108.4      | 99.9           | 3057   | 83 | 9420             | 110.8      | 102            |
| 80            | 74.2   | 80.9   | 7870            | 106.1      | 97.3           | 3151   | 79 | 8020             | 108        | 99.1           |
| 75            | 67.0   | 73.4   | 6930            | 103.5      | 94.3           | 3255   | 76 | 6550             | 97.7       | 89.2           |
| 70            | 62.7   | 69.1   | 6345            | 101.1      | 91.8           | 3338   | 74 | 5085             | 81.1       | 73.6           |
| 60            | 59.3   | 65.7   | 5790            | 97.6       | 88.1           | 3464   | 72 | 4300             | 72.5       | 65.4           |

### Light and wattage details for a PTo 150 3DIM system

| PTo 150 3DIM  |        |        | HCI-TT 150W WDL |            |                |        |    | NAV-T 150W Super |            |                |
|---------------|--------|--------|-----------------|------------|----------------|--------|----|------------------|------------|----------------|
| DIM-Level [%] | PL [W] | PS [W] | PHI [lm]        | ETA [lm/W] | ETA sys [lm/W] | CT [K] | Ra | PHI [lm]         | ETA [lm/W] | ETA sys [lm/W] |
| 100           | 148.5  | 161.9  | 16400           | 110.4      | 101.3          | 3009   | 88 | 17820            | 120.0      | 110.1          |
| 90            | 136    | 148    | 15010           | 110.4      | 101.4          | 3069   | 84 | 16010            | 117.8      | 108.2          |
| 80            | 121    | 132    | 13230           | 109.3      | 100.2          | 3222   | 79 | 13720            | 113.4      | 104.0          |
| 75            | 104.0  | 114    | 11050           | 106.2      | 97.0           | 3343   | 76 | 11020            | 105.9      | 96.7           |
| 70            | 92     | 101    | 9445            | 102.6      | 93.5           | 3502   | 73 | 9095             | 98.8       | 90.0           |
| 60            | 84     | 91.7   | 8230            | 97.9       | 89.7           | 3661   | 70 | 7800             | 92.9       | 85.1           |

#### Clarifications:

|         |                                          |
|---------|------------------------------------------|
| PL      | Lamp wattage                             |
| PS      | System wattage (lamp + control gear)     |
| PHI     | Luminous flux                            |
| ETA     | Lamp luminous efficacy                   |
| ETA sys | Luminous efficacy of lamp + control gear |
| CT      | Color temperature                        |
| Ra      | Color rendering                          |

**Please note:** The values shown should be considered as examples, as lamps and control gear are subject to tolerances due to a number of factors. The measured values indicated were obtained photometrically in a two-meter integrating sphere at a room temperature of 25 °C.

### 2.4. Hints on luminaire design

The general recommendations on luminaire design by IEC and the national authorities (VDE, KEMA, ANSI, etc.) should be followed.

In addition, it should be noted that POWERTRONIC® systems may be subject to ignition voltages of up to 4.5 kV. Components (sockets, cabling, etc.) and materials should be selected in accordance with these requirements. Data on the lamps to be used can be found in the relevant IEC standards 61167 (for metal halide lamps) and 60622 (for high-pressure sodium vapor lamps). In addition to these, the international standard for luminaires IEC 60598 is also relevant.

Notes on the wiring can be found in section "2.2.4. Wiring" while notes on conformity with EMC guidelines in section "2.2.4.4. Cable layout".

#### 2.4.1. Thermal coupling

POWERTRONIC® ECGs have an efficiency of 90 to 92 %. The remaining wattage is lost energy which causes the self-heating of the devices. Due to their excellent efficiency, ECGs are subject to relatively little self-heating. However, to achieve the maximum possible device service life and the minimum failure rate, this heat must be conducted away from the device as efficiently as possible. Especially for the integration in luminaires the following should be kept in mind:

- Use appropriate measures to achieve good heat transfer between the POWERTRONIC® device and the luminaire casing.
  - Direct, wide-surface contact between the ECG and the luminaire casing.
  - Make luminaires out of highly conductive materials, such as metals.
- Prevent air-filled gaps between the ECG and the luminaire casing
  - Air has an insulation effect
  - Do not mount the ECG on internal housing beams
  - Do not use any spacers between the ECG and the luminaire casing in order to fasten the ECG into the luminaire.
  - Place any mounting or holding plates in such a way as to ensure wide-surface contact between the ECG and the luminaire casing.
- Do not place any insulation material between the ECG and the luminaire casing
  - Do not use double-sided tape to secure the ECG
  - Do not place any materials with low heat conductivity between ECG and luminaire
- In order to achieve particularly good heat conductivity at critical positions thermal pads can be placed between the ECG and the luminaire casing.
- Ensure a clearance between the ECG and the lamp (ideally  $\geq 30$  cm); provide a separate chamber for the ECG; otherwise use cooling plates or heat sinks in order to keep heat radiation away from the device.

In all cases it will be necessary to measure temperature  $t_c$  at the test point in order to ensure that  $t_c$  max. is not exceeded.

#### 2.4.2. Ventilation slits, cooling fins

Ventilation slits in the luminaire ensure direct ventilation of the interior of the luminaire and thus allow the ECG to be cooled directly. The ventilation slits (for air in and out) should have a minimum width of 4–5 mm and should be arranged so that there is an air current flowing over the ECG no matter where the luminaire is positioned. Cooling fins on the outside surface of the luminaire increase its surface and thus contribute to improved thermal radiation properties for the luminaire.

#### 2.4.3. Materials that may be used in luminaire structures

Depending on design and intended applications, both plastics and metals can be used in building luminaires for HID systems. Each material has its own individual properties. The main consideration to be kept in mind, however, is that the material being used satisfies the thermal requirements demanded by the heat radiated from the light source. In addition, these materials need to have the appropriate resistance to UV light.



More information on this topic can be found in the application guide: "Metal halide lamps – hints on application and use"

From the ECG point of view, the best possible heat transfer should be the target (see also section "2.4.1 Thermal Coupling")

#### 2.4.4. Installation-friendly ECG

Depending on the intended application and the mounting conditions in the luminaire, a built-in ECG or one with a cable clamp can be used. Both the built-in devices (PTi S or B, PT-FIT S or B and PTo) and the devices with cable clamp (PTi I or SNAP and PT-FIT I) are particularly easy to mount.

S version for installation in luminaires



Figure 28: PTi 70/220-240 S

- Mounting the device using a grommet on its bottom or side
- Plug terminals for fast connection and release of wires without tools
- Stable and robust metal casing

## THE PRODUCT IN OPERATION

B version for installation in luminaires:



Figure 29: PT-FIT 70/220-240 B

- Mounting the device using grommets on the bottom
- Plug terminals for fast connection and release of wires without the need for tools
- The luminaire casing must provide protection in order to satisfy the EN 60598-1 and EN 61347-2-12 safety standards

PTo for installation in luminaires:



Figure 30: PTo 100/220-240 3DIM

- Mounting the device using grommets on the bottom
- Plug terminals for fast connection and release of wires without the need for tools
- Robust plastic casing
- For protection against moisture and damp, the inside of the casing (board) is potted

PTi I version for independent mounting with cable clamps:



Figure 31: PTi 70/220-240 I

- Large terminal compartment gives good access to terminals
- A generously proportioned terminal compartment allows for a floating terminal for mains looping
- The LUM PE connection allows safe and lasting direct earthing of the luminaire via the ECG's protective earth
- Cable clamp suitable for a variety of cable types and diameters between 7 and 11 mm
- PTi variants 20, 35, 50 and 70 offer mains looping
- Separate cable clamps for separate access to primary and secondary side
- Only a single screw per cable clamp cap for fast and yet secure cable fixation

PTi SNAP version for independent mounting with integrated connectors

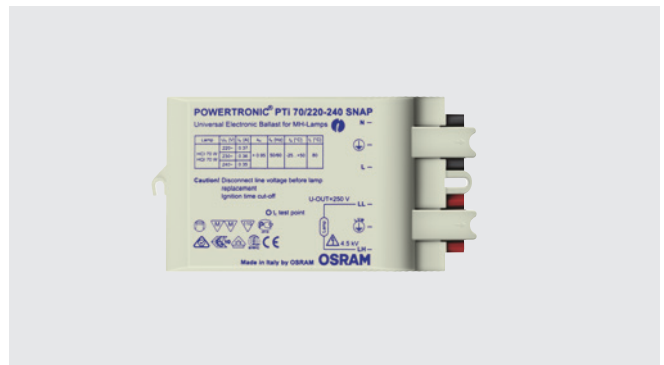


Figure 32: PTi 70/220-240 SNAP

- With integrated universal ST18 plug connection on the lamp side and GST18 plug connection on the mains side for fast, error-free installation
- With cable clamp integrated into casing



**2.4.5. Installation space for independent devices**

POWERTRONIC® PTi/PT-FIT I devices with integrated cable clamp are ideal for use in suspended ceilings. In such applications the diameter of the ceiling cut-out depends on the installation height available.

The following table gives an overview of the ceiling cut-out required as a function of the installation depth of the various devices with cable clamp.

| Indicative details for devices in suspended ceilings |          |                                                          |                          |                        |
|------------------------------------------------------|----------|----------------------------------------------------------|--------------------------|------------------------|
|                                                      | PTi 20 I | PTi 35 to 70 I<br>PT-FIT 35 to 70 I<br>PTi 35 to 70 SNAP | PTi 2x35 I<br>PTi 2x70 I | PTi 100 I<br>PTi 150 I |
| ∅ (mm)                                               | h (mm)   |                                                          |                          |                        |
| 95                                                   | 65       | 80                                                       | x                        | 140                    |
| 104                                                  | 55       | 70                                                       | 110                      | 105                    |
| 125                                                  | 40       | 55                                                       | 75                       | 70                     |
| 145                                                  | 35       | 45                                                       | 65                       | 60                     |

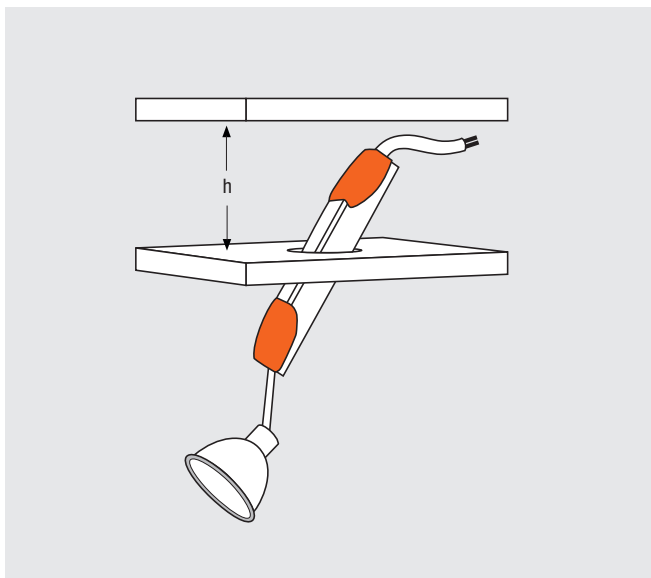


Figure 33: Schematic diagram of the installation space for independent devices

To ensure optimal thermal isolation, independent devices should be positioned at a sufficient distance (> 30 cm) from the luminaire.

**2.4.6. Plug-&Play installation with cable/socket system**

Especially in the project sector, the use of plug-in cable systems is always preferred. Such Plug-&Play solutions offer the following benefits:

- Quick and easy connection of the ECG with the luminaire and of the mains to the ECG
- A coded plug-in system reduces polarity errors in the installation
- The wiring for the ECG has been factory tested

OSRAM provides the following Plug-&Play solutions:

- PTi SNAP (with integrated connectors)
- PTi I/P and PT-FIT I/P (prefabricated lamp cable with plug)
- PTi I/2P and PT-FIT I/2P (prefabricated lamp and mains cable with plugs)

To ensure that the installation of the cable plug-in system is quick, reliable and, most importantly, safe, the following tests are carried out by OSRAM as part of prefabrication:

- High-voltage test
- Insulation test
- Function test

**2.4.7. Passing network cabling through via "floating" terminal**

Due to their generously sized terminal compartment, independent POWERTRONIC® ECGs with cable clamp allow the use of a terminal (e.g. a Wago terminal) to pass the mains cable from one device to the next. In order to use this option it should be kept in mind that the cable temperatures must not exceed the maximum permissible levels in the ECG.

**2.4.8. Lamp sockets that may be used**

In principle, all sockets that conform to the requirements for high-voltage can be used to operate the appropriate lamps with a POWERTRONIC® ECG. Generally, an ignition voltage of up to 4.5 kV can occur. Further details can be found on the stamp of the relevant ECG or in its technical information sheet.

When connecting the socket (or the luminaire) to the ECG it is essential to ensure that Lamp High and Lamp Low, i.e. the ignition cables with high and low potential respectively, are correctly connected.

The following list indicates the most commonly used sockets for metal halide lamps suitable to be operated by the ECG:

| Examples of socket types                |                       |                                  |
|-----------------------------------------|-----------------------|----------------------------------|
| Socket type                             | Lamp type             | Lamp designation                 |
| G12/G22                                 | Pin base lamp         | HCI-T, HQI-T                     |
| G8.5                                    | Pin base lamp         | HCI-TC                           |
| Rx7s/Fc2                                | 2-sided socketed lamp | HCI-TS, HQI-TS                   |
| E26/E27/E40 (suitable for high voltage) | Screw base            | HCI-PAR, HCI-TT, HCI-ET, HCI-E/P |
| GU 6.5, GU 8.5                          | Bayonet base          | HCI-TF, HCI-TX/P                 |
| GX 8.5, GX 10                           | Twist and Lock        | HCI-R111                         |

The polarity must be kept in mind especially for E26/E27 and E40 screw bases.

For all versions it is important to keep in mind the typical conditions required for discharge lamps; namely high ignition voltage and temperatures. The selection and technically correct integration of lamp sockets in accordance with the applicable standards (e.g. IEC 60598/VDE 0711, IEC 60335/VDE 0700) is the responsibility of the user. Sockets consist of several components, each of which have their own functional limits. Failure to remain within these limits will cause premature failure of the socket.



More information on the integration and use of lamp sockets can be found in the OSRAM application guide: "Metal halide lamps" – hints on application and use"

When changing the system (from HQL to NAV or HCI lamps), the socket must be tested and/or replaced.

#### 2.4.9. Protection against electrostatic build-up in outdoor luminaires

Electrostatic charge in metal parts of outdoor luminaires may in some circumstances cause failure or damage to the ECG. Such metal parts are charged by clouds or lightning storms and may reach voltages of up to 50 kV. In order to prevent their discharge onto the ECG, the following aspects in the luminaire design should be considered, to ensure a problem-free operation of the ECG:

1. Connection or wiring between the metal part of the luminaire and the "Equipotential" terminal ⚡ of the ECG
2. The distance between this metal part and the ECG should be at least 8 mm
3. The lamp cables should have double insulation

These measures should ensure that high voltages can be limited to 6 to 8 kV. The PTo can generally withstand such voltages.

When installing the luminaire on masts, depending on the mast being used, further preventive measures may be needed, so that no electrostatic discharges can reach the luminaire from the ground via the mast.

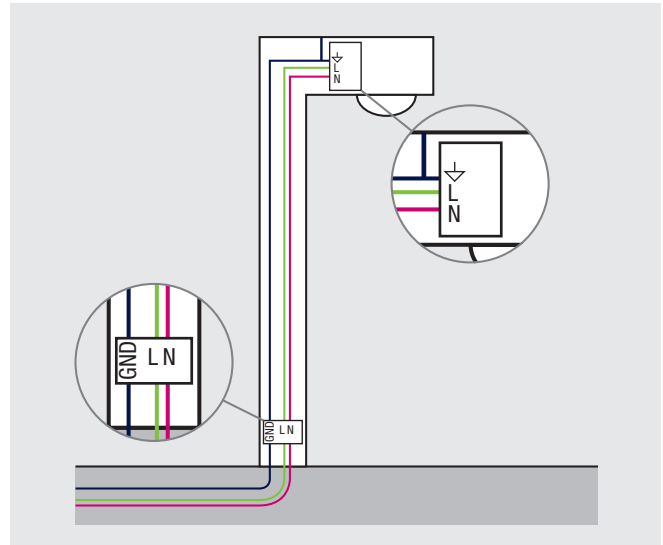


Figure 34: Safe connection with lightning conductor outside – Class I luminaire

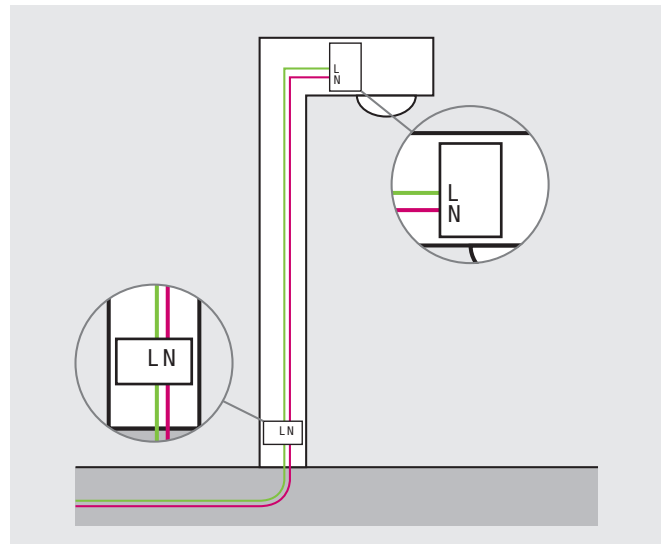


Figure 35: Safe connection with lightning conductor outside – Class II plastic luminaire

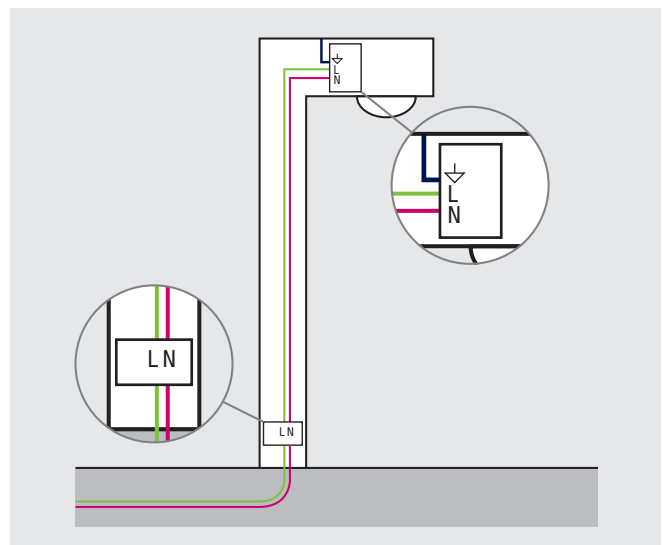


Figure 36: Safe connection with lightning conductor outside – Class II metal luminaire

**2.4.10. Protection against moisture in outdoor luminaires**

PTo ECGs have been developed for outdoor luminaires with a higher IP Class (IP Class 54 or higher spec luminaires are suitable). The potted construction leaves them better protected in the face of climatic effects (moisture, condensation, etc.). For older lighting installations (luminaires) or due to increased material fatigue of luminaire components (seals, covers, etc.) an installation that protects from spray water or precipitation should be preferred.

**2.5. Electromagnetic compatibility**

The term EMC (electromagnetic compatibility) and the stipulations relating to it stand for a whole range of different test criteria.

The most important of these criteria that play a role in the context of electronic control gears are regulated by the standards described below in relation to radio interference, harmonic content (up to the 39th harmonic) and resistance to interference.

| List of the most important standards for ECGs |                                   |                      |
|-----------------------------------------------|-----------------------------------|----------------------|
|                                               | IEC/CISPR International Standards | European standard EN |
| Harmonics                                     | IEC 61000-3-2                     | EN 61000-3-2         |
| Resistance to interference                    | IEC 61547                         | EN 61547             |
| Radio interference                            | CISPR 15                          | EN 55015             |
| Electromagnetic fields                        | IEC 62493                         | EN 62493             |

By displaying the CE marking OSRAM guarantees the conformity of POWERTRONIC® electronic control gear with the interference resistance requirements and the specified limits for harmonic currents and for radio interference (as well as for safety). See also section 3.2 "Quality marks".

**2.5.1. Specified harmonic limits**

Lighting installations are restricted in relation to mains harmonics. They are classified and are categorized in Class C. Up to 25 W lighter requirements apply.

For lighting installations > 25 W the following limits are specified:

| Specified harmonic limits |                                                      |
|---------------------------|------------------------------------------------------|
| Harmonic number           | Proportion of fundamental mains current in % (50 Hz) |
| 2                         | 2                                                    |
| 3                         | 30 x power factor ( $\lambda$ )                      |
| 5                         | 10                                                   |
| 7                         | 7                                                    |
| 9                         | 5                                                    |
| 11 < n < 39               | 3                                                    |

All POWERTRONIC® ECGs (> 25 W) for use with HCl, HQI and NAV lamps must have a total harmonic distortion (THD) < 10 %.

Employing devices that do not conform to the specified harmonics limits may have serious consequences:

- Premature failure of capacitors
- Premature triggering of circuit breakers and other safety equipment
- Failure or functional problems with computers, drivers, lighting installations and other sensitive electric devices
- Overload of the neutral conductor (especially in the 3rd harmonic)
- Explosion of discharge lamps

**2.5.2. Resistance to interference, immunity**

The devices conform to the requirements of IEC 61547 on immunity. This means that they are protected against external influences of electromagnetic fields against static electrical discharges (ESD), against short-term (transient) surge voltage and voltage drops or failures in the mains network.

### 2.5.3. Radio interference

Conformity with the specified limits for radio interference is a precondition for granting of the VDE-EMC mark by the VDE independent testing institute based in Offenbach, Germany.

Our electronic control gear (ECGs) are tested in a test set-up via a reference luminaire, as described in CISPR 30.

ECGs for independent assembly, in contrast, are tested exclusively according to CISPR 30. The levels of interference of a luminaire, however, not only depend on the ECG, but also on a number of factors:

- The arrangement of lamp and ECG components
- The structure of the luminaire
- Wiring

For this reason, conformity to the specified limit for a luminaire considered as a systematic whole is substantially more complex and must be tested separately for each luminaire approval (e.g. by the VDE testing institute). The manufacturer of the luminaire is responsible for this.

#### 2.5.3.1. Causes of radio interference

The term "radio interference" includes both the interference through the lines as well as the radiated interference from any electric device on another device on the same power network and/or in the immediate vicinity.

In order to ensure simultaneous, fault-free operation of the widest possible variety of electric devices, each of those devices must conform to particular limits and demonstrate a certain level of resistance to interference.

POWERTRONIC® ECGs are based on a high-frequency circuit topology to achieve higher energy efficiency and compact size. These high-frequency switching processes, together with non linear components (such as diodes, transistors, etc.) can create interference with the mains and lamp cables of the ECG. Both the mains and lamp cables can function as antennas in this context.

The greater part of the electromagnetic radiation is transferred onto these cables. Under unfavorable conditions the lamp cables can form a resonator in combination with the luminaire, thus leading to increased emission ( $\lambda/4$ , 100 MHz  $\rightarrow$  l = 75 cm). The resonance cycle is influenced by the inductivity of the cables, the capacitive coupling of cables with metallic surfaces of the luminaire and the lamp being used. Provided that as this resonance cycle cannot be controlled by structural measures it is recommended to apply ferrites to the lamp cables.

#### 2.5.3.2. Hints on installation to prevent radio interference

Since the cable layout has a decisive influence on the radiation characteristics of a luminaire, it is essential to make sure that cables are positioned carefully inside (and outside) the luminaire as described in section 2.2.4.4.

With the use of complex internal EMC filters the interference described above is reduced to levels below those required by the relevant standards, so that the OSRAM electronic control gear themselves conform to these standards. However, installing the ECG into luminaires can significantly change these properties.

2.6. Errors, causes and solutions

| Error                                                                                                                                                                                                                                              | Causes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Solutions                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lamps obviously too bright or not bright enough                                                                                                                                                                                                    | Check whether a lamp with the right wattage is installed                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | If necessary change the lamp or the ECG                                                                                                                                                                                                                                                                                         |
| The lamp flashes on and off                                                                                                                                                                                                                        | The lamp has reached the end of its useful life and can no longer be used in a stable state                                                                                                                                                                                                                                                                                                                                                                                                                                    | Change the lamp                                                                                                                                                                                                                                                                                                                 |
| The device switches off after some time in operation                                                                                                                                                                                               | The ECG is being operated outside specifications                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Adjust luminaire design or environment                                                                                                                                                                                                                                                                                          |
|                                                                                                                                                                                                                                                    | The ECG is being operated in a hot environment and switches off in order to prevent irreversible damage                                                                                                                                                                                                                                                                                                                                                                                                                        | Adjust luminaire design or environment.<br>To restart, power supply must be interrupted.                                                                                                                                                                                                                                        |
|                                                                                                                                                                                                                                                    | Mains voltage outside the permissible range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Adjust luminaire design or environment                                                                                                                                                                                                                                                                                          |
|                                                                                                                                                                                                                                                    | Lamp type not suitable for ECG (e.g. NAV with PTi)                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | If necessary change the lamp or the ECG                                                                                                                                                                                                                                                                                         |
| Lamp does not ignite (for 2-lamp systems, neither of them ignites) and no visible glow can be seen shortly after switching on (the same occurs when the device is switched on even after a minute of downtime and after an internal device reset). | <ul style="list-style-type: none"> <li>• RCD or some other protective component in the system has been triggered</li> <li>• Has the maximum permitted number of electronic control gears per automatic cut-out been exceeded for the installation in the 3-phase network?</li> <li>• Is it absolutely sure that the neutral conductor is correctly connected to all the fixtures and that it is making proper contact?</li> <li>• Is it possible that moisture has got into the luminaire, causing a short circuit?</li> </ul> | Check the mains side wiring and, where applicable, the insulation consistency                                                                                                                                                                                                                                                   |
|                                                                                                                                                                                                                                                    | Failure in the mains side wiring                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Check whether the mains input voltage, suitable for the specified area of application is actually present at the ECG. Make absolutely sure that the neutral conductor is correctly connected to all the luminaires and that it is making proper contact. Check whether all cables have the correct connection in the terminals. |
|                                                                                                                                                                                                                                                    | The irreversible surge protection in the ECG has been triggered (the ECG is permanently damaged)                                                                                                                                                                                                                                                                                                                                                                                                                               | Check whether the lamp is working using other lighting outlets. If this is not the case, check the mains input voltage to see whether it is within the specified range. If the neutral conductor is both properly connected and it is making proper contact, then both the ECG(s) and lamp(s) must be replaced.                 |
| Different lumen output levels between luminaires                                                                                                                                                                                                   | Lamps with different wattages/light colors have been installed                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | The lamp type and wattage must match the type indicated on the ECG. For any particular application, the chosen light color should be uniform.                                                                                                                                                                                   |
|                                                                                                                                                                                                                                                    | The wiring between ECG and lamp is faulty; there may be a contact problem                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Check the wiring on the lamp side for proper contact                                                                                                                                                                                                                                                                            |
|                                                                                                                                                                                                                                                    | Has the lamp wiring been installed according to the indications on the ECG?                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Where necessary wire up the lamp according to the indications on the ECG                                                                                                                                                                                                                                                        |
|                                                                                                                                                                                                                                                    | The ECG is operating outside the specified temperature range and is trying to reduce the thermal load on the lamp via power reduction control ("forced dimming")                                                                                                                                                                                                                                                                                                                                                               | Check whether the ECG is operating above the specified temperature in the affected luminaires. Make structural changes in order to lower the heat load on the device.                                                                                                                                                           |
| Problems with other electrical devices, especially with radio or TV receivers                                                                                                                                                                      | Wiring problems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | See also the information in section 2.2.4.4. Cable layout                                                                                                                                                                                                                                                                       |
|                                                                                                                                                                                                                                                    | Other electrical devices or receivers have insufficient resistance to interference                                                                                                                                                                                                                                                                                                                                                                                                                                             | Increase the distance between the luminaire and the affected electrical device or receiver; where necessary contact the manufacturer of the device.                                                                                                                                                                             |

## 3. Standards, quality marks and CE labeling

### 3.1. Standards

#### 3.1.1. Safety

##### EN 61347-2-12 together with EN 61347-1

"Lamp control gear – Part 2-12: Particular requirements for DC or AC supplied electronic ballasts for discharge lamps (excluding fluorescent lamps)" together with "Lamp control gear – Part 1: General and safety requirements"

The EN 61347-2-12 standard sets out particular general and safety requirements for AC and DC supplied electronic control gears. The supply covered includes AC voltages up to 1000V at 50 or 60 Hz. The ballast type is a converter that may contain components for ignition and stabilization for operating a discharge lamp using DC or using a frequency different to the mains frequency.

The lamps connected to the control gear are governed by IEC 60188 (high-pressure mercury vapor lamps), IEC 60192 (low-pressure sodium vapor lamps), IEC 60662 (high-pressure sodium vapor lamps), IEC 61167 (metal halide lamps) as well as other standards for general lighting purposes.

In addition, the EN 61347-2-12 also sets out the extent to which a section of EN 61347-1 is applicable and determines the sequence in which the required tests should be carried out.

The standard mainly sets the requirements for the following topics:

Labeling (of PE/FE, terminals, wiring, ignition voltage, U-OUT), connection terminals, protective earth connections, protection against accidental contact with live parts, water resistance and insulation, electric strength, failure conditions, protection of components, ignition voltage, anomalous conditions (behavior of the ECG at the end of lamp life), design, creep and clearance distances, screws, conductive components and connections, heat and fire resistance, creep resistance, resistance to corrosion.

Conformity with the standard is a precondition of granting the VDE-EMC mark and for CE conformity.

##### EN 60598-1

"Luminaires – Part 1: General requirements and tests"

The EN 60598-1 standard sets the general requirements for luminaires containing electrical light sources suitable for operation at supply voltages of up to and including 1000V. The requirements and the corresponding tests set in this standard apply to: classification, labeling, mechanical and electrical design.

The standard does not apply to built-in ECGs. However, the following sections are set as a standard for independent ECGs:

Construction (cable layout, connection terminals, connection points and mains connections, mechanical stability), external and internal cabling (mains connection and other external cabling, cable strain relief mechanism), protection against electric shock, protection against dust, solid foreign objects and water, insulation resistance, electric strength, contact current and protective current, clearance and creep distances.

For independent ECG conformity to these standards is a precondition for the VDE-EMC mark and for CE conformity.

#### 3.1.2. Electromagnetic compatibility (EMC)

##### EN 55015

"Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment"

The EN 55015 standard applies to emissions (both radiated and conducted) of high-frequency interference by, among other things, all lighting equipment with the main purpose of creating and/or distributing light for purposes of illumination, which are designed either for the low-voltage network or for battery operation, and for independent accessories for use exclusively with lighting applications.

The limits specified in this standard have been set, based on the probability that radio interference remains within economically acceptable limits and that, more generally, sufficient protection is ensured for radio reception and for electromagnetic compatibility. In unfavorable circumstances, additional measures may be required.

The standard includes regulations and methods of measurement of interference in the frequency range from 9 kHz to 300 MHz.

In this regard it sets the specified limits for interference voltage due to the cable layout in the frequency range up to 30 MHz on the mains connections and on the secondary and control terminals. In addition, for radiated interference, limits are specified for the magnetic component of the interference field strength in the frequency range of 9 kHz to 30 MHz and the electrical component of that interference field strength in the frequency range of 30 MHz to 300 MHz.

The measurement of interference in the frequency range of 30 to 300 MHz can be carried out using the CDN procedure for interference due to cable layout.



## STANDARDS, QUALITY MARKS AND CE LABELING

The limit specified for conducted interference for use with the CDN procedure is comparable with the limit for radiated interference and provides adequate protection to radio services using the frequency range of 30 to 300 MHz.

Conformity with the standard is a precondition of granting the VDE-EMC mark and for CE conformity.

### EN 55022

"Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement"

The EN 55022 standard describes the procedure for measuring the level of interference signals that may be created by information technology equipment facilities, and sets out limits for the frequency range from 9 kHz to 1 GHz.

The standard does not apply to ECGs.

### EN 61547

"Equipment for general lighting purposes. EMC interference resistance requirements"

The EN 61547 standard sets requirements for the electromagnetic interference resistance of lighting equipment; it does so both for connection to the low-voltage network and for battery operation.

The regulation includes requirements for ECG immunity against the following external disturbing influences: Static electrical discharge, high frequency and network frequency electromagnetic fields, fast transients, current inputs, surge currents/voltages, voltage drops and interruptions, voltage fluctuations.

Conformity with the standard is a precondition of granting the VDE-EMC mark and for CE conformity.

### EN 61000-3-2

"Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current  $\leq 16\text{ A}$  per phase)"

The EN 61000-3-2 standard applies to the limitation of the amount of harmonic currents that may be introduced into the public low-voltage network. It sets limits to the harmonic current component of input current that may be generated by a device equipment or facility, which is tested under specified conditions.

Different limits and testing methods are valid for lighting installations with an effective input power up to 25 W or greater than 25 W.

Conformity with the standard is a precondition of granting the VDE-EMC mark and for CE conformity.

### EN 61000-3-3

"Electromagnetic compatibility (EMC) – Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current up to 16 A per phase and not subject to conditional connection"

The EN 61000-3-3 standard applies to the limitation of the amount of voltage fluctuations and flicker that may be caused into the public low-voltage network. It sets out limits for changes in voltage that may be generated by devices and systems, which are tested under specified conditions, and gives information about calculation procedures.

Conformity with the standard is a precondition of granting the VDE-EMC mark and for CE conformity.

### EN 62386 (for PTo devices only)

This standard describes the DALI® industry standard and sets out a protocol and a testing procedure for the control of electronic control devices with digital signals for purposes of illumination. The tests described in this draft standard are type approval tests. Requirements for the testing of individual control gears during production are not included.

An overview of the DALI® standard:

- All control gears must conform to Part 102.
- A single operating device may belong to more than one device type (see Part 100, 200, 300).
- Specific commands and properties are defined and described in the Parts numbered 2xx.

| Digital Addressable Lighting Interface Standard |                                                        |                                                |
|-------------------------------------------------|--------------------------------------------------------|------------------------------------------------|
| Part 100: General requirements                  | Part 200: Special requirements for control gears       | Part 300: Special requirements for controllers |
| Part 101: System                                | Part 201: Fluorescent lamps                            | Part 301: SML description                      |
| Part 102: Control gear                          | Part 202: Emergency lighting                           | Part 302: 3-byte protocol                      |
| Part 103: Controllers                           | Part 203: Discharge lamps (HID)                        |                                                |
|                                                 | Part 204: Low-voltage halogen lamps                    |                                                |
|                                                 | Part 205: Incandescent bulbs                           |                                                |
|                                                 | Part 206: Conversion of a digital signal to DC voltage |                                                |
|                                                 | Part 207: LED modules                                  |                                                |
|                                                 | Part 208: Switching function                           |                                                |
|                                                 | Part 209: Color and color temperature control          |                                                |
|                                                 | Part 210: Sequencer                                    |                                                |
|                                                 | Part 211: Optical control                              |                                                |

### EN 62493 (for PTi I, PT-FIT I and PTi SNAP devices only)

This standard applies to the assessment of lighting equipment in relation to the exposure of persons to electromagnetic fields. The assessment contains induced current densities from 20 kHz to 10 MHz and the specific absorption rate (SAR) for frequencies from 100 kHz to 300 MHz in the immediate vicinity of lighting equipment.

### 3.2. Quality marks

#### 3.2.1. The VDE label



By granting the VDE label, the VDE testing and certification institute certifies that the relevant ECG conforms with the safety standards listed in the approval certificate from the point of view of the EC Low Voltage Directive. Certified products are subject to factory inspection and manufacturing monitoring.

At the same time, the approval certificate forms the basis of the EC Declaration of Conformity and the CE marking made by the manufacturers or their authorized persons.

The VDE label for ECGs for the operation of high-pressure discharge lamps includes conformity with the EN 61347-2-12 safety standard in conjunction with EN 61347-1.

#### 3.2.2. The ENEC mark



The ENEC mark stands for "European Norm Electrical Certification" and is the agreed symbol of conformity of the European Union's inspection authorities. It symbolizes conformity with the European safety and workplace standards listed in the ENEC agreement. As is the case with the VDE label, in addition to indicating the type approval tests made on the ECG, the ENEC mark also covers the continuous monitoring of both the manufacturing process and the relevant products. The number that appears to the right of the symbol stands for the relevant certification authority. For example, 10 stands for the VDE test and certification institute in Germany.

The ENEC mark for ECGs for the operation of high-pressure discharge lamps includes conformity with the EN 61347-2-12 safety standard in conjunction with EN 61347-1.

#### 3.2.3. The VDE-EMC mark



By granting the VDE-EMC mark, the VDE testing and certification institute certifies that the relevant ECG conforms with the safety standards listed in the approval certificate from the point of view of the EC Directive on electromagnetic compatibility. At the same time, the approval certificate forms the basis of the EC Declaration of Conformity and the CE marking made by the manufacturer or their authorized person.

The VDE-EMC mark for ECGs for the operation of high-pressure discharge lamps includes conformity with the EN 55015, EN 61547, EN 61000-3-2 and EN 61000-3-3.

#### 3.2.4. The CCC/CQC mark



The CCC symbol is a compulsory safety and quality mark for a variety of products that are sold in the Chinese market. It became applicable on 04/30/2003. In order to be granted the CCC mark, the product's conformity with Chinese standards must be certified by a testing laboratory approved by the CNCA (Certification and Accreditation Administration of the People's Republic of China). The standard also requires a plant inspection.

There is no CCC mark available for HID ECG. Apart from the compulsory certification, the China Quality Certification Centre also provides a voluntary product certification, the CQC mark. To obtain this mark, products are tested against standards for quality, safety, EMC, environmental friendliness or functioning.

The difference between the CCC and the CQC is that the CCC is compulsory while the CQC is voluntary. The process is identical. Since luminaires using HID lamps need CCC certification, it is advantageous to have the CQC mark on the HID ECG when applying for approval of the luminaire.

#### 3.2.5. The C-tick/RCM mark



This is an approval mark of the Australian standards authorities.

#### 3.2.6. The GOST mark



This is an approval mark of the Russian standards authorities.

### 3.3. The CE marking



The CE marking for products is a symbol defined by EU law with which a manufacturer declares his or her conformity with the relevant EC Directives. For OSRAM's POWERTRONIC® products, the relevant documents are the Low Voltage Directive 006/95/EC and the EMC Directive 2004/108/EC as well as the Ecodesign Directives 2009/125/EC and 245/2009. The CE marking is therefore a precondition for commercialization and operation of a product within the European Economic Area and is thus a precondition for its use in that area.

The CE marking was created mainly to provide the end user with safe and electromagnetically compatible products on the free market within the European Economic Area (EEA) and the European Community (EC) within that area. The CE marking is therefore often referred to as a product's "passport" for the European internal market.

The proof of conformity may be generated by the manufacturer under his own responsibility and it is monitored and, where necessary, enforced penalty by the national market surveillance authorities. In Germany, for example, the BNetzA (Federal Network Agency) is responsible for fulfilling this role. OSRAM has used the expertise of an independent test institute in order to obtain this certification for POWERTRONIC® products.

The CE marking is not a quality or test mark and implies nothing in relation to the quality of the products labeled with it. Therefore it should not be confused with the test marks of independent testing institutes (such as ENEC, VDE or VDE EMC marks).

### 3.4. Energy efficiency certification



The classifications of ballasts into a number of energy levels has been introduced by the CELMA association. CELMA is an umbrella organization of national manufacturers' associations for lighting and electro-technical components for luminaires in the European Union. CELMA has 19 member associations and represents over 1,000 businesses in 13 European countries. The manufacturers are mostly small and medium-sized enterprises with a total workforce of 107,000 employees and with total annual sales of 15 billion EUR. Amongst the aims of this amalgamation is the categorization of all control gear for HID lamps into energy classes in accordance with particular uniform criteria and to submit proposals to the European Union on energy classes that should not be permitted in the future for use in the EU.

All POWERTRONIC® ECGs are categorized in Energy Class A2 and fulfill all the efficiency requirements for control gear under the ErP Directive starting in 2017.

### 3.5. Other certifications



Mounting on materials whose flammability properties are unknown, where the temperature does not exceed 95 °C in normal operation or 115 °C under abnormal conditions or in cases of failure.



Max. casing temperature in the event of failure (e.g. 110 °C)



The WEEE symbol stands for "Waste Electrical and Electronic Equipment". It regulates the return and recycling of electronic products. The important central goals of this initiative are the prevention of electrical and electronic scrap and the reduction of waste by recycling.

# 4. ECG label

Illustrative example using PTi 70/220-240 S

**POWERTRONIC® PTi 70/220-240 S.**  
Universal Electronic Ballast for MH-Lamps

| Lamp     | U <sub>N</sub> [V] | I <sub>N</sub> [A] | λ <sub>N</sub> | f <sub>N</sub> [Hz] | t <sub>a</sub> [°C] | t <sub>c</sub> [°C] |
|----------|--------------------|--------------------|----------------|---------------------|---------------------|---------------------|
| HCI 70 W | 220~               | 0.37               | > 0.95         | 50/60               | -25...+55           | 85                  |
| HQI 70 W | 230~               | 0.36               |                |                     |                     |                     |
|          | 240~               | 0.35               |                |                     |                     |                     |

Caution! Disconnect line voltage before lamp replacement  
Ignition time cut-off

U-OUT=250 V

4.5 kV

OSRAM  
Made in China by OSRAM

Annotations:  
 - ECG description: Points to the product name and model.  
 - Lamp types to be used: Points to the table.  
 - Permissible t<sub>a</sub> and t<sub>c</sub> temperature values: Points to the temperature columns in the table.  
 - Connection schematic Mains side: Points to the L, N, LL terminals.  
 - Connection schematic Lamp side: Points to the LH terminal.  
 - Quality marks, conformity and classification: Points to the A2, 110, M, M, 10, D'E, EMC, AR 46, and CE marks.  
 - Mark indicating the t<sub>c</sub> test point: Points to the t<sub>c</sub> symbol on the lamp diagram.  
 - Installation information: Points to the wire preparation diagram (0.5-2.5 mm, 10-11 mm).

Illustrative example using PTo 100/220-240 3DIM

**POWERTRONIC® PTo 100/220-240 3DIM**  
Universal Electronic Ballast for MH- and HPS-Lamps

| Lamp      | U <sub>N</sub> [V] | I <sub>N</sub> [A] | λ <sub>N</sub> | f <sub>N</sub> [Hz] | t <sub>a</sub> [°C] | t <sub>c</sub> [°C] |
|-----------|--------------------|--------------------|----------------|---------------------|---------------------|---------------------|
| HCI 100 W | 220~               | 0.50               | ≥ 0.95         | 50/60               | -25...+55           | 75                  |
| NAV 100 W | 230~               | 0.48               |                |                     |                     |                     |
|           | 240~               | 0.46               |                |                     |                     |                     |

Caution! Disconnect line voltage before lamp replacement.  
Ignition time cut-off!

U-OUT=250V

4.5kV

OSRAM

Annotations:  
 - Connection schematic Lamp side: Points to the LH, LL terminals.  
 - Lamp types to be used: Points to the table.  
 - ECG description: Points to the product name and model.  
 - Marking indicating the t<sub>c</sub> test point: Points to the t<sub>c</sub> symbol.  
 - Installation information: Points to the wire preparation diagram (0.5-2.5 mm, 10-11 mm).  
 - Connection side Mains side: Points to the L, N, SD, DA, DA terminals.  
 - Quality marks, conformity and classification: Points to the EMC, 10, D'E, AR 46, DALI, A2, 110, and CE marks.

## 5. The System+ Guarantee

### The OSRAM System+ Guarantee

Where POWERTRONIC® electronic control gear and HQI®/HCI®/NAV® high-pressure discharge lamps by OSRAM are used together, OSRAM gives a full 5-year guarantee for POWERTRONIC® products and a full 1 or 2-year guarantee for HQI®/HCI®/NAV® products. In order for the System+ Guarantee to apply, the relevant lighting installation must be registered with OSRAM.



For more information and typical applications go to [www.osram.com/system-guarantee](http://www.osram.com/system-guarantee)



## 6. Further information



Datasheets, type lists and specification texts, as well as other information on the topic of POWERTRONIC® can be obtained from the following website:  
[www.osram.com/powertronic](http://www.osram.com/powertronic)

## 7. Glossary of key words

|                      |                                            |
|----------------------|--------------------------------------------|
| <b>3DIM</b>          | DALI <sup>®</sup> , StepDIM and AstroDIM   |
| <b>CT</b>            | Color temperature                          |
| <b>DA</b>            | DALI <sup>®</sup>                          |
| <b>EMC</b>           | Electromagnetic compatibility              |
| <b>EoL</b>           | End of Life                                |
| <b>ETA</b>           | Lamp luminous efficacy                     |
| <b>ETA sys</b>       | Luminous efficacy of lamp + control gear   |
| <b>HCI</b>           | Metal halide lamp with ceramic burner      |
| <b>HQI</b>           | Metal halide lamp with quartz glass burner |
| <b>HS</b>            | High-pressure sodium lamp                  |
| <b>MH</b>            | Metal halide lamp                          |
| <b>NAV</b>           | Sodium vapor high-pressure discharge lamp  |
| <b>PFC</b>           | Power factor correction                    |
| <b>PHI</b>           | Luminous flux                              |
| <b>PL</b>            | Lamp wattage                               |
| <b>PS</b>            | Wattage of system (lamp + control gear)    |
| <b>Ra</b>            | Color rendering                            |
| <b>SD</b>            | StepDIM                                    |
| <b>t<sub>a</sub></b> | Ambient temperature                        |
| <b>t<sub>c</sub></b> | Temperature at t <sub>c</sub> point        |



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