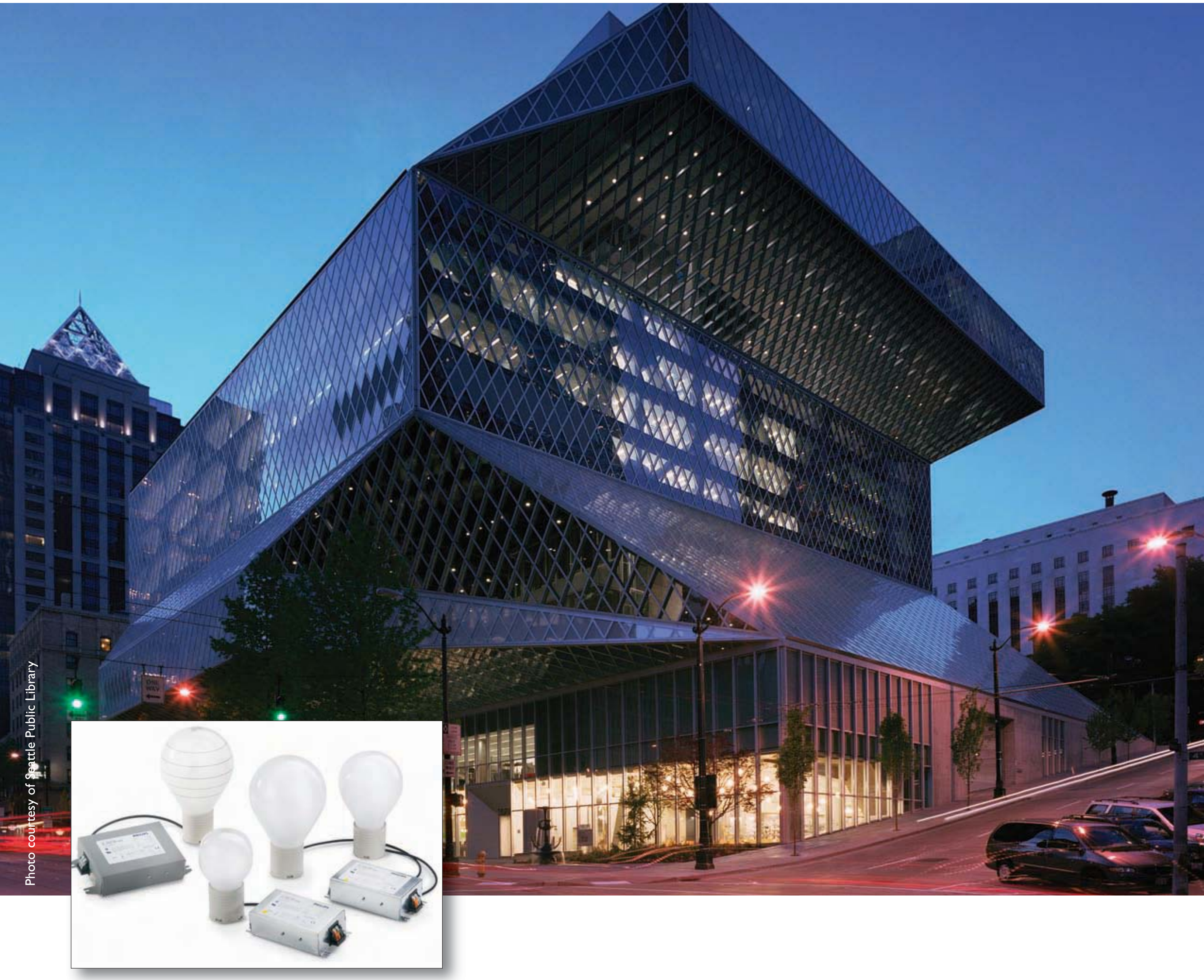

Photo courtesy of Seattle Public Library

Philips QL Induction Lighting Systems

Dear QL-Customer

We would like to inform you that from end of April 2011 onwards, we will switch to a new electronic platform. Reason for the switch is that one of the core components ("asic") in the current platform has been phased out by our component supplier. The QL system specifications will not change and therefore the ordering code remains the same.

The new generator can be distinguished from the old one by the off-center placement of the power coupler connector (see picture). Those customers with an EX certificate may need to re-certify their product.

The driver with the new platform is available end of April, 2011.

1. General information on Philips QL induction lamp systems

1.1 Introduction

The QL lamp systems use a unique physical principle of light generation. This lamp system is therefore classified in a new family of sources, the QL induction lamp systems.

QL induction lighting is a breakthrough for professional, general and special lighting applications; not only because of its high luminous efficacy and excellent light quality, but especially because of its unprecedented lifetime. System lifetime is rated at 60,000 hours, or about 15 years (based on 4000 burning hrs/year) in many applications, with a failure rate of less than 10%. Average lifetime with 50 % survivals is rated at 100,000 hrs. With this unmatched durability, QL offers substantial savings in direct maintenance costs, as well in indirect costs. The major features of QL lamp systems, and their related benefits for the user, are:

Features:	Benefits:
No electrodes or filaments	
• ultra long life time of < 10 % failure rate at 60,000 hrs	• high reliability and nearly maintenance free operation
• low lumen depreciation of < 30 % at 60,000 hrs	• lasting high light output right through lifetime
• low operating temperature of components	• increased safety: more standard luminaire construction
High frequency operation	
• high system efficacy (65-70 lm/W)	• economic, environment-friendly lighting in situations with long burning hours
• no flickering	• restful- non fatiguing light
• no stroboscopic effect	• no danger with rotating machinery
• no noise	• restful and non disturbing in operation
Electronic control	
• output protected HF generator	• automatic switch off in case of failure of lamp.
Instant (re-)start	
• when needed light always instantly available	• more comfort
	• extra energy saving feasible in combination with presence detectors
	• suitable for security and safety lighting
	• useful light immediately after switch on
3-line fluorescent coating	
	• choice of color temperature
	• white light
	• good color rendering (Ra>80)
Amalgam controlled Hg-vapor pressure	
	• constant light output over a wide range of ambient temperatures

Table 1: Features and benefits of QL lamp system

1.2 Lamp system technology and operation

1.2.1 Operating principle

QL induction lighting is based on a principle, which is fundamentally different from that of conventional fluorescent lamps (e.g. TL-D, TL-5 or PL type lamps).

In conventional fluorescent lamps the electric current is supplied to the gas discharge through the glowing electrodes. In QL induction lamps the electrical energy is supplied to the gas discharge by means of a high frequency electromagnetic field without any electrodes. In conventional discharge lamps the electrodes mostly are the life-determining factor. Since these electrodes are not present in QL induction lamps, life of QL lamps can be very long.

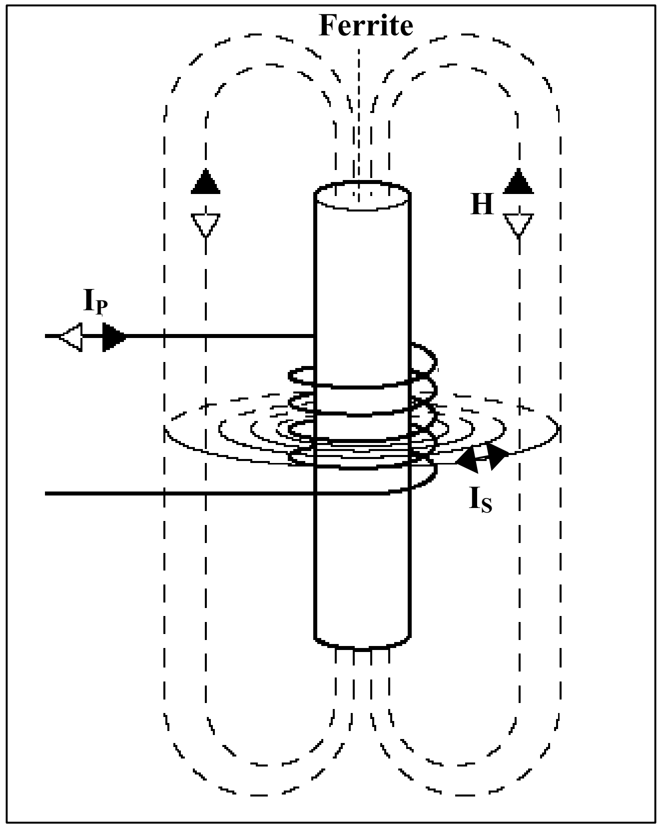

Figure 1: Induction principal

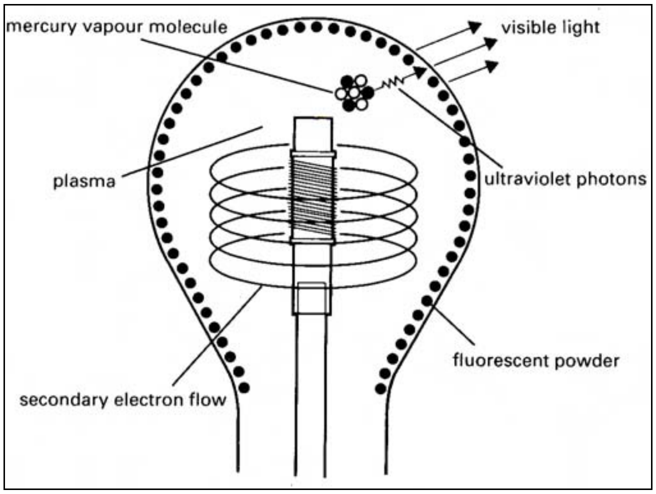

Figure 2: Discharge principle in the QL lamp bulb

In the QL induction lamp system, the energy source – equivalent to the primary coil in the transformer– is the lamp's induction coil, which is powered by high-frequency electronics. The secondary coil is represented by the low-pressure gas discharge (see figure 2). The induced current causes a low-pressure mercury discharge, like in conventional fluorescent lamps. Similar to other fluorescent lamps, the ultra violet radiation generated in the discharge is converted to visible light by the fluorescent phosphor coating on the inside of the bulb wall.

1.2.2 Lamp system components
The QL lamp system consists of three components (see figure 3), which will be described further in this chapter:

A: The lamp (discharge vessel)
B: The power coupler (construction base with antenna, mounting flange and electrical connection cable)
C: The HF generator (electronics inclusive housing)

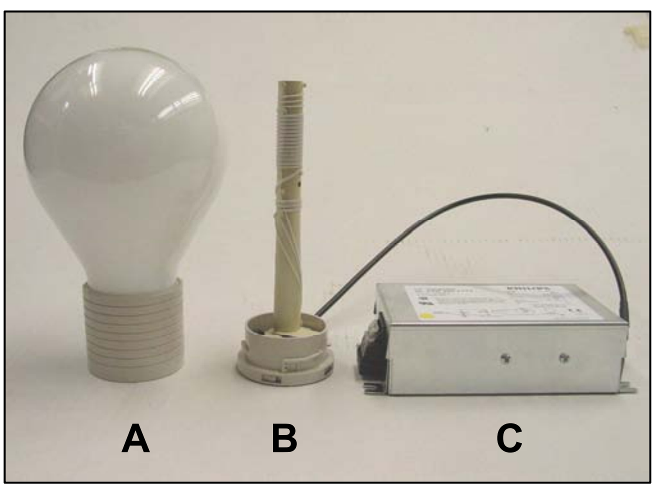

Figure 3: QL lamp system components

1.2.3 The lamp
The QL lamp or discharge vessel consists of a glass bulb (see figure 4) containing an amalgam (mercury metal mixture) and an inert buffer gas.

The discharge in the lamp is maintained by means of an alternating magnetic (induction) field. This is generated by an antenna (see figure 6) in the centre of the discharge, therefore without the use of electrodes. The wall of the lamp is coated on the inside with a fluorescent phosphor mixture, the well-known 3-line Super /80 phosphors used in TL-D, TL-5 and PL type lamps. These phosphor mixtures convert the generated UV light into visible light. Due to the absence of electrodes, which are the lifetime-limiting components of conventional fluorescent lamps, the ultra-long life of induction lamps is ensured.

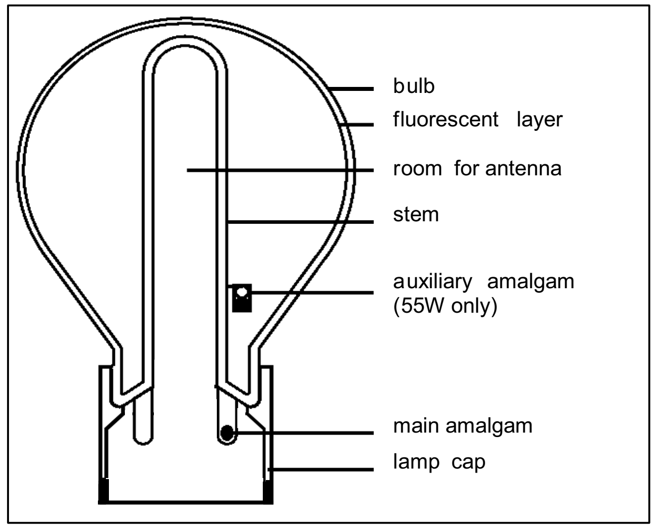

Figure 4: The QL 55W/85W lamp (165W lamp different shape)

In the same way as in other compact fluorescent lamps the light output is maintained over a wide temperature range by means of an amalgam. This amalgam is located in a reservoir attached to the discharge vessel (see figure 4).
The lamp is fixed to the bottom part of the power coupler by means of the unique twist base system (see figure 5).

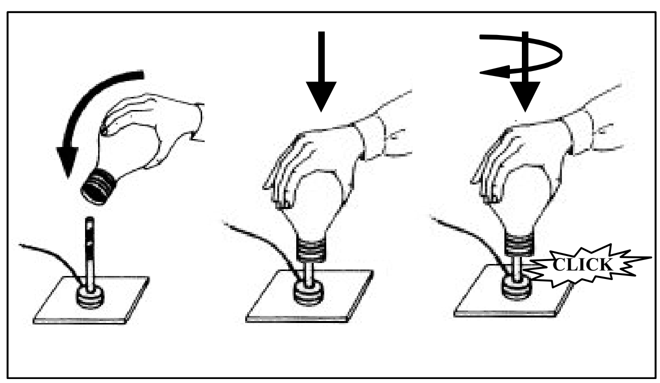

Figure 5: Assembly of lamp with power coupler

1.2.4 The power coupler
The power coupler (see figure 6) is the part of the QL lamp system, which transfers the energy from the HF generator to the discharge in the vessel. It consists of an antenna, a heat conduction rod with mounting flange and a coaxial connecting cable, all assembled together on a plastic carrier.

The mounting flange should be mounted on a metal heat sink.

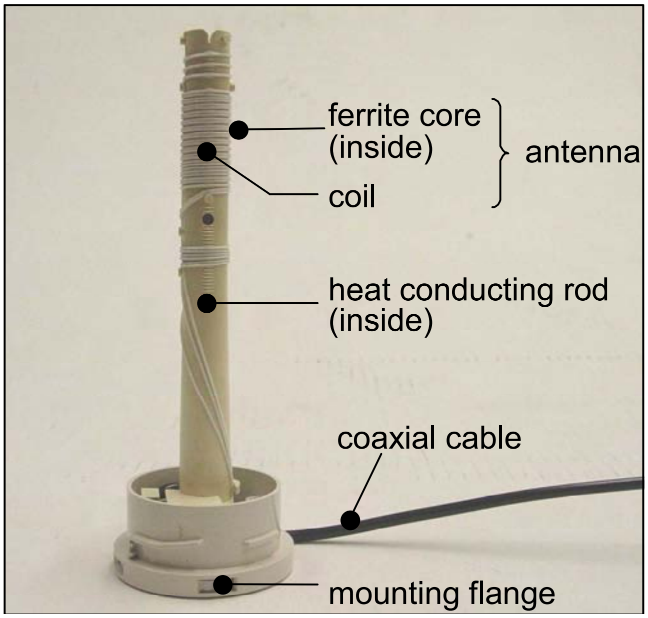

Figure 6: Power coupler

1.2.4.1 Antenna
This cylindrical element is the part of the power coupler located in the centre of the discharge vessel. It includes a coil and a ferrite core, which produce a high-frequency magnetic field (2.65 MHz).
The alternating magnetic field provides the energy for the gas discharge inside the lamp.

1.2.4.2 Heat conducting rod and mounting flange
By means of a conducting rod, which is located inside the antenna, the heat produced by the coil and the discharge is removed to the outside via the mounting flange. This metallic disk has a double function. Firstly, it ensures the mechanical connection between the lamp and the luminaire, and secondly it transfers the heat to a heat sink, which must be a part of the luminaire. The attachment to the luminaire heat sink is by means of 4 bolts. See section 2.5.5 for proper heat sink design.

1.2.4.3 Cable
A coaxial cable forms the electrical connection between the antenna and the HF generator. The cable is permanently fixed at the antenna side. It can be (dis-)connected at the side of the HF generator by means of a push-wire connector in order to facilitate mounting of the lamp system in the luminaire.
The coaxial cable is made of flexible stranded core conductors insulated in heat-resistant plastic (125°C/257°F max.) end provided with a ferrite for EMI reasons. For optimal performance of the system (light and live) the length of the cable is fixed (see figure 29)

The user may not change the length of the cable.

1.2.5 The HF generator
The HF generator primarily contains an oscillator, which supplies the high-frequency power to the antenna to initiate and maintain a gas discharge in the discharge vessel. The HF generator ensures a well-stabilized oscillator power supply and filtering of the mains power. In addition, it provides a very good power factor and a low harmonic distortion of the mains. All the electronics are housed in a metal box with a dual function: screening against RFI (Radio Frequency Interference) and heat conduction to ensure proper long-life functioning of the electronics. If the metal housing, and power coupler are properly electrically connected to ground, the system will comply with all (inter-) national requirements regarding electromagnetic compatibility. The HF generator output frequency is approximately 2.65 MHz.

1.3 Nomenclature

QL induction lamp systems:

- Family name of all QL lamp systems irrespective of wattage, supply voltage or color temperature and operating with low-pressure induction discharge technology.

QL lamp system:

- Combination of a lamp, a power coupler and an HF generator; <u>all with the same wattage indication</u>.

  E.g. QL 55W lamp system consists of:
  1x Lamp QL 55W/8.. Twist base
  1x Power Coupler QL 55W Twist base
  1x HF-Generator QL 55W 200-277V

Warning:

- Only system components with the same wattage indication (55W or 85W or 165W) may be combined! Any other combination might cause damage to the lamp system components and possible interference effects to the environment.

QL lamp:

- Lamp QL..W/8.. Twist base
  Represents a lamp for a specific system wattage (55W or 85W or 165W) and a certain color temperature (/827, /830 or /840 for 2700, 3000 and 4000K, respectively).

  E.g. Lamp QL 85W/830:
  Lamp for QL 85W lamp system and /830 phosphor coating (3000K).

QL-R lamp:

QL lamp with an internal reflective layer.

E.g. Lamp QL-R 85W/840:
Lamp for QL 85W lamp system and /840 phosphor coating (4000K) with internal reflective layer.

QL power coupler:

- Power Coupler QL..W Twist base
  Represents a power coupler for a specific system wattage (55W or 85W or 165W).

  E.g. Power Coupler QL 55W Twist base:
  power coupler for 55W system

QL HF generator:

- HF Generator QL ..W 200-277V (HV) or HF-Generator QL ..W 100-120V (LV)
  Represents a HF generator for a specific system wattage (55W or 85W or 165W) and supply voltage.

Remark:

- For all QL lamp system supply voltages (HV and LV) the same lamp (55W or 85W or 165W) should be used.
- For all QL lamp system supply voltages (HV and LV) the same power coupler (55 or 85W or 165W) should be used.

Warning:

- Every HF generator may only be combined with one lamp/power coupler set of the same wattage; failure to observe this basic rule might cause damage to lamp system components and possible interference effects to the environment.

2. Luminaire design

2.1 Introduction

The design of QL luminaire systems related to light distribution needs the same skills as those for conventional light sources. Extra attention should be paid to heat and heat transfer and EMI. In the following paragraphs you can find more explanations.

2.2 Positioning of components

The QL lamp system is constructed in such a way that it gives designers maximum freedom for positioning the lamp components in the luminaire, taking into account the restrictions of the size and the high-frequency operation of the lamp system itself.

2.3 Grounding and fixation

Unless specially mentioned, it is assumed that the QL lamp system is mounted in a Class I luminaire (provided with an earth connection point), and that it is electrically well connected to a metal part of the luminaire. For the HF generator this is normally done by means of the mounting bolts with which the ballast and power coupler are mounted to the earthed mounting plate. Star washers should be used to ensure a proper ground contact right through the paint or lacquer covering the luminaire. Bolts to mount the ballast should be 4 mm diameter. The power coupler must be fixed to the heat sink by means of its mounting flange. This mechanical fixation must take place with **4 (!) bolts** made of plated iron or other non-corroding material (preferred is not to use stainless steel).
The holes in the mounting flange are pre-tapped for M4 bolts and are positioned in a circle with diameter of 40±1 mm (1.575"), on two perpendicular axes (see figure 7).

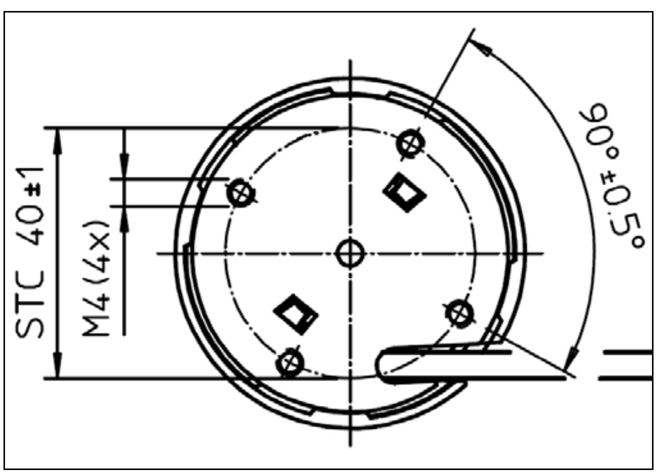

Figure 7: Drill pattern of power coupler mounting flange (55/85W)

Length of bolts *in* mounting flange		
	min (mm)*	max (mm)*
QL	**10**	16

Table 2: Wire-length of bolts in the mounting flange

Note*: this is without the thickness of the heat sink. Be aware, a too small length of the bolt can cause lamps to fall down

Advised torque is 2-2.5 Nm (1.5 – 1.8 lbs•ft) (see figure 8). The coaxial connection cable can be moved through an angle of 90 degrees with the mounting flange, allowing the cable to be led directly under the mounting flange through or along the luminaire heat sink to the generator compartment.

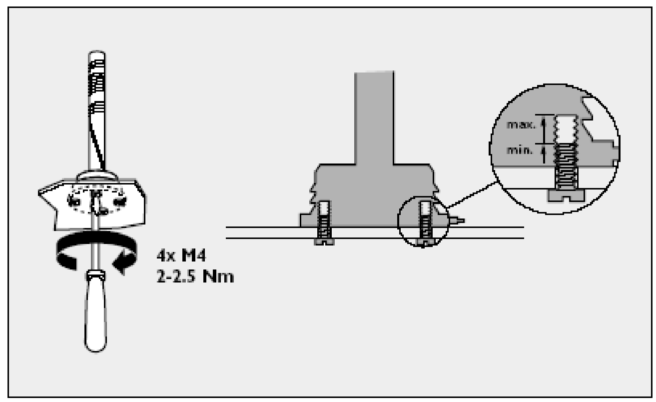

Figure 8: Fixation of power coupler to the heat sink with 4 bolts

2.4 General wiring

The wiring of the QL lamp system can be split up into two parts:

- power supply wiring
- HF output wiring

It is important to observe the following guidelines if optimum system performance and minimum radio frequency interference are to be obtained:

- Keep mains wiring away from coaxial cable and lamps (minimum distance 10 cm).
- If complete separation is not possible, screen the mains wiring by a grounded metal plate.
- Keep mains wires as short as possible.
- Keep the coaxial cable as close as possible to all grounded metal parts (maximum distance 2 cm) and away from the lamp.
- Avoid loops in all wiring.
- Ensure firm electrical contact between all metal parts and the ballast housing and power coupler.
- The shield of the coaxial cable may not be grounded.

2.4.1 Power supply wiring (class I)
The power supply wiring is the electrical connection between the power supply and the HF generator input. This wiring must always use a 3-core cable for phase, neutral and grounding connections. The phase and neutral of the power supply must be connected to the connector block as described on the housing label (see figure 9). In the case of DC power supply, the +pole must be connected to the phase connector, and the -pole to the neutral connector.

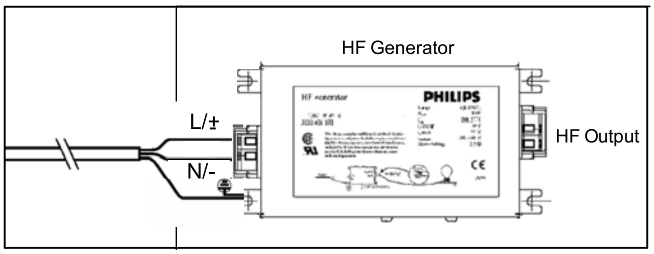

Figure 9: Wiring diagram class I luminaires

2.4.2 Power supply wiring (class II)
Under certain conditions it is possible to construct class II luminaires, in other words luminaires without grounding.

Warning:
All metal parts connected to the HF generator housing and mounting flange of the power coupler will be at 50% of the supplied voltage! The source resistance is high, so that under normal circumstances there is no danger by touching, but for safety reasons it is strongly advised to use a double-insulated construction.

The EMI performance will be worse than in class I designs. In this case EMI testing is recommended to ensure that the QL luminaire complies with the (inter-) national EMC standards. Extra precautions may be required. The use of shielded 2-core cable, with shielding only connected to the HF generator housing, can be beneficial in limiting EMI (see figure 10).

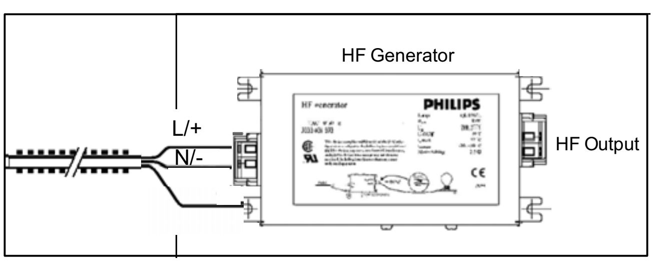

Figure 10: Wiring diagram class II luminaires

The phase and neutral of the power supply must be connected to the connector block as described on the housing label. If a DC power supply is used, the +pole must be connected to the phase and the -pole to the neutral connector.

2.4.3 HF output wiring (class I + II)
This wiring must be via the coaxial cable that is supplied as standard with the power coupler. Connections to the HF output of the HF generator must be made according to the color-coding of wires and the connector block (see table 3 and figure 11). Changing or extending of the coaxial cable is never allowed.

generator	power coupler
grey (-)	black
orange (+)	red

Table 3: Color-coding of generator and power coupler

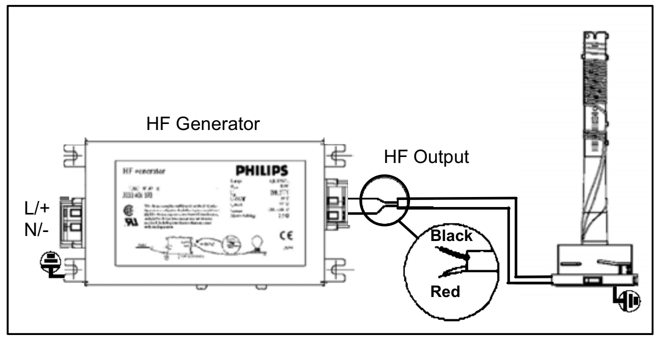

Figure 11: Connecting HF generator and power coupler

2.4.4 Strain relief
The HF generator is not equipped with strain relief, neither on the power supply side nor on the HF output side. It is advised to integrate these in the luminaire construction to prevent (future) contact interruptions, which can cause possible damage to the QL lamp system.

2.5 Temperature measurements

2.5.1 General
In order to achieve optimum operation of the QL lamp system, certain temperature limits should be observed.
Measurements must be made by means of thermocouples, which must be firmly fixed to the surface. For all measurements (temperature, light output and power), a stabilization period of at least two hours must be taken before any reliable data can be obtained.
The level of stabilization can be checked, by monitoring the power consumption of the system. If a continuous measurement has to be made for a range of ambient temperatures, the rate of temperature change should be less than 2°C/hour.

For obtaining good light output the QL lamps are provided with an amalgam. This amalgam is located in a short exhaust tube close to the base of the power coupler.
The temperature of the amalgam determines the mercury pressure in the vessel. There is a direct relation between mercury pressure and light output and mercury pressure and power consumption. The amalgam stabilizes more or less the mercury pressure in an amalgam temperature range of 70°C/160°F (see figure 12 between point 1 and 2). The system is designed in such a way that the most optimal result in light output is reached in case the power

consumption is 55W/85W/165W (see point 3 and 4). Good results (less than 15% deviation in light output) are reached in case the power consumption is more than 50W for a QL 55W lamp system, more than 72W for a QL 85W lamp system and more than 145W for a QL 165W lamp system.

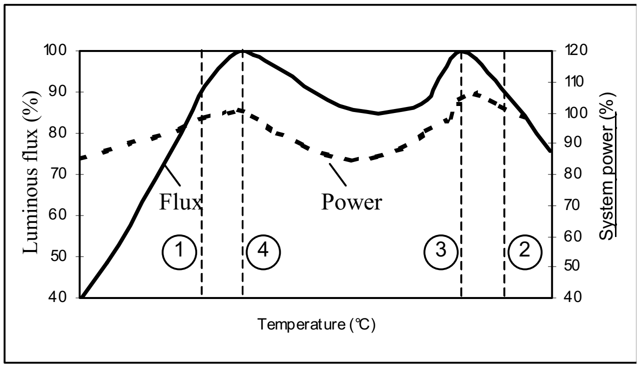

Figure 12: Typical curve for luminous flux / system power vs. temperature for an amalgam lamp. Temperature range between ① and ② is 70°C/160°F

2.5.2 Permissible temperatures and lifetime of HF generator

The maximum temperature inside the luminaire is important for the lifetime of the HF generator. The relevant parameter is the case temperature t_c on the **test point** of the HF generator (see "TEMP TEST POINT tc" on the label of the HF generator). For all HF generators, the maximum case temperature is 82°C/179°F. Safe end of life of the generator cannot be guaranteed above this temperature.

The lifetime of the QL lamp system is determined primarily by the lifetime of the generator, which is 60,000 hours with a failure rate of 10 % when operated at a t_c of 72°C/161°F. If the temperature t_c is below this value of 72°C/161°F, the lifetime increases.

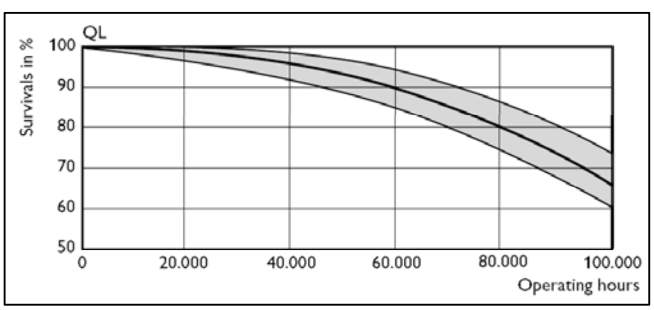

Figure 13: Typical life expectancy curve at a t_c of 72°C/161°F

Every increase of t_c by 10°C/18°F will halve the lifetime of the HF generator.

For example:
t_c = 62°C/143°F, lifetime (=10 % failures) approx. 100,000 hours,
$t_{c\ max}$ = 82°C/179°F, lifetime (=10 % failures) approx. 25,000 hours,

Exceeding the maximum t_c temperature will result in an **undefined reduction** of the HF generator lifetime.
Below t_c = 62°C/143°F the lifetime of the HF generator will improve, but not by a factor 2 per 10°C/18°F.

For ignition and operation of the QL lamp system, a temperature of ≥ -25°C/-13°F for the HF generator (test point) is required.

Tips for HF generator temperature reduction:
1. Do not mount the HF generator too close to the mounting flange of the power coupler.
2. Ensure good heat transport to the surroundings (heat sinking).
3. Use separate heat sinks for both the power coupler and HF generator.
4. Avoid heat radiation from lamp to HF generator.
5. Mount the bottom of the HF generator housing on its own heat sink; but never apply a heat sink for the test point only.
6. Create a cooling airflow along the housing, e.g. with a chimney effect.

2.5.3 Permissible temperatures of power coupler

There is a relation between the amalgam temperature and the temperature of the base of the power coupler (called $T_{mounting\ flange}$).
For the QL 55W and 165W the advised maximum $T_{mounting\ flange}$ temperature is 100°C/212°F. For the QL 85W, the advised maximum $T_{mounting\ flange}$ temperature is 90°C/194°F.
Exceeding the maximum $T_{mounting\ flange}$ temperature will result in an undefined reduction of the lamp system lifetime and lumen output.
The correct way of measuring $T_{mounting\ flange}$ is at the test point on the power coupler (see figure 14). The measurements can be made with a thermocouple.

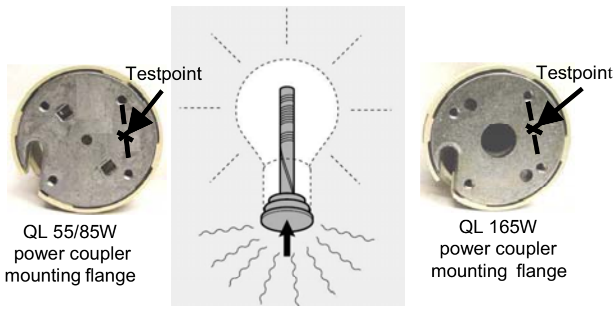

Figure 14: The location of the mounting flange temperature testpoint

Recommendation for power coupler temperature reduction:

1. Mount the power coupler on its heat sink with 4 bolts with proper length (see paragraph 2.3).
2. Heat sink materials must have good thermal conductivity e.g. aluminium (see table 4).
3. Use a material thickness of at least 3 mm for the heat sink.
4. Use a heat sink with the largest possible surface area.
5. Painting of the heat sink and metal housing of the luminaire can reduce the temperature of the power coupler and the generator.

2.5.4 Permissible temperatures of amalgam

In relatively compactly designed luminaires, used in high ambient temperatures, the amalgam could melt and drop in the lamp. The amalgam temperature should therefore not exceed 105°C/221°F.

2.5.5 Heat sink design

To ensure that the mounting flange of the power coupler and/or HF generator testpoint temperatures do not exceed the specified maximum permissible values, additional heat sinks can be used. The applicable heat transport mechanisms are conduction in the heat sink to divide the heat over a bigger surface area, and convection and thermal radiation to transfer the heat to the surroundings. This chapter will not indicate exactly how to calculate a heat sink, but gives some guidelines on how to improve its performance.

The type of material used for the heat sink has a relatively great influence on the final result. If we compare, for instance, the thermal conductivity (k) of copper with that of corrosion-resistant steel (see table 4), a substantially smaller heat sink can be made with copper. The most practical choice to be used for heat sinks is aluminium

Material	k (W/mK)
Copper	400
Aluminium	200
Brass	100
Steel	50
Corrosion-resistant steel	15

Table 4: Thermal conductivity (k)

The thickness (d) of the heat sink is also of major importance. Assuming that we have different heat sinks with the same size, but made from different materials, the same effect in temperature difference will be reached if the products of thermal conductivity (k) and material thickness (d) are constant. This means more or less the same result with a heat sink of 1 mm copper, 2 mm aluminium, 4 mm brass, 8 mm steel or 26 mm corrosion-resistant steel. Increasing the surface area of the heat sink will also lead to improvement, but the effect will be smaller at larger dimensions and is dependent on the thermal conductivity (k) of the material and the thickness (d) used (see figure 15).

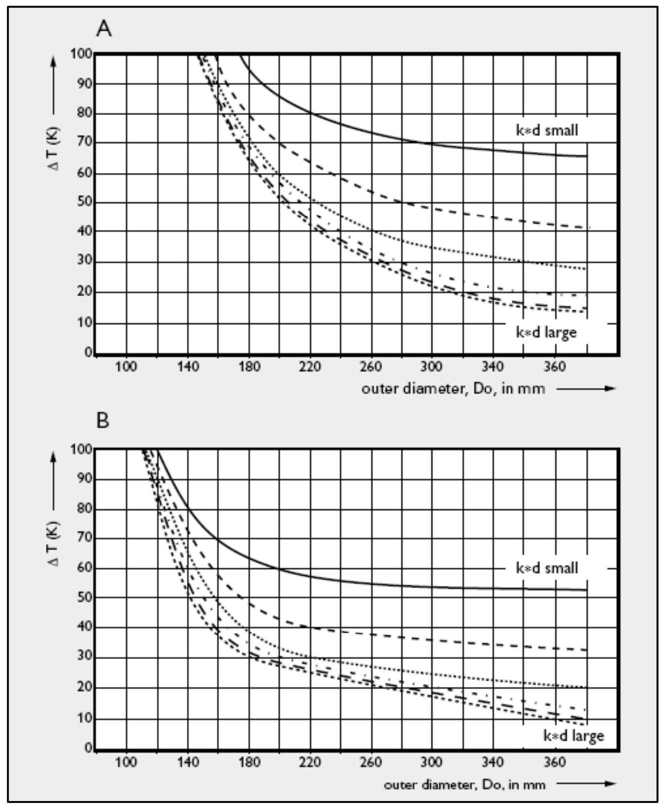

Figure 15: The influence of an increasing heat sink diameter for different k*d for:
A: polished unpainted surface
B: unpainted surface

Thermal radiation can also form a substantial part of the total heat transfer, and is of the same order as for convection. This depends strongly on the emission coefficient of the surface, which lies between 0 and 1. For example, a polished aluminium surface has a very low emission coefficient, while that of a painted surface is very high (see table 5).

Material	Finish	Emission coefficient
Aluminium	New/polished	0.04 ~ 0.06
	Oxidized	0.2 ~ 0.3
	Anodized	0.8
Paint		0.8 ~ 0.95
Copper	New/polished	0.03 ~ 0.07
	Heavy oxidized	0.7 ~ 0.8

Table 5: Emission coefficients

Example:
In table 6 and 7 practical information is given on actual surface area for two different thicknesses of aluminium, for the same luminaire in "open" and "closed" conditions. For both luminaire constructions, the recommended maximum ambient temperatures are given.

Luminaire construction	Heat sink (aluminium)		$T_{ambient\ max}$
	thickness	surface area	
	(mm)	(cm^2)	(°C)
Open	2	75	55
Open	1.5	150	55
Closed	2	75	35

Table 6: Typical heat sink design for power coupler of QL 55W lamp system

Luminaire construction	Heat sink (aluminium)		$T_{ambient\ max}$
	thickness	surface area	
	(mm)	(cm^2)	(°C)
Open	2	250	55
Open	1.5	500	55
Closed	2	250	35

Table 7: Typical heat sink design for power coupler of QL 85W lamp system

2.6 Lamp

Under normal conditions there are no lifetime-determining parts in the lamp, which means that it can be fully integrated in the optical housing system. Only the effectiveness of the fluorescent coating will decrease over time, but at a much lower rate than with conventional light sources. The light output after 60,000 hrs will still be more than 70% of the initial value. See figure 20

The lamp can be positioned in all possible burning positions. The maximum light output is controlled by the mercury vapor pressure in the lamp, which is determined by the temperature of the amalgam. The amalgam tip is in close proximity of the mounting flange. Therefore the luminaire should be designed in such a way that under operating conditions the temperature of the mounting flange of the power coupler reaches the maximum advised temperature. The measurable difference depends mainly on the luminaire heat insulation properties, reflector design and construction of the luminary heat sink. This may result in a light output difference of maximum 15% over about 70°C/160°F ambient temperature variation (see figure 12).

2.6.1 PET value

PET stands for Permissible Exposure Time for human beings in relation to the amount of radiated UV in hours x 1000 lux.
The amount of UV radiated by QL 55W and QL 85W lamp systems is about equal to the amount of UV radiated by conventional low-pressure mercury lamps per 1000 lm, i.e. > 24h x klx.
This means that QL lamp systems comply with the generally accepted value of 24 hours and can be used in open luminaires, so without any precautions like filters and front glasses.

2.6.2 Damage factor

Another effect of UV (and blue light) is the risk of fading of illuminated goods. The fading impact of a light source can be expressed by the so-called damage factor (Dfc). The total effect depends on this factor, the total exposure time and the illumination level.
The damage factor (Dfc) for QL 55W and QL 85W lamp systems is <0.35. This directly comparable to that of normal tubular fluorescent lamps of comparable light output, and is thus insignificant due to the very low UV radiation.

2.6.3 Application

QL lamp systems can be used in open indoor luminaries without special precautions..

2.6.4 Lamp holder / lamp base

QL lamp systems do not require (special) lamp holders. The power coupler acts as lamp holder. Due to their ultra-long life and the required additional heat sink for at least the power coupler, all system components are permanently fixed into the luminaires.

Remark:
- Under normal operating conditions no additional support of the lamp is needed.
- Be aware that metal parts do not touch the glass surface

3. Guidelines for the installation of QL luminaries

3.1 Earth leakage circuit breakers

The earth leakage current of the HF generator is normally less than 0.5 mA_{rms}. At the moment of switching-on the installation, the earth leakage may, however, be temporarily higher. For this reason it is advised not to connect more than 30 QL lamp systems to one 30 mA earth leakage circuit breaker.

3.2 Inrush current

Like all electronic equipment, QL lamp systems have a peak current shortly after the mains is switched on, the so-called inrush current (see figure 16).

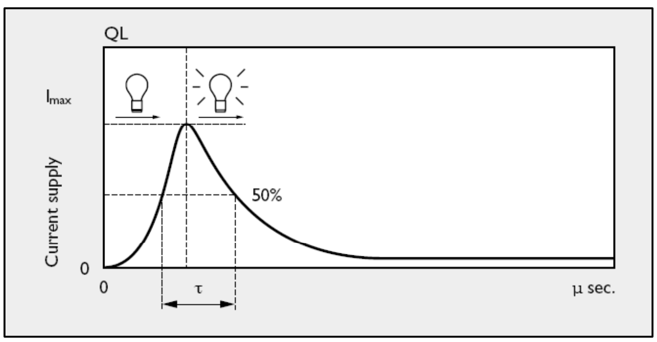

Figure 16: Max. duration and value of QL lamp system inrush current.

Typical values are shown in Table 8.

	Inrush current ½ value time at typical mains impedance			
	V nom. (V)	I nom. (mA)	I max. (A)	τ (μs)
QL 55W	230	260	12	170
QL 55W	120	460	16	170
QL 85W	230	400	12	170
QL 85W	120	730	16	170
QL 165W	230	740	24	140
QL 165W	120	1420	28	150

Table 8: Typical inrush currents for QL lamp systems

When a number of QL lamp systems are operated on Mains Circuit Breakers (MCBs) and are therefore switched on simultaneously, the inrush currents have to be taken into account when calculating the maximum permitted load on the MCBs. Both B-type and C-type 10A and 16A MCBs have been considered. The results of these measurements are reproduced in the tables, stating the recommended maximum number of QL lamp systems to be operated on one MCB.

Notes:

1. It is advised to use C-type MCBs in lighting installations equipped with electronic ballasts
2. Always make sure that the mains current of the load does not exceed the nominal permitted value of the MCB concerned. In fact, it is recommended that the installation be designed for a maximum load of 80% of the nominal permitted MCB load.

Maximum number of QL lamp systems to be used on one MCB on account of inrush currents, for 230-277V (HV) and 100-120V (LV) mains voltage.

MCB type	**QL 55W**		**QL 85W**		**QL 165W**	
	HV	**LV**	**HV**	**LV**	**HV**	**LV**
B type 10A	20	15	20	15	10	5
C type 10A	20	15	20	15	10	5
B type 16A	30	22	30	22	16	8
C type 16A	35	26	35	26	16	8

Table 9: Maximum number of QL lamps systems to be used on one MCB.

Note: If it is absolutely necessary to connect more than the specified number of QL lamp systems to one MCB, install a relay in the circuitry as shown in figure 17. This will ensure that the peak current in the connected QL lamp systems does not occur simultaneously.

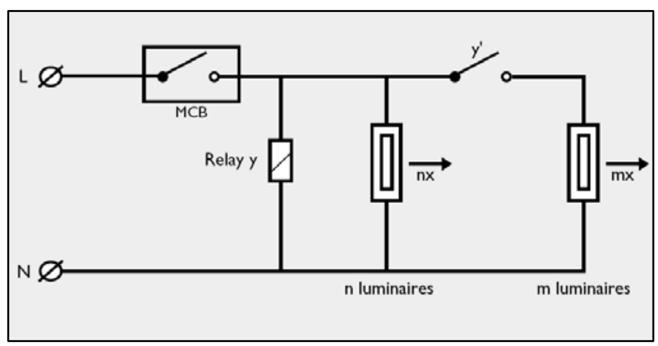

Figure 17: Inclusion of a relay in the circuit

3.3 Testing the installation

Testing a QL lamp system installation for wire insulation and electrical strength of the ballast should be carried out with the luminaries disconnected in order to exclude luminaire influences (see figure 18 and 19). The earth leakage current of the ballast will, for example, lead to unreliable measurements. If, however, in special circumstances the luminaires must remain connected, the following warnings should be observed:

1. Testing the insulation of the wiring:
   Connect 500V DC between ground and respectively the phase and the neutral supply cable.

2. Testing the electrical strength of the HF generator: Connect all QL lamp systems inputs together and connect (1000V + $2U_{out}$) AC for 1 minute between this point and ground (HF generator housing).
3. Testing between mains and neutral is not permitted, as this might cause damage to the HF generator.
4. After the test has been completed, make sure that the neutral is reconnected, since a disconnected neutral will result in unpredictable mains voltage (50V..400V), which may damage the HF generator.

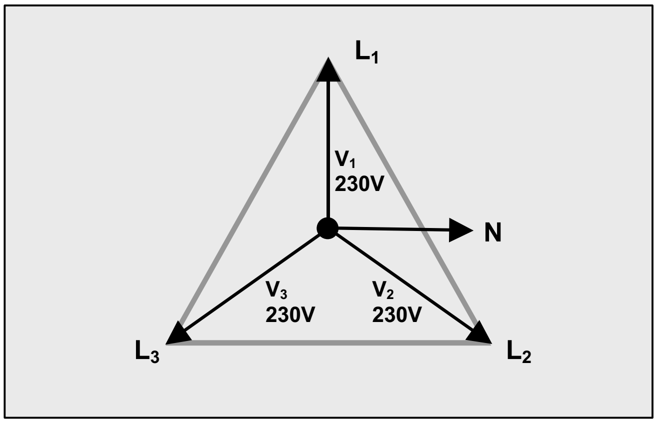

Figure 18: Normal situation in neutral connected

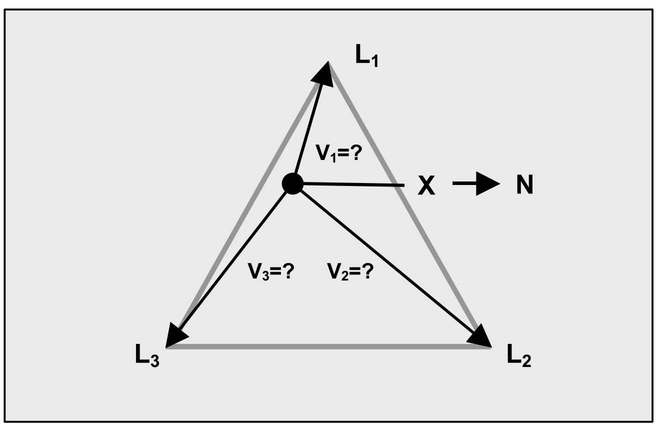

Figure 19: Situation when neutral is not connected ("loose neutral") and the load on all phases is not symmetrical.

3.4 Ambient luminaire temperatures and optimum QL lamp system lifetime

The heat produced in the luminaire by the HF generator and lamp must be conducted to the surroundings. When a luminaire is physically isolated by the ceiling or by isolating blankets (insulation), the produced heat cannot easily flow to the surroundings. This will result in the HF generator inside the luminaire being heated up, which in turn will have an adverse effect on its life. For an optimum lifetime of the HF generator it is important to remember that:

- **Air should be able to flow freely around the luminaire**
- **Air flow through the luminaire reduces the temperature inside**

3.5 On/off switching

The QL lamp system is designed for general lighting purposes (100,000 cycles). Exceeding this number of switching cycles could result in a reduction of the HF generator lifetime. In some applications (flashing, warning light etc.), frequent on/off switching is needed. A switching test with 85W 200-277V, 165W 200-277V and 165W 100-120V generators has been stopped after 7.500.000 switches without failures.

4. Lamp operation

4.1 Starting characteristics

4.1.1 Ignition and lifetime performance
QL lamp systems offer direct, flicker-free ignition after switch-on, in both cold and hot conditions.

Ignition time:	< 0.5 s
Hot-restrike time:	< 0.5 s

Minimum HF generator test-point temperature for ignition: -25°C/-13°F.

4.1.2 Luminous flux during starting period
The run-up behavior of QL lamp systems is influenced by:
- Luminaire construction.
- Ambient temperature at the moment of ignition.
- The duration of the period that the system was cool-downed after the last switch-off.

The QL lamp systems are based on the low-pressure mercury discharge technology and therefore in principle sensitive to (changes in) ambient temperatures. This means that after switch-on the light output of the lamp will vary until a stable situation is reached, which depends on the actual operating conditions. This will not happen in seconds but in minutes.
If a lamp has reached the stable level and is switched on again after a short off period, light output will immediately return to around the normal stable level (incandescent lamp-like).

4.1.3 Lumen maintenance
The luminous flux of a QL lamp system is expected to have depreciated after 60,000 hrs to no less than 75% of the initial flux (see figure 20 for a lumen maintenance curve).

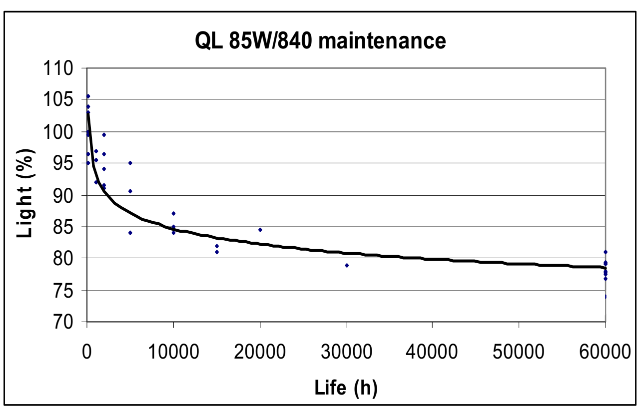

Figure 20: Lumen maintenance curve

4.2 Burning position

Although the burning position is universal, the relation between light output and temperature will be different for different burning positions. In the base-up position of the QL lamp system, the amalgam temperature will be slightly higher than in the base-down position with the same environmental conditions. This phenomenon can be used in luminaire design for specific ambient temperatures. As an example, the shift of the luminous flux curve for a typical design is given in figure 21.

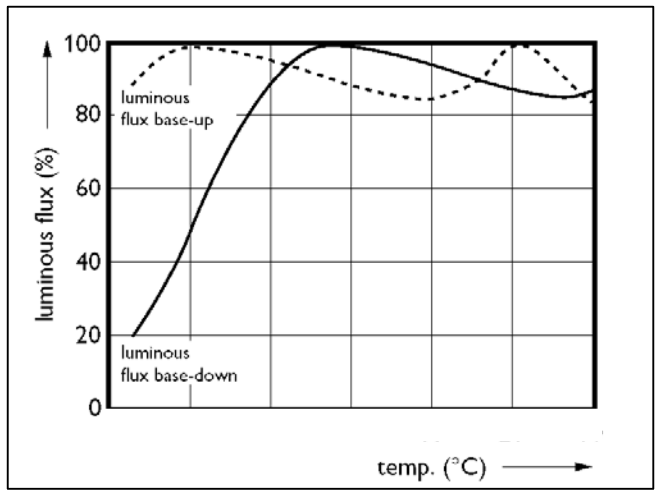

Figure 21: Typical influence of burning position on luminous flux

4.3 Optical design

QL lamp systems offer a homogeneous light distribution, and can be used in a variety of luminaire designs. The choice of material, shape and dimensions can help ensure optimum functioning of the lamp (mechanically, thermally and photometrically). If a lot of light is reflected back to the lamp, this will increase the lamp operating temperature and may result in lower light output. The reason for this is that the main amalgam temperature will increase, which in turn regulates the light output. For the same reason, it is advised to keep the lamp cap behind the reflector (if used), because the main amalgam is located in the lamp cap (see figure 22).

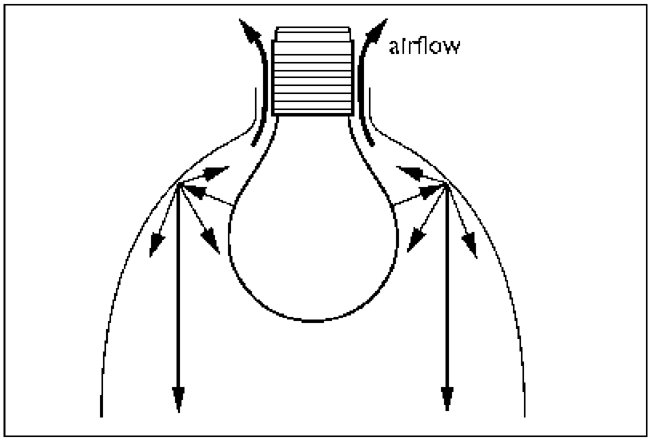

Figure 22: Influence of reflector position around lamp with chimney effect

A space between the reflector and the lamp ("chimney" effect) increases the main amalgam temperature. In some cases the main amalgam temperature can become too high, so that the lamp system's operating point falls outside the preferred range.

4.3.1 Relationship of luminous flux, system wattage, amalgam and ambient temperature

The QL lamp is provided with an amalgam. Therefore the light output and system wattage have a direct relationship to the amalgam temperature during operation. This means in practice that the actual luminous flux and system wattage depend on the luminaire construction, its heat insulation properties and the ambient temperature, which determine the actual amalgam temperature. For a typical QL lamp system the relationship between luminous flux and system wattage vs. temperature is shown in figure 23. See also the remarks about the amalgam temperature made in chapter 2.5.4.

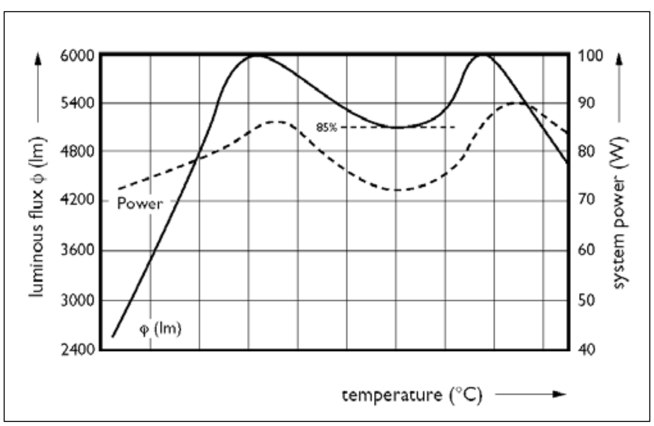

Figure 23: Typical QL 85W lamp system curves for luminous flux / system power vs. temperature

4.4 Luminous flux vs. $T_{ambient}$

The temperature of the main amalgam normally controls the luminous flux of QL lamp systems. Therefore it will be more or less constant (deviation max. 15%) over a wide temperature range. In outdoor luminaires, which may be used at temperatures below 0°C/32°F, the luminous flux can be too low. This can be improved by increasing the temperature of the main amalgam. This can be done in different ways:

- Position lamp base-up instead of base-down or horizontal if possible.
- Improve insulation of the total luminaire; care should be taken in this case that the maximum permissible temperature of the HF generator and power coupler-mounting flange is not exceeded in the practical application.
- Encapsulate the lamp base (partly) in a heat-radiating envelope; this envelope can be a part of the power coupler heat sink or of the reflector.

5. QL lamp system specifications

5.1 Mechanical characteristics

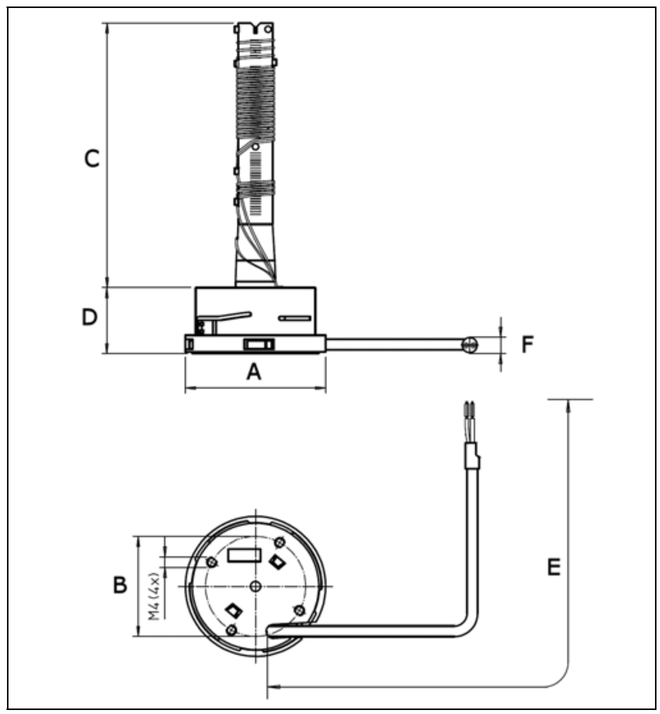

Figure 24: Power coupler dimensions

Power coupler type	QL 55W	QL 85W	QL 165W
A nom (mm / inch)	56 / 2.20	56 / 2.20	56 / 2.20
B nom (mm / inch)	40 / 1.58	40 / 1.58	40 / 1.58
C nom (mm / inch)	133.5 / 5.26	164.5 / 6.48	185 / 7.28
D nom (mm / inch)	27 / 1.06	27 / 1.06	27 / 1.06
E nom (mm / inch)	555 / 21.85	555 / 21.85	555 / 21.85
F max (mm / inch)	9.5 / 3.74	9.5 / 3.74	9.5 / 3.74

Table 10: Power coupler dimensions

The length and thickness of the coaxial cable of the power couplers have been changed in 2005. Table 11 shows the changes.

Power coupler type	dimension	old	current
QL 55W	E nom (mm)	450 ± 20	555 ± 20
	F max (mm)	5.5	9.5
QL 85W	E nom (mm)	450 ± 20	555 ± 20
	F nom (mm)	5.5	9.5
QL 165W	E nom (mm)	430 ± 20	555 ± 20
	F nom (mm)	9.5	9.5

Table 11: The length and thickness changes of the coaxial cable.

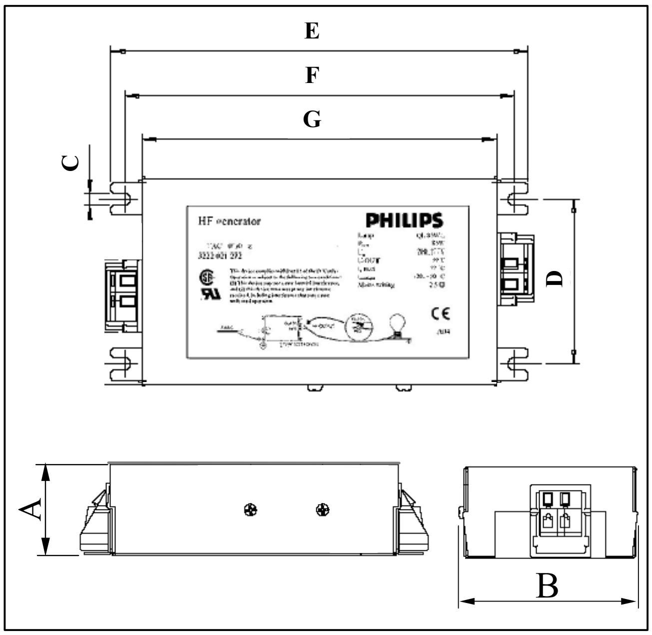

Figure 25: HF generator dimensions

HF generator type	QL 55W	QL 85W	QL 165W
A nom (mm / inch)	40.8 / 1.61	40.8 / 1.61	42.3 / 1.67
B nom (mm / inch)	78.0 / 3.07	78.0 / 3.07	118 / 4.65
C nom (mm / inch)	4.5 / 0.18	4.5 / 0.18	4.5 / 0.18
D nom (mm / inch)	60 / 2.36	60 / 2.36	70 / 2.76
E nom (mm / inch)	150 / 5.91	150 / 5.91	190 / 7.48
F nom (mm / inch)	140 / 5.51	140 / 5.51	178 / 7.01
G nom (mm / inch)	127.3 / 5.01	127.3 / 5.01	148.7 / 5.85

Table 12: HF generator dimensions

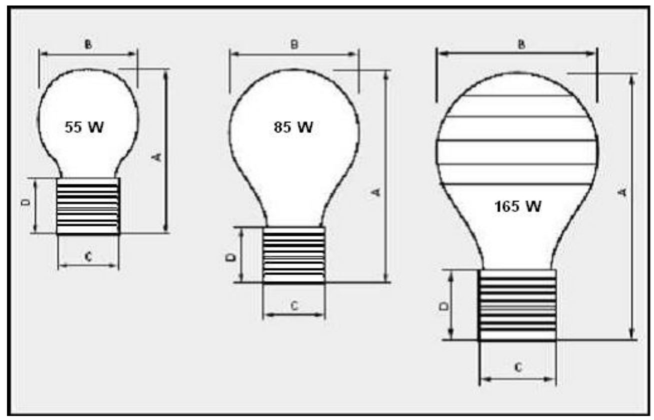

Figure 26: Lamp dimensions

Lamp type	QL 55W	QL 85W	QL 165W
A max (mm / inch)	141 / 5.55	180.5 / 7.11	205.5 / 8.09
B max (mm / inch)	86 / 3.39	111 / 4.37	131 / 5.16
C max (mm / inch)	57 / 2.24	57 / 2.24	57 / 2.24
D max (mm / inch)	49 / 1.93	49 / 1.93	49 / 1.93

Table 13: Lamp dimensions

Weights (g)	QL 55W	QL 85W	QL 165W
Lamp	120	135	205
Power coupler	185	220	290
Generator	590	620	705
Total QL lamp system	895	975	1205

Table 14: Weights.

5.2 Electrical characteristics

There is a relation between the system power and the amalgam temperature (see chapter 4.3.1). In table 15 the values of the system power are given if the amalgam temperature is between 50°C and 105°C (for 165W between 70°C and 105°C). This is in stable situation. In practice this means about two hours after ignition. During the run-up the values can deviate.

		QL 55W 100-120V	QL 55W 200-277V	QL 85W 100-120V	QL 85W 200-277V	QL 165W 100-120V	QL 165W 200-277V
System power*) nom.	W	55		85		165	
System power*) min.	W	51		71		160	
System power*) max.	W	57		89		190	

*) At design voltage; 115V and 230V respectively

Table 15: System power in stable burning situation.

More electrical characteristics:

		QL 55W 100-120V	QL 55W 200-277V	QL 85W 100-120V	QL 85W 200-277V	QL 165W 100-120V	QL 165W 200-277V
AC supply voltage nom.	V	120	230	120	230	120	230
AC supply voltage min.	V	90	180	90	180	90	180
AC supply voltage max.	V	140	305	140	305	140	305
DC supply voltage nom.	V	120	230	120	230	120	230
DC supply voltage min.	V	90	180	90	180	90	180
DC supply voltage max.	V	180	350	180	350	180	350
Supply frequency nom.	Hz	60	50	60	50	60	50
Supply frequency min.	Hz	47	47	47	47	47	47
Supply frequency max.	Hz	63	63	63	63	63	63
Supply current nom.	mA	460	260	730	400	1420	740
Inrush current max.	A	16	12	16	12	28	24
Duration inrush current max.	μs	170	170	170	170	150	140
Power factor nom.		>0.92	>0.92	>0.92	>0.92	>0.92	>0.92
HF output frequency nom.	MHz	2.65	2.65	2.65	2.65	2.65	2.65
HF output frequency min.	MHz	2.30	2.30	2.30	2.30	2.30	2.30
HF output frequency max.	MHz	3.00	3.00	3.00	3.00	3.00	3.00
HF output voltage max.	kV	1.5	1.5	1.5	1.5	1.5	1.5
Leakage current	mA	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ignition time	s	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Overvoltage		200VAC	400VAC	200VAC	400VAC	200VAC	400VAC*)

*) Max. 2 hours

Table 16: Electrical characteristics of QL lamp systems.

5.3 Light performance characteristics

5.3.1 Luminous flux and efficacy

Values at 100 h.		QL 55W	QL 85W	QL 165W
Color characteristic		/827/830/840	/827/830/840	/827/830/840
Luminous flux nom.	lm	3500	6000	12000
Luminous flux min.	lm	3200	5500	11000
Luminous flux max.	lm	3800	6500	12500
System efficacy nom.	lm/W	63.5	70	72.5

Table 17: Luminous flux and efficacy

5.3.2 Luminous intensity diagrams

gamma (degree)	Average lumen intensity (cd/1000lm)
0	66.1
5	67.6
10	69.1
15	71.2
20	73.3
25	75.6
30	78.1
35	80.6
40	82.9
45	84.7
50	86.0
55	87.0
60	88.1
65	89.3
70	90.1
75	90.7
80	91.1
85	91.1
90	91.0
95	90.4
100	89.0
105	87.2
110	85.0
115	82.3
120	79.1
125	75.6
130	71.6
135	67.2
140	62.3
145	57.1
150	51.8
155	46.6
160	41.0
165	32.6
170	23.1
175	0.5
180	0.5

Table 18: Luminous intensity QL55W

See figures 27 and 28

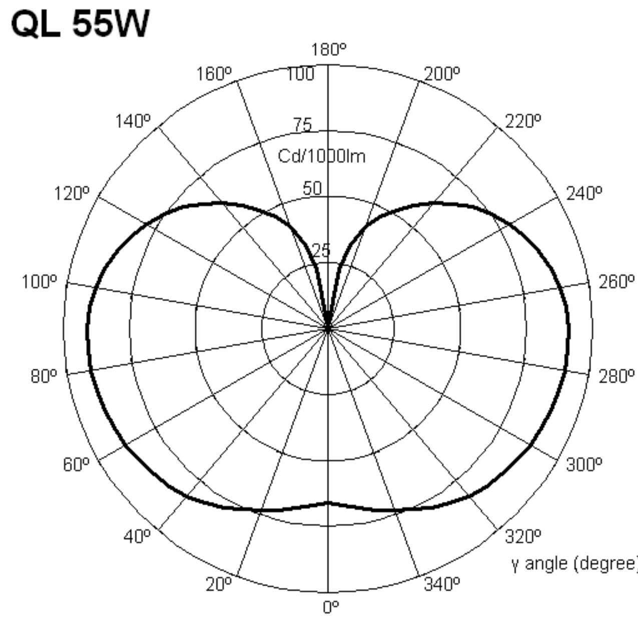

Figure 27: Light distribution QL 55W

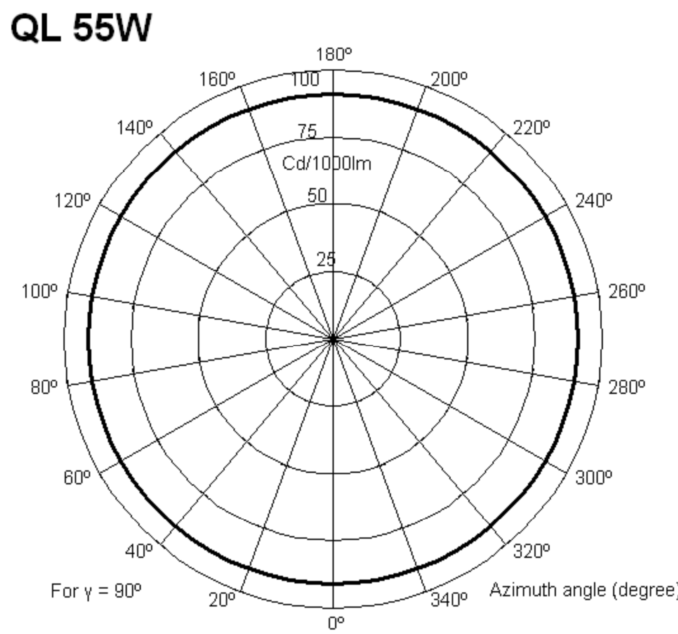

Figure 28: Azimuth angle QL55W

gamma (degree)	Average lumen intensity (cd/1000lm)
0	75.8
5	75.8
10	76.0
15	76.2
20	76.4
25	76.9
30	77.7
35	78.9
40	80.4
45	82.2
50	84.3
55	86.1
60	87.8
65	89.2
70	90.3
75	91.1
80	91.6
85	91.5
90	91.0
95	90.0
100	88.4
105	86.5
110	84.0
115	81.1
120	77.9
125	74.3
130	70.5
135	66.4
140	62.2
145	57.9
150	53.7
155	49.5
160	45.4
165	40.9
170	28.6
175	0.3
180	0.3

Table 19: Luminous intensity QL 85W

See figures 29 and 30

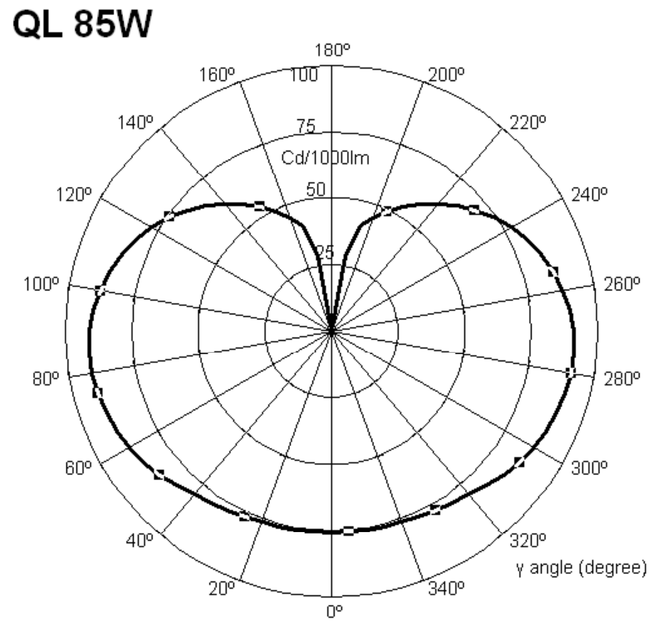

Figure 29: Light distribution QL 85W

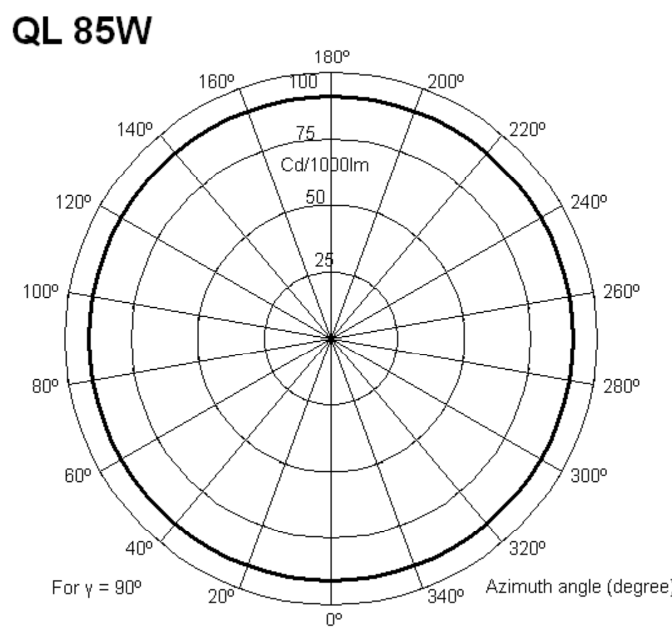

Figure 30: Azimuth angle QL 85W

gamma (degree)	Average lumen intensity (cd/1000lm)
0	65.5
5	65.6
10	65.7
15	66.1
20	66.6
25	67.3
30	68.3
35	69.8
40	71.7
45	74.1
50	76.8
55	79.5
60	82.3
65	84.9
70	87.2
75	89.0
80	90.3
85	91.1
90	91.5
95	91.4
100	90.9
105	89.8
110	88.3
115	86.3
120	83.8
125	80.8
130	77.5
135	73.8
140	69.9
145	65.9
150	62.0
155	59.4
160	54.0
165	49.1
170	37.9
175	3.54
180	0.22

Table 20: Luminous intensity QL 165W

See figures 31 and 32

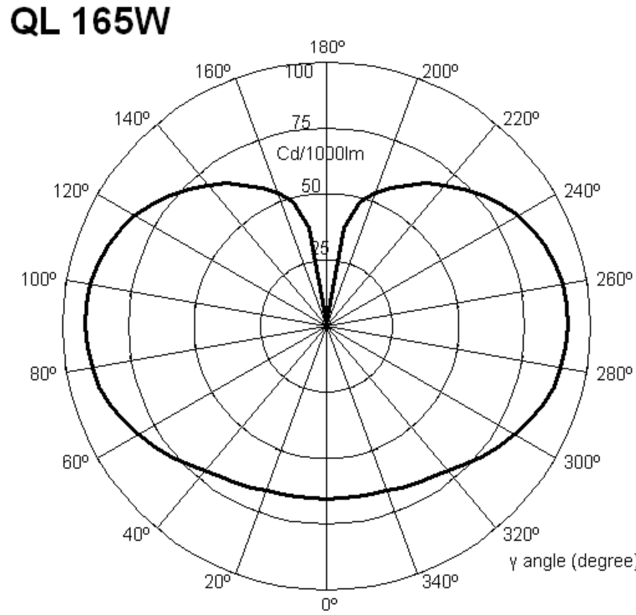

Figure 31: Light distribution QL 165W

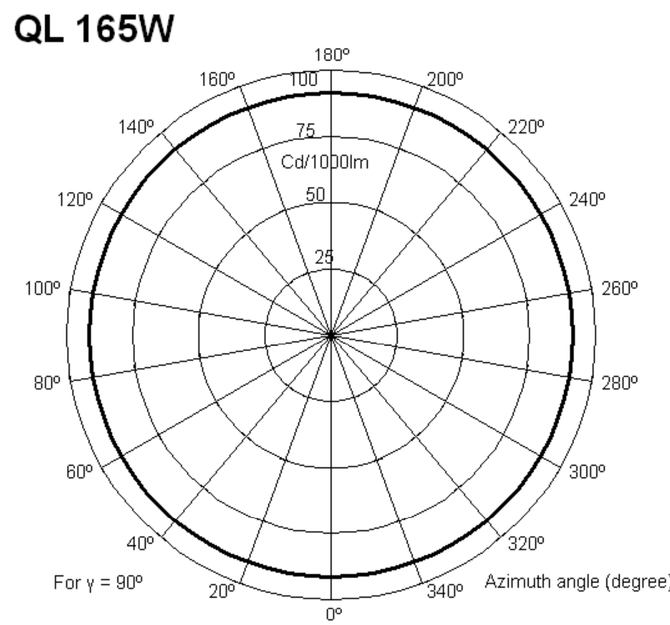

Figure 32: Azimuth angle QL 1685W

5.3.3 Color characteristics

Table 21 presents the color characteristics of QL lamps at 100 hours.

QL 55W		**/827**	**/830**	**/840**
Color rendering index CRI	Ra	>80	>80	>80
Chromaticity coordinate	x	0.471	0.442	0.392
Chromaticity coordinate	y	0.416	0.404	0.385
SDCM max.	SDCM	5	5	5
P.E.T. (NIOSH)	h*klx	>24	>24	>24
Damage factor	Dfc	<0.35	<0.35	<0.35

QL 85W		**/827**	**/830**	**/840**
Color rendering index CRI	Ra	>80	>80	>80
Chromaticity coordinate	x	0.476	0.444	0.392
Chromaticity coordinate	y	0.417	0.404	0.385
SDCM max.	SDCM	5	5	5
P.E.T. (NIOSH)	h*klx	>24	>24	>24
Damage factor	Dfc	<0.35	<0.35	<0.35

QL165W		**/827**	**/830**	**/840**
Color rendering index CRI	Ra	>80	>80	>80
Chromaticity coordinate	x	0.472	0.435	0.388
Chromaticity coordinate	y	0.418	0.398	0.380
SDCM max.	SDCM	5	5	5
P.E.T. (NIOSH)	h*klx	>24	>24	>24
Damage factor	Dfc	<0.6	<0.6	<0.6

Table 21: Color characteristics of QL lamps at 100hours.

5.3.4 Effect of supply voltage fluctuations

5.3.4.1 Luminous flux, system power, system efficacy, system current

Due to the built-in pre-conditioner in the HF generator, the light output (luminous flux), the consumed power and the system efficacy of the lamp system vary by less than 2% as a result of mains voltage fluctuations within the specified permissible range. This also applies to the power factor of the system. The only parameter, which really changes, is the system input current. At lower supply voltages the system input current increases and consequently it will be reduced at higher supply voltages.

5.3.4.2 Color characteristics

There is no noticeable effect (visual or measurable) on the color performance (color temperature, color rendering, chromaticity coordinates etc.) due to supply voltage variations.

5.3.4.3 Typical spectral power distributions

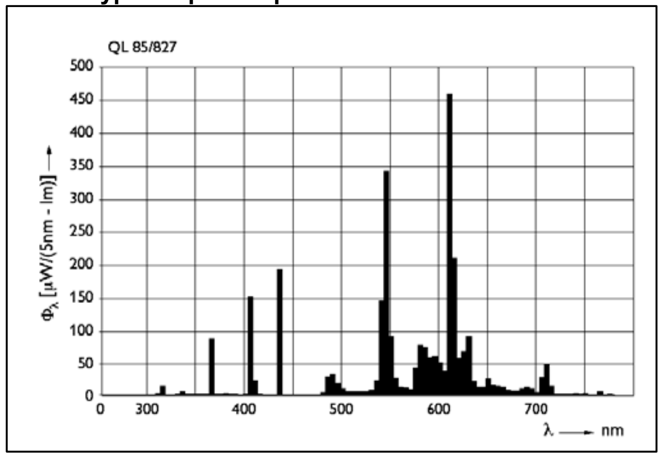

Figure 33: Spectral power distribution QL 85W/827

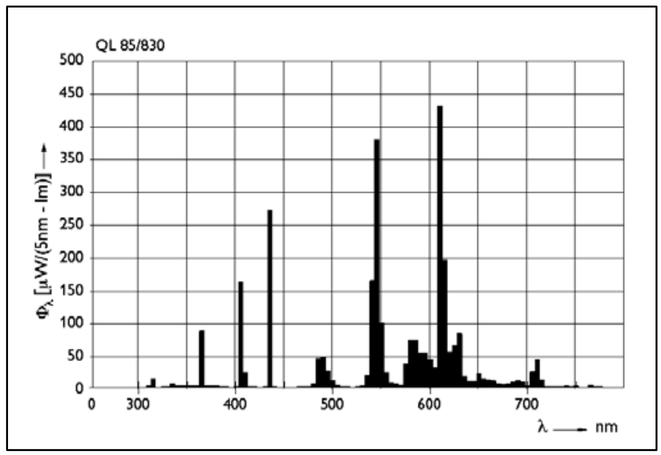

Figure 34: Spectral power distribution QL 85W/830

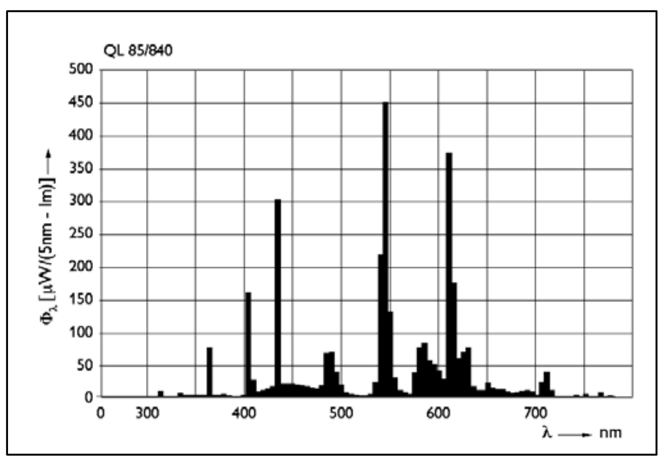

Figure 35: Spectral power distribution QL 85W/840

6. Lighting installation and environment

6.1 Electromagnetic compatibility

Electromagnetic compatibility, EMC, is the ability of a device or system to operate satisfactorily in its electromagnetic environment, without causing unacceptable interference in practical situations. Philips QL lamp systems fulfill the requirements with regard to electromagnetic compatibility as laid down in European Norms EN 55015, EN 61000-3-2 and EN 61547.

6.1.1 RFI (Radio Frequency Interference)
The Radio Frequency Interference (RFI) regulations as laid down in EN 55015 concern the frequency range between 9 and 30kHz. However, nowadays more and more electronic products are being marketed for operation on higher frequencies. The RFI requirements for this kind of equipment are laid down in the more stringent standard EN 55022, valid for frequencies up to 1000MHz. Philips QL lamp systems fulfill the requirements of this latter standard and are therefore the best choice if they are to operate in environments in which other equipment is used working at frequencies of up to 1000MHz.

6.1.2 Immunity
When the mains voltage deviates from its normal value by more than the tolerance permits (nominal voltage ±10%), adverse effects on lamp life, HF generator life and light output can be expected. Excessively high voltages (U_{mains} e.g. >350V) over a considerable period of time (>48 hours) will damage the HF generator. Mains transients and dips, on the other hand, will not harm the HF generator, provided they are within the regulations of EN 61547.

6.2 Humidity

Philips QL lamp systems have been tested for sensitivity to humid conditions and have proved to be able to resist a relative air humidity of up to 95%.

- Direct water ingress will damage the QL lamp system.
- Make sure that there can be no condensation on or in the HF generator and power coupler.
- The HF generator should be so mounted that no condensation or water from other sources can flow over or into the HF generator and power coupler.

6.3 Interference with infrared remote control equipment

Video and audio equipment, computers and also lighting installations nowadays are often operated by infrared remote control. The frequency of such infrared signals is in order of 36 kHz. To avoid any interference with this kind of equipment, the operating frequency of all Philips QL lamp systems has been chosen to prevent any problems in the 36 kHz frequency range.

6.4 Standards and approvals

Philips QL lamp systems comply with all relevant international rules and regulations, including:

Safety	EN 61199
Performance	EN 60929
Quality standard	ISO 9001
Environmental management system	ISO 14001

Interference LF

Mains current distortion	EN 61000-3-2 (200-277V)
THD	ANSI C82.11-2002 (200-277V)

Interference HF, measured with BU KGH085, equipped with one metal spacer between generator and power coupler plane, without metal gauze.

Conducted	EN 55015 (limit 56/46dB at 2.5-3.0MHz) & FCC class B, CFR 47 part 18
Radiated <30MHz	EN 55015 & FCC class B, CFR 47 part 18
Radiated >30MHz	EN 55022 class B & FCC class B, CFR 47 part 18
Electro Magnetic Immunity	Performance criteria A of EN 61547.
Radiated radio frequency electro magnetic fields. Test level 10V/m Sine Wave 80%AM@1kHz	EN 61000-4-3 80MHz-1GHz
Conducted disturbances induced by RF fields Test level 10Vrms Sine Wave 80%AM@1kHz	EN 61000-4-6 150kHz-80MHz
Power frequency magnetic fields	EN 61547 clause 5.4
Fast transients at max case temperature 2x2 minutes (Also under no load condition)	EN 61000-4-4, test level 4, limit 4kV/2.5kHz

Surge test at max case temperature. 4x5 pulses. Light flicker max 3 seconds is allowed above 1kV surges.	EN 61000-4-5 test level 4, requirement 4kV Line to Earth, 2kV Line to Line
Mains Voltage Dips. To be tested at max case temp.	EN 61000-4-11 70% of rated mains, 200ms
Mains Voltage Interrupt. To be tested at max case temp.	EN 61000-4-11 0% of rated mains, 5ms. Execute test with pos. and neg. half cycle.
ESD discharge test: Contact and air discharge.	EN 61547 clause 5.2
Mains transient	ANSI/IEEE C62.41, 7 strikes Ringing Wave 100kHz, minimum 2.5kV TBD
Safety	K123-1 EN61347-2-3 UL935
Approbations	CE, UL, CSA, KEMA (HV)

Environmental conditions

Humidity	IEC 60068-2-30-Db 40°C 21 days cyclic operative 2hrs on, 10 hrs off. In conformity with UN-D1639-1 table2.3.5, "protected outdoor use": 10-95%RH.
Vibration	IEC 60068-2-6-Fc Frequency range 10-150Hz, Frequency change 1 oct/min Acceleration/amplitude 2G/0.15mm peak, 3 directions, test time 40 min per direction.
Bumps	IEC 60068-2-29-Eb Acceleration 10G Number of bumps 1000 /16ms 3 directions.
Shock test	IEC 60068-2-27 40G / 11ms (semi sinusoidal), 3 directions, 5 shocks per direction.
Temperature shock	IEC 60068-2-14-Na 5 cycles -40°C/+80°C 30 min 2 chamber method cycle. IEC 60068-2-14-Nb -20°C/100°C 2000 cycles. (TBF)

The Philips QL lamp system carries the CE marking on basis of fulfillment of the following standards: EN 61547, EN 61000-3-2 and EN 55015 (as tested in a Philips reference luminaire).

6.5 IP codes; dust and moisture protection

The QL lamp system is designed for built-in purposes in appropriate luminaires. Next to effective temperature control, the luminaire must also provide dust and moisture protection, especially for the HF generator part and the power coupler. Direct water intrusion or a high humidity causing condensation inside the HF generator and power coupler should be prevented, as should heavy dust accumulation. In practice, this means that QL luminaires applied in outdoor applications should be at least classified as IP 54.
The HF generators for the QL 55W, 85W and 165W lamp systems are classified as IP 40.

6.6 Dimming

At present QL lamp systems are not available with dimming facilities.

6.7 Lamp system disposal

At the end of their (economic) life, appropriate disposal of QL lamp systems or their components is recommended.

6.7.1 The lamp
Although only a very small mercury dose is used, it is still recommended to treat the lamp system part as small chemical waste. The QL lamp can very well be recycled together with other low-pressure mercury discharge lamps. Follow local regulations for disposal of this type of light source.

6.7.2 The power coupler
Due to the fact that no materials are used in the construction of this part, which at present are known to be harmful to the environment, this part can be disposed of as normal waste. Disassembling is relatively easy, so recycling of materials is also possible.

6.7.3 The HF generator
This component is a RoHS compliant electronic device, which can be disposed of with normal care. It is recommended to dispose of this part as normal electronic waste, according to local regulations.

7. Service

7.1 General

Although QL lamp systems can be regarded as "light sources for life" because of their specified lifetime of 60,000 hours, it may nevertheless occur that parts of the system fail before this period is reached, due to internal or external influences. This does not mean that the total system has to be replaced but, depending on the failure, only a part of it. Failures that can occur are:

a) breakage of lamp caused by external influences
b) no light generation after switch-on or failure during operation

In case a) the (broken) lamp can easily be replaced by a new one in color /827, /830 or /840. After removing the remaining parts of the vessel from the power coupler (see figure 37), a new lamp can be installed by the unique twist base system to the bottom part of the power coupler (see figure 5).

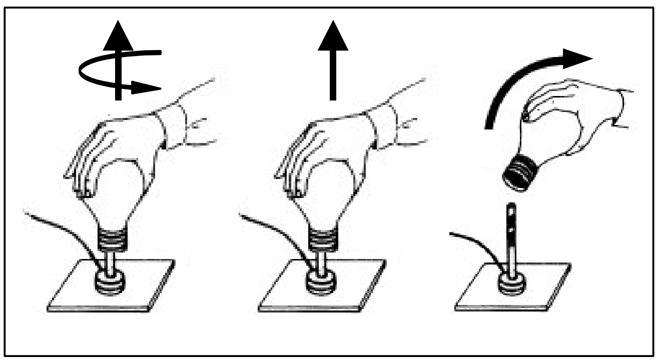

Figure 36: Release of lamp from power coupler

In case b) it will in most cases mean that the HF generator has failed, although there is also the possibility that the lamp has developed a leak or a contact breakage has occurred somewhere in the power coupler or the system wiring. Faultfinding should start by first checking the wiring. If the wiring is correct, a new one with the same specifications can replace the HF generator. Then a try-out can be made with a new lamp, and finally a replacement of the power coupler. Instructions on (dis-)assembly can be found on the enclosure packed with the new component.

Servicing must always be done with the QL lamp system disconnected from the supply voltage. Protective glasses should always be worn!

7.2 Luminaire measurement

As extra service we offer a free of charge luminaire measurement. The temperature household of the fixture is compared with the requirements and if needed recommendations for improvement will be given. To make use of this service fill in the ‘Luminaire measurement request form’ (see page 29/30 and send it to us by e-mail).

8. Derived product QL-R 85W

8.1 Summary

The QL-R is a new QL induction lamp with internal reflector. Most of the light is emitted in the forward direction. This lamp is very suitable for applications where light in a certain direction is needed and for very small luminaries where extensive mirrors are not possible.

Figure 37: QL-R lamp system

8.2 Description

- Ultra-long life up to 15 years based on 4000 burning hours / year
- Low energy consumption
- Constant light, independent of mains voltage fluctuations
- Automatic stop circuit is activated within 5 seconds in case of lamp failure (safety stop)
- Flicker-free start, ideal for areas with high switching frequency

8.3 Applications

Typical areas of application include:

- Indoor, general lighting. Especially for places with much traffic from passengers like arrival halls in airports, railway stations and also parking garages.
- Industry, petrochemical industry, offshore. QL is often used in explosion-proof luminaries.
- Cold-storage rooms
- City lighting
- Illumination of roadway signs and advertisement boards.

8.4 Philips quality

This implies optimum quality regarding:

- Ultra-long life.
  As supplier of the QL lamp system, Philips ensures that, from the earliest development stage, optimum lamp/ HF generator performance is maintained.
- International standards.
  Philips QL lamp systems comply with all relevant international rules and regulations.

8.5 Compliances and approvals

- RFI < 30MHz — EN 55015
- RFI > 30MHz — EN 55022
- Harmonics — EN 61000-3-2
- Immunity — EN 61547
- Safety — EN 61347, EN 60928
- Performance — EN 60929
- Vibration & bump tests — IEC 68-2-6-Fc, IEC 68-2-29-Eb
- Quality standards — ISO 9001
- Environmental standard — ISO 14001

- Approval marks:

8.6 Dimensions

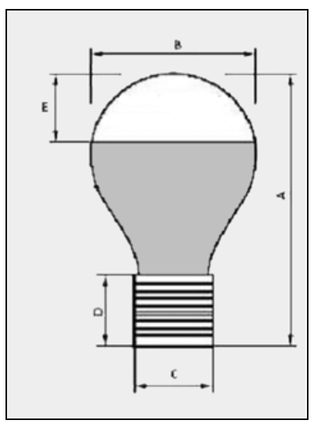

Figure 38: QL-R dimensions

Lamp type	QL-R 85W
A max (mm / inch)	205.5 / 8.09
B max (mm / inch)	131 / 5.16
C max (mm / inch)	57 / 2.24
D max (mm / inch)	49 / 1.93
E (mm/inch)	50 / 1.97

Table 22: QL-R dimensions

8.7 Electrical characteristics

There is a relation between the system power and the amalgam temperature (see chapter 4.3.1). In table 15 the values of the system power are given if the amalgam temperature is between 50 and 105 ºC. This is in stable situation. In practice this means about two hours after ignition. During the run-up the values can deviate.

		QL-R 85W 100-120V	**QL-R 85W 200-277V**
System power*) nom.	W	89	88
System power*) min.	W	85	84
System power*) max.	W	93	92

*) At design voltage; 115V and 230V respectively
Table 23: System power in stable burning situation.

More electrical characteristics:

		QL-R 85W 100-120V	**QL-R 85W 200-277V**
AC supply voltage nom.	V	120	230
AC supply voltage min.	V	90	180
AC supply voltage max.	V	140	305
DC supply voltage nom.	V	120	230
DC supply voltage min.	V	90	180
DC supply voltage max.	V	180	350
Supply frequency nom.	Hz	60	50
Supply frequency min.	Hz	47	47
Supply frequency max.	Hz	63	63
Supply current nom.	mA	730	400
Inrush current max.	A	16	12
Duration inrush current max.	µs	170	170
Power factor nom.		>0.92	>0.92
HF output frequency nom.	MHz	2.65	2.65
HF output frequency min.	MHz	2.30	2.30
HF output frequency max.	MHz	3.00	3.00
HF output voltage max.	kV	1.5	1.5
Leakage current	mA	<0.5	<0.5
Ignition time	s	<0.5	<0.5
Overvoltage		200VAC	400VAC

Table 24: Electrical characteristics of QL lamp systems.

8.8 Light performance characteristics

QL lamp system	System power	Lamp				
		Efficacy	Lumen	Color rendering index	Lumen maintenance 60,000hrs	
	W	lm/W	lm		%
QL-R 85W *)	85	70	6000	80	75

*) 100-120V or 200-277V
Table 25: Luminous flux and efficacy

8.9 Spectral power distribution

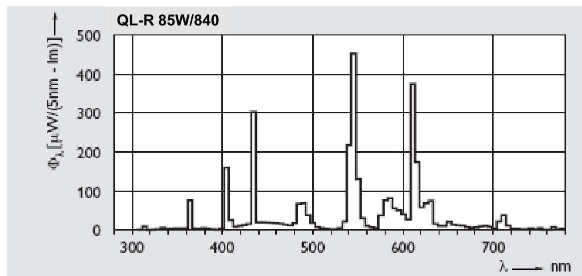

Figure 39: Spectral power distribution QL-R 85W/840

Derived product QL-R 85W

8.10 Polar light distribution

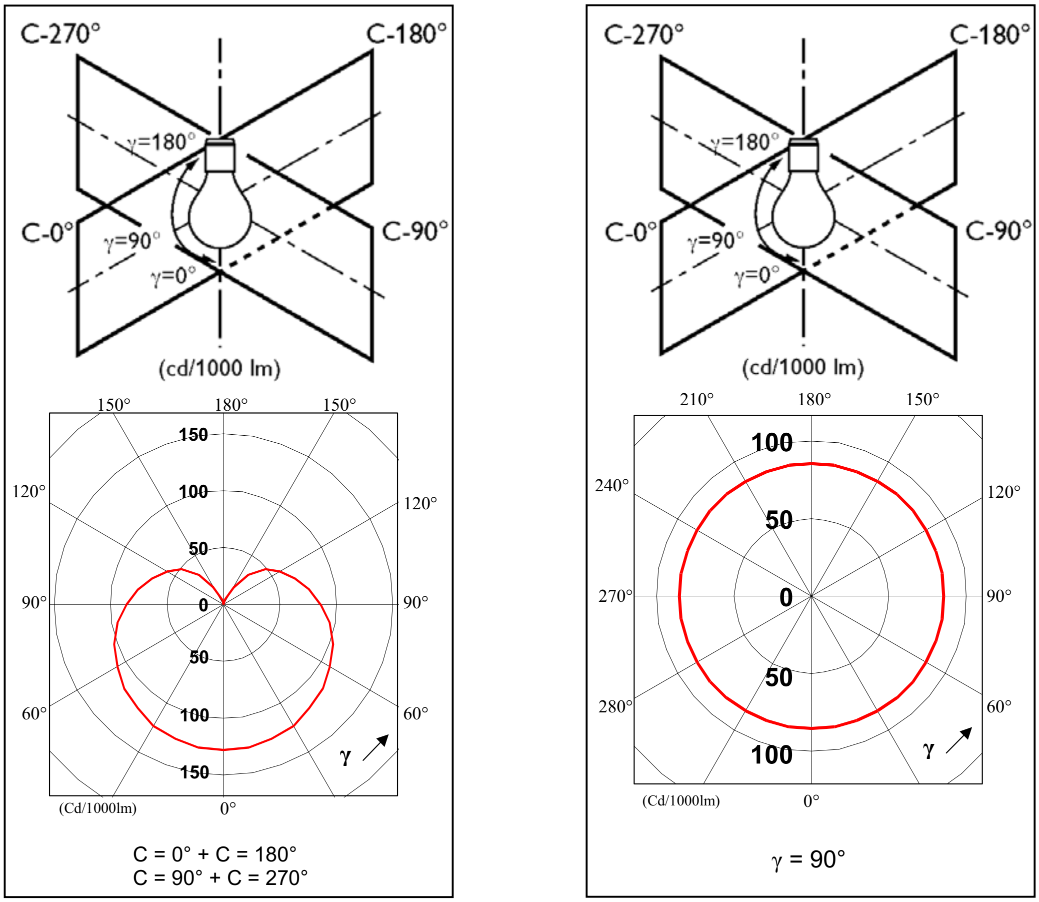

Fig 40: Polar light distribution

QL Induction Luminaire Design Checklist

	Lamp (Discharge Vessel) & Power Coupler
	Lamp and power coupler are firmly attached to a heat sink plate with 4 bolts with a prescribed diameter, length & material (QL OEM Guide, Section 2.3)
	Lamp is attached to the luminaire by the power coupler only; see that all click-fit mounting is correct and no metal parts touch the glass surface (QL OEM Guide, see Sections 1.2.3 & 2.6.4)
	The coax cable may not be crushed, i.e. the bending diameter is limited
	The temperature of the amalgam does not exceed 105°C (221°F, melting point of the amalgam) in base-up position (QL OEM Guide, Section 2.5.4)
	The temperature of the flange is less than 105°C (221°F) in every operating position. This temperature is determined by the maximum allowed temperature of the used coaxial cable.
	Bulb wall temperature must not exceed 170°C (338°F)
	At the test point on the power coupler flange, the temperature does not exceed 90°C (194°F) for the QL 85W and 100°C (212°F) for the QL 55W & QL 165W (QL OEM Guide, Sections 2.5.3 & 2.5.4)
	Wire and mating plug-in connectors between the lamp assembly and generator (driver) must not be altered in any way and must be kept away from the surface of the lamp (the length of the coaxial cable cannot be altered and may not touch the bulb)

	Generator (Driver)
	Ambient temperature of the generator is kept as low as possible (QL OEM Guide, Section 2.5)
	The bottom of the generator (largest surface area possible) is mounted flat against a large metallic surface of the luminaire
	Test point temperature of the generator does not exceed the following values

$t_{testpoint}$	HF generators QL 55W		HF generators QL 85W		HF generators QL 165W	
65°C (149°F)	9137 001 162	QL 55W/S03	9137 001 163	QL 85W/S03	9137 001 474	QL 165W/S01
65°C (149°F)	9137 001 249	QL 55W/S13	9137 001 250	QL 85W/S13		
72°C (161°F)	9144 999 950	QL 55W 200-277V	9144 999 952	QL 85W 200-277V	9144 999 963	QL 165W 200-277V
72°C (161°F)	9144 999 948	QL 55W 100-120V	9144 999 951	QL 85W 100-120V	9144 999 964	QL 165W 100-120V

	Generator is properly grounded
	Generator input leads and generator/lamp output leads are separated as much as is physically possible (minimum distance 10 cm) to minimize EMI (QL OEM Guide, Section 2.4)
	The generator and power coupler are not mounted on a shared heat sink

	Luminaire
	Wire and mating plug-in connectors are routed within the luminaire so as to comply with regulatory agency approvals
	The luminaire is always grounded
	High emissive surfaces are used to obtain a good heat transfer
	The luminaire is suitably sealed for outdoor application to prevent penetration of moisture, dust and insects
	The luminaire is designed or shaped in such a way that the maximum recommended temperatures of the QL lamp system parts are not exceeded (QL OEM Guide, Section 2.5)

OK	☺	OK/NOK	😐	NOK	☹	Not measured	?

Troubleshooting guide

If you experience troubles using Philips QL induction lighting, please use this troubleshooting guide for a quick solution of your problem.

System is inoperative

Check		Action	See reference
Is there power to the fixture?	**no**	Correct external cause and check for normal operation.	
Are in-line fuses (or other devices such as photocells and sensors) blown, faulty, or causing the problem?	**yes**	Replace or reset the faulty component(s), and check for normal operation.	
Is the mains voltage in accordance with the voltage on the generator's label?	**no**	Use the correct generator.	
Are abnormal system conditions at fault?	**yes**	Replace the failed system part and check for normal operation.	**(A)**
Has the system failed under normal conditions?	**yes**	replace the failed system and check for normal operation.	**(B)**
Are the lamp, power coupler and generator compatible?	**no**	Replace the incorrect component(s) and check for normal operation.	**(C)**
Is the line voltage correct?	**no**	Correct the supply voltage to within the specified tolerance.	**(E)**
Problem solved?	**no**	*Contact experts for further problem solving at infoQL@philips.com*.	

Very short system life

Check		Action	See reference
Is the generator wired correctly?	**no**	Correct and check for normal operation.	**(A)**
Is the lamp broken	**yes**	Replace the failed system part and check for normal operation.	**(A)**
Are the components compatible?	**no**	Replace the incorrect component(s) and check for normal operation.	**(C)**
Is the line voltage correct?	**no**	Correct the supply voltage to within the specified tolerance.	**(E)**
Is the ambient temperature or system temperature high?	**yes**	Check temperature conditions and system mounting.	**(F)**
Problem solved?	**no**	*Contact experts for further problem solving at infoQL@philips.com.*	

Low lamp light output

Check		Action	See reference
Is there a low light output after first ignition?	**yes**	Wait 1 hour for normal operation.	
Is there a repeated low light output?	**yes**	Burn the lamps for 100 hours continuously.	
Is the generator wired correctly?	**no**	Correct and check for normal operation.	**(A)**
Is the light output decreasing over time?	**yes**	Refer to the system lumen maintenance over life.	**(B)**
Are the lamp, power coupler and generator compatible?	**no**	Replace the incorrect component(s) and check for normal operation.	**(C)**
Is the line voltage correct?	**no**	Correct the supply voltage to within the specified tolerance or correct tap connection.	**(E)**
Is the ambient temperature or system temperature high?	**yes**	Check temperature conditions and system mounting.	**(F)**
Problem solved?	**no**	*Contact experts for further problem solving at infoQL@philips.com.*	

Light flickering

Check		Action	See reference
Are abnormal wiring conditions at fault?	**yes**	Correct abnormal condition(s) and check for normal operation.	**(A)**
Has the system reached the normal end of life?	**yes**	Replace the system and check for normal operation.	**(B)**
Are the lamp, power coupler and generator compatible?	**no**	Replace the incorrect component(s) and check for normal operation.	**(C)**
Is the generator operating correctly?	**no**	Replace faulty generator and check for normal operation.	**(D)**
Is the line voltage correct?	**no**	Correct the supply voltage to within the specified tolerance or correct tap connection.	**(E)**
Are the lamp, power coupler and generator compatible?	**yes**	Correct abnormal condition(s) and check for normal operation.	**(F)**
Is the system temperature high?	**yes**	Check temperature conditions and system mounting.	**(F)**
Problem solved?	**no**	*Contact experts for further problem solving at infoQL@philips.com.*	

Reference (A)

Lamp base to power coupler contact	Good contact between the lamp base and the power coupler is essential. The lamp is attached to the fixture by the power coupler only, check to see if the lamp is mounted on the power coupler correctly.
Faulty wiring	Check all 5 connections (ground, mains input, HF-output) on the generator for correct wiring, loose contacts, poor connections, or broken wiring. All generators must always be grounded. Generators and components may be grounded to the fixture or otherwise connected to the ground. It is hazardous and possibly fatal for a human to make contact with an ungrounded fixture, generator or other electrical component while it is in operation.
Coaxial cable	The coaxial cable of the power coupler may not be crushed, i.e. the bending diameter is limited. The distance between the (coaxial) generator output cable and the generator input leads (mains cable) should be as big as possible, but at least 10cm (~4 inch). The wire and plug-in connectors between the power coupler and generator must not be altered in any way and must be kept away from the surface of the lamp.
Power coupler cooling	QL lamps are restricted to an optimum operating temperature. For example, lamp and power coupler should be firmly attached on a heat sink with 4 bolts with a prescribed diameter, length and material. Otherwise, the lamp may produce low light output or fail early. The generator and power coupler are not mounted on a shared heat sink.
Generator cooling	The bottom of the generator is mounted flat against a large metallic surface of the fixture for good heat transfer. The generator and power coupler are not mounted on a shared heat sink.
Lamp damage due to handling or shipping	Damage to the system from handling or shipping may cause a crack in the glass or broken wires.

Reference (B)

Rated average life	Rated average life is based on tests of large groups of systems under specified conditions. All systems do not last until rated average life. They fail in accordance with a mortality curve.
Normal end-of life	Normal end-of-life is caused by failure from the power coupler and/or generator. The lamp will not be able to start.
System lumen maintenance	The light output of the QL system depreciates as the lamp accumulate burning hours. The degree depends on the lamp wattage and colour.
Group replacement of systems	The interval between group replacement of systems is determined by the minimum acceptable light level for the application and economics. The light level will be determined by lumen maintenance of the lamp and dirt conditions, and the economics by the mortality curve, system and labour costs. Your system supplier has information for determining the best time schedule for your conditions.

Reference (C)

Incompatible components	These components could include an improper lamp, power coupler or generator. All components must be compatible. Check the system description and the stamps or labels on the lamp, power coupler and generator (package). System performance will not be according specifications. Lifetime behaviour is unpredictable.

Reference (D)

Improper generator wiring	Check the wiring diagram on the generator label.
Generator test	1. Install a known good power coupler and lamp 2. If the lamp lights normally, you have just corrected the cause of the problem. 3. If the lamp does not light, the generator is inoperative. Replace the generator.
Power coupler test	1. Install a known good generator and lamp 2. If the lamp lights normally, you have just corrected the cause of the problem. 3. If the lamp does not light, the power coupler is inoperative. Replace the power coupler.
Lamp test	1. Install a known good generator and power coupler 2. If the lamp lights normally, you have just corrected the cause of the problem. 3. If the lamp does not light, the lamp is inoperative. Replace the lamp.

Reference (E)

Operating line voltage limits	To receive the full benefits of rated lamp light output and to prolong generator life, it is essential that the voltage supplied to an installation be maintained within the prescribed limits. Low voltage has no damaging effect on the generator. It could, however, have an adverse effect on lamp performance and starting dependability. Subjecting a ballast to excessive voltage will cause early ballast failure.

Reference (F)

Temperature	A generator and a lamp, like any other electrical device, generates heat during normal operation. Planning for a maximum heat dissipation with proper fixture design, installation planning will minimize the possibility of a heat-related problem. Excessive temperature will have an adverse effect on the QL system life.
Temperature conditions	The temperature of the amalgam does not exceed 105°C (221°F) with a base-up angle less than 75°. The temperature of the flange does not exceed 125° (257°F) in every operating position. The temperature of the bulb wall does not exceed 170°C (338°F). The temperature of the power coupler flange-test point does not exceed 90°C (194°F) for the QL 85W and 100°C (212°F) for the QL 55W & QL 165W.
Generator and/or power coupler location	The generator and/or power coupler may be located in such a way that thermal contact and/or heat flow is limited. Bad thermal contact and/or low heat flow can result in an excessive lumen drop, lamp extinguishing, or even early failure of the system. Check the OEM Guide for proper mounting conditions.

More information about the QL systems, including the OEM guide can be found on the Philips Internet, or requested at infoQL@philips.com.