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OSRAM DULUX®
Electronic energy-saving lamps.

Technical guide.

SEE THE WORLD IN A NEW LIGHT

OSRAM

1 GENERAL

1.1 OSRAM DULUX® electronic energy-saving lamps

OSRAM DULUX® EL lamps are compact fluorescent lamps with integrated electronic control gear for ac line voltage from 220 to 240 V. They are commonly referred to as energy-saving lamps or energy savers. They are available with E14 and E27 screw bases or B22d and GU10 bases and combine the simple installation of incandescent lamps with the efficiency benefits of fluorescent lamps.

OSRAM DULUX® lamps are particularly economical, consuming very little electricity and lasting a very long time. For just 1 euro an OSRAM DULUX® lamp will provide light for around 500 hours (10 W, 0.2 €/kWh). To “ignite” the lamp no more power is needed than in normal operation. Almost all OSRAM DULUX® lamps meet the requirements of Energy Efficiency Class A.

Different categories with different designs and different properties are available.

The various types come in different color temperatures (2500 K, 2700 K, 4000 K, 6500 K), and with different bases (E14, E27, B22d, GU10). For details see the brochure for the entire range.

1.2 The range

1.2.1 Overview

Typical values for the different categories

OSRAM DULUX®	INTELLIGENT	SUPERSTAR	DULUXSTAR
Average lifespan	10,000 to 20,000 h	10,000 to 15,000 h	8,000 to 10,000 h
Switching cycles	500,000 to 2,000,000	50,000 to 500,000	8,000 to 30,000
Lumen run-up*	Quick light	Quick light	Normal run-up
Benefits	▪ Extra long life ▪ Very frequent on/off switching ▪ Short startup time ▪ Special versions (DIM, FACILITY, VARIO, 12 V_{DC}, SENSOR)	▪ Long life ▪ Frequent on/off switching ▪ Short startup time	▪ Normal life ▪ Normal on/off switching

* see 3.2

1.2.2 OSRAM DULUX® INTELLIGENT

OSRAM DULUX® energy-saving lamps with special outstanding properties.

1.2.2.1 OSRAM DULUX® INTELLIGENT Longlife

Standard OSRAM DULUX® INTELLIGENT with extra long life (up to 20,000 hours), short startup time thanks to Quick light® technology and extremely frequent on/off switching capability.

1.2.2.2 OSRAM DULUX® INTELLIGENT DIM

Dimmable OSRAM DULUX® INTELLIGENT.

- Dimmable from 7% to 100%
- Double energy savings from the energy-saving lamp and from dimming
- Can be dimmed with most leading edge phase dimmers
- Flickerfree dimming
- Not suitable for touch dimmers, trailing edge phase dimmers or universal dimmers
- If more than four OSRAM DULUX® INTELLIGENT DIM lamps are connected to a dimmer an additional ohmic load (e.g. an incandescent lamp) must be used which is at least as great as the minimum load of the dimmer
- The maximum number of OSRAM DULUX® INTELLIGENT DIM lamps is determined by the maximum load capacity of the dimmer

$$\text{Number}_{\text{DEL DIM}} = \frac{P_{\text{max. dimmer}} - P_{\text{ohmic load}}}{40\text{VA}}$$

For OSRAM DULUX® INTELLIGENT DIM GLOBE only 30 VA (as the denominator).

1.2.2.3 OSRAM DULUX® INTELLIGENT 12 V_{DC}

OSRAM DULUX® INTELLIGENT lamps for all 12 V dc voltage sources, such as solar power units and car batteries.

- Ideal for use with solar power systems
- Voltage range from 9.6 V_{DC} to 14.4 V_{DC}
- With reverse polarity protection
- The base thread is the negative pole (the middle contact is the positive pole)
- Also available as OSRAM DULUX® INTELLIGENT 12 V_{DC} VARIO (see 1.2.2.5, VARIO function)

1.2.2.4 OSRAM DULUX® INTELLIGENT FACILITY

OSRAM DULUX® INTELLIGENT for professional use with DULUX® IC technology (see 3.1.1, IC starting) for any number of switching operations.

- Short ignition time of less than 0.5 s
- Suitable for operation between -30°C and +50°C
- Reliable starting down to -30°C (even at 176 V_{DC})
- Suitable for operation on dc voltages from 176 V_{DC} to 310 V_{DC}
- For the maximum number on an automatic circuit breaker see table:

Type	DINTFCY 10 W	DINT FCY 14 W	DINT FCY 18 W	DINT FCY 22 W
B 6A	13	9	7	5
B 10A	28	20	16	13
B 16A	46	32	25	20

Not suitable for use with electronic switches or systems that warn of imminent disconnection by dimming the light, see “Use with stairwell lighting time switches”.

The lamps reach their rated values in dc operation at around 280 V_{DC}. For other dc voltage values the differences are as follows:

Supply voltage	**Power draw**	**Luminous flux**
310 V_{DC}	110 %	110 %
280 V_{DC}	100 %	100 %
220 V_{DC}	80 %	78 %
176 V_{DC}	70 %	65 %

Emergency lighting

With a starting time of less than 0.5 s, OSRAM DULUX® INTELLIGENT FACILITY lamps are suitable in accordance with VDE 0108 for use in emergency lighting systems in a dc voltage range from 176 V_{DC} to 310 V_{DC}.

This applies to both standby circuits and permanent circuits.

Use with stairwell lighting time switches

In addition to the switching load, the provisions of DIN 18015-2 must also be noted: "… in the case of lighting systems in stairwells of multi-family residences, automatic disconnection circuits must be equipped with a warning function (such as dimming of the lights) to avoid sudden darkness". The type and design of this warning function have not been standardized.

- Warning function with reduced brightness (dimming): The dimming function is generally achieved by half-wave rectification of the mains voltage. OSRAM DULUX® INTELLIGENT FACILITY is not suitable for this mode of operation.
- Warning signal by flashing before disconnection: The lamp is not likely to suffer damage. The warning signal is noticeably changed by the preheating phase (approx. 0.4 s). If there is an unsuitable pulse sequence the lamp may go off (dark) for a long period (but at least 0.4 s for each switching operation).

1.2.2.5 OSRAM DULUX® INTELLIGENT VARIO

OSRAM DULUX® INTELLIGENT with two light levels (100 % and 30 %). Optimum lamp operation thanks to the use of DULUX® IC technology (see 3.1.1, IC start).

- The lighting level can be varied by briefly switching the lamp off and on again within 1 second.

Recommendation

At ambient temperatures below 20° C the lamps should burn for about one minute each time before being dimmed to achieve stable dimmed operation.

1.2.2.6 OSRAM DULUX® INTELLIGENT SENSOR

This is an OSRAM DULUX® INTELLIGENT equipped with microprocessor technology and controlled by ambient light.

Operating principle

OSRAM DULUX® INTELLIGENT SENSOR automatically switches on at dusk and off again at dawn. Two light sensors continually measure the infrared component of the ambient light.

- OSRAM DULUX® INTELLIGENT SENSOR is affected only to a very small extent by its own light
- Plug & Play installation possible in all normal fittings for incandescent lamps
- May only be used outdoors and in appropriate fixtures
- Brief extraneous light causes the lamp to continue burning (e.g. a passing vehicles or flashlights)
- Unaffected by interference light
- Automatic adjustment to ambient lighting conditions, without a setting controller
- The lamp indicates it is ready by coming on for two seconds each time power is applied

Operation

The lamp is controlled by the infrared component of ambient light. Infrared radiation is emitted by sun, by remote controls and by artificial light sources such as incandescent lamps and halogen lamps. By contrast, fluorescent lamps emit very little IR radiation.

It can be assumed that the intensity of the infrared radiation from the sun is proportional to the brightness of the visible light. The two sensors detect the radiation around the lamp and this is then evaluated by the lamp electronics.

Evening	Bright ➔ Dark High IR ➔ Low IR ⬇ Switch-on value is reached ⬇ The lamp switches itself on

Morning	Dark ➔ Bright Low IR ➔ High IR ⬇ Switch-off value is reached ⬇ The lamp switches itself off

Each time ac line voltage is applied the lamp performs a self-test; measurement of the lighting conditions of the fixture will be completed after no more than 30 minutes.

Power is applied
⬇
Processor test
⬇
Evaluation of the sensors
⬇
The lamp switches itself on

⬇	⬇
In brightness	In darkness
⬇	⬇
The lamp switches off after about 6 to 8 seconds	The lamp stays on

1.2.2.7 Additional information on OSRAM DULUX® INTELLIGENT SENSOR

1. Why does the lamp not come on immediately?
   - IR (= infra-red) radiation from the sun is still hitting the sensor
   - An IR source (such as an incandescent lamp) is nearby
   - Depending on the IR level it may take up to 45 seconds for the lamp to switch on
2. Can I have several lamps in one fixture or in neighboring fixtures?
   - Yes, provided the sensors are not pointing directly at the other lamps. Malfunctions cannot be ruled out however.
3. How can I test a lamp in a fixture?
   - You can do this by simply applying ac line voltage (see Self-test)
   - Further testing can only be carried out at considerable cost. Covering the sensors may cause the lamp to go out after 45 seconds. If the sensors are then uncovered again the lamp will switch on again only after a lengthy period of time and will switch off as the ambient brightness increases.
4. In one fixture the lamp switches on too early in the evening.
   - Cause: The fixture or lamp is pointing east-north-east. In the evening very little light (and therefore IR radiation) falls on the lamp. Remedy: Change the position of the fixture, change the shade over the fixture, turn the sensor towards the source of light.
5. In one fixture the lamp switches off too late in the morning.
   - Cause: The fixture or lamp is pointing west-north-west.
   - In the morning very little light (and therefore IR radiation) falls on the lamp. The problem may rest with the design of the fixture – the sensors may not be “seeing” any IR radiation.
   - Remedy: Change the position of the fixture, change the shade over the fixture, turn the sensor towards the source of light.
6. The lamp flashes at night in the fixture.
   - Cause: An external light source (IR) is interfering with the normal operation of the lamp or the fixture cover is the problem. Remedy: Change the fixture cover, turn the sensors towards daylight (IR).
7. The lamp does not switch off in daylight.
   - Cause: The fixture is in too much shade. Remedy: Change the position of the fixture.

1.2.3 OSRAM DULUX® SUPERSTAR

Long-life energy-saving lamps (up to 15,000 hours) with rapid starting (Quickstart® technology).

1.2.4 OSRAM DULUXSTAR®

Energy-saving lamps with a life of up to 10,000 hours.

1.3 Economy

1.3.1 Comparison of operating costs

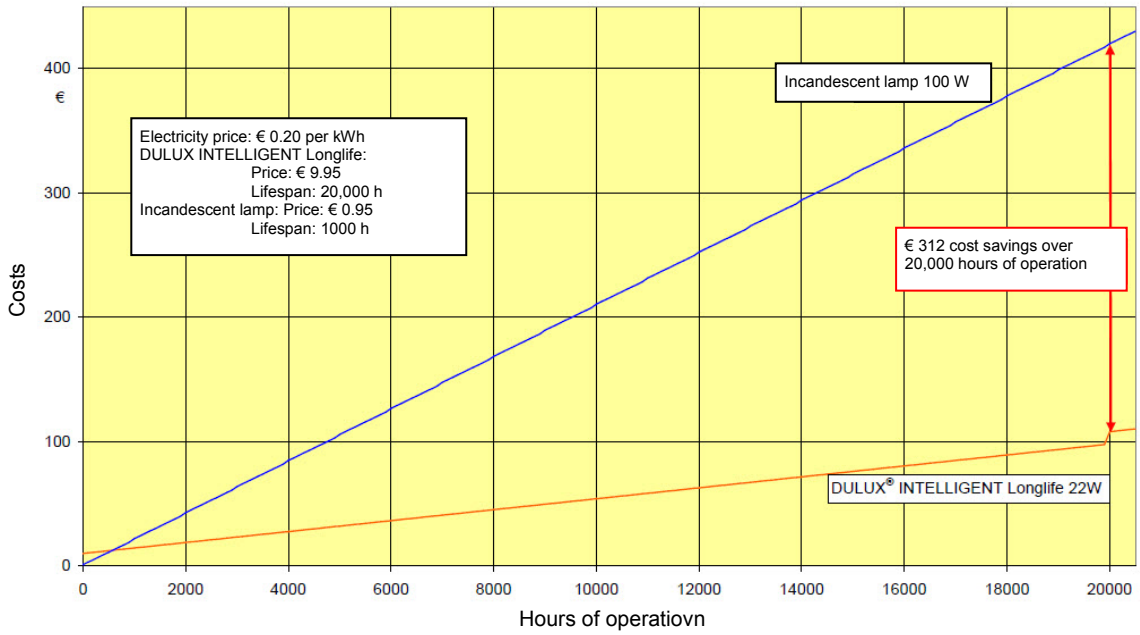
OSRAM DULUX® lamps consume only about one fifth of the electricity of incandescent lamps of comparable brightness.

In commercial applications, the price of the lamps and their maintenance costs play an important role.

A comparison between the operating costs of incandescent lamps and those of the OSRAM DULUX® range shows that because of the lower electricity costs and longer life of OSRAM DULUX® lamps there are considerable benefits despite the higher purchase price. What's more, there are savings in maintenance costs (labor costs for replacing lamps), which are much higher for incandescent lamps because of their shorter life, and possible savings in air-conditioning costs.

Comparison of operating costs between OSRAM DULUX® INTELLIGENT Longlife 22 W and a 100 W incandescent lamp after 20,000 hours of operation. The break-even point is reached after only about 600 hours of operation.

Cost comparison: incandescent lamp/compact fluorescent lamp



Lamp	OSRAM DULUX® INTELLIGENT Longlife	Incandescent lamp
Power draw	22 W	100 W
Quantity	1	20
Hours burned	20,000 h	20,000 h
Average lamp life	20,000 h	1,000 h
Power consumption	440 kWh	2,000 kWh
Electricity costs at € 0.20kWh	88 €	400 €
+ Lamp price [1]	9.95 €	0.95 €*20=19 €
= Total costs	97.95 €	419 €

1) Recommended retail price

1.3.2 Typical relamping intervals

Application	Operating time in hours	Relamping intervals for	
		OSRAM DULUX® INTELLIGENT	**Incandescent lamp**
Private household	2.7 h/day=1,000 h/year	20 years	12 months
Commercial use	10 h/day=3,650 h/year	5-6 years	2-3 months

1.4 Environmental aspects

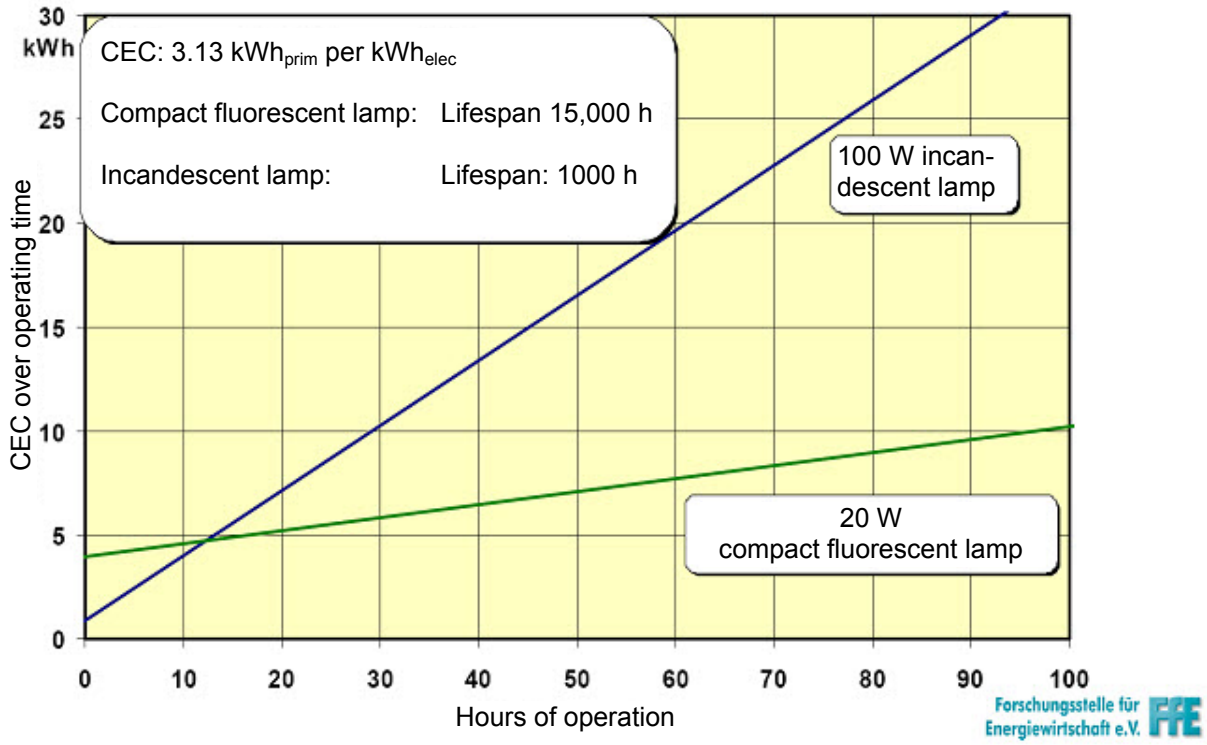
1.4.1 Energy balance

High energy use results in an impact on the environment. This impact principally takes the form of the release of carbon dioxide (CO_2) when electricity is generated in power stations that run on fossil fuels. CO_2 has a major influence on climate change.

Saving energy is therefore of utmost importance for environmental protection and for OSRAM.

Compared with incandescent lamps, all OSRAM DULUX® lamps not only save energy during their lives but also in their manufacture.

CEC comparison: incandescent lamp/compact fluorescent lamp



All OSRAM DULUX® lamps are eco-friendly products because of their energy savings and the associated reduced environmental impact.

1.4.2 Contents

Like all discharge lamps, OSRAM DULUX® lamps are enclosed systems in normal use. Apart from emitting light, they therefore can have no direct impact on the environment.

1.4.2.1 Mercury

OSRAM DULUX® lamps contain a small quantity of mercury, a naturally occurring chemical element (symbol: **Hg**) with special properties including toxicity. Mercury is needed in virtually all low-pressure discharge lamps and most high-intensity discharge lamps for the energy-efficient production of light. OSRAM is constantly looking for ways to reduce the amount of mercury needed for operation. Over the last few years the amount has been reduced on average to less than 1.9 mg per lamp. This is well below the limit values for mercury specified in the relevant EU directives (2002/95/EC – RoHS, 2011/65/EU RoHS Recast). The average mercury content is indicated on the packaging under the “Hg” symbol.

Depending on the type of lamp, different dosing methods are used to insert the mercury. For most OSRAM DULUX® versions a mercury-iron or mercury-zinc pellet (Hg-Fe or Hg-Zn) is used in which metallic mercury is made available for the discharge process. These lamps are characterized by their rapid starting, among other things. Mercury alloys (known as amalgams) are preferred for lamps designed to look like light bulbs.

The mercury is hermetically sealed in the lamp and is only released if the lamp breaks (see below). During the lifetime of the lamp there are consumption processes in which some of the mercury is removed from the discharge process, for example by chemical conversion or ion exchange.

1.4.2.2 Glass

Potassium sodium barium silicate glass is predominantly used.

1.4.2.3 Metals

Aluminum or nickel-plated brass is used for the bases. The lamp filaments are made of tungsten. The solders are lead-free and contain only tin, silver and copper.

These materials do not pose any danger to health if the lamp breaks.

1.4.2.4 Phosphors

The phosphors used consist of yttrium oxide, cerium lanthanum phosphates, cerium terbium magnesium aluminates and barium magnesium aluminates, activated with europium, terbium and manganese. The proportions of the materials depends on the light color of the lamp. These materials have been used for a great many years in fluorescent lamps. Toxic effects are unknown.

1.4.2.5 Electronic control gear

Control gear consists of a pc board with components soldered on it, similar to the electronics in consumer goods. According to EU Directive 2002/96/EC (WEEE) all energy-saving lamps, like all other electronic equipment, must be disposed of separately from normal household waste.

1.4.2.6 Plastics

The main plastics used are PBT (polybutylene terephthalate), PC (polycarbonate) and PMMA (polymethyl metacrylate).

1.4.3 Disposal

Within the EU, OSRAM DULUX® lamps, like all discharge lamps, come under the EU directive covering the disposal of waste electrical and electronic equipment (2002/96/EC – WEEE). This means that the lamps have to be collected separately from normal household waste and recycled in accordance with strict statutory requirements. Throughout the EU, lamp manufacturers and other enterprises have set up collection centers where lamps can be recycled free of charge. Private users must dispose of their old fluorescent lamps and energy-saving lamps at local recycling centers or collection points. Addresses of local collection centers can be found on the internet.

Lamps should be placed carefully in the containers to prevent them from breaking.

1.4.4 Environmental and health-related information relating to mercury in lamps

1.4.4.1 What should you do if a lamp breaks?

The only way that you can come into contact with mercury is if a lamp breaks. If that happens you should follow the rules below to minimize your exposure to mercury.

- Stay calm. A fluorescent lamp contains only a very small amount of mercury.
- If the lamp has broken in a fixture, first disconnect the fixture from the power supply to prevent electric shock.
- Mercury vapor is heavier than air so it accumulates near the floor. Children should therefore leave the room immediately.
- Ventilate the room for at least 15 minutes. If possible, ensure a through-draught.
- Tip: Wear disposable or household gloves to prevent you getting cut by shards of glass.
- After ventilating the room, collect up all the bits of the lamp in an airtight container (such as a glass jar or plastic bag) and seal it.
- Take this container to your nearest lamp recycling center. If you cannot go to the recycling center immediately you should store the container outdoors if possible.

If the lamp broke on a smooth surface (parquet/laminate flooring, tiles, PVC, linoleum):

- Sweep up the bits of the lamp with stiff cardboard for example.
- Clean the floor thoroughly twice with a damp disposable cloth.

If the lamp broke on carpet:

- Vacuum the area carefully for 5 minutes with the window open. Then ventilate the room for 15 minutes. Repeat the process at least twice.
- If possible, take the carpet outside to clean it and leave it outside overnight.
- Clean the head of the vacuum cleaner thoroughly and remove the bag or, if your vacuum cleaner is a bagless model, clean the container. Leave the vacuum cleaner running outside for 15 minutes.
- Dispose of the vacuum cleaner bag, contents and any cloths you may have used outside the home.
- If possible, ventilate the room.

Further information is also available on the internet at:

http://www.osram.com/osram_com/About_Us/Sustainability/Products/Sustainability_criteria/Key_Performance_Indicators/Mercury/Handling_broken_lamps/index.html

1.4.4.2 Mercury in lamps: a health risk?

OSRAM DULUX® lamps contain only a very small amount of mercury. Even if the lamp breaks it does not pose a risk to health if the measures described above are taken[1]. This has been proven by a series of experiments, including ones conducted by the German Federal Environmental Agency. Even if the recommended long-term guide values for indoor spaces are temporarily exceeded it is unlikely that more mercury will be absorbed into the body than would normally come from other sources such as dental amalgam or a portion of fish[2,3]. Various experiments have shown that intensive ventilation reduce mercury concentrations below the recommended values within only a few minutes[4]. The Scientific Committee on Health and Environmental Risks (SCHER) came to the following conclusion in its May 2010 report to the EU Commission entitled “DG Health & Consumer Protection”:

[…] Given the measured Hg air concentrations after CFL breakage, the rapid decrease of these concentrations and the above-stated considerations on the RfC of Hg, the SCHER is of the opinion that a human health risk for adults due to CFL breakage is unlikely. Regarding risk for children, possible exposures from oral intake of dust and hand-to-mouth contact cannot be evaluated due to lack of scientific data; therefore, no conclusions on potential risk are possible. […]

(http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_124.pdf

[1] K. Süring, Gesundheitliche Gefahr durch Quecksilber in Energiesparlampen? (Health risks due to mercury in energy-saving lamps)? UMID1 , 2010, pp. 7-11

[2] Link, B.: Richtwerte für die Innenraumluft: Quecksilber, (Guide values for indoor air: Mercury) Bundesgesundheitsblatt 42, 1999, pp. 168-174

[3] Schierl, R.; Boehlandt, A.; Nowak, D., Quecksilber- Biomonitoring nach Bruch von Energiesparlampen? (Mercury biomonitoring after breakage of energy-saving lamps), Thieme Verlagsgruppe, Deutsche Medizinische Wochenschrift, April 6, 2011

[4] Fromme, H.; Büscher, O.; Matzen, W.; Drasch, G.; Roscher, E.; Nitschke, L., Raumluftbelastung durch quecksilberhaltige Kompaktleuchtstofflampen (Energiesparlampen), Gefahrstoffe – Reinhaltung der Luft (Indoor air pollution from compact fluorescent lamps (energy savers) containing mercury, noxious substances – air purification), 71 (2011), No. 5, p. 215 ff

1.4.4.3 Mercury in lamps from an ecological viewpoint

It may seem paradoxical but the use of discharge lamps in most areas of the world actually leads to a reduction in the use of mercury. Fossil fuels, particularly coal, contain traces of mercury. When these fossil fuels are burned to generate electricity the power plant emits mercury in its waste gases.

The energy savings achieved by using a compact fluorescent lamp lead to a reduction in the amount of mercury released. This reduction is greater than the amount of mercury contained in the lamp.

To prevent the mercury contained in the lamp from being released into the environment each energy-saving lamp must be taken to an appropriate collection point for recycling.

Further information is also available on the internet at www.osram.de/Quecksilber

1.4.5 Energy Efficiency Index (EEI)

Commission Directive 98/11/EC, Energy labeling of household lamps:

The EEI (Energy Efficiency Index, e.g. EEI = A), also known as the “energy label”, classifies lamps according to their energy efficiency.

Directive 98/11/EC for implementing Directive 92/75/EEC has been in force since April 1998.

The seven classes are defined by certain limit values in lamp output.

Lamps in class A are the most efficient at converting electrical energy into light. Almost all OSRAM DULUX® lamps meet the requirements of Energy Efficiency Class A. The exceptions are some special types. Reflector lamps have not yet been classified.

1.5 International standards

OSRAM DULUX® compact fluorescent lamps carry the CE symbol of the EU and comply with all the relevant European standards.

- 2006/95/EC Electrical equipment for use within certain voltage limits
- 2009/125/EC Eco-Design, replacing the old 2005/32/EC Eco-Design Directive
- 244/2009 Commission regulation for implementing directive 2005/32/EC
- 2004/108/EC Electromagnetic Compatibility (EMC)
- 2011/65/EC RoHS compliant (**R**estriction **o**f **H**azardous **S**ubstances)
- 1907/2006/EC REACh (**R**egistration, **E**valuation, **A**uthorization and **R**estriction of **Ch**emicals)
- 2002/96/EC WEEE (**W**aste **E**lectrical and **E**lectronic **E**quipment)
- 98/11/EC Energy labeling of household lamps
- EN 50285 Energy efficiency
- EN 55015 Radio interference
- EN 60968 Safety requirements
- EN 60969 Working Practices
- EN 61000-3-2 Mains current harmonics
- EN 61000-3-3 Voltage fluctuations, flicker
- EN 61547 Immunity
- EN 62471 Photo-biological safety
- EN 62493 Electromagnetic fields

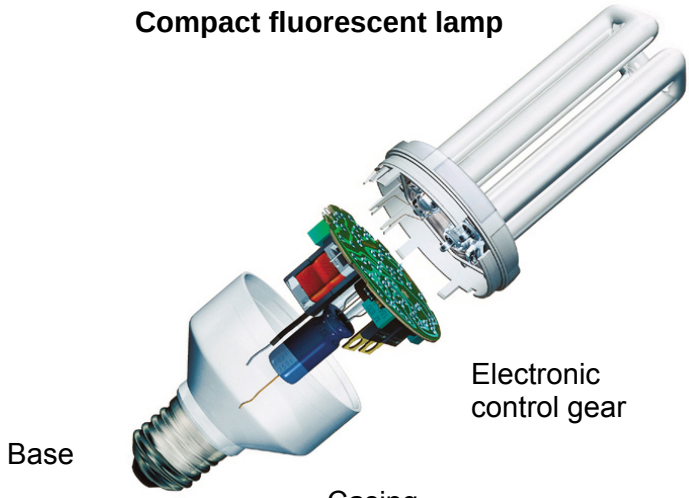
2 FUNCTION AND TECHNICAL DESIGN

2.1 Construction

An energy-saving lamp consists essentially of the following

- Compact fluorescent lamp
- Electronic control gear
- Casing
- Base
- Outer bulb (Classic types only)

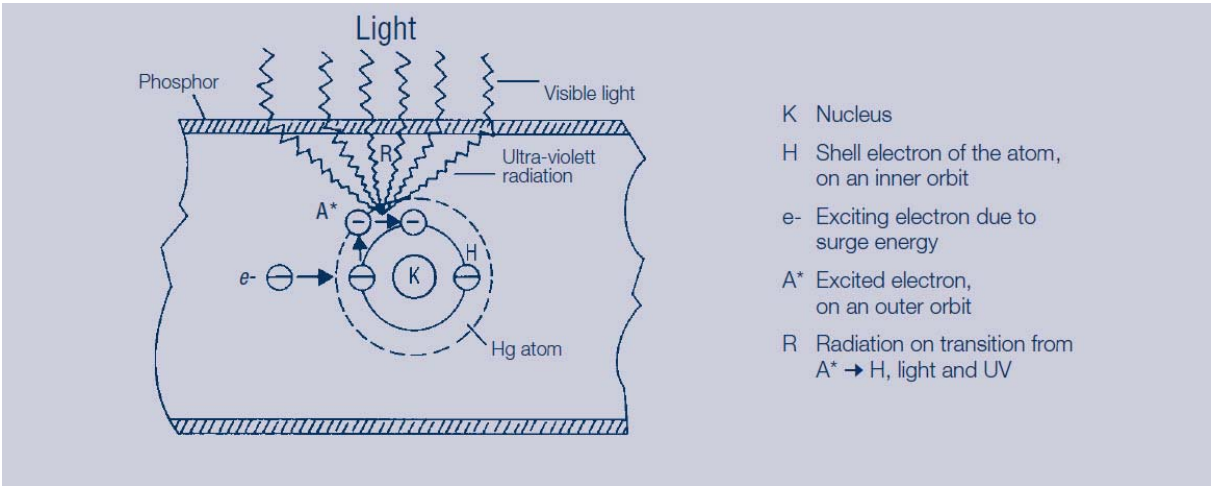
Compact fluorescent lamp



2.2 Generation of light

A low-pressure gas discharge produces light in a glass tube. Electrical current is passed via the two filament electrodes through the tube which is filled with partially ionized gas. The electrons excite mercury atoms to emit short-wave ultra-violet light, which is converted into visible light in the phosphor layer on the inside of the tube. Different light colors are produced depending on the phosphor mix.

Compared with an incandescent lamp, only around one fifth of the electrical energy is needed to produce the same amount of light.



2.3 LUMILUX® phosphors

LUMILUX® phosphors are three-band phosphors that have clear advantages over halophosphate phosphors.

- Higher efficiency of the lamp (more lumens per watt)
- Reduced loss of luminous flux over the life of the lamp (better lumen maintenance)
- Better color rendering
- Smaller amount of mercury

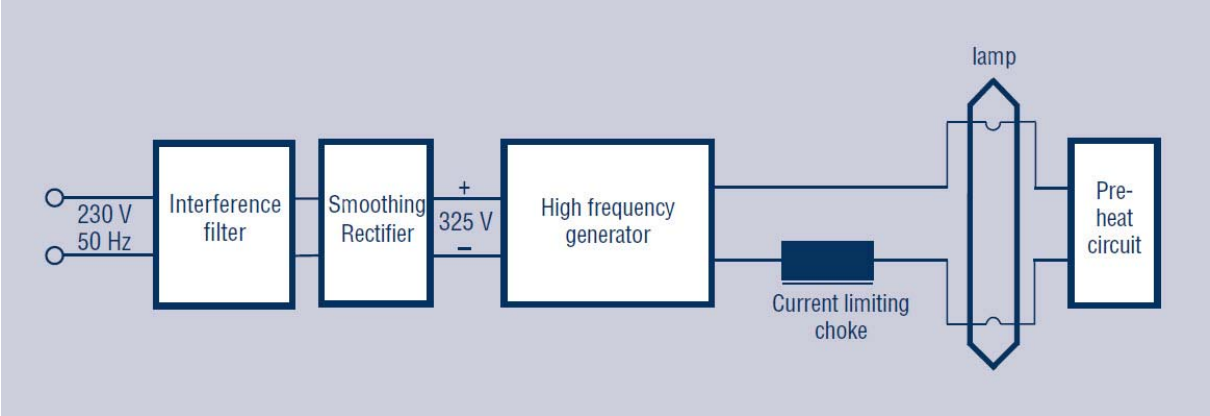
2.4 Electronic control gear

Fluorescent lamps need a voltage pulse of several hundred volts in order to start, and need the current to be limited to several hundred mA in order to continue operating properly. In conventional control gear (CCG operation), these two functions are covered by an inductive resistor (choke) and starter. Chokes for a mains frequency of 50 Hz are large and heavy and cause power losses that in the case of compact lamps may be as much as 40% of the power input.

OSRAM DULUX® lamps have integrated electronic control gear for starting and current limitation. The electronic circuitry is small and lightweight. The lamp starts instantly and without flickering. It is also silent in operation. High-frequency operation of the fluorescent lamp also improves its efficiency.

2.4.1 Operation

Electronic control gear (ECG) contains a number of functional elements:



First, a dc voltage of about 280 V_{DC} is produced from the 50 Hz line voltage by a rectifier with a smoothing capacitor. This voltage is converted into a high-frequency ac voltage in the high-frequency generator (oscillator), in which two transistors operate as fast-acting switches. Current limitation and power setting are handled by a choke which because of the high operating frequency, however, has a smaller inductance (impedance Z = Lx □) and smaller dimensions than conventional control gear.

For the lamp to start properly, the ECG must apply a voltage of several hundred volts to the lamp. In OSRAM DULUX® lamps capable of frequent on/off switching the lamp electrodes are heated up to the electrode emission temperature prior to starting (hot restart).

With the electronic control gear used, this is achieved by a series resonance circuit, whose resonating for OSRAM DULUX® lamps is deliberately delayed by a PTC thermistor (preheat phase). In OSRAM DULUX® INTELLIGENT lamps (DIM, FACILITY, SENSOR and VARIO) preheating of the filaments and starting of the lamp are so well controlled by an integrated circuit (OSRAM DULUX® IC) that the lamps can be switched on and off any number of times with no adverse effect (> 2 million operations). The life of the lamp can be apportioned to any lengths of operation.

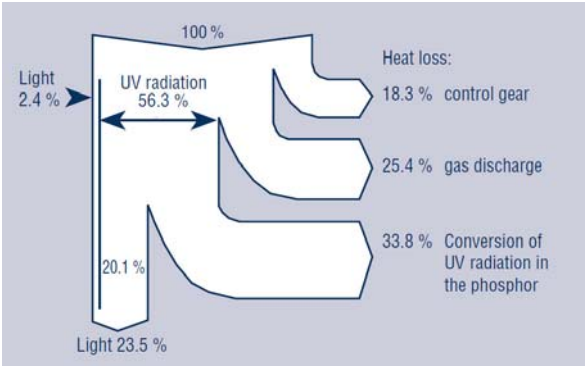
A radio interference filter prevents the generator frequency and its harmonics from affecting the power cables. Thanks to the electronic control gear, an OSRAM DULUX® lamp can be operated on any standard line frequency and is virtually unaffected by fluctuations in the line frequency.

2.4.2 Energy savings thanks to electronic control gear

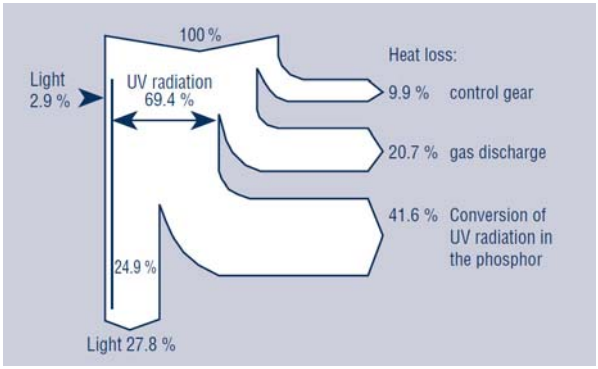
Electronic control gear offers further energy savings of around 20% compared with conventional control gear.

- Lower electrical losses in the electronic control gear (choke losses)
- Better gas discharge efficiency at high frequencies

Conventional control gear



Electronic control gear



2.4.3 Visual comfort

Electrode flickering and luminous ripple, which are normal with conventional control gear, cannot be perceived by the human eye at the high frequencies at which the lamp is operated. The eye therefore does not tire as quickly and the light is considered pleasant and calm.

3 LAMP DATA AND LAMP PROPERTIES

Unless otherwise indicated, the following conditions apply to all the technical data specified in this document:

- Supply voltage 230 V, 50 Hz (exception: 12 VDC lamps)
- Lamp installed base up, free burning
- Ambient temperature 25° C ± 1° C

3.1 Starting properties

For OSRAM DULUX® INTELLIGENT/SUPERSTAR lamps, correct starting is assured in the line voltage range from 220 V to 240 V and at temperatures from –30°C to +50°C, with the following exceptions:

		Operating temperature
OSRAM DULUX® INTELLIGENT	VARIO 12 V_{DC}	0°C to 50°C
	12 V_{DC}	0°C to 50°C
	SENSOR MINI BALL	–15°C to 40°C
	Longlife 5 W and 7 W	–20°C to 50°C
OSRAM DULUX® SUPERSTAR	5 W and 7 W	–20°C to 50°C
	MINI GLOBE	–15°C to 40°C
	MINI CANDLE	–15°C to 40°C
	MINI BALL	–15°C to 40°C
	MICRO TWIST	0°C to 50°C

OSRAM DULUX® lamps with hot restrike (IC starting and PTC starting) ignite in less than two seconds; OSRAM DULUX® lamps with instant or cold strike are even faster but their life is reduced by frequent on/off switching.

	Ignition time
Instant or cold strike	≤ 0.3 s
Hot restrike < 10 W	< 1.5 s
Hot restrike ≥ 10 W	< 1.0 s

3.1.1 IC starting (IC-controlled filament preheating)

Lamps with IC starting such as OSRAM DULUX® INTELLIGENT FACILITY, VARIO, 12 V_{DC}, DIM and SENSOR can be switched on and off virtually without restriction. This makes them ideal for stairwell lighting with automatic disconnection circuits for example or for rooms where people often go in and out. Preheating of the filaments and starting of the lamp are so well controlled by an integrated circuit (OSRAM DULUX® IC) that the lamps can be switched on and off any number of times and in any cycle with no adverse effect.

3.1.2 PTC starting (cold conductor controlled filament preheating)

Lamps with PTC starting such as OSRAM DULUX® INTELLIGENT/SUPERSTAR have hot restrike functionality. In a hot restrike the filaments are preheated generally in less than one second before the lamp is ignited. This time is needed to increase the lamp's .

Before the gas discharge is ignited the electrodes of the fluorescent lamp are brought up to a temperature that makes it easier for the electrons to escape from the electrode. There is virtually no wear on the electrode material and high resistance to switching transients is achieved.

For a switching cycle of 60 s on/180 s off, an OSRAM DULUX® SUPERSTAR can handle more than 500,000 switching operations. This means that can be operated for about four years continuously on this switching cycle.

The requirement here is that the PTC thermistor, which controls the starting process and which is hot while the lamp is in operation, can cool down before the lamp is switched on again. A period of three minutes is normally sufficient (up to 15 minutes at high lamp temperatures).

3.1.3 Cold starting (without filament preheating)

In lamps with cold starting, such as OSRAM DULUXSTAR®, a high voltage pulse leads to sudden ionization of the filler gas and gas discharge starts immediately. This rough handling of the electrodes causes rapid wear and therefore reduced resistance to switching transients and a shorter life.

Lamps with cold starting should not be switched on and off too often in order to ensure they achieve their full lifespan.

3.2 Lumen run-up

3.2.1 Quick light technology

OSRAM DULUX® INTELLIGENT/SUPERSTAR lamps with Quick light technology achieve 60% of their stable-state luminous flux 10 to 20 seconds after they are switched on.

This is achieved thanks to the perfect interplay between electronics, lamp electrode and fluorescent lamp.

40% of the stable-state luminous flux is reached immediately the lamp is switched on, and 90% within 60 seconds.

3.2.2 Normal run-up

OSRAM DULUX® lamps without Quick light technology meet the requirements of EU Directive 244/2009 and reach 60% of their stable-state luminous flux after 60 seconds.

3.2.3 Amalgam run-up

OSRAM DULUX® lamps with amalgam technology, as used in lamps with outer bulbs, meet the requirements of EU Directive 244/2009 and reach 60% of their stable-state luminous flux after 120 seconds.

Typical run-up times

As a percentage of stable-state luminous flux:

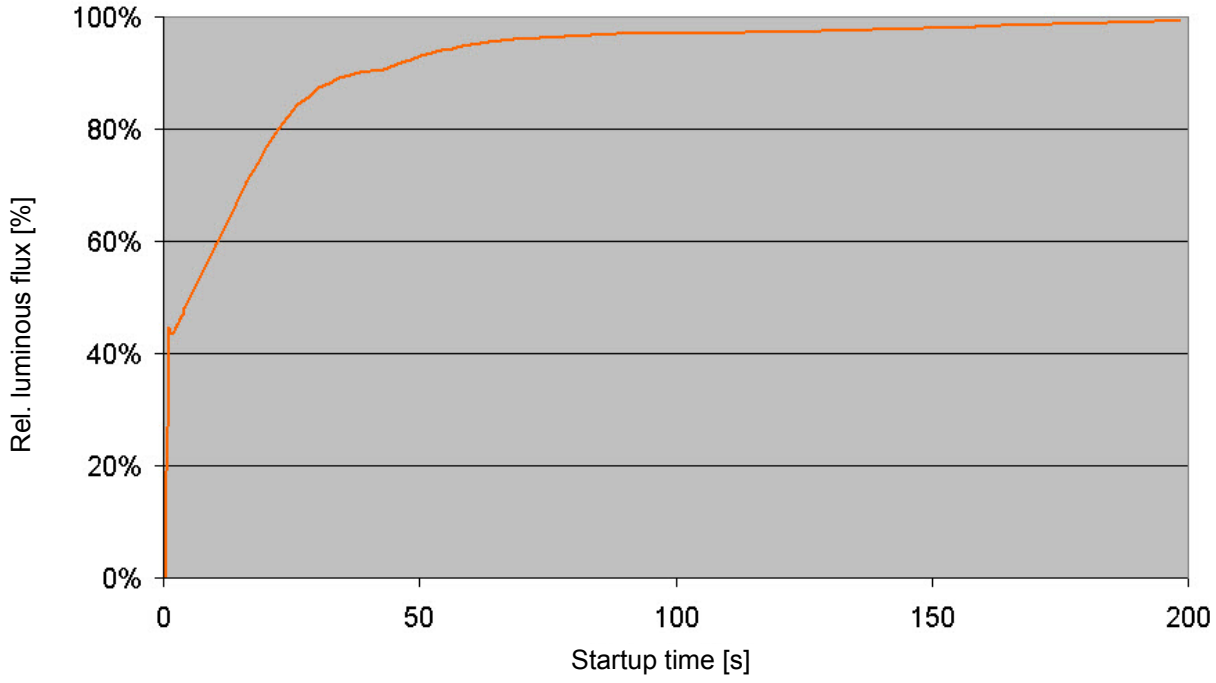
	After 30 s	**After 60 s**	**After 120 s**
Quick light	85 %	95 %	100 %
Normal run-up	70 %	85 %	95 %
Amalgam run-up	40 %	60 %	80 %

In seconds until the percentage of the stable-state luminous flux is reached:

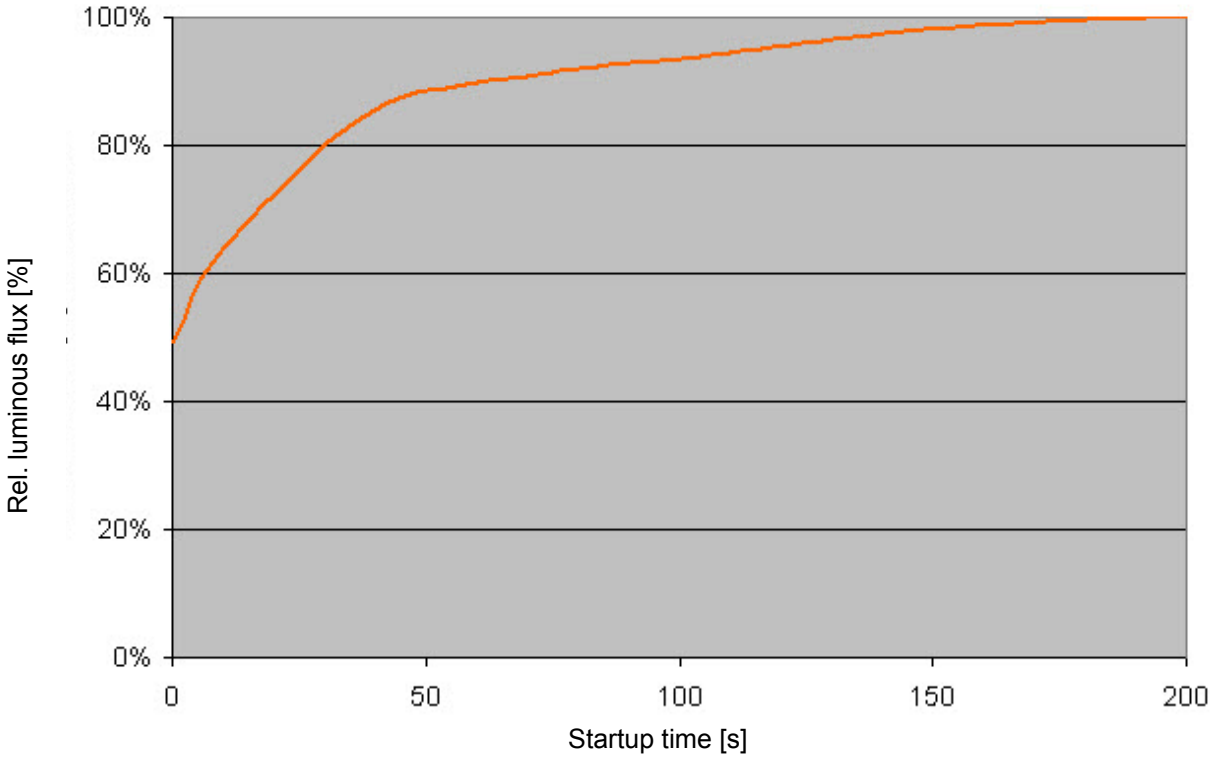
	40 %	**60 %**	**90 %**
Quick light	1 s	10 s	40 s
Normal run-up	1 s	10 s	80 s
Amalgam run-up	30 s	60 s	140 s

Typical run-up curves

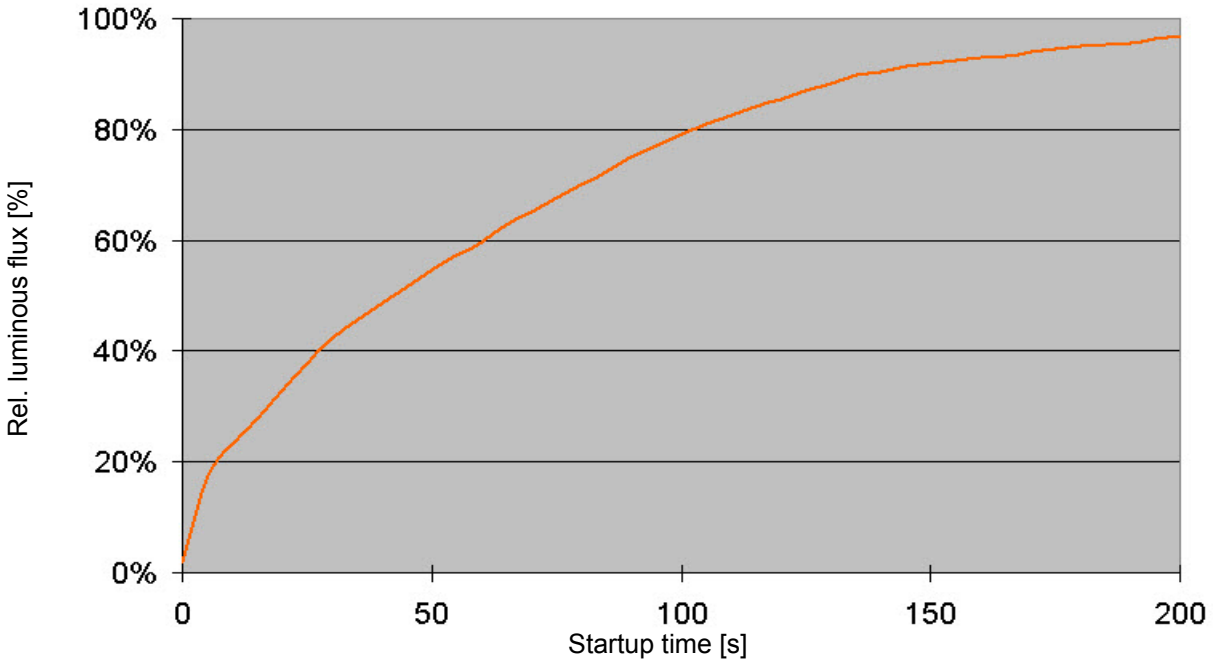
Quick light:



Normal run-up:



Amalgam run-up:



3.3 Switch-on current

Contrary to popular belief, frequent switching does **not** increase energy consumption. At the moment of starting there is a short high surge of current of up to 50 A (approx. 80 µs half-value width) to charge the internal smoothing capacitor. The amount of energy needed here is very small however and corresponds to the power draw during an operating time of 0.03 s.

To limit the switch-on current OSRAM DULUX® lamps are equipped with limiting circuit elements.

Standard fuses (10 A, 16 A, B characteristic) do not normally respond to the high switch-on currents as the time interval is too short.

As a rule of thumb we can say that at one tenth of the permitted connected load of incandescent lamps OSRAM DULUX® lamps do not cause any problems with fuses.
If triggering of fuses and RCD devices is caused by a large number of lamps being switched on simultaneously this can be prevented by using devices with a trigger delay.

If necessary, contact the fuse manufacturer.

3.4 Photometric data

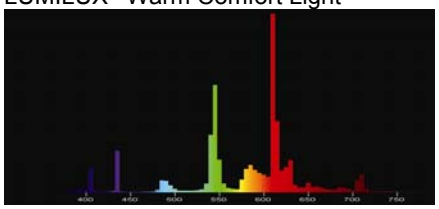
3.4.1 Spectral distributions

The spectral distribution is determined mainly by the light color, whereas the various types and wattages have only a small effect on this curve. The light color is a result of the composition of the phosphors used.

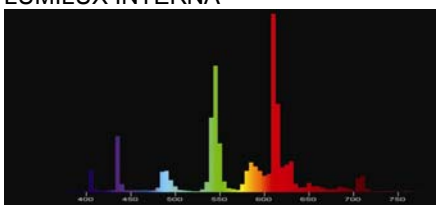
The spectral distributions shown are therefore typical of all OSRAM DULUX® lamps of the relevant light color.

The spectral intensities are grouped in wavelength ranges of five nanometers. The values integrated across 5 nm are specified, irrespective of the actual distributions. This corresponds to the procedure that is the basis for all calculations of subsequent results (e.g. color and color rendering).

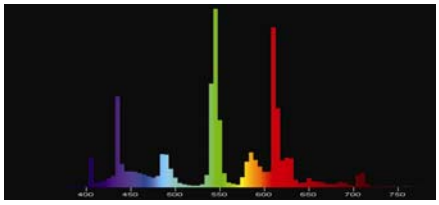
Light color 825 (2500 Kelvin)
LUMILUX® Warm Comfort Light



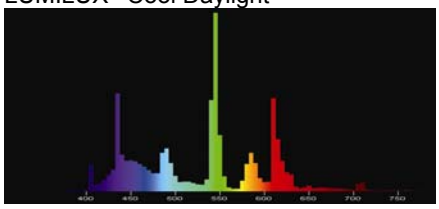
Light color 827 (2700 Kelvin)
LUMILUX INTERNA®



Light color 840 (4000 Kelvin)
LUMILUX® Cool White



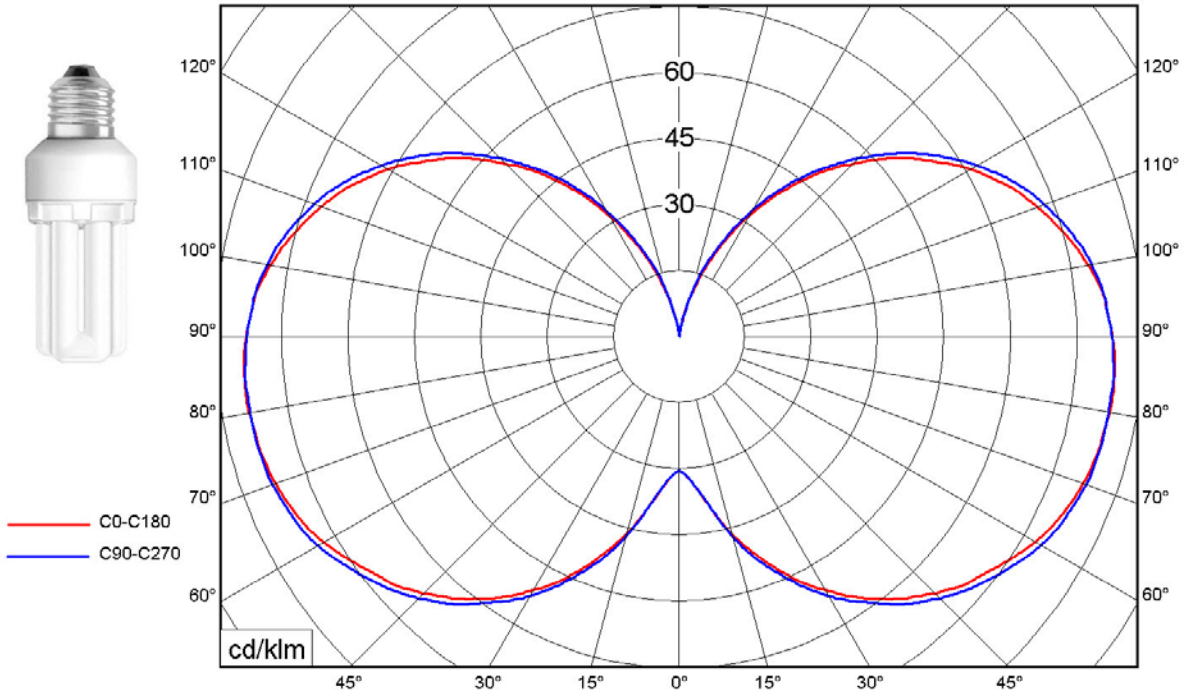
Light color 865 (6500 Kelvin)
LUMILUX® Cool Daylight



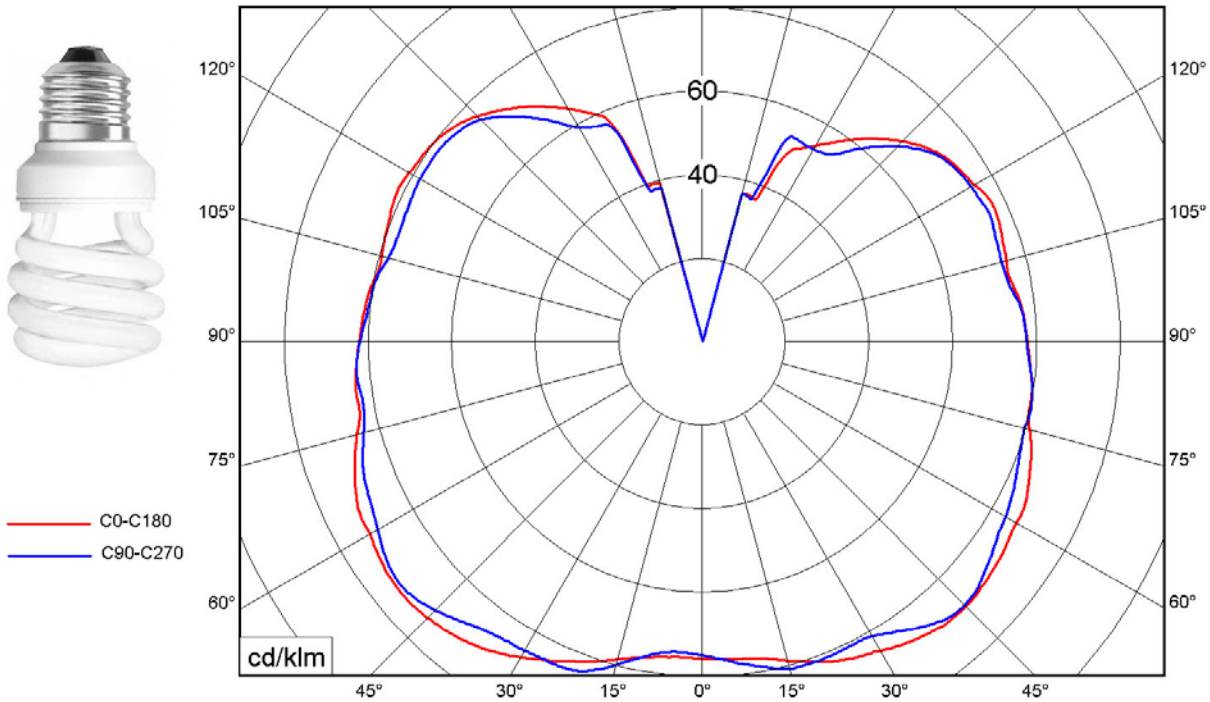
3.4.2 Luminance

The average luminance of OSRAM DULUX® lamps without an outer bulb (stick and spiral shapes) is between 2.5 and 6 cd/cm^2 depending on the tube diameter and the lamp geometry. Frosted lamps with an outer bulb (Classic, Globe and Ball) have an average luminance of less than 1 cd/cm^2.

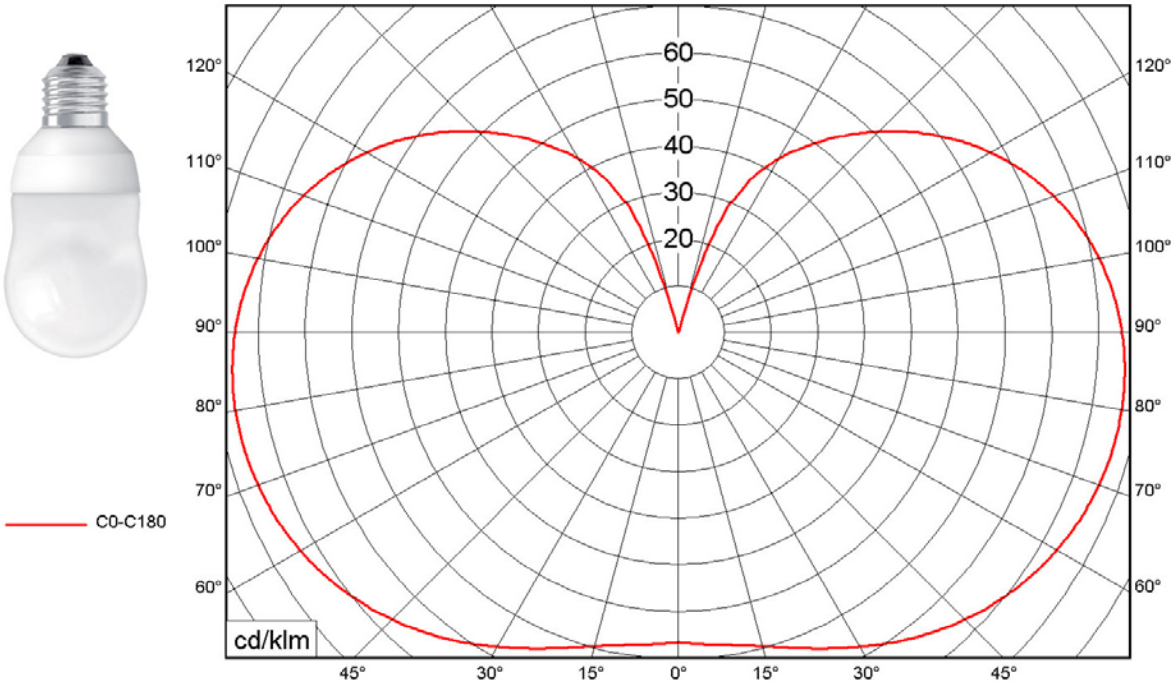
3.4.3 Luminous intensity distribution



Stick lamps (double and triple-turn tubes)



Twist lamps (spiral lamps)



Outer bulb lamps (Classic and Globe types)

3.5 Temperature influences

OSRAM DULUX® INTELLIGENT/SUPERSTAR achieve their rated lifespan in a temperature range from -30°C to +40°C. For exceptions see Section 3.1. At lower temperatures an excessive ignition voltage may destroy the lamp. The thermal load on the components at temperatures above 40°C may lead to premature failure of the integrated electronic control gear. As a rule of thumb, an increase from 40°C to 50°C will shorten the life of the lamp by about half).

Low temperatures will lengthen the ignition time (not in the case of IC starting) and the run-up time.

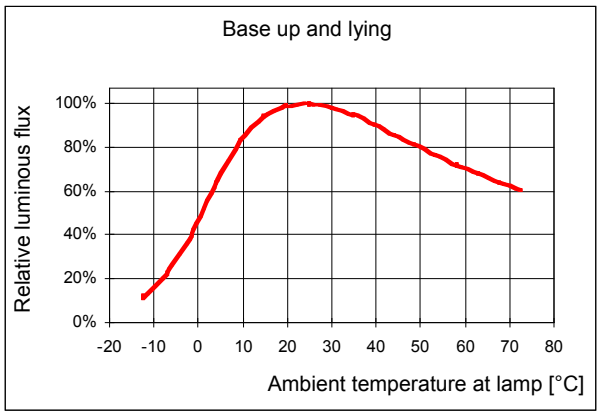
3.5.1 Dependence on burning positions and temperature

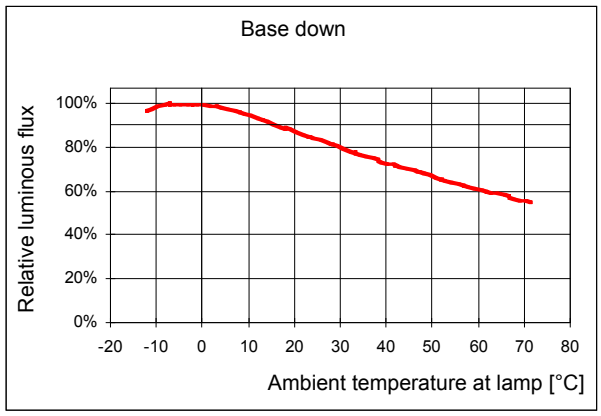
The luminous flux of Hg low-pressure discharge lamps such as the OSRAM DULUX® lamps is dependent on the mercury vapor pressure in the lamp and on the temperature at the coolest point of the lamp tube (cold spot).

When OSRAM DULUX® lamps are used in the base up position, the bends in the tubes act as cold spots. Optimum luminous flux is achieved in both the base-up and lying burning positions at an ambient temperature between 20°C and 25°C. With the lamp in the base down position the maximum luminous flux is achieved at lower ambient temperatures because the cold spot regulating the Hg vapor pressure forms at a different position in the discharge tube.

In an ambient temperature range of 10°C to 40°C most OSRAM DULUX® lamps in the base up position provide at least 90% of the maximum luminous flux. There are significant losses of light at lower and higher ambient temperatures.

For free-burning lamps the ambient temperature corresponds to the room temperature. If the lamps are operated in fixtures, the temperature in the fixture is crucial for the luminous flux.





3.5.2 Lamp temperatures

Compared with incandescent lamps the temperatures are much lower. Replacing incandescent lamps with OSRAM DULUX® lamps is therefore straightforward. Excessively high temperatures at the electronic control gear lead to a shorter average life but the safety of the lamp is not affected. If the lamp has enough space in the fixture and adequate heat exchange is provided (good ventilation for example) the lamp will achieve its average life.

A lamp operated at optimum luminous flux will normally achieve its full average life.

3.5.3 Notes on fixture design

Fixture designers must ensure adequate heat exchange, preferably by ventilation, to protect the electronic components and the plastic parts.

OSRAM has developed a procedure for evaluating the thermal load relating to OSRAM DULUX® lamps. Lamp-specific information regarding permissible ambient temperatures can be requested (for contact details see Section 4).

Burning position

Because of the thermal conditions on the lamp there are significant differences in the luminous flux/temperature curve for base down, base up and lying burning positions. The base down position is recommended for all applications in which low ambient temperatures are expected (in outdoor fixtures for example).

Outdoor fixtures

In the case of outdoor fixtures measures must be taken to ensure that water cannot penetrate the lamp (e.g. condensate in the fixture).

3.6 Power supply

OSRAM DULUX® lamps designed for 220-240 V operate perfectly on ac voltage in the range from 198 V to 254 V (according to DIN IEC 38).

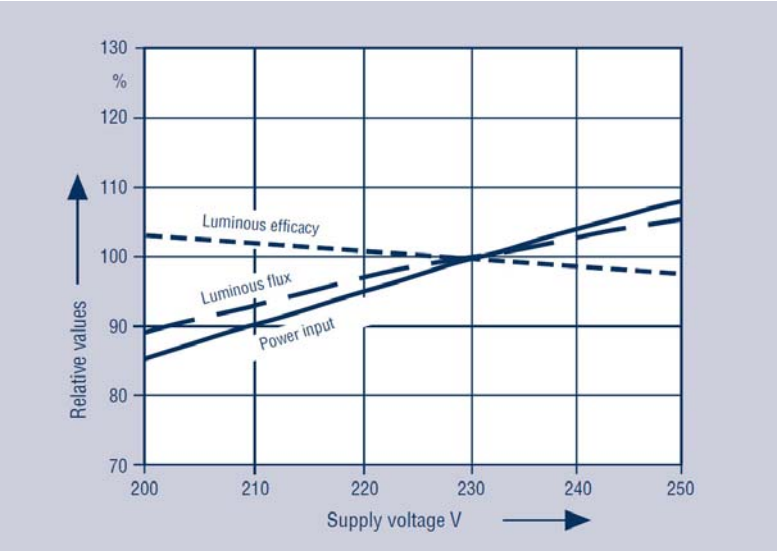
3.6.1 Dependence on line voltage and line frequency

The characteristics of lamps differ according to the line voltage.

Changes in the luminous flux and in lifespan are much smaller with OSRAM DULUX® lamps than with incandescent lamps.

As the voltage increases or decreases, the output and the luminous flux change more or less proportionally. Voltage fluctuations in the permitted range have only a small effect on the life of OSRAM DULUX® lamps.

In contrast to the situation with incandescent lamps, the luminous efficacy as a measure of the conversion of electrical power into light is virtually unaffected by changes in the line voltage in the usual fluctuation range of -10% to +10%.



3.6.2 Operation on dc voltage for emergency lighting

Only OSRAM DULUX® INTELLIGENT FACILITY lamps are suitable for operation on dc voltage in the range from 176 V_{DC} to 310 V_{DC}.

3.6.3 Operation on dimmers

3.6.3.1 General

Brightness control with standard dimmers (leading-edge phase dimmers) is only possible with OSRAM DULUX® INTELLIGENT DIM lamps.

Alternatively, OSRAM DULUX® INTELLIGENT VARIO lamps can be used as they offer two-stage brightness regulation. The brightness is selected using a standard light switch; dimmers must not be used.

No OSRAM DULUX® lamps except OSRAM DULUX® INTELLIGENT DIM lamps may be connected to dimmers.

The electronic control gear contains a rectifier and smoothing capacitor in the input circuit. This capacitor is always charged to the peak value of the ac voltage; line current flows only briefly and up to the maximum line voltage. This design prohibits operation with standard dimmers since leading-edge phase dimmers would damage the capacitor with their steep voltage rises and associated high needle-like charging currents.

Many dimmers require a minimum load of many times that of an OSRAM DULUX® lamp so that even with the dimmer set to max brightness its switching element would not find an adequate holding current, with the result that the lamp would be continually switched on and off. This would damage the OSRAM DULUX® lamp so much it may be destroyed and would risk damaging the dimmer.

3.6.3.2 OSRAM DULUX® INTELLIGENT DIM

OSRAM DULUX® INTELLIGENT DIM lamps contain specially matched control gear that get around the technical difficulties mentioned in Section 3.6.3.1. When operating this lamp on a dimmer there is no need to worry about the minimum load for the dimmer. The life of the lamp is not dependent on the dimmer setting and there is no risk to the dimmer at all. For more information on operating OSRAM DULUX® INTELLIGENT DIM lamps see Section 1.2.2.2.

3.6.4 Operation on electronic switches

Operation on electronic switches is possible only in certain circumstances.

Because of the design of the input circuit, current flows only for about 2 ms per half-wave. The peak value of this current is three times the rms value. This high crest or peak factor must be taken into account when operating the lamp with electronic switches. Simple thyristor or triac switches that are triggered only once shortly after zero crossing are not suitable because the OSRAM DULUX® does not draw current at this point. An ohmic load (such as an incandescent lamp) would have to be operated in parallel with the OSRAM DULUX® lamp. This would then ensure the holding current for the electronic switch.

More suitable are electronic switches that do not need a holding current (for example those with a MOSFET as the active switching element), or a relay and contactor.

The supply voltage applied to the OSRAM DULUX® lamp must have a sinusoidal curve.

Note the maximum switch-on current of 50 A for approx 80 µs half-value width. A reduction to less than 1 A per OSRAM DULUX® is possible if, with appropriate control of the electronic switch, the lamp is only switched on at zero crossing.

The maximum charge taken up in the switch-on current surge is between 0.4 and 3 mAs (depending on the wattage); the maximum energy taken from the source per switch-on current surge is 0.6 Ws.

OSRAM DULUX® lamps must not be operated on electronic switches, the mode of operation of which is either unknown or unsuitable.

3.6.5 Operation on switches with load relief, spark quenching or glow lamps parallel to the switch path

OSRAM DULUX® lamps cannot be operated on high-resistance jumpered switches.

Because of the parallel path to the switch the OFF setting is never fully at high resistance. If incandescent lamps are used this is of no importance. If however all the incandescent lamps are replaced by OSRAM DULUX® lamps, then even small currents with the switch in the OFF setting will cause the high-impedance input circuit of the OSRAM DULUX® to charge up until the threshold voltage at the capacitor for starting the HF generator is reached and the lamp consumes the energy stored in the capacitor in an attempt to start.

This leads to premature ageing and, in the case of cold-start lamps, brief weak flashes of light that are irritating.

Necessary load relief elements have to be wired parallel to the load, and glow lamps for illuminating the switches need to be connected parallel to the power supply as permanent lights or parallel to the load as ON signals.

3.6.6 Operation on motion detectors

OSRAM DULUX® lamps can be operated with motion detectors provided the provisions of the previous sections regarding operation on switches are met (see Sections 3.6.4 and 3.6.5).

If motion detectors are used, particularly in highly frequented areas, we recommend installing OSRAM DULUX® INTELLIGENT FACILITY lamps. Because of the luminous flux run-up tends to be faster the base down burning position is better than the base up position. There is no need to worry about minimum ON periods or OFF periods if OSRAM DULUX® INTELLIGENT FACILITY lamps are used.

If the lamps are used outdoors in conjunction with motion detectors, note that at low temperatures only a reduced amount of luminous flux will be available shortly after the lamp is switched on. Again, the base down position is better.

3.6.7 Operation parallel to uncorrected CCG lamps

If uncorrected conventional control gear is used or other highly inductive loads a large voltage surge may be generated when the control gear is switched off at maximum current.

If an OSRAM DULUX® lamp is connected in parallel on the same circuit it will be exposed to this large voltage surge. If the maximum peak current of the CCG exceeds half the rms current of the OSRAM DULUX® lamp there will be an overvoltage that may destroy the lamp.

Appropriately dimensioned varistors, corrected CCGs or OSRAM ECGs should be used.

3.6.8 Operation on BUS systems

If the OSRAM DULUX® lamp is controlled by a BUS system, the requirements of Sections 3.6.4 and 3.6.5 regarding switches must be met.

3.6.9 Operation on non-sinusoidal voltage sources

Operation of OSRAM DULUX® lamps on non-sinusoidal voltage sources (e.g. square wave and trapezoidal inverters) is not straightforward.

The rms current must under no circumstances exceed the value for sinusoidal supply, the peak value of the input voltage of the lamp must not exceed that of a sinusoidal voltage and the frequency of the supply voltage must not be greater than 150 Hz. In dimensioning the inverter, bear in mind that at the moment it is started an OSRAM DULUX® lamp has four times the current draw for a few hundreds of milliseconds (or up to several seconds if the lamp is started at a low temperature) (temporary overload capacity of the inverter). The smoothing capacitor of the lamp must be charged by the inverter (start-up current, stability of the control loop).

3.6.10 Phase shift, power factor, pf correction

The phase shift factor $\cos\varphi$ indicates the phase shift between line current and line voltage and relates exclusively to the fundamental (50/60 Hz).

The phase shift of harmonics that occur because of non-sinusoidal current draw is not considered here. OSRAM DULUX® lamps (P<25 W) have a phase shift factor of $\cos\varphi \approx 0.9$ (capacitive).

The power factor λ is defined as: $$\lambda = \frac{\text{Active power}}{\text{Apparent power}}$$

The power factor for OSRAM DULUX® lamps with P<25 W is approx. 0.6; for lamps with P>25 W it is approx. 0.95. These values result from the distorted non-sinusoidal draw (line current harmonic content) and to a lesser extent from a current/voltage phase shift of the fundamental component. For this reason, correction of the power factor by capacitors, which is usual with fluorescent lamps in CCG mode, is not possible.

The actual energy consumption of OSRAM DULUX® lamps is only about 20% of that of an incandescent lamp of the same brightness. It is independent of the power factor and is determine only by the active power, which can be measured by a standard ammeter. The savings of around 80% have a direct impact on fuel consumption (coal, oil and so on) and on emissions from power stations.

3.6.11 Line current harmonics

European standard EN 61000-3-2 “Electromagnetic compatibility (EMC) - Part 3: Limits, Main section 2: Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)” plus Amendments A1 and A2 defines harmonic current limits for energy-saving lamps up to 25 W and more than 25 W power draw. All OSRAM DULUX® lamps comply with the requirements.

3.6.12 Radio interference

All OSRAM DULUX® 220 V to 240 V lamps are RI suppressed and comply with the requirements of EN 55015. Interference on the mains supply is prevented by the interference suppression filter connected on the incoming side of the electronics.

3.6.13 Resistance to electro-magnetic interference and transient overvoltages

All OSRAM DULUX® lamps comply with the immunity requirements defined in EN 61547 relating to external electromagnetic interference.

3.6.14 Interference from IR remote control systems

The discharge characteristics of fluorescent lamps means that a small amount of infrared radiation cannot be avoided. If conditions are less than ideal, particularly if the lamps and the IR receiver are arranged too close to one another, this may lead to interference with IR remote control systems. This depends on the modulation of the radiation emitted by the lamp (depending on the operating frequency of the ECG), the modulation frequency and the coding of the signals used for IR signal transmission. The signal-to-noise ratio also plays a role.

If interference occurs, we recommend moving the IR receiver out of the radiation range of the lamp or by making sure it is not exposed to direct light.

The IEC has produced recommendations for avoiding such interference on IR signal transmission equipment.

The operating frequency of most OSRAM DULUX® lamps is either below 32 kHz or above 40 kHz to minimize the risk of interference.

The latest generation of IR controlled equipment is now making use of “intelligent” IR systems that continue to operate correctly even if they receive IR radiation.

3.6.15 Bases/holders

OSRAM DULUX® lamps are available with E14 or E27 screw bases or with B22d or GU10 bayonet bases and will therefore fit in any standard incandescent lamp fixtures.

3.7 Reduction in luminous flux over time

Chemical changes in the phosphor, mercury absorption and blackening by vaporized filament material lead to a reduction in the luminous flux of a fluorescent lamp throughout its life. External contamination can also lead to a loss of luminous flux.

3.8 Lifespan

The life of fluorescent lamps is determined essentially by the consumption of the emitter on the lamp electrodes. The average life is defined as the time when half the lamps have failed (50% mortality).

The following factors may shorten the life of OSRAM DULUX® lamps:

- Overloading the lamp by operating it at a supply voltage greater than that permitted
- Underloading the lamp by operating it at a supply voltage lower than that permitted
- Failure of electronic components at excessively high/low ambient temperatures
- Operation on dimmers (except OSRAM DULUX® INTELLIGENT DIM)
- Operation on electronic switches (except OSRAM DULUX® INTELLIGENT DIM)
- Operation on switches with load relief or spark quenching
- Glow lamps parallel to the switch path (cold start lamp)
- Operation parallel to uncorrected CCG lamps
- Operation on non-sinusoidal voltage sources
- Frequent switching of lamps with low resistance to switching transients
- Off periods too short (does not apply to OSRAM DULUX® INTELLIGENT: DIM, FACILITY, SENSOR and VARIO)

When lamp comes to the end of its life the lamp circuit is broken; the flickering typical of fluorescent lamps operated on chokes and starters does not occur with electronic energy-saving lamps.

3.9 Suitability for outdoor applications

OSRAM DULUX® lamps for outdoor applications and damp locations may only be operated in fixtures approved for the purpose.

To protect them from moisture they must be used in enclosed ventilated fixtures that have a drain hole where condensate can escape.

If the lamps are used outdoors in winter the luminous flux may be affected by the low temperatures.

3.10 Suitability for explosion-proof luminaires

OSRAM DULUX® lamps can also be used in areas where there is a heightened risk of fire or explosions. The requirement here is that they should be used in fixtures that comply with type of protection “flameproof enclosure” to EN 50018. The fact that these lamps produce much less heat than incandescent lamps is advantageous here.

4 OSRAM CONTACT DATA

For further product information on compact fluorescent lamps go to:

http://www.osram.de

http://www.osram.com

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