POWERTRONIC® Technical Guide.

Electronic Power Supplies for HID lamps.

- Product Overview
- Installation Instruction
- Working Condition

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Contents

Contents 4

1. System comprising HID lamp and ECG 5
1.1 Metal halide lamp 5
1.2 POWERTRONIC ECG 6
1.2.1 Product range 6
1.2.2 Functioning 6
1.2.3 Advantages of the intelligent POWERTRONIC PTi ECG 7
1.2.4 Advantages of ECGs compared to conventional control gears (CCGs) 8
1.2.5 Applications 9
1.2.5.1 Indoors/Outdoors 9
1.2.5.2 Integration or independent installation? 10

2. The product in practical use 11
2.1 Supply voltage 11
2.1.1 Permissible voltage range 11
2.1.2 Overvoltage > 254 V 11
2.1.3 Undervoltage < 198 V 12
2.1.4 DC voltage 12
2.1.5 ECGs for 120 V/277 V line voltages 13
2.1.6 Three-phase operation 13
2.1.7 Unbalanced load endurance 14
2.2 Installation 15
2.2.1 ECG operation for luminaires of protection class I and II 15
2.2.2 Insulation 16
2.2.2.1 Insulation distances in luminaires 16
2.2.2.2 Insulation test of luminaires 16
2.2.2.3 Insulation resistance in lighting installations 17
2.2.3 Output voltage 18
2.2.3.1 Lamp ignition voltage 18
2.2.3.2 Working voltage (U-OUT) 18
2.2.4 Wiring 19
2.2.4.1 Wire and cable types 19
2.2.4.2 Cable cross-section 19
2.2.4.3 Cable length between the ECG and lamp 20
2.2.4.4 Cable routing 20
2.2.4.5 Wiring diagrams for built-in ECGs 22
2.2.4.6 Wiring diagrams for downlights with POWERTRONIC ECGs with cable clamps 23
2.2.4.7 Wire stripping length 25
2.2.5 Automatic circuit breakers / Inrush current 25
2.2.6 Leakage current/PE conductor current/Touch current/ Residual current detectors (RCDs) 26
2.3 Operating characteristics 27
2.3.1 Lamp ignition and lamp operation 27
2.3.2 Hot re-ignition 27
2.3.3 ECG restart/reset 27

2.3.4 Constant lamp power ... 28
2.3.5 Power factor/Compensation ... 28
2.3.6 ECG temperatures and influence on the service life ... 29
2.3.6.1 Control gear temperature t_c ... 29
2.3.6.2 Ambient ECG temperature t_a ... 30
2.3.6.3 Self-heating of the electronic control gear (ECG) ... 31
2.3.6.4 Practical analysis of the service life and thermal quality of an electronic control gear (ECG) ... 31
2.3.6.5 Influence of the temperature on the service life ... 33
2.3.6.6 Failure probability ... 34
2.3.7 General installation instructions in terms of temperature 34
2.3.7.1 Power reduction due to excess temperature ... 35
2.3.7.2 Measuring the temperature of the ECG in the luminaire . 35
2.3.8 Switching resistance of the ECG ... 36
2.3.9 Short circuit resistance ... 36
2.3.10 Cut-off criteria and cut-off mechanisms ... 37
2.3.10.1 Control of the lamp voltage ... 37
2.3.10.2 Ignition time limit ... 37
2.3.11 Shutdown at the end of the lamp service life ... 37
2.3.12 Noise development ... 39
2.3.13 Dimming ... 40
2.4 Instructions for luminaire construction ... 40
2.4.1 Thermal coupling ... 40
2.4.2 Louvres/Cooling fins ... 41
2.4.3 Materials for use in luminaire construction ... 41
2.4.4 Easy installation of electronic control gears (ECGs) ... 42
2.4.5 Installation space for independent installation devices ... 43
2.4.6 Plug & Play installation with cable/plug-in systems ... 44
2.4.7 Wiring the mains cable in a loop using unsecured push wire connector ... 44
2.4.8 Suitable lamp holders ... 44
2.5 Electromagnetic compatibility ... 45
2.5.1 Harmonic limiting values ... 46
2.5.2 Immunity ... 47
2.5.3 Radio interference characteristics ... 47
2.5.3.1 Causes of radio interference ... 47
2.5.3.2 Installation instructions for avoiding radio disturbance ... 48
2.6 Faults, sources of faults and elimination of faults ... 49

3. Standards, approval marks and CE mark ... 51
3.1 Standards ... 51
3.1.1 Safety ... 51
3.1.2 Electromagnetic compatibility (EMC) ... 52
3.2 Test marks ... 54
3.2.1 VDE mark ... 54
3.2.2 ENEC approval mark ... 54
3.2.3 EMC mark of the VDE ... 55

3.2.4 CCC mark ... 55
3.2.5 c-tick/RCM mark ... 55
3.3 CE marking ... 55
3.4 Other markings ... 56

4. ECG imprint ... 57

5. System+ guarantee ... 58

6. Datasheets ... 59

7. Type lists ... 64

8. Tender documents ... 65

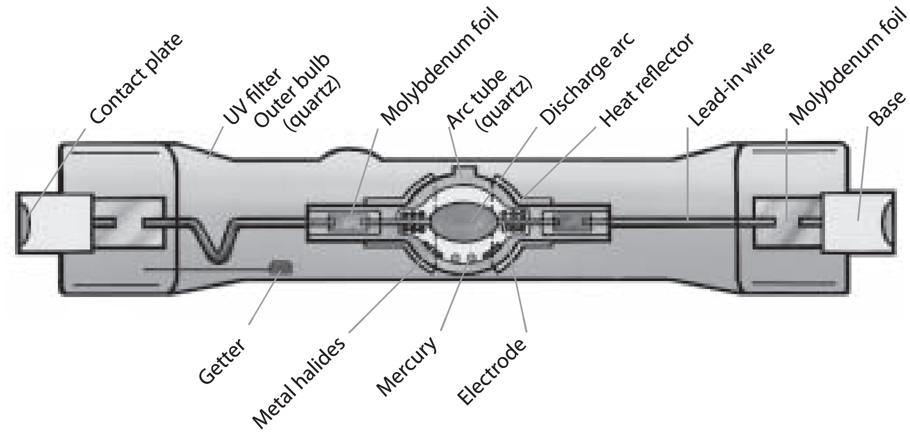
Contents

Electronic control gears (or ECGs for short) for metal halide lamps have become considerably more important in recent years and represent the current state of the art.
This technical guideline deals with the product characteristics of these electronic control gears (ECGs), shows the differences to operation with conventional control gears (CCGs) and provides instructions and tips for appropriate and standardized installation and for putting the equipment into operation. In addition, the final part of this guideline contains instructions on light design, an overview of the basic standards and test marks, and technical datasheets of the currently available products.
Please always check the POWERTRONIC website at www.osram.com/powertronic for additional or updated information and pay special attention to supplementary instruction sheets delivered with our products.

1. System comprising HID lamp and ECG

1.1 Metal halide lamps

Metal halide lamps belong to the group of high-pressure discharge lamps. In contrast to low pressure discharge, in high-pressure discharge a high pressure and a high temperature is generated in a discharge tube. In discharge lamps, light is generated by a gas discharge of particles created between two hermetically sealed electrodes in an arc tube. In high intensity discharge lamps, the arc tube is usually enclosed in an evacuated outer bulb which isolates the hot arc tube thermally from the surroundings, similar to the principle of a thermos flask. But there are also some discharge lamps without outer bulbs as well as lamps with gas-filled outer bulbs. In an arc tube gas discharge works through excitation of the luminous additives (metal halide salts) and the mercury by the current flow, generating visible radiation characteristic for the respective elements involved. The mixture of the visible radiation of the different elements results in the requisite color temperature and color rendering for a particular lamp.



This figure shows an example of how a metal halide lamp works based on a double-ended lamp with a quartz arc tube.

Metal halide lamps are also referred to as HID lamps which stands for **H**igh **I**ntensity **D**ischarge or HIT lamps (from the “LBS" lamp designation system) where **H** stands for High pressure
I stands for iodide, e.g. halogen
and **T** stands for tubular

They are also occasionally referred to as MH lamps (Metal Halide). Metal halide lamps are distinguished by the following properties in particular:

- High luminous efficacy
- Long service life
- Extremely good color quality
- Good to very good color rendering
- A spot light source with advantages in terms of light control and brilliance of the illumination

More detailed information on metal halide lamps can be found in the application document entitled "Metal halide lamps - Instructions for the use and application" which can be downloaded from the Internet using the following link:

www.osram.de/downloads or under the search term “Metal halide lamps. Instructions for the use and application"

1.2 POWERTRONIC ECG

POWERTRONIC is the name given by OSRAM to ECGs for the operation of metal halide lamps that have ceramic (HCI) or quartz glass arc tubes (HQI).
These ECGs not only replace the components of choke, ignition unit and correction capacitor familiar from CCGs, but also offer considerable simplification of installation as well as advantages in lamp operation. The benefits of ECGs now make them the No. 1 choice - especially for the operation of metal halide lamps with ceramic arc tube - because they realize the full potential of the lamps.

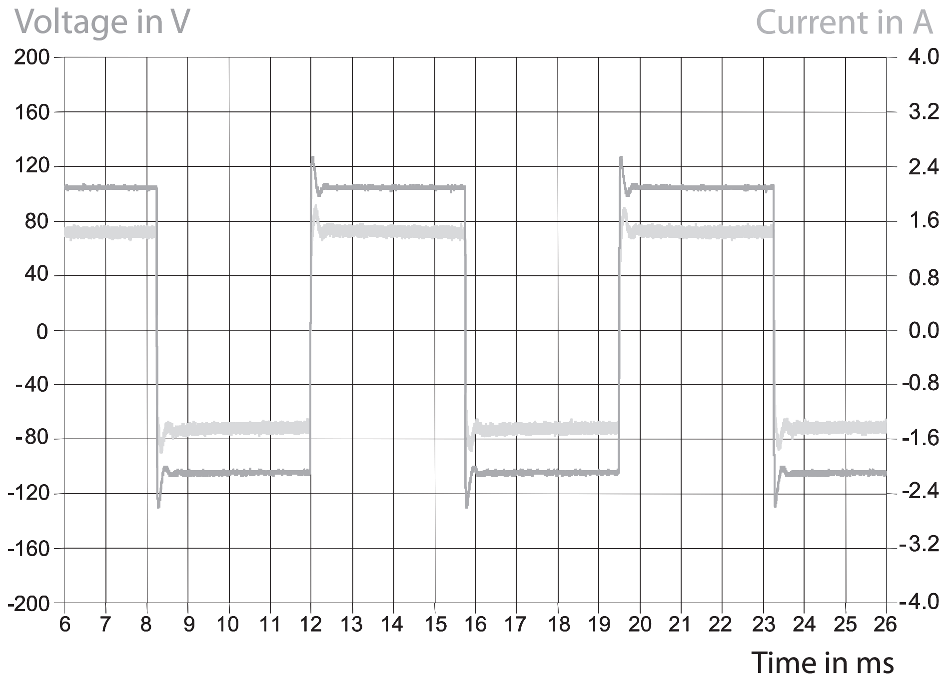
1.2.1 Product range

POWERTRONIC ECGs are currently offered in wattages between 20 W and 150 W as single-lamp ECGs and, depending on the wattage class, also as two-lamp ECGs. An overview of all ECG wattage classes and device types presently available incl. detailed technical datasheets is provided in the Appendix (see also Chapters 6 and 7)

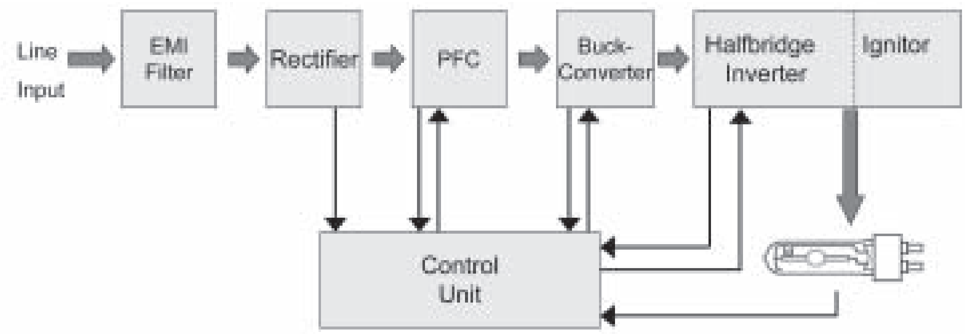
1.2.2 Functioning

The POWERTRONIC ECG for metal halide lamps combines in a single unit all the functions for lamp ignition, lamp operation as well as controlled and reliable shutdown of lamps at the end of their service life.
To achieve optimum lamp operation, POWERTRONIC ECGs convert the sinusoidal AC voltage of the mains supply into a square wave voltage with an operating frequency of between 150 and 200 Hz.
For optimum lamp ignition a voltage up to 4.5 kV is provided by the ECG. This max. 4.5 kV is usually enough for the reliable starting of cold lamps, but does not permit the immediate re-ignition of hot lamps.

The chart shows the square-wave current and voltage trend on the output side of a 150 W POWERTRONIC ECG



The following block diagram shows the setup principle of a classic square-wave ECG using half-bridge technology.



1.2.3 Advantages of the intelligent POWERTRONIC PTi electronic control gear (ECG)

The essential advantages of the intelligent OSRAM POWERTRONIC PTi ECG are listed in the following section:

- Compact dimensions and low weight
- High ECG service life of at least 40,000 h taking into account the maximum permissible temperatures
- High thermal quality: High t_a and t_c temperatures of the ECG for best possible ECG performance even in thermally critical luminaires
- Microcontroller for fully digital lamp control, intelligent ignition management and safe shutdown at the end of the lamp service life
- Power reduction and reversible shutdown of the ECG at ambient ECG temperatures above the specified limits

- Constant lamp wattage across the entire rated voltage range and across the entire specified temperature range of the ECG
- Versions with easy-to-assemble, two-part cable clamp for proper strain relief

1.2.4 Advantages of ECGs compared to conventional control gears (CCGs)

Formerly, HID lamps were almost exclusively operated with conventional, ferromagnetic control gear.
Due to a wide range of advantages, CCGs are being increasingly superseded by ECGs.

The following table provides an overview of the characteristic advantages of metal halide lamps and, at the same time, shows the essential advantages of operating lamps with an ECG in comparison with a CCG.

When comparing conventional and electronic control gears, the performance of the CCG constitutes the reference parameter and is given a value of 100. This is also based on the fact that the lamp parameters are still defined for the most part with the reference CCG.

	Magnetic or conventional control gear (CCG)	**POWERTRONIC electronic control gear (ECG)**
Energy efficiency	75 - 85 %, lower wattages display lower efficiency	88 - 92 %, almost constant over all wattages
Service life of the lamp	100	Up to 30 % prolongation depending on the type of lamp and application
Lamp start-up	Depends on type: usually approx. 60 to 90 sec. to reach 90% of the luminous flux level	Up to 50% faster
Color stability	Color variation possible	Clearly reduced scattering; initially and throughout service life
Shutdown at the end of the lamp service life	Not available or only simple cut-off mechanisms	Permanent parameter control, intelligent cut-off mechanisms
Ignition cut-off	Only with timer ignition units	Standard ignition time limited to 20 min
Light flicker	Visible flicker	Flicker-free thanks to 150-200 Hz square wave operation
Consistent wattage	Increase in wattage over service life, also dependent on fluctuations in temperature and supply voltage, and on lead length	± 3 % over the entire service life, regardless of fluctuations in temperature and supply voltage or lead length

	Magnetic or conventional control gear (CCG)	POWERTRONIC electronic control gear (ECG)
Handling	3 components, complicated wiring	1 unit, simple wiring
Size and weight	Heavy, several components, large in some cases	Light and compact
Power factor correction (PFC)	0.5 – 0.95, considerable aging fluctuations	≥ 0.95
Noise development	Clearly audible humming possible	Almost noiseless
Bidirectional data exchange	Not possible	Generally possible

The corresponding values and statements are based on tests and experience with OSRAM POWERTRONIC PTi ECGs, so they cannot necessarily be transferred 1:1 to control gears of other makes.

1.2.5 Applications

1.2.5.1 Indoors/Outdoors

POWERTRONIC PTi ECGs are basically designed to be operated indoors and were developed for these conditions. Using them in outdoor applications cannot be recommended because damage and even destruction of the unit can occur due to external influences such as moisture and humidity, salt mist, vibrations or transients on the power supply (switching operations or lightning strikes (EN 61000-4-5 Section 1)).

Because POWERTRONIC PTi ECGs of the current generation have been designed for use indoors, any claims under guarantee become void if they are used out of doors – irrespective of any possible IP classification of the luminaires used.

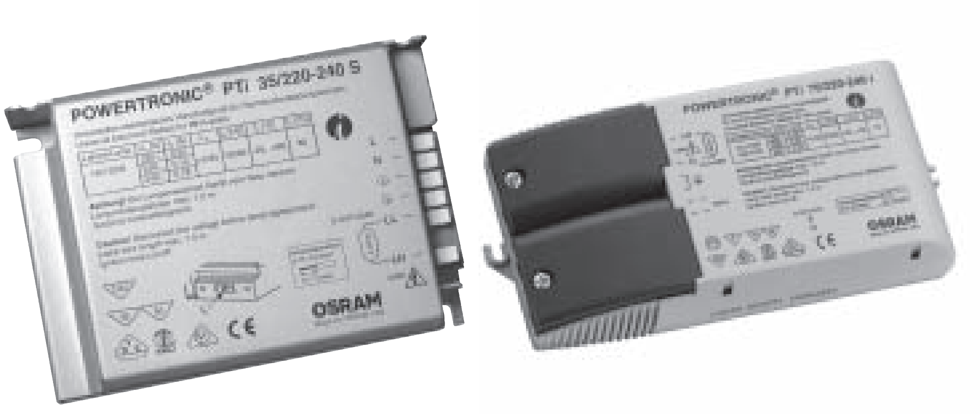
From a standards perspective, the PTi ECGs fulfill the requirements in compliance with IEC/EN 61547 for interference immunity against surge voltages between L and N of 1 kV and between L/N and PE of 2 kV in ECGs with an input power greater than 25 W or half these values at input powers below 25 W. These severity levels (test levels) correspond to installation classes 2 (< 25 W) or 3 (> 25 W) in compliance with IEC/EN 61000-4-5 Annex A.

For industrial applications and street lighting, however, an impulse voltage of at least L to N greater than 2 kV and L/N to PE greater than 4 kV is usually required. POWERTRONIC PTi are therefore not suitable for these types of application.

1.2.5.2 For integrated or independent installation

POWERTRONIC ECGs are available in two different types – each meeting the requirements of the luminaires that are used. Basically, a differentiation is made between the following types.

1. ECGs for installation in luminaires
2. ECGs with cable clamp for independent installation in false ceilings, for example



PTi **S** for installation in luminaires — PTi **I** with cable clamp for independent installation

The HID ECGs for installation in luminaires are indicated in OSRAM nomenclature with the abbreviation “S", the units with cable clamp are indicated with “I".

Built-in ECGs usually have a metal housing (aluminum or sheet steel) to enable as good a thermal "link” as possible to the luminaires.

ECGs with cable clamp for independent installation must have the following properties:

1.) Guarantees protection against electric shock (as per IEC/EN 60598-1). Effective possibilities for fulfilling this requirement are housings made of electrically non-conducting material (plastic, e.g. polyamide)
2.) Cable clamp and transverse force relief of the connection cable

Mounting on wood is permissible for all POWERTRONIC PTi because the units meet the requirements with reference to creepage distances and clearances, insulation and thermal behavior for the MM label as per VDE 0710-14 and DIN VDE 0100-559.

The units are therefore also labelled with the M M mark.

2. The product in practical use

2.1 Supply voltage

2.1.1 Permissible voltage range

All POWERTRONIC ECGs are designed for the operation of HCI or HQI metal halide lamps for a sinusoidal AC voltage of 50 to 60 Hz in a rated voltage range of 220-240 V. Deviations of -10 %/+6 % from the respective rated voltage limits are permitted – even in this range the lamps are still operated with rated data by the ECG.

Valid for: POWERTRONIC PTi	
Rated voltage range	
AC voltage	220 V to 240 V, 50/60 Hz
Permissible voltage range for continuous operation	
AC voltage	198 V ... 254 V, 50/60 Hz
Performance at undervoltage	
Lamp operation at undervoltage	198 - 220 V → guaranteed lamp operation
Voltage drop during operation	198 V ≥ U ≥ 176 V → lamp start and operation generally possible, but no guarantee U < 176 V → unspecified range → continuous operation not possible
Performance at overvoltage	
Lamp operation at overvoltage	240 V ≤ U ≤ 254 V → guaranteed lamp operation
Voltage increase during operation	U > 254 V → Continuous operation not possible; depending on the voltage level, the ECG can be irreversibly damaged after a few seconds.
Rapid transients or surge voltages as per EN/IEC 61547	POWERTRONIC ECGs are protected

Operation outside the permissible rated voltage range can result in damage to the ECG. Therefore, pay attention to the design of the mains and tolerances of the ECGs when using them.

2.1.2 Overvoltage > 254 V

For operation above the permissible rated voltage range, (“overvoltage"), a differentiation is made between two different types of overvoltage:

1. Transient overvoltages with a typical duration of microseconds (high-speed transients, surge voltages). These overvoltages can be caused by:
   - switching of inductive loads such as welding machines, elevators, alternators, CCG etc.
   - lightning

POWERTRONIC ECGs are protected against transient mains overvoltages as per EN/IEC 61547.

2. Quasi-stationary overvoltages that can range from a few minutes to several hours. These overvoltages can be caused by:
   - different loads on the mains side (interruption of the neutral conductor in 3-phase installations plus an additional asymmetric load distribution)
   - unstable power supplies

In any case, overloads mean more stress to electronic components. This leads to higher thermal loads and can, therefore, have a negative influence on the service life of the ECG.

POWERTRONIC ECGs are not suitable for operation with quasi-stationary overvoltages. In extreme situations overvoltages can even destroy the ECG.

2.1.3 Undervoltage < 198 V

Operation of the ECG below the permissible rated voltage range ("undervoltage") is not permissible and can result in the following consequences:

- Lamp operation outside the rated data → affecting the service life of the lamp
- No safe lamp start, safe ignition is only guaranteed above supply voltages of 198 V
- Unstable lamp operation up to the lamp going out
- In order to keep the lamp wattage constant, most ECG types are controlled on the lamp side. In this case, reduced supply voltages cause much higher currents

In extreme situations, this can lead to physical stress of components and to failure of the entire ECG.

The following causes can lead to undervoltage:
- Different loads on the mains side
- Incorrect electrical installation
- Unstable power supply
- Contact resistance at clamping points

2.1.4 DC voltage

ECGs suitable for DC voltage are indicated in the technical data with “≃ " or “0 Hz". Currently there are no units in the POWERTRONIC ECG product range that meet the requirements for DC voltage suitability.

2.1.5 ECGs for 120 V/277 V line voltages

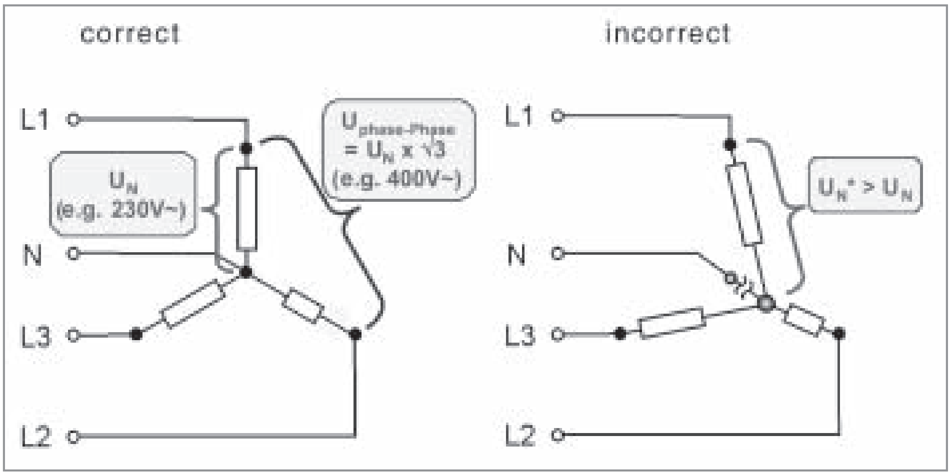
ECGs for metal halide lamps are also becoming more popular in North America (USA, Canada). OSRAM SYLVANIA offers a growing number of units for the North American line voltages of 120 V/277 V and 60 Hz line frequency. For further information, please refer to:

www.sylvania.com/BusinessProducts/LightingForBusiness/Products/Ballasts/

On the North American market, the HID ECG family is known as QT... MH (= **M**etal **H**alide).

2.1.6 Three-phase operation

Luminaires or luminaire groups can also be wired in 3-phase operation with a common N conductor (neutral conductor). The following diagram shows the correct wiring (figure on the left) and faulty wiring (figure on the right) and the possible consequences.



- $U_N^* > U_N$
- Theoretical maximum value:
  $U_N^*max = U_N \times \sqrt{3}$ (= 400 V AC @ U_N = 230 V AC)
- In practice:
  $U_N^* < 350$ V in most cases (no complete asymmetrical load distribution)

If the common neutral conductor is interrupted in a 3-phase star configuration and voltage is present, luminaires or groups of luminaires operated with ECGs may be exposed to unacceptably high voltages (unbalanced load) and the ECG itself may be destroyed.

When using ECGs in three-phase operation, the following points must be considered:

1. Check that the mains voltage is within the permissible rated voltage range of the ECG.
2. Make absolutely sure that the neutral conductor is correctly connected to all the ECG luminaires and that it is making proper contact.
3. Only disconnect or connect cables when no voltage is present.
4. For 3x230/240 V supply networks in delta circuit arrangements, protection by way of common disconnection of the phase conductor is necessary.

Important:

- In new installations the load must not be connected when the insulation resistance is measured at 500 V DC since the test voltage is also applied between the neutral (N) conductor and all three external lines (L1, L2, L3) according to IEC 60364-6 Section 61.3.3. In existing installations it is sufficient to carry out an insulation test between the external lines (L1, L2, L3) and the protective ground conductor without disconnecting the loads. The neutral conductor (N) and the protective ground (PE) conductor must not be electrically connected in any way when this is done. For this insulation measurement (500 V DC to ground), the neutral conductor disconnection terminal may only be opened with the mains voltage switched off!

- Before the equipment is put into operation, make sure that the N conductor is correctly connected!

- During operation do not disconnect the N conductor on its own or first!

2.1.7 Unbalanced load endurance

Usually, ECGs work with input voltages between 220 V and 240 V in a standard three-phase installation. If the contact of the neutral conductor is missing or faulty, this value can rise – depending on the load distribution – up to a maximum value of $\sqrt{3}$ x 230 V = 400 V:

POWERTRONIC ECGs do not have resistance to unbalanced loads for permanent voltages above 254 V.

2.2 Installation

2.2.1 ECG operation for luminaires of protection classes I and II

As per EN 60598-1, luminaires are grouped into protection classes according to the measures taken against electric shock among others:

Protection class I

In luminaires of protection class I, all accessible conducting parts which may become live as a result of a fault must have a good conductive connection to the PE conductor.

All POWERTRONIC ECGs to operate HCI/HQI lamps are, in principle, suitable for operation in lamps of protection class I. A good conductive connection to the PE conductor of the ECG must be assured.

Protection class II

In luminaires of protection class II, the protection against electric shock does not rely on the basic insulation alone, but on further precautionary measures such as additional or reinforced insulation. Protection class II luminaires do not therefore have an ground connection (PE).

POWERTRONIC ECGs are approved as per the ECG safety standard EN 61347-1 (general and safety requirements) and EN 61347-2-12 (special requirements) as protection class I ECG (with protective earth symbol). In addition, the EMC approval is also applied as protection class I ECG.

Under certain conditions these ECGs can however also be used in protection class II luminaires (without PE connection). The following conditions must be fulfilled in this case:

- Only L and N are available as luminaire terminals. There is no PE luminaire connection. = > No PE is connected to luminaires and ECG.
- The ECG is built in such a way that the PE ECG terminal/protective earth symbol or the ECG is not visible and, as a result, also cannot be inadvertently connected with PE.
- The requirements with respect to additional/reinforced insulation and creepage distances and clearances are met by ECGs with cable clamp or assured by appropriate measures (films, clearances ...) in built-in ECGs.
- The EMC requirements are also met without the connection of PE or assured by appropriate measures (ferrites, ...).

2.2.2 Insulation

2.2.2.1 Insulation distances in luminaires

The EN 60598-1 / IEC 60598-1 standard is definitive in the construction of luminaires with respect to the topic of electrical safety (above all, protection against accidental contact).

To guarantee the electrical safety of luminaires, special attention must be paid to creepage distances and clearances. These terms are defined as follows in EN 60598-1 Section 11 for the mains terminal of the luminaire:
"Creepage distances at the mains terminal shall be measured between the active parts in the terminal and any exposed metal part. Clearance shall be measured between the incoming mains cable and exposed metal parts (i.e. from the bare end from which the insulation has been stripped the furthest to the metal part that is exposed). On the side of the terminal to which the internal wires are connected, the clearance shall be measured between the active parts in the terminal and the exposed metal parts."

For further information, please refer to luminaire standard EN 60598-1.

2.2.2.2 Insulation test of luminaires

Luminaires must be subjected to insulation and high voltage testing (according to EN 60598). Proceed as follows:

- The power supply terminals and all lamp terminals of the luminaires – except the PE conductor terminal – must be connected with one another in such a way as to provide good electrical conductivity
- Apply a test voltage between the connected power supply terminals and lamp leads and grounded metal parts
  - o Insulation test with 500 V DC:
    min. 2 MΩ required (corresponds to a max. leakage current of 0.25 mA)
  - o High voltage test with 1.5 kV AC/50 Hz:
    1 s without flashover (i.e. leakage current < 10 mA)

The following are permissible test alternatives for luminaire manufacturers (PM 333, PM 395):

- 100 % high voltage testing (insulation testing may be omitted) or
- 100 % insulation testing and 1-2% high voltage testing or
- alternative testing by agreement with the testing authority (such as VDE, ...)

2.2.2.3 Insulation resistance in lighting installations

Insulation resistance in lighting installations (> 1.0 MΩ) must be measured in accordance with IEC 60364-6 Section 61.3.3 between:

a) the outer conductors (L1, L2, L3) and the protective earth (PE) conductor
b) the neutral conductor (N) and the protective earth (PE) conductor

In areas exposed to fire risk, also measure between:

c) the outer conductors (L1, L2, L3) among themselves
d) the outer conductors (L1, L2, L3) and the neutral conductor (N)

The insulation test is performed at 500 V DC.

Measuring the insulation resistance between N and PE or L and PE

The tests are performed on new and existing installations. In existing installations the test intervals are defined in the workplaces ordinance or ordinance on industrial safety and health. Measurement of the insulation resistance should be carried out without disconnecting the luminaire.
There must be no electrical connection between the neutral conductor (N) and the PE conductor. In this insulation measurement (500 VDC with respect to PE), the neutral conductor isolating terminal should only be disconnected if the mains voltage is disconnected! Make sure the connection is secure before reapplying mains voltage. Failure to observe these instructions can lead to destruction of all the ECGs in the system due to an unbalanced load and resultant overvoltage.
Permissible: 500 V = max. 1 mA measurement current

Measurement procedure:

- The ECG appears momentarily to have low resistance (charging of the capacitors in the interference suppression filter).
- The ECG then appears to have high resistance.
  An insulation fault in the lamp circuit does not affect the ECG.

The ECG will not be damaged by insulation tests provided a maximum current of 1 mA is not exceeded!

Attention:
Before using the lighting system, check for correct N conductor connections! During operation of the lighting system, do not disconnect the N conductor on its own or first!

2.2.3 Output voltage

In the operation of an HID lamp, a differentiation has basically to be made between the ignition phase and normal operation of the ECG. During the ignition phase very high ignition voltages of up to 4.5 kV can occur temporarily on the output terminal. In contrast, the output voltage which is applied to both output terminals during normal operating of an HID lamp must never be higher than the working voltage U-OUT.

2.2.3.1 Lamp ignition voltage

POWERTRONIC HID ECGs have an asymmetric ignition. Therefore it is important to clearly mark the lamp terminals. The live terminal is marked with Lamp High (LH) and the other terminal with Lamp Low (LL).

LH and LL are clearly marked on the unit imprint.

LH must basically be kept as short as possible. In addition, in Edison sockets, attention must be paid to correct connection of the live lead where applicable.

2.2.3.2 Working voltage (U-OUT)

U-OUT is a binding ECG label in accordance with the safety standard EN 61347-2-12. U-OUT specifies the greatest effective working voltage during the nominal operation of an HID lamp between:

- the output terminals
- each output terminal and ground connection.

The output working voltage U-OUT is occasionally also referred to as the open circuit voltage.

This information is important for all components that are electrically wired or connected on the lamp side of the ECG.

All components such as lamp cables, sockets (EN 60061-2), insulating materials etc. that come into contact with the ECG lamp terminals must be designed for the following voltages:

- the working voltage U-OUT for the connection LL
- the ignition voltage for the connection LH.

As manufacturer, OSRAM takes care that no higher voltages than those specified above appear at the output terminals with respect to other potentials as well as with respect to the PE, e.g. at the reflector. Therefore no additional voltage reserve is required.

2.2.4 Wiring

2.2.4.1 Wire and cable types

Please pay attention to the voltage value U-OUT imprinted on the ECG housing when wiring luminaires for the operation of HCI/HQI metal halide lamps. The U-OUT value indicates the possible cable type.
If the voltage value U-OUT is greater than 430 V, cables with the classification H07 must be used.
POWERTRONIC ECG values have an U-OUT less than 430 V, allowing luminaires to be wired with H05 cables.

While starting the lamp, pulse loads of up to 4.5 kV occur. Hence, the use of high-voltage resistant, double-insulated cable is recommended on the luminaire side.
In addition, to withstand the increased temperatures in the vicinity of the luminaires, cables insulated with teflon or silicon have proved themselves for this application.
The suitability of certain types of cable for momentary voltage peaks can also be requested from the cable manufacturer.

Cables with the designation SiHF J 3x1.5, for example, have proven themselves as ignition cables.

The use of simple standard cables is unadvisable because adequate insulation between the individual wires is not guaranteed throughout the entire service life and damage to the ECGs or luminaires can therefore occur.

2.2.4.2 Cable cross-section

The cable cross sections to be used are marked on the label of the ECG. Generally, the following values apply:

a) Solid wire:
   These should have a cable cross section of at least 0.5 mm^2 to a max. of 2.5 mm^2 (PTi 35 -150 W)
b) Stranded wire:
   These should have a cable cross section of at least 0.5 mm^2 up to a max. of 2.5 mm^2 (PTi 35 -150 W)

   - Wire-end sleeves may be used but they are not mandatory. Please note that the maximum cross section only applies without wire-end sleeves.
   - Soldering (tin coating) the cable ends has not proved useful because a permanent, stable contact between the terminal and conductor cannot be guaranteed. This method, therefore, also cannot be recommended.

Solid wires can be inserted directly into the terminal. In the case of stranded wires, use the contact release button for inserting and releasing the contacts.

Note for mains connection with stranded wires (according to EN 60598-1).
To achieve sufficient mechanical strength, the cross section of the cable must not be less than:
- 0.75 mm^2 for standard luminaires
- 1 mm^2 for other luminaires.

2.2.4.3 Cable length between the ECG and lamp

The cable length between the POWERTRONIC ECG and the lamp/luminaire is critical for:

- Reliable starting of the system
- Compliance with the EMC limit values of the lighting installation

Reliable lamp starting must also be ensured even under adverse conditions such as low ambient temperatures, high humidity levels and aged lamps.

The load capacity of the cable is definitive for the length of the cable. A standard cable of approximately 80 pF/m can be taken as an orientation value for the cable capacity. The exact values must be requested each time from the respective cable manufacturers.

If longer cable lengths are required, it is recommended:
1. to use cables with especially low capacities
2. to select a luminaire structure that has lamp-sided wiring with a low coupling capacitor to PE.

In general for POWERTRONIC PTi ECG a load capacity of 120 pF applies which equals a cable length of about 1,5 m. A detailed overview of the maximum possible load capacity for each ECG can be found in the technical data in the Appendix.

As well as reliable ignition, the cable length has a major influence on the EMC behavior of the lighting installation.
Detailed information can be found in the following section on cable routing.

2.2.4.4 Cable routing

To ensure good radio interference suppression as well as maximum operational safety, the following points for cable routing should be observed:

1. The cable between the ECG and lamp should be kept as short as possible.
2. To avoid mutual interference between the lamp cable and mains cable, they should never be routed in parallel. The distance between them should be at least 5 cm. If it is not possible to avoid crossing mains cables and lamp cables, they should cross at right angles.
3. If long lamp cables are unavoidable, the two wires should be twisted together.
4. Keep mains cables in the luminaire as short as possible and keep them as far away from the ECG as possible.
5. Very short, low-inductive connection of the PE conductor to the ECG and an all metallic parts of the luminaires (e.g. reflector).
6. For luminaires that do not comply with the EMC limits, it may be necessary to attach a ferrite over both lamp cables. The impedance of the ferrite is dependent on the power class of the unit and the luminaires. The higher the power, the greater the impedance must also be selected. The impedance can be varied by the number of windings.
   → Typical ferrite values: 35 W/70 W → 250 Ω; 150 W → 400 Ω
7. Cable entries through metal components should never be left unprotected but should be fitted with additional insulation (sleeve, grommet edge protector etc.).

Wiring must comply with the provisions of the luminaire standard EN 60598-1 as well as the latest versions of the relevant national standards.

The body of the luminaire or parts of the body must never be employed as a conductor or come into contact with mains or lamp cable conductors in any way (e.g. as a result of bare cables, too much insulation stripped away, screws protruding through insulation, or sharp metal edges). There is a serious risk that a person could be electrocuted and the control gear damaged beyond repair.

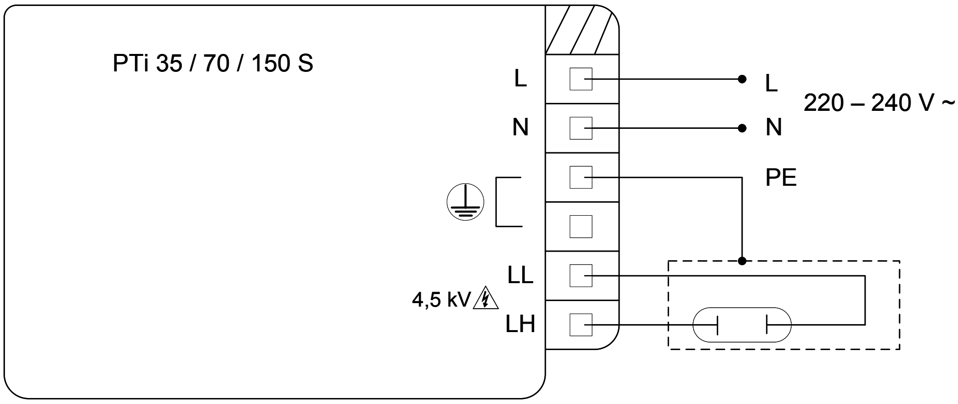
Question: Are **L** and **N** interchangeable (e.g. for portable luminaires)?

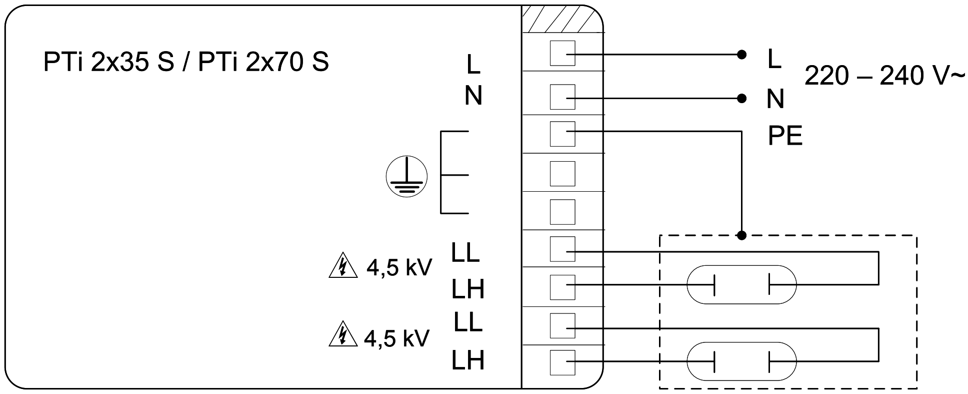
- **Yes** housing labeling “≈"
- **No** housing labeling “L, N"

Note:
When using ECGs labeled with L and N in portable luminaires, the “N" input of the ECG must be safeguarded by means of an additional fuse.

2.2.4.5 Wiring diagrams for built-in POWERTRONIC ECGs

The wiring plans of one-lamp and two-lamp PTi ECGs can be found in the following section.



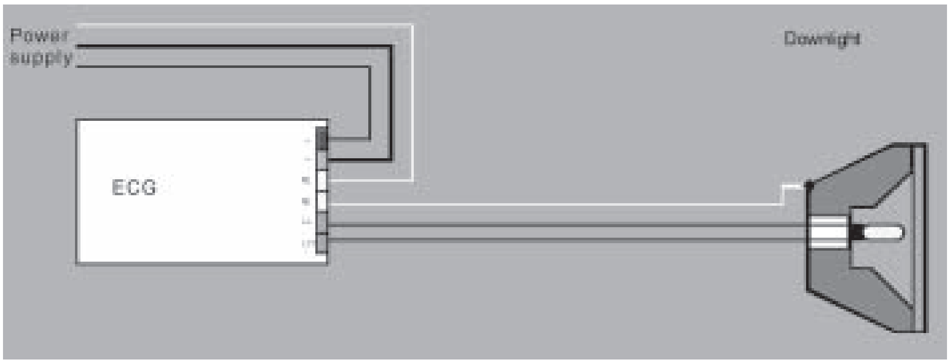


2.2.4.6 Wiring plans for downlights with POWERTRONIC ECGs with cable clamp

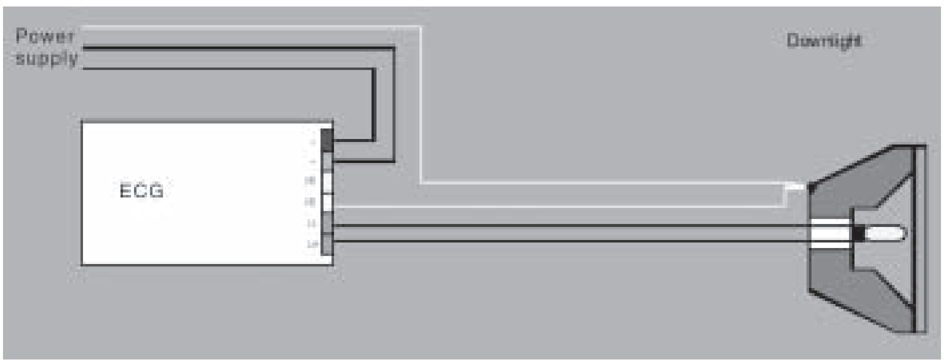
The wiring of independent units presents special demands, particularly from the perspective of EMC. Therefore, this application case is dealt with specially in the following chapter.

Short lamp cable – approx. 0.5 m

(A) Standard:
Short lamp cable (< 0.5 m), PE is connected to ECG

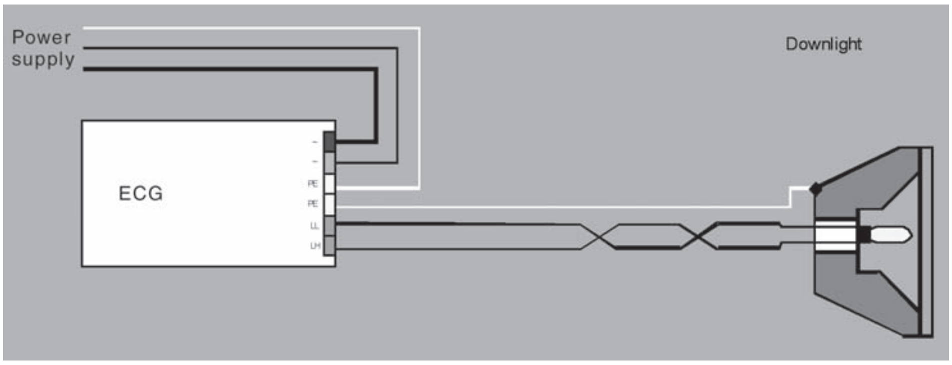


(B) Recommended wiring for improved EMC behavior:
Short lamp cable (< 0.5 m), PE is first connected to luminaire and then routed to the ECG

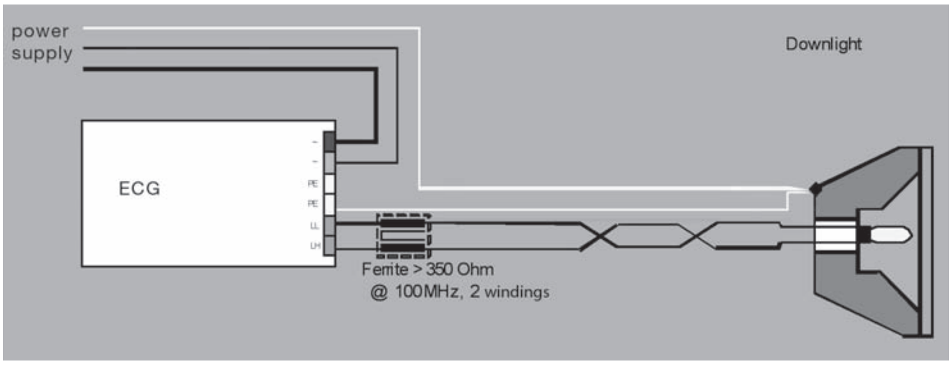


Long lamp cable – approx. 1.5 m

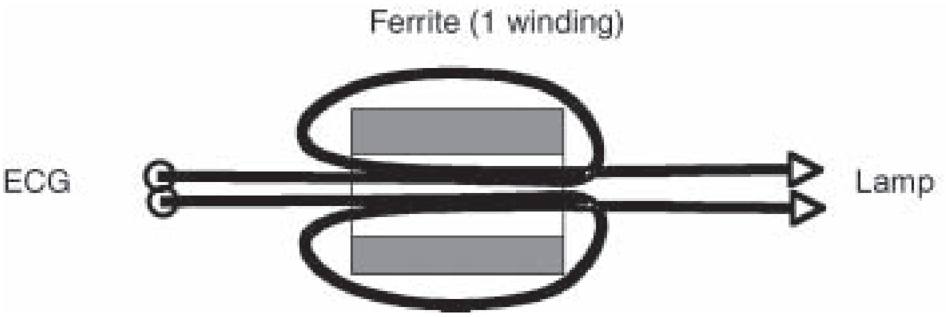
(A) Standard:
Long lamp cable (< 1.5 m), PE is connected to an ECG and routed from there to the luminaire; Lamp cables are twisted

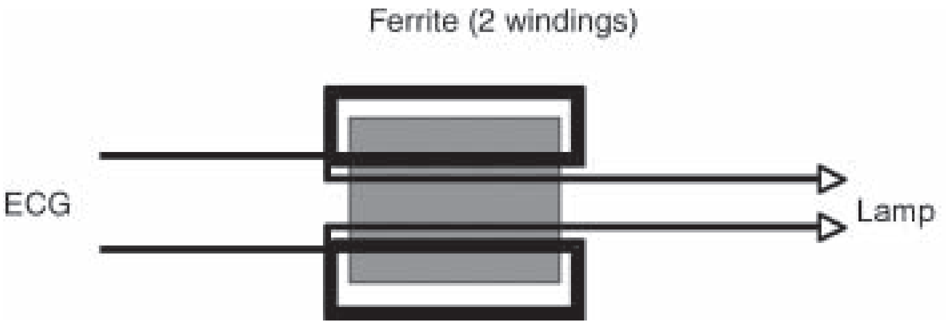


(B) Recommended wiring for improved EMC behavior:
Long lamp cable (< 1.5 m), PE is connected to luminaire first and then continues to the ECG; Lamp cables are twisted; Additional ferrite is inserted in the lamp cable



Example of how to seat a ferrite in order to reduce the EMC radiation:





2.2.4.7 Wire stripping length

The length of insulation to be stripped from the ends of the cables depends on the type of terminal used on the ECG. According to the terminal, a value of 8.5 mm – 9 mm or 10 mm – 11 mm can be assumed. The exact value is printed on the ECG.

2.2.5 Automatic circuit breakers / Inrush current

When an ECG is switched on, a high inrush current pulse of very short duration (< 1 ms) occurs as the storage capacitors responsible for internal power supply charge up. If a large number of ECGs are switched on simultaneously (particularly if they are switched on at peak rated voltage), a total current which is noticeably higher will therefore flow for a short time. The maximum permissible number of ECGs per automatic circuit breaker can be derived from regarding the total of the maximum starting current pulses for each unit and the time period. This value is given in the datasheets in the Appendix.
All switching equipment and protection devices must therefore be selected according to their current carrying capacity.

The values mentioned in the Appendix on page 59 refer solely to automatic circuit breakers of type B from SIEMENS.

Simple measures for increasing the number of ECGs per circuit breaker:

1. Use of an inrush current limiter, e.g. from Busch & Jäger. The most suitable are units based on “Zero Voltage Switching".
2. Use of AC voltage relays after each group with the max. permissible number of ECGs. The relays are connected so that they close as soon as the mains voltage is applied. As a result of the delay of the relays, the inrush current of the second group is delayed compared to the first group. This effectively reduces the peak value of the inrush current into several smaller, consecutive currents.

2.2.6 Leakage current/PE conductor current/ Touch current/Residual current detectors (RCDs)

In the present luminaire standard, the descriptions contact current and PE conductor current are quoted under the term of leakage current.
In luminaires of protection class I the internal interference suppression filters in the ECG and in the lamp cable near grounded areas cause a leakage current through the ground wire whose value depends on the respective series.

All POWERTRONIC ECGs with a current consumption < 4 A have an appreciably lower ground leakage current than the maximum permissible 2 mA_{rms}.
Like the starting current, the ground leakage current limits the number of ECGs that can be operated on an RCD.

To increase the number of units, the following solutions are offered:
- Divide the luminaires into three phases and use three-phase RCDs
- Use surge current-resistant, short-delay residual current detectors (RCDs)
- Use 30 mA RCDs (if possible)
- Connect a max. of 30 ECGs per phase and residual current detector (RCD).

The touch current for all POWERTRONIC ECGs is limited to 0.7 mA_{peak}, or 0.5 mA_{rms}.

2.3 Operating characteristics

2.3.1 Lamp ignition and lamp operation

The operation of HID lamps is divided into the start phase and running operation as a result of very different behaviors. In the start phase ignition voltages in the range of 3000 to 4000 V are required for the initial ignition of a metal halide lamp. In turn, during normal operation such a lamp is operated with voltages between 80 and 140 V depending on the type of lamp and condition of the lamp.
To enable a safe and reliable lamp start, POWERTRONIC ECGs temporarily provide ignition voltages of up to 4.5 kV for starting the lamp. Because the ignition is asymmetric, the high potential is routed via the lamp output labeled with LH and marked with the “triangle with lightning".

The intelligent POWERTRONIC PTi monitors every phase of the start process and as soon as the lamp is in a stable operating mode after the so-called "breakthrough", the voltage is returned to the required value of the lamp voltage in a range of 80-140 V.

2.3.2 Hot lamp re-ignition

POWERTRONIC PTi cannot ignite metal halide lamps when they are hot.
If a metal halide lamp requires an ignition voltage of up to 4.5 kV in the cold state, this value increases up to 30 kV in the hot state.
With progressive cooling of the lamp this value is reduced again. Depending on the power of the lamp, the luminaire construction and the cooling conditions of the lamp in the luminaire, HID lamps again reach a level at which they can be re-ignited by the PTi with the maximum available 4.5 kV after a period of between approx. 3 minutes and a maximum of 20 minutes.

Special hot re-ignition units are required for the hot re-ignition of MH lamps. In addition, the approval of the lamp manufacturer with respect to the suitability of the lamp is a prerequisite.

2.3.3 ECG restart/reset

If a POWERTRONIC ECG shuts itself down (e.g. ignition time limitation, thermal protection, ..), it must be disconnected from the mains for at least for 0.5 seconds before it can be switched on again. During this time the capacitors internal to the unit are fully discharged.

2.3.4 Constant lamp power

In comparison to the CCG, a PTi ECG operates an MH lamp with constant power over the entire lifetime of the lamp. The fluctuation is max. 3 %. The increase in the lamp voltage over the lifetime is regulated by the lamp current that the ECG provides.

The system power consumption on CCGs, in contrast, can fluctuate very substantially because it is not possible to regulate the lamp voltage.
See also the application document “Metal halide lamps - Instructions for the use and the application" (order number 106T020DE).

2.3.5 Power factor / Compensation

For all electric loads the power factor is the ratio of effective power (P_{eff} =voltage x effective current) to apparent power (P_{app} = voltage x apparent current). This value is affected both by the phase shifting cos φ between current and voltage and by the current waveform distortion ε (nonsinusoidal waveform).

$$\lambda = P_{eff}/P_{app} = \varepsilon \cos \varphi$$

In contrast to CCGs (inductive, 50 Hz), there is hardly any phase shifting with ECGs which means that capacitor correction is not required. Slight distortions in the current sine-wave curve, however, occur during operation of ECGs. These distortions are generally characterized by integer multiples of the mains frequency (harmonics).

The harmonic content of the mains current is controlled by national and international regulations (IEC 61000-3-2, EN 61000-3-2). OSRAM ECGs have built-in active electronic harmonic filters for this purpose which guarantee a value for ε of more than 0.95 and hence a power factor λ greater than 0.95. ECGs are markedly better than CCGs in this respect.

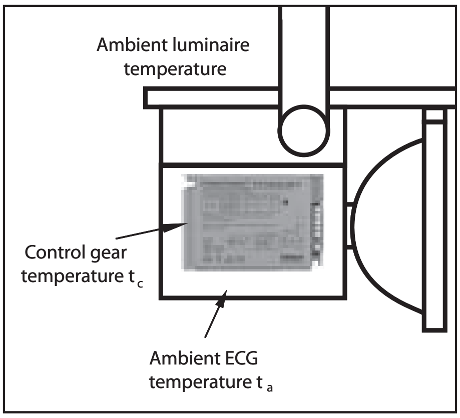
Exemption:
For system power consumptions less than 25 W there are less severe analysis criteria for the harmonics content so that a power factor of ~ 0.6 is typically permissible in this case.

With regard to their harmonics content, all POWERTRONIC have been tested by VDE according to EN 61000-3-2 and carry the EMC approval mark of the VDE.

2.3.6 ECG temperatures and influence on the service life

Consideration of the thermal behavior with regard to the maximum permissible temperatures is important for the analysis of the quality of an ECG.
In terms of the temperatures under consideration, a differentiation is made in principle between the ambient temperature of the luminaire, the ambient temperature of the ECG and the housing temperature of the ECG.

The following figure shows these different temperatures



The temperature must be assessed separately for the two system components (ECG and lamp). In the case of the lamp, there are physical laws that restrict the temperature range and limit temperatures that must be met for reasons of safety.

Fixed limits must be specified for ECGs for reasons of operational reliability.
Apart from this, there are external factors such as the reciprocal influences of ECG, lamp and luminaire and the selected installation site which have a substantial influence.
Compliance with the specified limits, and hence the guarantee of operational reliability, is the responsibility of the relevant luminaire or system manufacturer.

2.3.6.1 Control gear temperature t_c

According to EN 60598-1, t_c (case temperature) is the maximum permissible temperature that may occur at a specially indicated point on the ECG (t_c-measuring point) during normal operation at the rated voltage (or at the max. value of a rated voltage range), and is a safety-related value.

In practice, the temperature of the ECG measured at the t_c-point depends on several factors:
1. The ambient luminaire temperature
2. The losses and resulting self-heating of the ECG

3. The luminaire design and the thermal connection of the ECG on the luminaires

The temperature of the ECG at the t_c -measuring point is of major importance in any service life analysis of an ECG while taking into account the values in the datasheet. To reach the service life stated in the datasheet, t_c must never be exceeded.

The position of the t_c measuring point can be freely defined by every ECG manufacturer. This can be defined at especially warm as well as at rather cooler locations which means it has a direct influence on the actual temperature measured on the unit.
The t_c point of POWERTRONIC ECGs is placed so there is a good correlation between the temperature measured at the t_c point and the actual temperatures of components that are crucial for the service life of the ECG.

It must be pointed out that the absolute height of the t_c value itself does not represent a quality feature because, as described above, this is an individually placed measuring point for measuring the t_c value.

2.3.6.2 Ambient ECG temperature t_a

According to EN 60598-1, t_a (a stands for ambient) is the maximum value of the steady state temperature at which the luminaire (i.e. the ECG) can be operated which means that this temperature must also not exceed the temperature t_c described in section 2.3.6.1.

In POWERTRONIC ECGs the specified maximum t_a correlates with the value for t_c. This relationship applies for a reference structure as per EN 61347-1 Annex D. The ECG is operated without thermal contact to a luminaire.

Because the ECG ambient temperature t_a is determined under reference conditions for all ECGs, it is also suitable for the direct comparison of the thermal quality of different ECGs.

This means that the t_a-temperature can be used to compare ECGs if there is no other possibility for measuring.
In practice the measurement of the t_c-temperature is selected for the thermal design of luminaires and for determining the lifetime of an ECG in a luminaire.
In doing so, however, the values of the lifetime depending on the t_c- temperature must always be strictly observed for each ECG.

ECG ambient temperature t_a is too low:
The ECG cannot ensure the reliable starting of the lamp. Also at too low temperatures the properties of some electronic components may change to such an extent that the ECG can malfunction.
Consequently, the minimum t_a specified on the ECG must not be undercut.

ECG ambient temperature t_a is too high:
The ECG service life is shortened or the ECG can even be damaged.
→ High ECG failure rates

Typical temperature values for storage of ECGs are:

Storage temperature: -40 °C to max. +80 °C
Humidity: 5 % to max. 85 %, not condensed

It is important to note:
Before the units are used, they must be within the permissible t_a temperature limits again.

The values of the t_a temperatures for the respective unit types can be found in the technical datasheets in the Appendix.

2.3.6.3 Self-heating of ECGs

POWERTRONIC PTi ECGs have an efficiency of 90 % to 92 %. The rest of the power leads to the self heating of the units as losses. The temperature rise on the ECG housing in comparison with the ambient temperature is typically 10 °C ... 30 °C. This allows a very wide range of ambient temperatures which generally covers almost all applications in compliance with the respective limit values.

2.3.6.4 Practical analysis of the service life and thermal quality of an ECG

There are 2 ways of ensuring clarity in terms of the expected service life of an ECG:

1) Without measuring the temperature
- Comparison of the **t_a values** of the ECG to be analysed with the t_a temperature, the values in the datasheet of the respective ECG should be used to view/derive the corresponding ECG lifetime

2) <u>By measuring the temperature in a luminaire:</u>

- Specify ambient temperature of the luminaire (e.g. + 25 °C)
- Measure the **temperature at the t_c measuring point** of the ECG to be compared
- The measured temperature in the respective datasheet of the respective ECG should be used to view/derive the corresponding ECG lifetime

→ If only the rated or catalog data are compared, the specifications for the t_a temperature are preferred over those for the t_c temperature

→ Real measurements of the ECG t_c temperature in a luminaire (not freely burning) and the derivation of the ECG service life are, however, appreciably more descriptive and more realistic than the specifications in the datasheet

→ The connection of the ECG to the luminaire has substantial influence on the real lifetime of the ECG and, therefore, the possibility of improving the heat dissipation

The actual measurement of the t_c temperature on the ECG when it is installed and a comparison with the specified data for the ECG service life in dependence on the t_c temperature is the only reliable way to determine the service life of an ECG.

ATTENTION:
A simple comparison of the absolute rated values of the t_c temperatures of the ECGs from different manufacturers doesn't say anything about their quality and service life because the position of the t_c point can be freely selected by the ECG manufacturer.

Illustration using an example:

ECG 1:
Rated values: t_c = 80 °C, t_a = 55 °C, 40,000 h service life at $t_{c\ life}$ = 80 °C

→ The max. t_c temperature is reached at an ECG ambient temperature of 55 °C and, therefore, a service life of 40,000 h.

ECG 2:
Rated specifications: t_c = 80 °C, t_a = 55 °C, 40,000 h service life at $t_{c\ life}$ = 70 °C

→ The max. t_c temperature is reached at an ECG ambient temperature of 55 °C; but the $t_{c\ life}$ is exceeded by 10 °C which corresponds to a service life of approx. 20,000 h

→ At an ECG ambient temperature of 55 °C -10 °C = **45 °C** a t_c temperature of 80 °C-10 °C = **70 °C** (corresponds to $t_{c\ life}$) appears and the service life of 40,000 h is achieved.

Conclusions:

a) Despite identical nominal maximum t_c and t_a temperatures, ECG 1 achieves its service life of 40,000 h at its max. permissible ECG ambient temperature t_a whereas ECG 2 has only half the service life of 20,000 h.

b) To achieve the same service life of 40,000 h, ECG 2 must only be operated at $t_{c\ life}$ = 70 °C. To achieve this, the ambient temperature must be reduced by 10 °C accordingly.

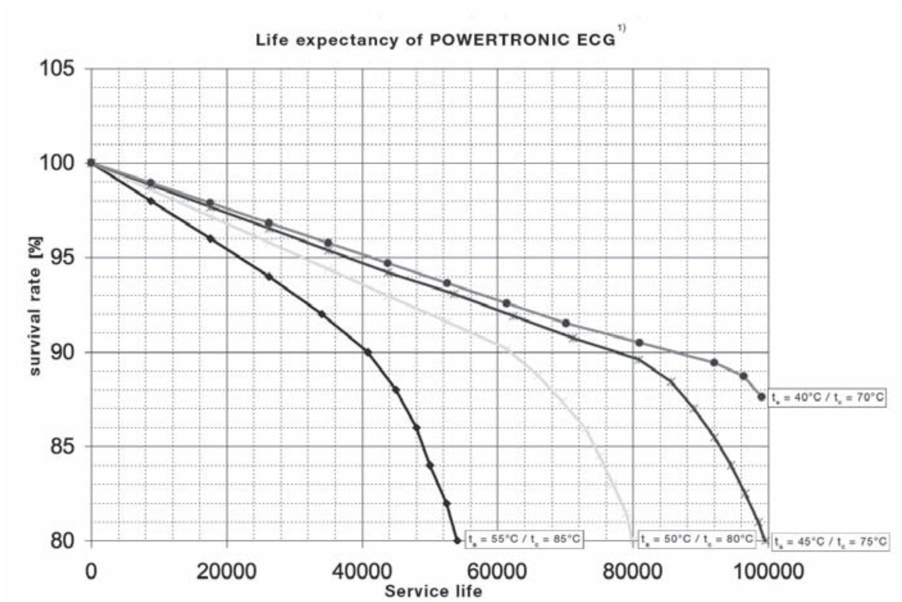
c) ECG1 has temperature reserves 10 °C higher than ECG 2 → which corresponds to an ambient luminaire temperature that is 10 °C higher.

2.3.6.5 Influence of the temperature on the service life

The service life of the ECG depends on the failure rate of the electronic components. There is a relationship between the failure rate of specific electronic components and their thermal and also electrical loading.

Extreme overheating can destroy electronic components in a short period of time. Permanently increased temperatures also lead to premature failure of the ECG. In specific areas there often exists an almost exponential relationship between the failure rate of an electronic component and its thermal behavior.

Due to this exponential dependence on temperature, exceeding the permissible t_c temperature dramatically reduces the service life of the ECG. On the other hand, if the ECG temperature remains below the limit, the service life is extended disproportionally. The diagram shows the expected lifetime of the ECG at various t_c temperatures.



[1] The values shown apply to an installed PTi 70 S unit, for example

Note:
In the POWERTRONIC, as a rule of thumb, every 10 °C below the imprinted temperature value doubles the lifetime of the ECG and every 10 °C above the t_c-temperature cuts the service life in half.
The t_c-temperature of an OSRAM ECG is closely linked to the service life of the ECG. In POWERTRONIC ECGs, the max. permissible temperature at the t_c-measuring point correlates to a service life of 40,000 h.

The t_c-temperature is an important limiting parameter for both the safety approval of a luminaire according to EN 60598-1 as well as the service life of the ECG provided by the manufacturer under consideration of the thermal loading of the components.

2.3.6.6 Failure probability

Besides component specification and quality, the failure rate is absolutely intrinsically dependent on the operating temperature. POWERTRONIC are designed in such a way that a failure rate of less than 2.5 promille per 1,000 operating hours can be expected if operation takes place at the maximum permitted ECG temperature (t_c max). This corresponds to a failed unit percentage of less than 10 % at a service life of 40,000 hours.

2.3.7 General installation instructions in terms of temperature

It is important to ensure that the lamp and the ECG are positioned in the luminaire so that they do not mutually heat one another and that the ECG power loss can be properly dissipated even at the maximum expected ambient temperature and/or supply voltage.

The t_c-temperature at the measuring point on the ECG must not be exceeded during operation, even at the maximum expected ambient temperature and supply voltage. Under “normal” ambient conditions the t_c-temperature measured at the measuring point should be at least 5 °C to 10 °C below the specified maximum value so there is a safety margin to allow for extreme situations.

For an optimum temperature balance it may be necessary to split the system (with, for example, the lamp in the luminaire and the ECG in the stand or luminaire support). This is to avoid, that - without special measures - the lamp and the ECG would mutually heat each other if arranged in close proximity, thereby leading to excessive temperatures of the ECG. In such arrangements, of course, the maximum permissible cable length between the ECG and lamp(s) must not be exceeded.

→ See also wiring instructions in section 2.2.4
→ See also instructions for luminaire construction, thermal coupling (section 2.4)

2.3.7.1 Power reduction due to excess temperature

Unsuitable or incorrect luminaire design or external heat sources (e.g. solar radiation in show windows) can cause an ECG to operate at excessive temperatures (i.e. outside the specified range). To protect the unit against damage, the POWERTRONIC ECG automatically reduces the output power. This reduction is synonymous with thermal protection of the unit and should serve to safeguard the unit against irreversible damage. The power reduction can reach a max. 40 % of the rated power. If this is still not enough, the ECG is shut down in the next step.
If the unit returns again to the permissible temperature range, the power is increased accordingly. Any possible reduction in the power is registered by the user as a drop in the light output or as a change of the color temperature or in the color impression of the lamps supplied.

The reduction of power due to excess temperature must be regarded as the “last resort" before disconnection or destruction of the unit. It is essential in luminaire design, therefore, to ensure that there are sufficient thermal reserves for the ECG at normal ambient temperatures and that the unit is not already being operated near the limits.

Permanent power reduction of the lamp with negative influence on the light quality, the efficiency and the service life of the lamp as well as more frequent shutdown or early aging and premature failure of the ECG are the logical consequences in this case.

2.3.7.2 Measuring the temperature of the ECG in the luminaire

According to EN 60598-1 there are also precisely defined testing and measuring requirements for both surface mounted luminaires (fixed: e.g. downlights and portable, e.g. floor lights) and recessed luminaires.

The simplest way to measure the relevant temperatures on the ECG (t_c point) is with thermocouples affixed to the lamp/ECG or a suitable measuring instrument. Make sure the adhesive/kit used is neutral in terms of its thermal properties.

For measuring the ECG temperature, it is generally sufficient to have a thermocouple permanently attached to a housing cover.

The temperature values should only be measured when the steady-state temperature has been reached or, in other words, when there has been no significant change in temperature for some time.
According to the standard this measurement should be carried out at the maximum value of the measuring voltage range. But it makes

sense to use the thermally most unfavorable voltage of the measuring voltage range (which is mostly the lower limit) because the maximum currents and associated maximum thermal loads occur at this value.
The following **procedure** is recommended for the thermal analysis of the luminaire, taking into account the design requirements specified in EN 60598-1:

1. Thermal situation in the luminaire without heating by the control gear. Luminaire in measurement setup according to EN 60598-1 in standard installation position, equipped with ECG and lamp and fitted with thermocouples. The lamp is supplied from external control gears, however, and not from built-in control gears. In this way, the temperature rise in the entire setup resulting only from the lamp can be measured and the thermal "link" to the environment can be optimized.

2. Thermal situation in the luminaire with heating of the control gear. Arrangement as described in 1. but the lamp is supplied from the internal control gear. The additional heat generated by the ECG can now be assessed by comparison with the measured values already obtained.

2.3.8 Switching resistance of the ECG

The resistance to frequent switching of ECGs is determined on the basis of possible lamp starts per day. Extrapolating this over the lamp service life gives a switching cycle count for professional ECGs.

HID ECGs, however, have a number of special features:

- Due to the physics of the lamps, HID lamps are not designed for frequent switching because a cooling period in the order of 3 to 15 minutes is required after the lamps are switched off until they can be started again
- In typical HID applications only a few switching operations are made each day for this reason
- Because of the ignition time limitation in the ECG, the ECG is switched off after a specific number and duration of unsuccessful attempts at starting the lamp.

Switching cycle tests have shown that POWERTRONIC ECGs can carry out 40,000 lamp starts without any problem which corresponds to one lamp start an hour for a lifetime of 40,000 hours.

2.3.9 Short circuit resistance

In POWERTRONIC ECGs the secondary outputs are short circuit proof for approx. 5 minutes.
By contrast, a short circuit between a lamp connection and the housing/PE conductor must be avoided under all circumstances because

this leads to so-called "ground fault" or "short-to-ground" and to certain destruction of the ECG.

2.3.10 Cut-off criteria and cut-off mechanisms

One of the key advantages of the lamp operation on ECGs compared to CCGs is presented by the active and intelligent protective mechanisms of the ECG for ensuring safe und reliable lamp operation. The principal causes of failure of the MH lamps and the corresponding cut-off mechanisms of the ECG are described in the following:

2.3.10.1 Controlling the lamp voltage

One of the definitive parameters for safe and reliable lamp operation is the lamp voltage. Therefore, PTi ECGs permanently monitor the lamp voltage. If the lamp voltage undercuts or exceeds its defined limits, the unit switches the lamp off because proper lamp operation can no longer be guaranteed and the probability arises that the lamp is in an unspecified state.

2.3.10.2 Ignition time limitation

The safety standard EN 61347-2-12 calls for a defined cut-off of the ignition voltage after a specific time for ECGs for high intensity discharge lamps with ignition voltages above 5 kV. Although the ignition voltages are less than 5 kV, POWERTRONIC ECGs have an ignition time limitation as standard. This means that the ECG will shut down after a specified time period without successfully starting the lamp. To enable the warm re-ignition of HID lamps with PTi ECG after cooling, the ECG is shut down after 20 minutes. Renewed starting is possible again after a brief interruption in the mains supply (t > 0.5 seconds).
An autonomous autostart function of the ECG after a definable time period (e.g. 3 hours) is not allowed because of the standard mentioned above.

2.3.11 Shutdown at the end of the lamp service life

The end of the service life of a metal halide lamp can be indicated in many different ways.
From leaking arc tubes or outer bulbs, an increase in the re-ignition peak, broken leads or electrodes in the arc tube up to ignition failure, scaling of the base contacts by arcing in the socket or, at worst, even to explosion of the lamp.
POWERTRONIC PTi generally operate metal halide lamps safely and reliably.
Particular attention must be paid to recognizing and controlling the "end of life" effects of the lamps.

For this reason, intelligent PTi ECGs are capable of detecting different "end of life" modes of the lamps and of switching off the lamps accordingly.

The following operating modes and discharges in the outer bulb are detected by the PTi and switched off

1. Glow discharge
2. Arc discharge
3. Incandescent mode

Details of the "end of life" phenomena described above can also be found in the application document entitled "Metal halide lamps - Instructions for the use and application" available from www.osram.de/downloads

1) Increase in re-ignition peak

In conventional operation the re-ignition peak is a peak in the lamp voltage after the zero crossing of current and voltage. For sinusoidal lamp current, the current decreases gradually before the zero crossing. The decreasing current flow causes the plasma to cool down and reduces its conductivity until the supply voltage is no longer capable of re-igniting the plasma and the lamp goes out.

The reduced occurrence of the re-ignition peaks is one of the main advantages of the operation in the POWERTRONIC ECG. As the zero crossing for current is very steep in these units, the periods in which low currents or no currents flow are very short and the plasma has considerably less chance to cool down.

Finally, a metal halide lamp can be operated longer on the ECG. The lower re-ignition peaks on the ECG is responsible to a large extent for the longer service life during ECG operation in comparison to conventional choke operation.

2) Rectifying effect

Differently heated electrodes, malfunction of one of the electrodes or a discharge in the outer bulb are possible causes of an asymmetrical mode (rectifying effect) of high pressure discharge lamps. The rectifying effect causes a high DC current component.
As a result, the conventional choke goes into a saturated state with a marked decrease in choke impedance. In extreme cases, the lamp current is only limited by the choke’s ohmic resistance. This can cause overheating of the choke and ignition unit.

In POWERTRONIC ECGs the current and voltage are permanently monitored and controlled by a microcontroller. POWERTRONIC ECGs, therefore, switch off before rectifying effects can lead to damage of the ECG and, as a result, offer a clear plus in safety compared to CCGs.

2.3.12 Noise development

POWERTRONIC are so quiet in operation that even in very quiet surroundings they cannot be discerned by the human ear. Their limiting value is generally less than 30 dB (A).
In comparison, standard values provide an acceptable ambient noise level:

- for an office: 35 dB (A)
- in a salesroom: 35 dB (A)

The factors affecting the sound pressure level are the sound power level of the ECG, the acoustic properties of the luminaires, the mechanical installation conditions of the ECG in the luminaires, the absorption properties of the room characterised by its volume and reverberation time, and the number of ECGs.

Tip:
To develop luminaires that are as quiet as possible, it is therefore essential to insulate the control gear and chassis or luminaire support. In other words, there should be sufficient clearance below the ECG with the ECG mounted on point supports on the luminaire chassis or on rubber absorbers as is familiar from CCGs.

Under certain circumstances, however, this type of mounting can lead to thermal problems (maximum permissible temperature at the measuring point t_c is exceeded due to poor thermal connection) since the best way to dissipate the power loss to the environment is to have the ECG in full contact with the chassis.

Solving this problem with an appropriate housing design and/or type of installation for the luminaire (forced cooling, increased convection effect) has the further advantage of reducing the interference noise level and should, therefore, be seriously considered.

Experiments have shown that the amount of noise generated is closely linked to the operating temperature of the ECG. This is a particularly important factor if the unit has been installed in accordance with the recommendations described above. In extreme cases, it will not be possible to work without an additional heat sink.

The noise level also increases disproportionately as the temperature of the ECG rises. It is, therefore, best to operate ECGs at a temperature below the maximum recommended value. In practice this means that the amount of noise generated is less, the lower the measuring point temperature tc. A combination of acoustic insulation of the ECG and reduced operating temperature presents the best technical solution.

2.3.13 Dimming

High intensity discharge lamps on the basis of sodium discharge lamp or metal halide lamp can generally be operated with reduced power. But the fact that dimmed operation leads to losses in the light quality and the efficiency (lm/W) must be taken into account. The dimming of HID lamps cannot, therefore, be unconditionally recommended from a present-day perspective.
If dimming is required, however, specially dimmable HID ECGs must be provided.

In this context, please also refer to the OSRAM publication “Technical Instructions for Power Reduction" which is available from www.osram.de/downloads

2.4 Instructions for luminaire construction

It is important to comply with the general recommendations for luminaire design from the IEC and national approval authorities (VDE etc.).
It is also important to remember that ignition voltages of up to 4.5 kV can occur in HID systems. The components (lamp holder, leads etc.) and materials must be selected to meet these requirements.
Data on the lamps that are used are available in the relevant IEC standard, IEC 61167.
The international luminaire standard IEC 60598 applies.

Wiring instructions can be found in section 2.2.4 “Wiring" and instructions for compliance with the EMC guidelines in section 2.2.4.4 “Cable routing"

2.4.1 Thermal coupling

POWERTRONIC PTi ECGs have an efficiency of 90 % to 92 %. The rest of the power leads to losses which results in self heating of the units. Because of their high efficiency, PTi ECGs have relatively low self-heating. To achieve a unit service life that is as high as possible together with low failure rates, however, it is essential to find the best way to dissipate this heat from the unit. Especially for installation in luminaires, therefore, the following points must be observed:

- Ensure good heat transfer between the POWERTRONIC unit and the luminaire housing through appropriate measures.
  - Direct, large-area connection of the ECG to the luminaire housing
  - Manufacture luminaires from good conductive materials such as metal, for example

- Avoid any air gap between the ECG and luminaire housing – air works as an insulator
  - Do not mount ECGs on intermediate struts
  - Do not use spacers between the ECG and luminaire body for fixing the ECG in the luminaire
  - Insert the fitting panel or retaining plates in such a way that a large-area contact is assured between the ECG and luminaire body
- Do not place insulation material between the ECG and luminaire body
  - Do not use double-sided adhesive tape for fixing the ECG
  - Do not use any materials with low heat transition between the ECG and luminaire
- For especially good dissipation of heat at critical locations, thermal pads can be inserted selectively between the ECG and luminaire body
- Keep a minimum distance between the ECG and lamp (ideal > 30 cm). If possible, provide a separate chamber for ECGs; otherwise use cooling fins or heatsinks to keep as much heat radiation as possible away from the unit.

In any case, the temperature t_c at the measuring point must be measured in order to ensure that t_c max. is not exceeded.

2.4.2 Louvres/Cooling fins

Louvres in the luminaire provide direct ventilation in the luminaire interior, thus enabling direct cooling of the ECG. The louvres (for air inlet and air outlet) should have a minimum width of 4 to 5 mm and be arranged so that an airstream is provided in the luminaire and passes the ECG in any position.
Cooling fins on the outside of the luminaire increase the surface area, thus also ensuring improved thermal directional characteristics of the luminaire.

2.4.3 Materials for use in luminaire construction

Plastics and also metals are now being used in constructing the luminaires of HID systems depending on the version and application background. Every material has its own specific characteristics.
It is always important to ensure that the material meets the thermal requirements through the radiated heat of the lamps. An adequate UV resistance of the material is also a prerequisite.

Further details of this are available in the application document:
“Metal halide lamps – Instructions for the use and application".

From the ECG perspective, as good a heat transition as possible must be pursued (see also section 2.4.1 Thermal coupling)

2.4.4 Easy installation of ECGs

A built-in ECG or an ECG with cable clamp is used depending on the application and installation situation in the luminaire. Both the built-in units (PTi S) as well as the units with cable clamp (PTi I) are distinguished by high ease of installation:

S version for installation in the luminaire:

- Fixing of the unit by means of mounts on the floor or side
- This means ECGs can be fixed standing, lying or positioned
- Plug-in connectors for fast, tool-free connection and disconnection of the wires
- Robust metal housing, dimensionally stable

I version for independent installation

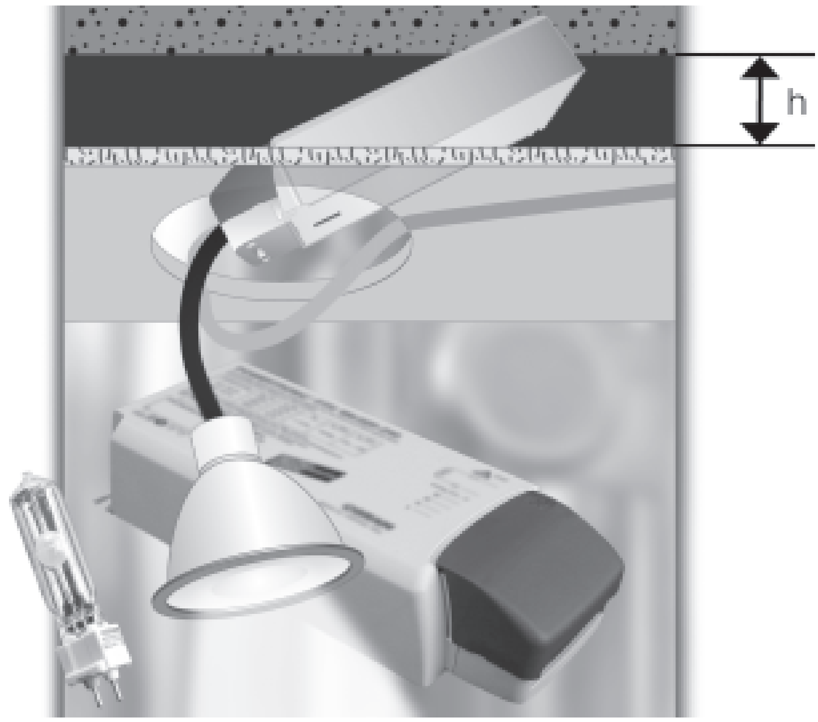
- Separate cable clamp flap for separate access to primary and secondary side
- Only 1 screw per cable clamp flap for fast but secure fixing of the cable
- Plug-in connectors for convenient, tool-free connection and disconnection of the wires
- Large clamping space provides good access to the terminals
- Generously dimensioned clamping space enables the use of an additional terminal for the mains-sided through wiring
- Two bridged PE terminals ensure durable, secure and direct grounding of the luminaires with the protective ground connection of the ECG
- Cable clamp approved for diverse cable types and diameters between 7 mm and 11 mm

2 .4.5 Installation space for independent installation devices

POWERTRONIC PTi I ECGs with integrated cable clamp are ideally suited for use in false ceilings. The diameter of the ceiling cutout must be selected according to the available installation height:

The following table provides an overview of the requisite ceiling cutouts depending on the installation depth of the individual PTi units with cable clamp.

	PTi 35 I	PTi 70 I	PTi 2x35 I	PTi 2x70 I	PTi 150 I
Ø / h					
95	80	80	95	-	140
104	70	70	80	110	105
125	55	55	65	75	70
145	45	45	50	65	60



2.4.6 Plug & Play installation with cable/plug-in system

The use of cable plug-in systems is becoming increasingly popular, especially in the project business. These so-called "Plug&Play" solutions offer the following advantages:

- Simple and rapid connection of luminaires and ECGs or mains and ECGs
- Reverse polarity protected connection reduces errors in installation
- Correct wiring of the ECG is already checked ex works

So that the use of cable plug-in systems really is quick, dependable and – above all – also safe, the following tests are carried out by OSRAM during assembly:

- High voltage test
- Insulation test
- Function test

OSRAM offers assembled ECGs with the designation PTi I/P.

2.4.7 Wiring the mains cable in a loop using a unsecured push wire connector

Due to its generously dimensioned clamping space, the PTi I with cable clamp offers the possibility of connecting the mains cable by means of a terminal (e.g. Wago terminal) in a loop from one ECG to the next.
It is important to make sure, however, that the cable in the ECG does not exceed the maximum permissible cable temperatures.

2.4.8 Suitable lamp holders

In principle, all sockets that comply with the requirements for high-voltage stability can be used to operate the corresponding lamps with a POWERTRONIC ECG.
Generally an ignition pulse voltage of up to 4.5 kV can be assumed. Details are marked on the unit or can be found in the datasheet.

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 leads with high and low potential, are correctly connected.
The most common sockets for metal halide lamps that are suitable for operation on the ECG are described in the following:

Type of socket	Type of lamp	Lamp description
G12/G22	Pin-base	HCI-T, HQI-T
G8.5	Pin-base	HCI-TC
Rx7s /Fc2	with double-ended base	HCI-TS, HQI-TS
E26/E27/E40 (suitable for high voltage)	Screw-base	HCI-PAR
GU 6.5	Bayonet-type base	HCI-TF
GX 8.5, GX 10	Twist and Lock	HCI-R111

Especially with E26/E27 and E40 screw-base lamps, attention must be paid to correct polarity.

All sockets must be rated for the typical conditions of discharge lamps, i.e. high ignition voltage and high temperatures. It is up to the user to make an appropriate selection and to ensure that the lamp holders are installed correctly according to the corresponding regulations (e.g. IEC 60598 / VDE 0711, IEC 60335 / VDE 0700). Sockets consist of several parts, each with its own function limits. Exceeding these limits causes premature failure of the sockets.

Please refer to the section 7.3. “Lamp holders" of the OSRAM application document entitled "Metal halide lamps - Instructions for the use and application" for further installation instructions and instructions for use with reference to sockets.

2.5 Electromagnetic compatibility

The abbreviation EMC stands for **E**lectro**M**agnetic **C**ompatibility and the EMC regulations specify a series of different test criteria.
The most important criteria in connection with ECGs are covered by the regulations of the following standards governing radio interference suppression, harmonic content (up to the 39th harmonic) and immunity to interference.

	International standard IEC/CISPR	European standard EN
Harmonics	IEC 61000-3-2	EN 61000-3-2
Interference immunity	IEC 61547	EN 61547
Radio interference characteristics	CISPR 15	EN 55015

The EN 55015 was amended on 1st. May, 2008 to include the radio interference field measurement in the range of 30 - 300 MHz. Until now only interference voltages and magnetic interference field strengths in the range 9 kHz to 30 MHz were covered.
This means that all new units since May 1st, 2008 should meet the

expanded requirements of the radio interference suppression. For existing units, a transitional period up to May 1st, 2010 has been specified in the EN standards.

As a manufacturer of ECGs and by using the CE label on POWERTRONIC ECGs, OSRAM confirms compliance with the requirements for EMC interference immunity, the limiting values for harmonic content and radio interference suppression requirements as well as safety (see also section 3.2 Test marks).

2.5.1 Harmonics limiting values

Lighting equipment is subject to restrictions on harmonics. They are classified and are in class C. For systems up to 25 W, simpler requirements apply.

For lighting installations > 25 W, the following limiting values apply:

Harmonic number	Proportion in % of the mains current of the fundamental wave (50 Hz)
2	2
3	30x power factor (λ)
5	10
7	7
9	5
11 < n < 39	3

All POWERTRONIC ECGs (> 25 W) for operating HCI and HQI lamps have a total harmonic distortion (THD) of less than 15 %.

If ECGs that do not comply with the limiting values for harmonic content are used, this can lead to serious consequences:

- Premature failure of capacitors
- Premature triggering of protective switches and other safety devices
- Failure or malfunction of computers, drivers, lighting installations and other sensitive consumers
- Overload of the neutral conductor (particularly by the 3rd harmonic wave)
- Shattering or bursting of discharge lamps

2.5.2 Immunity

The ECGs comply with the conditions according to IEC 61547 for immunity which means they are protected against external factors such as electromagnetic fields, electrostatic discharges (ESD), momentary overvoltages (transients) and voltage dips or interruptions in the mains supply.

2.5.3 Radio interference characteristics

Compliance with the limit values for radio interference suppression is also a requirement for VDE EMC approval by the independent VDE inspection institute in Offenbach/Germany.

ECGs for installation in luminaires in accordance with CISPR 15 are measured in a test setup in a reference luminaire as described in CISPR30.

By contrast, ECGs for independent installation are tested solely according to the CISPR 15. However, the interference level depends not only on the ECG but also on the arrangement of the lamp and ECG, the luminaire design and, in particular, the wiring. To obtain approval, compliance with the limit values must be checked for each luminaire (by the VDE, for example). This is the responsibility of the luminaire manufacturer.

2.5.3.1 Causes of radio interference

Radio interference refers to both the radiated and mains-borne influences of an electrical load on other units connected to the same mains supply and/or in the immediate vicinity.

To ensure that the various electrical loads can operate simultaneously and trouble-free, each unit must not exceed certain radio interference values and must exhibit a certain immunity to interference.

POWERTRONIC ECGs are based on a high-frequency switching topology to achieve a high level of energy efficiency and a low installation size of the ECG. These high-frequency switching cycles in interraction with non-linear components (diodes, transistors etc.) cause interference on the mains and lamp cables connected to the ECG. Both the mains and lamp cable can be regarded as antennae here.

The majority of the electromagnetic radiation is emitted by the cables. Under unfavorable conditions the lamp cable can form a resonator with the luminaire, thus leading to increased radiation ($\lambda/4$, 100 MHz = > l = 75 cm). The resonance circuit is influenced by the inductivity of the line, the capacitive line coupling to metallic surfaces of the luminaires and the lamp that is used. If this resonance circuit cannot be attenuated by structural measures, the use of ferrites in the lamp cable is recommended.

Because the routing of the cable has decisive influence on the radiation characteristics of a luminaire, it is essential to pay attention to careful cable routing inside (and outside) the luminaire as described in section 2.2.4.4.

Through the use of more complex internal EMC filters, it is possible to reduce the disturbances mentioned above to a level below the limits prescribed by the standard so that the ECG from OSRAM - viewed on their own terms - comply with the standards.
The installation of the ECGs in the luminaires can, however, significantly alter these properties.

2.5.3.2 Installation Instructions for avoiding radio interference

See section 2.2.4.4 Cable routing

2.6 Faults, sources of faults and elimination of faults

Some typical faults are described in the following section together with tips and instructions for analyzing and avoiding these faults:

- Lamp definitely too bright or too dark - > check that the correct wattage is set.
- Lamp flashes - > lamp has reached the end of its service life and stable operation is no longer possible - > the lamp must be replaced
- ECG switches off after some time in operation - > ECG is operated in too high ambient temperature and switches itself off to avoid irreversible destruction. A mains interruption is required for a restart
- Lamp does not ignite:
  The metal halide lamp does not start (in two-lamp ECGs both lamps fail to start), no visible glow shortly after start-up. Same behavior even after being off for 1 minute (internal reset) and restart.
  Possible cause:
  1) RSD or other protective device in the installation has operated
     Remedy:
     Check the wiring on the mains side or insulation resistance.
     Has the max. recommended number of ECGs on one phase in a 3-phase system been exceeded?
     Is the neutral conductor properly connected to all the luminaires and makes good contact?
     Has moisture penetrated the luminaire and caused a short circuit?

2) Fault in the wiring on the mains side
   Remedy:
   Check that the mains voltage is actually present in the specified range for the ECG.
   Make sure that the neutral conductor is connected properly to all the luminaires and makes good contact.
   Check that the cables sit correctly in the terminals.

3) The “fail-safe” overload protection device in the ECG has responded (the ECG is permanently damaged).
   Remedy:
   Check that the lamp(s) operate at other positions. If not, check that the mains voltage is within the permissible range. Make sure that the neutral conductor is connected properly to all the luminaires and makes good contact. Replace the ECG and lamp(s).

- Different brightness levels between different positions.
  Possible causes:
  1) Lamps of different wattages color appearance or incorrect wattage
     Remedy:
     The lamp type and wattage must match the type indicated on the ECG. The color appearance should be homogenous within an application.

  2) Incorrect wiring between the ECG and lamp, possibly contact problems
     Remedy:
     Check the lamp-side wiring for correct contact. Has the lamp connection been wired according to the wiring diagram on the ECG?

  3) The ECG is operated outside the specified temperature range and attempts to achieve thermal relief by reducing the power of the lamp (“forced dimming“)
     Remedy:
     Check that the ECG is operating above the specified temperatures at the affected positions. Implement constructive changes to provide thermal relief of the ECG

- Fault in other electrical equipment, particularly radio and television receivers
  Possible cause
  1) Wiring problems
     Remedy:
     See also the instructions in section 2.2.4.4 Cable routing

  2) Electrical equipment, radios and televisions are insufficiently immune to interference
     Remedy:
     Increase the distance between the luminaire and the equipment; if necessary, contact the manufacturer.

  3) The ECG causes distortion in the higher frequency range of 30-300 MHz
     Remedy:
     Replace the unit; POWERTRONIC PTi ECGs of the latest generation exhibit a considerably improved radio interference response, especially in the range between 30 and 300 MHz.

3. Standards, approval marks and CE mark

3.1 Standards

3.1.1 Safety

EN 61347-2-12 used in conjunction with EN 61347-1
“Lamp control gear – Part 2-12: Particular requirements for d.c. and a.c. supplied electronic ballasts for discharge lamps (except fluorescent lamps)" used in conjunction with “Lamp control gear – Part 1: General and safety requirements"

The standard EN 61347-2-12 stipulates special general and safety requirements for DC and AC supplied ECGs. The supply includes AC voltages up to 1000 V at 50 Hz or 60 Hz. The type of control gear is a converter that can include components for the ignition and stabilization for the operation of a discharge lamp with DC current or a frequency deviating from the supply frequency.
The lamps used with the control gear are stipulated in 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) and other norms for general lighting purposes.

Furthermore the standard EN 61347-2-12 stipulates how far a section of EN 61347-1 is applicable and determines the sequence for carrying out the tests of the requirements.

The standard basically includes requirements on the following range of topics:
Markings (PE/FE, terminals, wiring, ignition voltage, U-OUT), connection terminal, PE connection, protection against accidental contact of live parts, moisture resistance and insulation, electric strength, fault conditions, protection of the associated components, ignition voltage, aberrant conditions (behavior of the control gear at the end of the lamp service life), structure, creepage distances and clearances, screws, live parts and contacts, thermal and fire resistance, creep resistance, resistance to corrosion.

Compliance with the standards is prerequisite for: CE symbol, VDE test marks

EN 60598-1
“Luminaires – Part 1: General requirements and tests"

The standard EN 60598-1 stipulates general requirements for luminaires that contain electrical light sources for operation with supply voltages up to and including 1000 V. The requirements and related tests of this standard apply for: arrangement, labeling, mechanical and electrical construction.
This standard does not apply to built-in ECGs.

For independent ECGs, however, the following sections are required by the standards:
Design requirements (cable routing, mains connection terminals, connection points and mains connections, mechanical strength), external and internal cables (mains connection and other external cables, cable clamps), protection against electric shock, resistance to dust, solid particles and water, clearances and tracking distances.

For independent ECGs, compliance with the standards is prerequisite for: CE, VDE test marks

3.1.2 Electromagnetic compatibility (EMC)

EN 55015
"Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment"

The standard EN 55015 applies to the emission (radiation and redirection) of high frequency interference of all lighting installations (among others) with the main task of creating and/or distributing lighting for lighting purposes that are either provided on the low-voltage network or for battery operation and independent accessories for use solely in lighting installations.

The limiting values in this standard were determined on the basis of probability in such a way that the radio interference suppression remains within economically acceptable limits while, on the whole, still assuring sufficient protection of radio reception and electromagnetic compatability. In unfavorable cases, additional measures may be necessary.

The standard includes provisions and measurement processes for interference emissions in the frequency range from 9 kHz to 300 MHz.

It specifies the limiting values of conducted interference voltages in the frequency range up to 30 MHz on the power supply connections, the load connections and the control connections. For the radiated interference emissions, the standard also specifies the limiting values of the magnetic component of the interference field strength in the frequency range of 9 kHz to 30 MHz and the electrical component of the interference field strength in the frequency range of 30 MHz to 300 MHz.
The radiated interference emission in the frequency range of 30 MHz to 300 MHz can be carried out with the CDN procedure, using a coupling/decoupling network, as a measurement of conducted interference emissions. The limiting value for the conducted interference emissions for applications with the CDN procedure can be compared with the limiting value for radiated interference emissions and of-

fers adequate protection for radio systems in the frequency range of 30 MHz to 300 MHz.

Compliance with the standard is a prerequisite for: CE, EMC test marks of the VDE

EN 55022
"*Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*"

The standard EN 55022 quotes procedures for the measurement of the level of interfering signals generated by information technology equipment and specifies limits for the frequency range of 9 kHz to 1 GHz.

Compliance with the standard is not specified for ECGs.

EN 61547
"*Equipment for general lighting purposes – EMC immunity requirements*"

The standard EN 61547 specifies requirements regarding the electromagnetic interference immunity of lighting equipment and namely both for the connection to the low voltage network as well as for battery operation.

The standard includes requirements of the immunity of the ECG to the following external sources of interference:
Static electricity discharge, high-frequency and mains frequency electromagnetic fields, rapid transients, injected currents, surge voltages/currents, voltage drops and interruptions, fluctuations in voltage.

Compliance with the standard is a prerequisite for: CE, EMC test marks of the VDE

EN 61000-3-2
"*Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)*"

The standard EN 61000-3-2 applies for the limitation of harmonic current emissions that are injected into the public low-voltage network. It defines limits of the harmonic components of the input current that can be caused by a device (electrical equipment, installations) that is tested under specified conditions. Different limits and measurement procedures apply for lighting installations with a mains input effective power of up to and including 25 W or greater than 25 W.

Confomity with the standard is a prerequisite for: CE, EMC test marks of the VDE

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 and including16 A per phase and not subjected to conditional connection"

The standard EN 61000-3-3 applies for the limitation of fluctuations in voltage and flicker that characterize the public low-voltage power supply. It specifies limits for changes in voltage that are generated by devices and installations and that are tested under specified conditions, and gives directions on methods of calculation.

Compliance with the standard is a prerequisite for:
CE mark, VDE-EMV mark

3.2 Test mark

3.2.1 VDE mark

By awarding the VDE mark, the VDE testing and certification institute certifies the conformity of the certified ECG with the safety standards listed in the mark approval certificate in accordance with the EC low-voltage directive. The certified products are subject to factory inspection and production control accordingly.

The mark approval certificate also forms the basis for the EC declaration of conformity and CE marking by the manufacturer or its agent.

The VDE mark for ECGs for the operation of high-pressure discharge lamps includes the safety standard EN 61347-2-12 together with EN 61347-1.

3.2.2 ENEC approval mark

10

stands for European Norm Electrical Certification. The ENEC approval is also a conformity mark agreed upon between the testing institutes of the European Union.
It stands for compliance with the European standards for safety and performance listed in the ENEC agreement. Besides sample testing, ENEC also includes a permanent control of products and production processes. The number on the right beside the approval mark identifies the certifying institute. For example, 10 stands for the VDE testing and certification institute in Germany.
The ENEC approval mark for ECGs for the operation of high-pressure discharge lamps includes the safety standard EN 61347-2-12 together with EN 61347-1.

3.2.3 EMC mark of the VDE

By awarding the EMC mark, the VDE testing and certification institute confirms the compliance of the certified ECG with the EMC standards mentioned in the mark approval certificate according to the EU directive on electromagnetic compatability (EMC). The certified products are subject to factory inspection and production control accordingly.

The mark approval certificate also forms the basis for the EC declaration of conformity and CE marking by the manufacturer or its agent.

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

3.2.4 CCC approval

CCC approval is an obligatory mark of safety & quality for various products that are sold on the Chinese market which came into effect on 30.04.2003.
In order to obtain CCC approval, the compliance of the product with Chinese standards must be confirmed by a laboratory accredited by the CNCA (Certification and Accreditation Administration of the People‘s Republic of China) and the product must undergo a factory inspection.

The relevant test specifications are expected to be awarded to HID ECGs in 2009.

3.2.5 c-tick/RCM mark

The c-tick/RCM mark is a registration mark of the Australian regulatory authorities.
For further details please check http://rcm.standards.org.au/

3.3 CE marking

The CE marking of products is a mark required by EU law which the maufacturer uses to declare compliance with the applicable EU directives. POWERTRONIC products from OSRAM comply with the low-voltage directive 2006/95/EU and the EMC directive 2004/108/EU. The CE mark is therefore obligatory for the sale and putting into operation of a product within the European Union and, hence, a prerequisite for its sale.

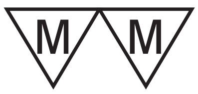
The CE mark was primarily created to guarantee the safety and electromagnetic compatibility of products to the end consumer because of the free movement of goods inside the European economic area (EEA) and the European Union (EU) within that area. The CE mark is frequently described as a “passport" for the European Single Market.

The verification of conformity must be independently furnished by the manufacturer himself and is controlled and prosecuted if necessary by the national market surveillance authorities. In Germany this is the German regulatory authority for the telecommunications industry, postal services, railways and electricity, the BNetzA (Bundesnetzagentur). For this verification with regard to POWERTRONIC products, OSRAM draws on the expertise of an independent testing institute.

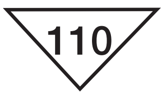
The CE mark is not a quality or approval mark and consequently does not make any statement with regard to the quality of labeled products. It should not, therefore, be mistaken as an approval mark issued by independent testing institutes (such as ENEC, VDE or EMC mark of the VDE).

3.4 Other marks

Luminaires for discharge lamps for installation at or on flame-retardant construction materials.

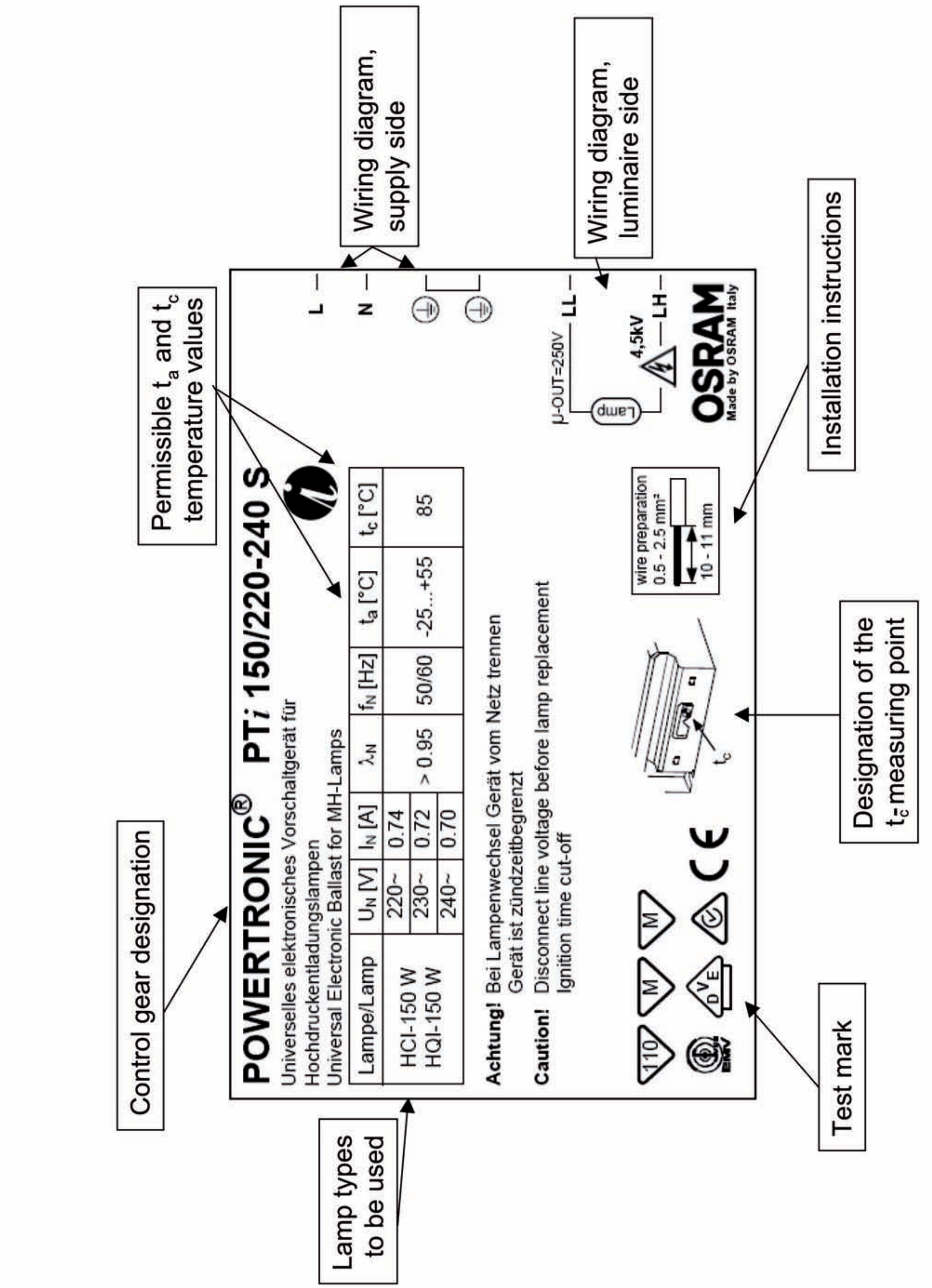


Installation on materials whose flame-retardant properties are not known where 95 °C HID must not be exceeded during normal operation or 115 °C must not be exceeded in the case of abnormal operation or malfunction.



Max. housing temperature as the result of a fault (110 °C)

4. ECG imprint



5. System$^+$ guarantee

ECGs from OSRAM are characterized by the most modern circuit design and high-quality components. The best possible functionality is exhibited in the operation of systems with innovative lamps from OSRAM because the OSRAM lamp and ECG are always optimally matched to one another.

Innovative technologies and uncompromising quality sustainably assure the excellent workmanship and functionality of our products. This pays off for our customers:

OSRAM has extended the guarantee for its PTi ECG systems and HCI and HQI high-pressure discharge lamps and offers the following guarantees:

- 5-year guarantee for OSRAM POWERTRONIC ECGs in combination with HCI/HQI
- 3-year guarantee for POWERTRONIC ECGs for separate use
- 1-year guarantee for HCI lamps for operation with PTi products;

The system$^+$ guarantee (lamp + ECG) refers to the POWERTRONIC PTi ECGs in the wattages 35 W, 70 W and 150 W and their operation with the following HCI lamps from OSRAM (PTi 20 W and PTi 100 W in preparation):

- HCI-T in the wattages 35, 70 and 150 W,
- HCI-TS in the wattages 70 and 150 W
- HCI-TC in the wattages 35 and 70 W
- HQI-T and HQI-TS in the wattages 70 and 150 W

The requirements and registration are available in detail on the Internet at www.osram.com/system-guarantee

6. Datasheets

Order designation	PTi 20/220-240 S	PTi 35/220-240 B	PTi 35/220-240 S
Lamp (Watts)	HCI 20 W	HCI 35 W	HCI 35 W
Number of lamps	1	1	1
Rated voltage (AC):	220 - 240		
Permissible input voltage range (AC):	198 - 254 V	198 - 254 V	198 - 254 V
Mains frequency:	50/60 Hz		
Rated current (230 V):	0.11 A	0.19 A	0.19 A
Mains power factor λ:	> 0.95	0.95	0.95
Inrush current:	12 A/210 µs	30 A/150 µs	30 A/150 µs
System power:	23 W ±0.7 W	43 W ±2 W	43 W ±2 W
Lamp power:	20 W ±0.7 W	39 W ±2 W	39 W ±2 W
Line frequency (50 Hz mains frequency):	100 Hz	165 Hz	165 Hz
Max. ECG number @ 10 A fuse (type B)	tbd	15	15
Max. ECG number @ 16 A fuse (type B)	tbd	26	26
U-OUT between LH and LL	300 V	250 V	250 V
U-OUT beween LH/LL and PE	300 V	250 V	250 V
Protection against excessive temperatures through power reduction and shutdown at:	T at t_c > 80 °C	T at t_c > 85 °C	T at t_c > 85 °C
Min. ECG reset time (through interruption of the mains supply)	0.5 s		
Max. ignition voltage:	3.0 kVp	4.5 kVp	4.5 kVp
Max. ECG/lamp cable length:	0.5 m	1.5 m	1.5 m
Max. capacity of the ECG/lamp cable:	40 pF	120 pF	120 pF
Ignition time limitation:	20 min	20 min	20 min
Max. permissible temperature at the measuring point t_c:	80 °C	85 °C	85 °C
Max. ambient temperature t_a:	60 °C	70 °C	65 °C
Min. ambient temperature t_a:	-25 °C		
Service life (@ $t_{c\ max.}$):	40,000 h		
Dimensions*:	97 mm x 43 mm x 30 mm	110 mm x 73 mm x 28 mm	110 mm x 75 mm x 30 mm
Weight:	≈ 105 g	≈ 190 g	≈ 245 g
Terminal: permissible wire cross section	max.1.5 mm^2	0.5-2.5 mm^2	0.5-2.5 mm^2
Diameter of the cable to be clamped:	x	x	x
Mains cable:			
Lamp cable			
Length of wire insulation to be stripped:	8.5 – 9.5 mm	10 - 11 mm	10 - 11 mm
Length of cable insulation to be stripped	x	x	x
Radio interference suppression:	EN 55015		
Harmonics content of the line current:	EN 61000-3-2		
Immunity:	EN 61547		
Safety:	EN 61347-2-12		
VDE registration no.:	40016889	40016889	40004469
EMC mark of the VDE	40025469	40004500	40004500

Order designation	PTi 35/220-240 I	PTi 2x35/220-240 S	PTi 2x35/220-240 I
Lamp (Watts)	HCI 35 W	HCI 35 W	HCI 35 W
Number of lamps	1	2	2
Rated voltage (AC):	220 - 240		
Permissible input voltage range (AC):	198 - 254 V	198 - 254 V	198 - 254 V
Mains frequency:	50/60 Hz		
Rated current (230 V):	0.19 A	0.37 A	0.37 A
Mains power factor λ:	0.95	> 0.95	> 0.95
Inrush current:	30 A/150 µs	40 A/250 µs	40 A/250 µs
System power:	43 W ±2 W	86 W ±4 W	86 W ±4 W
Lamp power:	39 W ±2 W	2 x 39 W ±2 W	2 x 39 W ±2 W
Line frequency (50 Hz mains frequency):	165 Hz	165 Hz	165 Hz
Max. ECG number @ 10 A fuse (type B)	15	7	7
Max. ECG number @ 16 A fuse (type B)	26	13	13
U-OUT between LH and LL	250 V	250 V	250 V
U-OUT beween LH/LL and PE	250 V	250 V	250 V
Protection against excessive temperatures through power reduction and shutdown at:	T at t_c > 75 °C	T at t_c > 80 °C	T at t_c > 75 °C
Min. ECG reset time (through interruption of the mains supply)	0.5 s		
Max. ignition voltage:	4.5 kVp	4.5 kVp	4.5 kVp
Max. ECG/lamp cable length:	1.5 m	1.5 m	1.5 m
Max. capacity of the ECG/lamp cable:	120 pF	120 pF	120 pF
Ignition time limitation:	20 min	20 min	20 min
Max. permissible temperature at the measuring point t_c:	75 °C	80 °C	75 °C
Max. ambient temperature t_a:	65 °C	55 °C	55 °C
Min. ambient temperature t_a:	-25 °C		
Service life (@ $t_{c\ max.}$):	40,000 h		
Dimensions*:	155 mm x 83 mm x 32 mm	135 mm x 75 mm x 30 mm	180 mm x 83 mm x 32 mm
Weight:	≈ 320 g	≈ 290 g	≈ 260 g
Terminal: permissible wire cross section	0.5-2.5 mm²	0.5-2.5 mm²	0.5-2.5 mm²
Diameter of the cable to be clamped:	min. 7 mm – max. 11 mm	x	min. 7 mm – max. 11 mm
Mains cable:	e.g.: H03VV-F, H05 VV-F, NYM: 2x0.75; 2x1.5; 3x0.75; 3x1.5; 3x2.5		e.g.: H03VV-F, H05 VV-F, NYM: 2x0.75; 2x1.5; 3x0.75; 3x1.5; 3x2.5
Lamp cable	e.g.: SiHF J 3x1.5		e.g.: SiHF J 3x1.5
Length of wire insulation to be stripped:	10 - 11 mm	10 - 11 mm	10 - 11 mm
Length of cable insulation to be stripped	max. 40 mm	x	max. 40 mm
Radio interference suppression:	EN 55015		
Harmonics content of the line current:	EN 61000-3-2		
Immunity:	EN 61547		
Safety:	EN 61347-2-12		
VDE registration no.:	400016889	40016889	40016889
EMC mark of the VDE	40004500	40004500	40004500

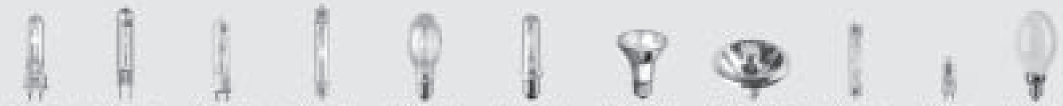
PTi 70/220-240 B	PTi 70/220-240 S	PTi 70/220-240 I	PTi 2x70/220-240 S
HCI 70 W, HQI 70	HCI 70 W, HQI 70	HCI 70 W, HQI 70	HCI 70 W, HQI 70
1	1	1	2
220 - 240			
198 - 254 V	198 - 254 V	198 - 254 V	198 - 254 V
50/60 Hz			
0.35 A	0.35 A	0.35 A	0.7 A
> 0.95	> 0.95	> 0.95	> 0.95
40 A/250 µs	40 A/250 µs	40 A/250 µs	70 A/250 µs
80 W ±3 W	80 W ±3 W	80 W ±3 W	159 W ±6 W
73 W ±3 W	73 W ±3 W	73 W ±3 W	2 x 73 W ±3 W
165 Hz	165 Hz	165 Hz	165 Hz
	7	7	4
	13	13	7
250 V	250 V	250 V	250 V
250 V	250 V	250 V	250 V
T at t_c > 85 °C	T at t_c > 85 °C	T at t_c > 75 °C	T at t_c > 85 °C
0.5 s			
4.5 kVp	4.5 kVp	4.5 kVp	4.5 kVp
1.5 m	1.5 m	1.5 m	1.5 m
120 pF	120 pF	120 pF	120 pF
20 min	20 min	20 min	18 min
85 °C	85 °C	75 °C	85 °C
60 °C	55 °C	55 °C	55 °C
-25 °C			
40,000 h			
110 mm x 73 mm x 28 mm	110 mm x 75 mm x 30 mm	155 mm x 83 mm x 32 mm	165 mm x 90 mm x 30 mm
≈ 190 g	≈ 245 g	≈ 320 g	≈ 400 g
0.5-2.5 mm²	0.5-2.5 mm²	0.5-2.5 mm²	0.5-2.5 mm²
x	x	min. 7 mm – max. 11 mm	x
		e.g.: H03VV-F, H05 VV-F, NYM: 2x0.75; 2x1.5; 3x0.75; 3x1.5; 3x2.5	
		e.g.: SiHF J 3x1.5	
10 - 11 mm	10 - 11 mm	10 - 11 mm	10 - 11 mm
x	x	max. 40 mm	x
EN 55015			
EN 61000-3-2			
EN 61547			
EN 61347-2-12			
40016889	40016889	40016889	40016889
40004500	40004500	40004500	40004500

Order designation	PTi 2x70/220-240 I	PTi 100/220-240 S	PTi 100/220-240 I
Lamp (Watts)	HCI 70 W, HQI 70	HCI 100 W, HQI 100 W	HCI 100 W, HQI 100 W
Number of lamps	2	1	1
Rated voltage (AC):	220 - 240		
Permissible input voltage range (AC):	198 - 254 V	198 - 254 V	198 - 254 V
Mains frequency:	50/60 Hz		
Rated current (230 V):	0.7 A	0.72 A	0.72 A
Mains power factor λ:	> 0.95	> 0.95	> 0.95
Inrush current:	70 A/250 µs	60 A/250 µs	70 A/250 µs
System power: λ	159 W ±6 W	106 W ±3 W	106 W ±3 W
Lamp power:	2 x 73 W ±3 W	97 W ±3 W	97 W ±3 W
Line frequency (50 Hz mains frequency):	165 Hz	165 Hz	165 Hz
Max. ECG number @ 10 A fuse (type B)	4	5	5
Max. ECG number @ 16 A fuse (type B)	7	8	8
U-OUT between LH and LL	250 V	250 V	250 V
U-OUT beween LH/LL and PE	250 V	250 V	250 V
Protection against excessive temperatures through power reduction and shutdown at:	T at t_c > 75 °C	T at t_c > 80 °C	T at t_c > 70 °C
Min. ECG reset time (through interruption of the mains supply)	0.5 s		
Max. ignition voltage:	4.5 kVp	4.5 kVp	4.5 kVp
Max. ECG/lamp cable length:	1.5 m	1.5 m	1.5 m
Max. capacity of the ECG/lamp cable:	120 pF	120 pF	120 pF
Ignition time limitation:	20 min	20 min	20 min
Max. permissible temperature at the measuring point t_c:	75 °C	80 °C	70 °C
Max. ambient temperature t_a:	55 °C	55 °C	55 °C
Min. ambient temperature t_a:	-25 °C		
Service life (@ $t_{c\ max.}$):	40,000 h		
Dimensions*:	207 mm x 96 mm x 32 mm	150 mm x 85 mm x 31 mm	195 mm x 96 mm x 33 mm
Weight:	≈ 450 g	≈ 350 g	≈ 203 g
Terminal: permissible wire cross section	0.5-2.5 mm^2	0.5-2.5 mm^2	0.5-2.5 mm^2
Diameter of the cable to be clamped:	min. 7 mm – max. 11 mm	x	min. 7 mm – max. 11 mm
Mains cable:	e.g.: H03VV-F, H05 VV-F, NYM: 2x0.75; 2x1.5; 3x0.75; 3x1.5; 3x2.5		e.g.: H03VV-F, H05 VV-F, NYM: 2x0.75; 2x1.5; 3x0.75; 3x1.5; 3x2.5
Lamp cable	e.g.: SiHF J 3x1.5		e.g.: SiHF J 3x1.5
Length of wire insulation to be stripped:	10 - 11 mm	10 - 11 mm	10 - 11 mm
Length of cable insulation to be stripped	max. 40 mm	x	max. 40 mm
Radio interference suppression:	EN 55015		
Harmonics content of the line current:	EN 61000-3-2		
Immunity:	EN 61547		
Safety:	EN 61347-2-12		
VDE registration no.:	40016889	40016889	40016889
EMC mark of the VDE	40004500	40004500	40004500

PTi 150/220-240 S	PTi 150/220-240 I
HCI 150 W, HQI 150 W	HCI 150 W, HQI 150 W
1	1
220 - 240	
198 - 254 V	198 - 254 V
50/60 Hz	
0.72 A	0.72 A
> 0.95	> 0.95
70 A/250 µs	70 A/250 µs
160 W ±4.5 W	160 W ±4.5 W
147 W ±4.5 W	147 W ±4.5 W
165 Hz	165 Hz
4	4
7	7
250 V	250 V
250 V	250 V
T at t_c > 85 °C	T at t_c > 75 °C
0.5 s	
4.5 kVp	4.5 kVp
1.5 m	1.5 m
120 pF	120 pF
20 min	20 min
85 °C	75 °C
55 °C	50 °C
-25 °C	
40,000 h	
150 mm x 85 mm x 32 mm	195 mm x 96 mm x 33 mm
≈ 370 g	≈ 420 g
0.5-2.5 mm²	0.5-2.5 mm²
x	min. 7 mm – max. 11 mm
	e.g.: H03VV-F, H05 VV-F, NYM: 2x0.75; 2x1.5; 3x0.75; 3x1.5; 3x2.5
	e.g.: SiHF J 3x1.5
10 - 11 mm	10 - 11 mm
x	max. 40 mm
EN 55015	
EN 61000-3-2	
EN 61547	
EN 61347-2-12	
40016889	40016889
40004500	40004500

7. Type lists

The table provides an overview of the lamps/ECG combinations of POWERTRONIC ECG and HQI and HCI metal halide lamps.



Which ECG for which lamp?	HCI®-T	HCI®-TC	HCI®-TF	HCI®-TS	HCI®-E/P	HCI®-T/P	HCI®-PAR	HCI®-R111	HQI®-TS	HQI®-T	HQI®-E
PTi 1x20/220-240 S		•	•				•	•			
PTi 1x/2x35/220-240 (S and I)	•	•	•		•		•	•			
PTi 1x/2x70/220-240 (S and I)	•	•		•	•	•	•	•	•	•	•
PTi 1x100/220-240 (S and I)	•				•	•					
PTi 1x150/220-240 (S and I)	•			•	•	•			•	•	•

The use of high-pressure sodium lamps (NAV) is possible in principle, but the following restrictions apply:

- NAV lamps have slower starting behavior when they are started so that, under unfavorable conditions, clean ramp-up and stable operation of the lamps is not possible with POWERTRONIC PTi ECGs
- POWERTRONIC PTi are not approved for use in outdoor applications
- HCI-PAR in the wattages 35 and 70 W

The requirements and registration are available in detail on the Internet at: www.osram.com/system-guarantee

8. Tender documents

Along with other documention, tender documents for POWERTRONIC ECGs can be found on the Internet under the following link:

www.osram.com/ecg-tender

ECGs for high-pressure discharge lamps:

Ordering designation: PTi .../230-240 S for luminaire installation or PTi .../230-240 I with protection against pulling through cable clamps fixed in place by screws

- ECGs for operating metal halide lamps with 35, 70, 100, 150 W
- Excellent lamp operation: Up to 30 % longer service life of the lamp compared to CCG
- Constant lamp power independent of mains voltage fluctuations, ambient temperatures and aging of the lamps
- Reliable lamp starting: max. cable length 150 cm (120 pF), ignition voltage max. 4.5 kV
- Flicker-free lamp operation
- No flashing of defective lamps (ignition time limited to 20 min.)
- Reliable and safe lamp switch-off at the end of the service life of the lamp
- ECG efficiency > 90 %
- Excellent temperature response in a wide temperature range from -25 °C to +55°/65 °C
- Lamp service life: 40,000 h at max. permissible ambient temperature t_a (max. 10 % failure rate)
- Power reduction at excess temperature of the ECG
- 5-year system$^+$ guarantee: For every ECG that has failed due to a material or manufacturing fault, there is a replacement
- Power factor without further compensation ≥ 0.95
- Only for AC
- For interior lighting only
- For luminaires of protection class I and suitable for protection class II applications
- No automatic restart after lamp replacement
- Test mark: VDE, EMC, c-tick
- EN 61347-2-12, EN 55015, EN 61000-3-2, EN 61547, EN 61000-3-3

Index

A

Advantages of ECG compared with conventional control gear	1.2.4
Advantages of the intelligent POWERTRONIC PTi electronic control gears (ECGs)	1.2.3
Ambient ECG temperature ta	2.3.6.2
Applications	1.2.5
Automatic circuit breakers	2.2.5

C

Cable cross section	2.2.4.2
Cable length between the ECG and lamp	2.2.4.3
Cable routing	2.2.4.4
Causes of radio interference	2.5.3.1
CCC mark	3.2.4
CE symbol	3.3
Constant lamp power	2.3.4
Control gear temperature t_c	2.3.6.1
Control of the lamp voltage	2.3.10.1
Cut-off criteria and cut-off mechanisms	2.3.10

D

Datasheets	6.
DC voltage	2.1.4
Dimming	2.3.13

E

Easy installation of electronic control gears (ECGs)	2.4.4
ECG imprint	4.
ECG restart/reset	2.3.3
ECGs for 120 V/277 V line voltages	2.1.5
Electromagnetic compatibility	2.5
Electromagnetic compatibility (EMC)	3.1.2
EMC mark of the VDE	3.2.3
ENEC approval mark	3.2.2

F

Failure probability	2.3.6.6
Faults, sources of faults and elimination of faults	2.6
Functioning	1.2.2

H

Harmonic limiting values	2.5.1
Hot lamp re-ignition of MH lamps	2.3.2

I

Ignition time limit 2.3.10.2
Indoors/Outdoors 1.2.5.1
Influence of the temperature on the service life 2.3.6.5
Inrush current 2.2.5
Installation instructions 2.3.7
Installation Instructions for avoiding radio interference 2.5.3.2
Installation space for independent installation devices 2.4.5
Insulation 2.2.2
Insulation distances in luminaires 2.2.2.1
Insulation resistance in lighting installations 2.2.2.3
Insulation test of luminaires 2.2.2.2
Integration or independent installation 1.2.5.2

L

Lamp ignition and lamp operation 2.3.1
Lamp ignition voltage 2.2.3.1
Leakage current 2.2.6
Louvres/Cooling fins 2.4.2
Luminaire construction - instructions 2.4

M

Materials for use in luminaire construction 2.4.3
Measuring the temperature of the ECG in the luminaire 2.3.7.2
Metal halide lamps 1.2

N

Noise development 2.3.12

O

Operating characteristics 2.3
Outdoor lighting 1.2.5.1
Output voltage 2.2.3
Overvoltage > 254 V 2.1.2

P

PE conductor current 2.2.6
Permissible voltage range 2.1.1
Plug & Play installation with cable/plug-in system 2.4.6
Power factor/Compensation 2.3.5
Power reduction due to excess temperature 2.3.7.1
Practical analysis of the service life and thermal quality of an ECG 2.3.6.4
Product range 1.2.1
Protection classes I and II of luminaires 2.2.1

R

Radio interference	2.5.3
Rectifying effect	2.3.11
Residual current detectors (RCDs)	2.2.6

S

Safety	3.1.1
Self-heating of the ECG unit	2.3.6.3
Service life	2.3.6
Short circuit resistance	2.3.9
Shutdown at the end of the lamp service life	2.3.11
Standards, test marks and CE symbol	3.1
Supply voltage	2.1
Susceptibility to interference, immunity	2.5.2
Switching resistance of the ECG	2.3.8
System+ guarantee	5.

T

Temperatures and influence on the service life	2.3.6
Tender documents.	8
Test marks	3.2
Thermal coupling	2.4.1
Three-phase operation	2.1.6
Touch current	2.2.6
Type lists	7.

U

Unbalanced load endurance	2.1.7
Undervoltage < 198 V	2.1.3
Usable holders	2.4.8

V

VDE mark	3.2.1

W

Wire and cable types	2.2.4.1
Wire stripping length	2.2.4.7
Wiring	2.2.4
Wiring diagrams for built-in ECGs	2.2.4.5
Wiring plans for downlights with POWERTRONIC ECGs with cable clamp	2.2.4.6
Wiring the mains cable in a loop using a unsecured push wire connector	2.4.7
Working voltage (U-OUT)	2.2.3.2

Global presence.

OSRAM supplies customers in around 150 countries.
• 73 companies and sales offices for 111 countries
• 38 countries served by local agents or OSRAM GmbH, Munich

OSRAM associated companies and support centres.

Albania
Argentina
Asia Pacific Hongkong
Australia
Austria
Azerbaijan
Belarus
Benelux
Bosnia-Herzegovina
Brazil
Bulgaria
Canada
Chile
China
Croatia
Czechia
Denmark
Egypt
Estonia
Finland
France
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United Arab Emirates
USA
Vietnam

OSRAM GmbH
Head Office
Hellabrunner Strasse 1
81543 MUNICH
GERMANY
Fon +49 (0)89-6213-0
Fax +49 (0)89-6213-20 20
www.osram.com

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