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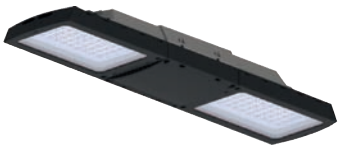
# How to select and specify the right linear LED fitting in IECEx and ATEX hazardous environments

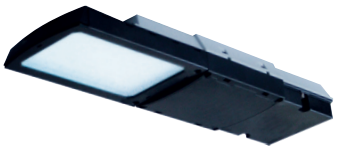
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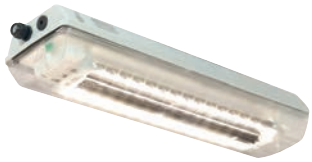
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For the past 60 years, luminaires equipped with fluorescent tube, also known as linear fittings, have been commonly used in IECEx and ATEX hazardous area locations. This has constrained the linear fitting design for years and thus resulted in most linear fittings looking and performing similar. In turn, this made specifying a linear fitting easy; the user could simply consider the power of the light source, such as 2x18W, 2x36W or 2x58W for T8 bi-pin fluorescent tubes, to select the correct solution.

Over time with the introduction LED technology, fittings became more efficient, extended lifetime performance and provided application flexibility, making LED luminaires the ideal solution for lighting IECEx and ATEX hazardous area locations.







As the selection of LED lighting options grew, most of the linear LED fittings on the market still held many of the constraints of the fluorescent tube design era and many users continue to base their selection criteria in the same way they selected fluorescent tubes. This limits the full potential of the technology and the advantages for the end user.

This article is intended to provide the keys to selecting and specifying linear LED fittings for IECEx and ATEX hazardous environments to improve overall return on the investment.

## Considerations in selecting and specifying linear LED fittings

It is critical to understand the considerations necessary to select and specify the right linear LED fitting as a lighting source to take full advantage of the energy efficiency, longer life and return on the investment.

### Light source and complete luminaire

When selecting or specifying a linear LED fitting, you may first focus only on the LED light source.

However, comparing performance at an LED level can be misleading, since the performance of the complete luminaire is a trade-off between several factors; these include thermal management, efficiency, light quality, optical efficiency and many more. For example, the lifetime of the LED chip does not correspond to the lifetime of the fitting.

### Equipment category, gas and dust groups

The equipment category or protection level, as well as the gas and dust groups, must be known and part of the selection criteria before selecting any explosion proof product.

A linear LED fitting with equipment category of 3G or protection level of Gc can only be installed in Zone 2, while a fitting with an equipment category 2G or protection level Gb can be installed in Zone 2 and Zone 1.

In this case, it is important that the end user consider the flexibility and operating time of the installation before selecting these parameters.

For example, the requirement for 2G are much higher than 3G, but can be used in both Zone 1 and Zone 2 areas. This can reduce complexity by having only one product and can increase safety by helping eliminate the risk of installing the wrong product.

By selecting a fitting as 2G even in a zone 2 area, allows the future modification to a Zone 1 area without the need to modify the complete lighting installation. This is important as hazardous duty installations can have a lifetime span of more than 20 years.

Also, the 2G equipment category rated fitting has a higher protection level compared to the 3G, which helps provide additional safety for the end user.

When considering gas and dust group requirements for fittings, selecting a fitting with gas group IIC compared to IIB or IIB+H2 helps reduce complexity and helps improve safety and flexibility for the same reasons mentioned above.

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## Ex protection concept and product life cycle

Historically, end users require a light fitting with a hazardous area location protection of Ex e or Ex d. Both e and d protection achieve an equipment category of 2G and a protection level Gb. The choice of protection method really comes down to the total life cycle of the plant and how the product can support the best maintenance options.

Light fittings based on Ex d protection feature industrial components and the Ex protection is provided by the flame path. Maintaining a proper functioning flame path takes skill. Even a small scratch in the flame path can damage the Ex protection functionality.

Therefore, it is very important to consider that an equipment with Ex d protection will require regular maintenance for repair and component replacements to ensure proper functionality of the protection mechanism, as specified in the operating instructions.

Conversely, a fitting with Ex e protection is designed to exclude sources that can generate an explosion. Therefore, it is much easier to open it and replace components, unless otherwise specified in the operating instructions.

Therefore, in order to select the right protection for the linear LED fitting, it is important to evaluate the maintenance and product lifecycle in the specific application, as well as the level of skills and expertise in repairing and dealing with Ex d protection.

In the case above, the selection of Ex e protection for a linear LED fitting can result in a longer operational lifetime and reduces maintenance complexity.

## Serviceability of linear LED fittings

Over time, end user's plant processes, equipment moves, new equipment installations and other factors can change. Because of these changes, the original lighting may not support the requirements of the new environment. These changes can result in the need to modify the installation base on fixed linear fittings. This can be quite time consuming, expensive and, in some cases, not even possible due to limited space for cables or infrastructure.

To avoid the costly and complex lighting changes, it is helpful to consider a lighting design that can be easily added or replaced with an improved version.

Take for example, Eaton's Crouse-Hinds series ExLin linear LED fitting. The ExLin solution can streamline the installation, replacement process and improve overall optics. ExLin's modular design easily changes from standard to wide or narrow beam. This is possible thanks to the modular design of the fitting combined with the separate hazardous area location certification of the components.

If a complete redesign is required, such as changes to the normative landscape and different lighting intensity becoming mandatory, the ExLin linear LED fitting can save both time and cost due to its serviceability.

While many manufacturers claim extremely long lifetimes for fittings, a linear LED fitting will not last forever. Statistically some critical components, such as LED light source, the control gear or battery, will fail over time. *(See lifetime section for additional information and recommendations.)* In many cases, it can be economically preferable to replace only the failed component or control gear, instead of having to replace the complete luminaire.

Crouse-Hinds series ExLin linear LED fitting is designed to incorporate ease of access to the light source and the control gear. This allows users to easily maintain and replace components while helping reduce the waste and supports a circular economy, with important social and economic consequences for the environment.

## Material of the linear LED fitting

In today's market, many linear LED fittings for hazardous area locations are manufactured with glass reinforced polyester (GRP) or aluminum (AL) materials.

While these options are durable, it is critical to consider the impact of chemical stability and sunlight radiation on the fitting.

Chemical plants may use corrosive substances that can corrode aluminum. Offshore and marine applications can accelerate aluminum corrosion due to the salt in the environment. Some manufacturers paint the aluminum to add an additional level of protection, but paint can be damaged during operation.

In these types of environments or where corrosion is probable, a linear LED fitting with glass reinforced polyester material is the ideal solution.

However, direct sunlight is not considered during the IECex or ATEX certification process. The operating range in any hazardous area location (Ex) certificate for GRP or AL fittings does not include sunlight radiation. But constant and continuous sunlight radiation can damage glass reinforced polyester.

The IEC/EN60079-17 requires the owner to take measures against external factors that could put the equipment in a situation outside the certified parameter, such as sunshade canopies.

Compared to other manufacturers' glass reinforced polyester fittings, the Crouse-Hinds series ExLin and eLLK linear LED fittings are manufactured with a special, textured glass reinforced polyester design that significantly increases protection against sunlight and UV light.

Light transmitting element materials, also called covers, can differ depending on specific fitting design. Glass and polycarbonate (PC) are available and historically polycarbonate is widely used with fluorescent linear fittings and in many LED linear fitting, such as our eLLK LED series solution.

Toughened glass is much easier to clean compared to polycarbonate. Glass has a higher resistance to detergents, sunlight/UV rays with no discoloration and is suitable for low temperature applications.

Many owner and plant designers require a grid to be used in combination with glass. This is often the result of the use of glass in hazardous area locations with Ex d tubular linear fittings.

According to the standard IEC/EN60079-0, any cover able to withstand protection level 4J during the impact test for certification does not require any additional grid for IIC gas group application, even in area where the risk of high mechanical impact is present.

If it does not meet this protection level, then a mechanical element to protect the glass, such as a grid, should be used or the product should be used only in area with low mechanical risk. This information should be mentioned in the certification and in the manufacturer's operating instructions.

The Crouse-Hinds series ExLin linear LED fitting fulfills 4J requirement and can be used in Zone 1 areas with gas group IIC without additional grid or protection.

Some hazardous area locations, for example in Food & Beverage application require no external glass because of the risk of glass splinter. In these types of applications, polycarbonate is a good solution. Alternatively, a plastic protective cover can be used to avoid glass splinter dispersion. The ExLin LED series solution features a plastic laminated glass to help avoid possible splinters.

## Lumen output, quality and efficiency

A fluorescent fitting's lighting performance is described by the light source power: 18W, 36W, 58W.

The performance of an LED fitting is described by lumen, which is the total light emitted from a light source. The higher the value, the higher the total amount of light emitted.

While this may lead some to think more lumen is better. This is not always the case.

When comparing different fitting options, the focus should be on the lighting task of providing the required light intensity in the right area to allow for proper visibility.

It is also important to note that the parameter related to the complete fitting is relevant and not the LED source itself. The performance (lumen output, efficiency, lifetime…) of the LED chip are not the performance of the luminaire.

Instead, the light emitted in a completely different direction contributes to the total lumen output but does not improve visibility.

In the EN 12464-1: Lighting of workplace-Part 1, indoor workplace tasks and applications require a minimum average lux level - the unit of light intensity on a surface and not a minimum lumen level.

Therefore, it is important to understand how much and how well the emitted light will reach the task and application area. This is where the use of optics can help.

Due to the point-like emission surface of the LED, it is much easier to control the beam pattern in an efficient way.

In some situations, where light is directed into a required area, the lower lumen output can result in a more efficient design.

The ExLin series solution provides one of the most cost-effective solutions with three different beam patterns.

It should also be noted that the total lumen output does not provide information on the quality of the light. The specific color temperature and color rendering index of the light source can have an influence on the light output.

Additionally, if no specific measures are taken, the higher the light output, the higher the risk of glare.

To select a fitting, consider the value and description in the manufacturer's LED fitting datasheet. If it is not specified, the lumen output published relates to measurements performed at 25°C ambient temperature.

At higher temperature, the value will be different. How different depends on the product specific design and thermal management.

One parameter used to describe the performance of a linear LED fitting is the efficiency which is measured in Lumen/Watt. This consists of the total lumen output divided by the total power consumption. (As noted previously, a higher efficiency indicates a good fitting, but the focus should be on the customer application to select the right fitting for the task.)

Once the total number of fittings required has been verified on the required lux, it is recommended to analyze the total electrical losses between the different solutions.

In many cases, the use of fittings with optic options can help reduce the number of fittings and the total energy consumption. This provides a significantly effective way to determine lighting system efficiency and performance.

## Electronic performance

With the LED technology reaching a maturity level, the control gear becomes one of the most critical components in an LED linear fitting.

The voltage range can vary between different products.

For constant output and adaption to change, it is helpful to select a fitting that supports a broader range of voltage within one fitting to support voltage change over time with a constant light output. This also allows the use of a single fitting solution to be used globally, thus helping reduce supply chain and design complexity.

Higher harmonic distortion can create disturbance to critical equipment in the electric circuit. A good quality control gear with a low harmonic distortion level helps ensure low losses and reliable functionality.

The surge protection value of at least 4kV phase-to-phase and phase-to-ground provides added safety and helps improve the luminaire reliability.

In critical environments, such as areas with high risk of lightning, it is recommended to install central, high surge protection at the circuit panel boards. This helps ensure the safety of the circuit without additional cost to the linear fitting.

The inrush current is a critical parameter for any light fitting. A high value can require a complicated design of the circuit panel board and of the complete installation, with additional costs for the installation or a lower reliability.

In general, LED fittings have a much lower power compared to fluorescent. The functionality with constant voltage input provides a cost-effective way to use LED light fittings with central battery system for emergency lighting.

When LED fittings are used to replace conventional luminaires, the control gear performance plays an important role in any retrofit project.

By selecting fittings based only on light output can result in a redesign and extra cost.

The Crouse-Hinds series ExLin control gear has outstanding electrical parameters with a total harmonic distortion lower than 8%, built-in surge protection of 4kV and integrated in-rush current limiter. This makes ExLin the perfect solution in new installation and retrofit lighting project.

## LED fitting profile

Many LED linear fittings kept the same dimension as typical fluorescent linear fitting to make one to one replacement easier. While this may appear to be the ideal solution, it can result in multiple compromises.

The same dimensions allow the installer to utilize the same wiring of the current installation. But this also implies that the same number of fittings will be used whose position was defined based on the beam pattern of the fluorescent fitting.

The optimized used of LED, high power electronics and material science technology allows a completely new approach to the lighting installation design. These advancements help reduce the number of LED fittings required to obtain the same light intensity as fluorescent. This also helps reduce the overall initial invest and can provide a higher saving in maintenance cost and energy consumption. The additional advantages can more than compensate the additional effort in changing the cabling even in retrofitting projects.

## Humidity

In high humidity environment, ambient temperature changes from day to night or switching from on to off on any artificial light source can lead to water condensation inside the fitting.

The following are ways to help reduce condensation.

1. Adding a breather drain to help leveling out inner and outer humidity
2. Reduce hotspots by separating the artificial heat sources such as LEDs and control gear
3. Reduce the volume of air in the fitting

A breather drain is typically preferred for large LED fittings. It helps reducing condensation in the fitting but does not eliminate it.

With a newer designed LED fitting, option 2 and 3 above can be used to help eliminate condensation.

The Crouse-Hinds series ExLin linear LED fitting design inherently compensates for natural condensation. In fact, the ExLin fitting has shown to help reduce the total condensation volume. This is achieved by,

- Separate compartments and gaskets for the LED source and the control
- Sealing the LED module with minimal air volume

## Lifetime

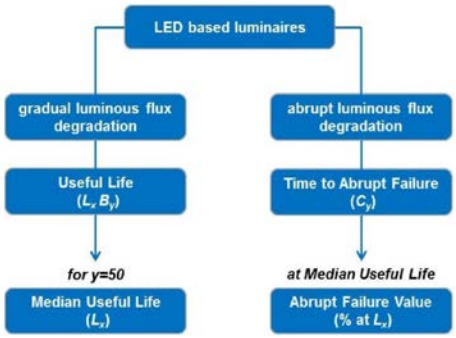
The lifetime value of conventional light sources is based on the same assumptions between different manufacturers; this is not the case for LED.

For LED lights, there are several descriptions for lifetime in the market today, such as system life, rated life or values claiming L70 exceeding 20 or more years continuous operation.

The definition of lifetime for LED luminaires can be found in IEC62722. An extensive overview can be found in the guidance paper published by Lighting Europe, reference Guidance.

Two relevant values to be considered in the lifetime of LED fittings are related to the gradual and abrupt light output degradation over time as described in the graph A. The gradual degradation is mostly related to the LED light source and the abrupt degradation is mostly related to control gear failure.

**Graph A**




The Useful Life LxBy is the time until y% of the LED luminaires produces a lumen output lower than x% of the initial value.

In order to estimate the useful life, only the LED luminaires still operating are considered.

The Time to Abrupt Failure Cy is the time until y% of the LED luminaires have failed abruptly and are not operating anymore.

Lighting Europe recommends the publication of the Median Useful Life (Lx with y=50) at predefined age values up to a maximum of 100k hours, and the expected abrupt failure rate (or control gear failure rate) at the same number of hours specified in the Medial Useful Life.

There are two important aspects to consider.

1. The lifetime of the LEDs is not the lifetime of the complete luminaire. The IEC standards currently describe the lifetime metrics for LED based products, but not how to calculate the parameters. Reputable manufacturers calculate Median Useful Life and the corresponding Abrupt Failure Value based on historical data, knowledge, component level testing and so on.
2. The values of the lifetime metric are statistical values and not absolute values.

Another parameter is required to compare different LED products - the ambient temperature at which the lifetime has been estimated.

The temperature has an important contribution to the reliability of the LED and control gear. The higher the temperature, the lower the lifetime.

Therefore, good thermal management is required to help ensure a long operating time.

For optimal thermal management, it is important to consider the main sources of heat and how components, such as LED and control gear, perform in high temperature environments.

One way this is achieved is to incorporate a derating feature into the control gear which allows the LED driving current to be reduced at higher temperature. This reduces the heat generated, but at the same time reduces the lumen output generated by the fitting.

Since a lower lumen output could cause a light intensity lower than what required by the local legal requirement or the project specification, thermal management should be taken into consideration during the planning stage.

Another option is to design the fitting based on the unique feature of the LED.

Many LED linear fittings are constructed based on the design of the old fluorescent. LEDs are often soldered on a board with the control gear placed behind it. This configuration cause heat transfer between the LEDs and the control gear, increasing their temperature and reducing their reliability.

Another approach is to locate the control gear away from the heat source generated from the LED. This improves thermal management by separating the control gear and the LED. This helps dissipate the heat coming from the back of the LED.

The Crouse-Hinds series ExLin linear LED fitting separates the control gear and LED which results in optimized thermal management, higher output and longer lifetime in higher temperature environments.

## Summary

To optimize the advantages of LED technology, a completely new approach to the lighting installation design selection and specification for IECEx and ATEX hazardous environments should be considered.

With advancements in the LED technology, high power electronics and material sciences, the number of LED fittings required to obtain the same light intensity as fluorescent can be dramatically reduced. This results in a reduced initial investment and higher savings in maintenance cost and energy consumption.

By considering the above, the Crouse-Hinds series ExLin linear LED fitting superior and robust design makes it the ideal solution for new and retrofit lighting projects in hazardous area locations.

**Crouse-Hinds series ExLin linear LED fitting features and benefits**

- Superior optics with three different beam patterns; modular design from standard to wide or narrow beam.
- Separate control gear and LED areas for optimized thermal management, higher output and longer lifetime in higher temperature environments; also allows for easy maintenance and replacement of component parts.
- Features special, textured glass reinforced polyester design that significantly increases protection against sunlight and UV light
- Can be used in Zone 1 areas with gas group IIC without additional grid or protection
- Control gear has outstanding electrical parameters with a total harmonic distortion lower than 8%, built-in surge protection of 4kV and integrated in-rush current limiter.

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