

**PHILIPS**

White paper



# PerfectAccent

Flexible store lighting with  
the accent on visual comfort



# Introduction

Lighting will always be influenced by market trends. Whether that's designing sustainable store luminaires, using sensors and controls to save valuable energy, or delighting customers with color-changing displays. Lighting is also an effective tool that retailers can use to their commercial advantage. Such as the influence of light on human behavior, it answers some of retail's biggest challenges. From differentiating with innovative store experiences to influencing how customers engage while shopping. So, as part of a larger in-store strategy, it can increase sales – and add to a company's bottom line.

These are all factors that form the basis of our quality lighting development process. With ideas that are founded on needs and thoroughly tested and endorsed by market research. So we can create truly meaningful solutions that address the most important challenges facing today's retailers.

In this whitepaper, we'll explore the importance of reflectors in building robust, high-performance lighting solutions. From the selection of materials to minimize corrosion and maximize reflectivity, to the design choices that influence light quality and eye comfort. Fundamental building blocks that every retailer should take into account when installing or updating store lighting.



## Designed to sell more

Market research has revealed that quality retail lighting must deliver a pleasant shopping environment, which includes providing visual comfort for shoppers. Our retail lighting solutions do exactly that. They put displays in the spotlight, bring out colors and textures, make objects look more appealing, and stores more enticing.

## Quality of light, perfected

So what makes the difference between a lighting solution that promises quality of light, and one that actually delivers it?

In LED lighting fixtures, quality of light is determined by:

- The optics, which affect light appearance and quality of distribution
- The spectral content of the light source.

As an integral part of the optics, the design of the reflector also determines quality of light, because it influences the beam characteristics.

Not only does the reflector play a vital role in providing high-quality, comfortable light that improves the shoppers' eye comfort; as we'll go on to explain, it can also enhance the optical efficacy of the fixture to improve the return on investment (ROI) in retail applications.

PerfectAccent reflectors offer a range of optics to create different beam characteristics to suit a wide array of LED fixtures from narrow to very wide beam. But critically, they live up to our promise of appealing fixtures with optimized design, high optical efficiency and consistent performance over a long and reliable lifetime.

In this paper, we will explain the material and design choices that have made lasting efficiency and performance possible, along with the commercial advantages that PerfectAccent reflectors can bring to retail applications.

# Aluminum, the superior choice

Lighting represents a significant investment for retailers. The retailer's intention is always to make an enduring investment, which is why our development process focuses specifically on the quality of our products during their lifetime. Because this ensures the quality and intensity of light does not deteriorate over time. For this reason, our aim is always to select the best optical stack, where every component has been designed to optimize luminaire efficacy in the long term.

The reflector is a key element in the optical stack. This is due to its material properties, and also because of the influence that its shape and design has on light quality. For the new PerfectAccent reflector ranges we have selected only the best base materials. Together with our precise design specifications, this ensures that PerfectAccent reflectors will suit a wide array of LED fixtures and applications. Now and for many years to come.

## Optical stack



### Base material selection

In selecting the right materials for this new range of reflectors, our key objectives were to optimize luminaire efficacy and deliver consistent lighting performance over time. The result is two distinct PerfectAccent ranges; each made from different base materials, but with the same aluminum coating.

PerfectAccent reflectors with the plastic base material offer the most cost-effective solution of the two thanks to more flexible design and production methods. The reflectors with the metal base material deliver superior light reflectivity (up to 6% higher, depending on the type of reflector), and therefore maximize luminaire efficacy.

Although the initial cost of the full aluminum reflectors is marginally higher, it can easily be offset by the energy savings delivered by the lighting product. This can result in an attractive return on investment, as can be seen in the calculation in Deep Dive #1.



Figure 1: Reflector with aluminum base material + aluminum coating



Figure 2: Reflector with plastic base material + aluminum coating

## Deep Dive #1

### Calculating Return on Investment

The formula for calculating the ROI of a product with PerfectAccent metal reflectors compared to a product with plastic reflectors is as follows:

$$\text{ROI (years)} = \frac{\left[ \text{Investment of PerfectAccent reflectors (€)} - \text{Investment in traditional product (€)} \right]}{\left[ \text{Energy consumption traditional product (W)} - \text{Energy consumption PerfectAccent Metal based (W)} \right] \times \text{Yearly operating hours (hr)} \times \frac{\text{Energy cost (€/kWh)}}{1000}}$$

The ROI depends on the exact cost of both the lighting product and the electricity it consumes. However, in our experience, the typical ROI period is well within 3 years. For example, a 5€ delta with 10% energy saving (3W) and 8ct/kWh energy cost leads to a ROI of 2,7 years.





# Coating selection

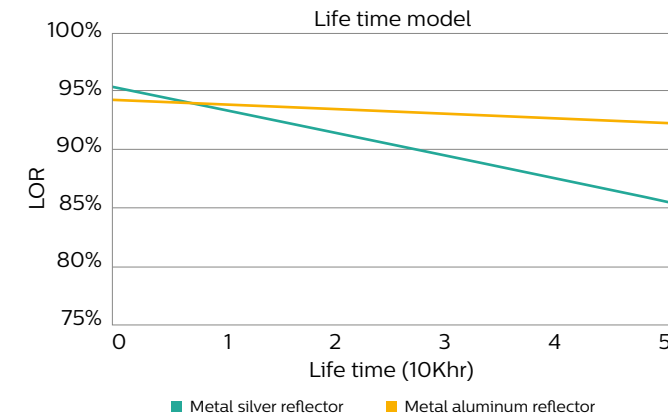
Reflectors can be manufactured from a wide range of materials, but for the coating there are two main options:

- High-reflectivity aluminum coating
- High-reflectivity silver coating

The reflectivity of silver is higher than that of aluminum. However, despite this we have selected a high-reflective aluminum coating for our PerfectAccent reflector ranges. Why aluminum? Because; unlike silver, which corrodes and deteriorates over time, the reflective properties of aluminum remain stable.

This means that aluminum offers the best long-term performance, which is more beneficial to customers.

This is demonstrated in Figure 3, which compares the performance of aluminum and silver reflectors over lifetime. The loss of reflectivity of each reflector is mapped over a typical application lifetime of around 10 years. This graph clearly shows that well within the first 10,000 hours, the silver reflector already displays a significant loss of reflectivity, while the aluminum reflector remains stable, making it the better choice.



This loss of silver's reflectivity can be explained by its intrinsic characteristics. Although widely used as a reflector material, silver degrades easily due to a chemical reaction that causes a thin layer of corrosion known as tarnish. Tarnish mainly occurs due to sulfur compounds reacting with oxygen in the atmosphere. This, along with exposure to high temperatures and blue and UV light, will shift the silver coating towards the base layer. And in turn, this will result in the reflective surface of the reflector wearing out prematurely.

You can find more detailed information on the difference between silver and aluminum coatings in Deep Dive #2.

## Deep Dive #2

### Reflectivity: aluminum versus silver coating



There are two reasons for loss of reflectivity over lifetime:

- Corrosion by oxygen
- Corrosion by low concentrations of natural sulfur in the air

The difference in corrosion between silver and aluminum is demonstrated in Figure 4. Here, accelerated testing in an unnatural setting was used to simulate the effects of exposure to pollutants in the air on aluminum and silver reflectors.

#### The avalanche effect

The corrosion process of silver coatings can be described as having an avalanche effect, as can be seen in Figure 5. With exposure to oxygen and sulfur, high temperatures, and blue and UV light, the silver coating will shift towards the base material. As a result, black holes appear in the silver layer, causing the reflector to degrade even further. This is in contrast to aluminum coatings, which are far more resistant to exposure to high temperatures and light.

#### Mechanical stress

In terms of loss of reflectivity due to a reaction with sulfur, it is important to consider the way that metal reflectors are manufactured. During the production process, the base material is folded into its final form, causing a significant number of localized cracks in the protective layer that are not visible to the naked eye (see Figure 6). These will result in an unprotected area of silver that will immediately tarnish when exposed to sulfur.

In contrast, reliability tests have proven that if an aluminum coating is missing part of its protective layer, for example due to mechanical stress fractures, this part of the metal will only revert to the properties of normal aluminum, which ensures a stable light reflectivity.

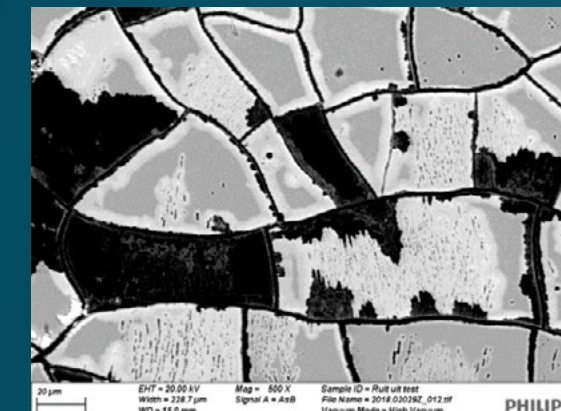
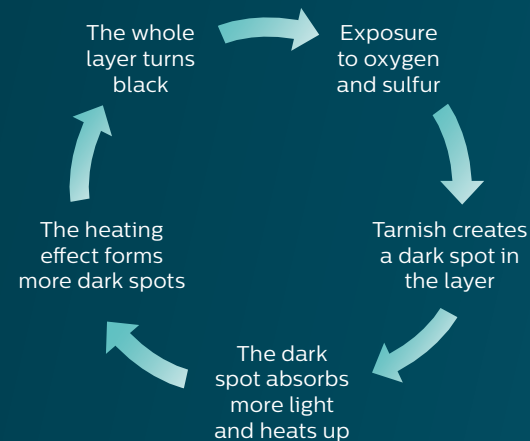
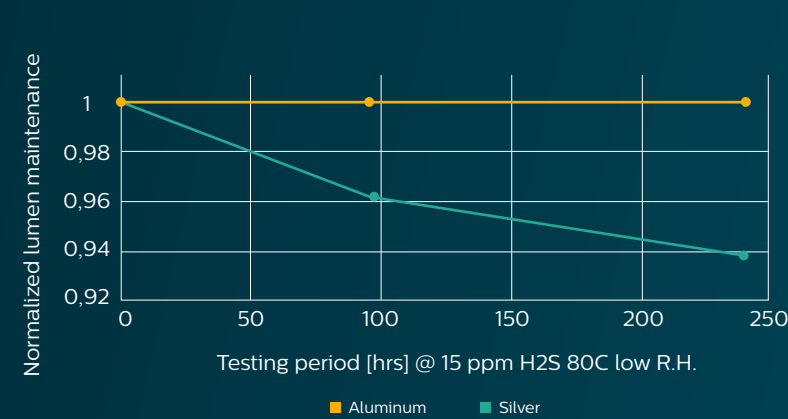


Figure 4: Accelerated H<sub>2</sub>S corrosion testing on reflectors

Figure 5: Corrosion process of silver coating

Figure 6: Cracks in the metal reflector with silver coating (microscopical view)





# Designing light that transcends

## Perfecting the beam shape

We have considered the importance of material choice on the long-term performance of a reflector. But what about the design challenges in terms of reflector shape that will have a direct impact on light quality, shopper comfort and optical efficacy?

There are three key factors that influence how suitable lighting solutions are for retail applications:

- Light beam quality
- Shopper eye comfort
- Front cover use

In terms of light beam quality, the profile is the most important factor to consider when creating a reflector. A parabolic shape will always produce a perfectly aligned, parallel beam when all the light originates from a single focus point (see Figure 7).

But the reality is slightly different. Lighting manufacturers work with Chip on Board (CoB) LED light sources, which are not perfect point sources, but larger in size, and more difficult to accommodate. A larger CoB can be compensated for by using a larger reflector. However, this has consequences for the desired light intensity, light output and final product size.

To overcome these challenges, the PerfectAccent reflector is shaped as closely as possible to a parabola and the LED chip entry window is kept as small as practicable (see Figure 8). By finding the optimal balance between the different LED chip sizes and the reflector shape, we are able to offer a complete product portfolio with a wide range of lumen packages, beam shapes and light output.

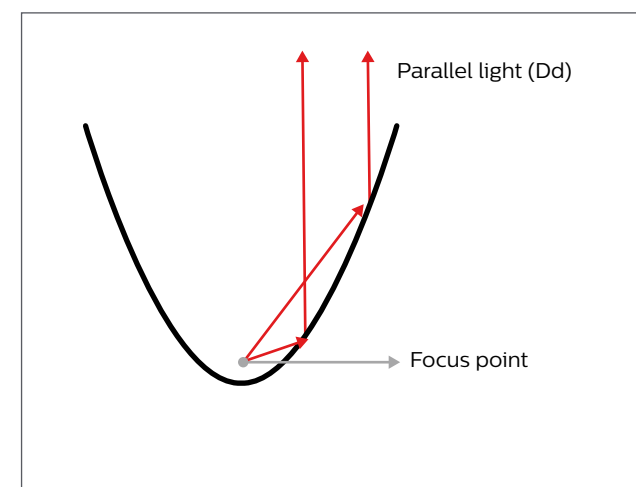


Figure 7: Parabola characteristics

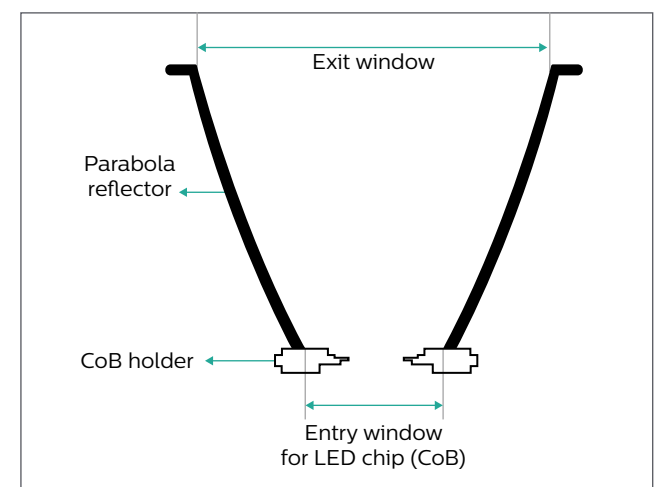


Figure 8: The PerfectAccent reflector



## Shopper eye comfort

The next consideration is designing for visual comfort. How will the quality of light be perceived by shoppers? And how will they experience the reflector once the lights are switched on?

PerfectAccent reflectors are designed with multiple, small 3D facets in the optic that influence shoppers' eye comfort in two important ways. They:

- Improve the appearance of the reflector
- Improve the uniformity of the beam



## Deep Dive #3

# “Sparkle, the good glare”

A concept that observers can understand without training<sup>1</sup>

### Sparkle, the good glare

The dimensions of the 3D facets are different for each beam angle in the PerfectAccent portfolio. However, they all feature an innovative new optic design that produces a pleasant sparkle inside the reflector, while avoiding perceived glare. Perceived 'glare' can be described as a negative effect of light and 'sparkle' as a positive effect of light. These two light effects are difficult to translate into numbers as they are based on subjective user experiences. So we can't say for certain when a shopper will perceive light as sparkling and when they will find it unpleasant. But we can make some informed assumptions based on our investigations into the subject.

In 2019, Signify published a research study<sup>2</sup> on the perception of glare and sparkle in small LED light sources. The results of the study can be seen in Figure 9. The study compares the size of the light source (X-axis) with the brightness of the light source (Y-axis). An important conclusion is that the perception of glare increases with the size of the light source (red lines). The green lines indicate areas in which the combination of brightness and size of light source creates the perception of comfortable sparkling light.

At a specific point (A), the precise light source size and luminance will be perceived as sparkling by 90% of the population, and fewer than 10% will perceive the light source as glary.

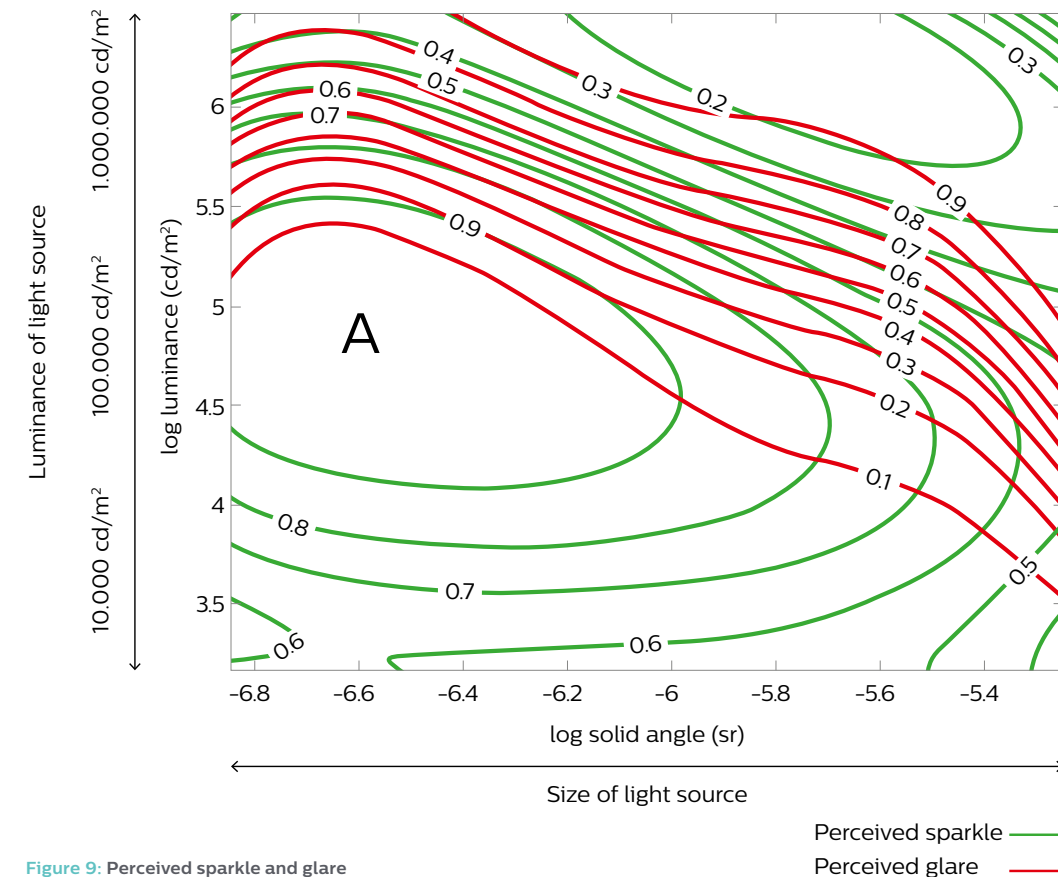


Figure 9: Perceived sparkle and glare

1. AKASHI, Y. MYER, M. A. BOYCE, P. R. 2006. Identifying sparkle. Lighting Research & Technology, 38 (4), 325-337.  
2. Exploring the Pleasant Side of Glare in the LED Era. Dragan Sekulovski et al. DOI 10.25039/x46.2019.OP39.



We've incorporated the insights from this published research into the optical design of PerfectAccent reflectors. Each facet in the reflector profile acts as an individual light source by reflecting the light coming from the LED chip. The specific size of each facet has been chosen because it will still be noticeable at a distance of up to two meters. When positioned next to each other on the inside of the reflector profile, these multiple individual light sources create the overall perception of sparkling light that's pleasant and comfortable to the eye.

But it's not just the size of the facet that plays a role in how the reflector is perceived; two other important design characteristics also influence visual comfort:

- The finish: A facet with a shiny/mirror finish provides more comfort than a matt/diffuse finish
- The curve: A facet with a small radius curvature provides more comfort than a flat or almost flat facet.

All three of these influential characteristics are taken into account during the PerfectAccent design process. The size, finish and curve of each facet in every reflector is designed in such a way that the reflected light optimizes eye comfort for shoppers, at the same time as creating.

### Color-consistent light

One of the main challenges in combining LEDs with optics is achieving a beam that has no color artefacts. Due to the inherent characteristics of all LEDs, applying even simple optics may create a small but noticeable shift between the blue and yellow color values in the beam. That's why it is important that the light reflected by the optic has a uniform color appearance across the full spread of the beam.

The small 3D facets in the PerfectAccent reflector not only influence the appearance of the light by ensuring more eye-comfort, but they also help to correct any variations in light color in the beam. The honeycombed 3D faceted, faceted reflective surface is designed to provide a color-consistent beam. As a result, objects are rendered more evenly, which gives displays in retail outlets more visual appeal.

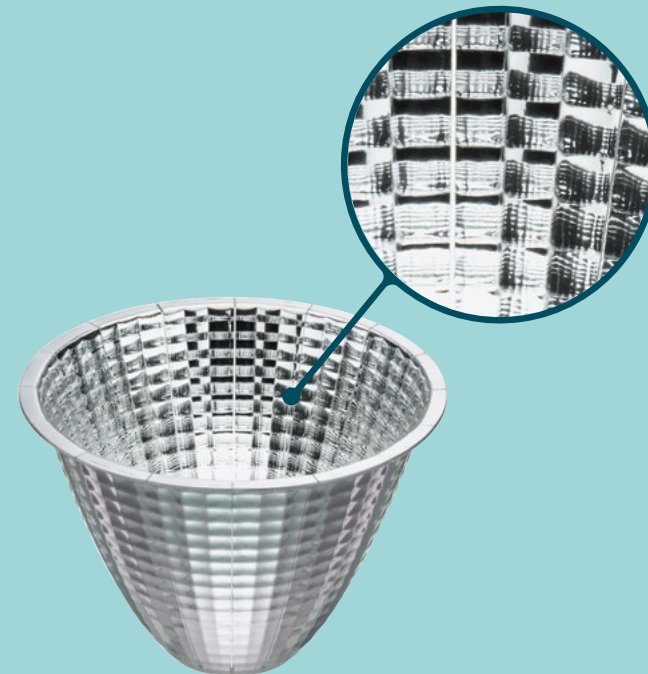


Figure 10: Honeycombed 3D faceted reflector

## Front cover use

Most accent lighting fixtures are designed with a front cover. This means that the reflector is enclosed within the lighting fixture by a thin, transparent disc of glass or plastic. A front cover is commonly used to:

- Protect the reflector surface from moisture, dust and chemicals in the air
- Protect the LED
- Make cleaning easier (front glass is far easier to clean than a reflector)
- Improve light color mixing to provide a color-consistent beam.

But applying a front cover also has its downsides. It reduces the amount of available light and diffuses the optical beam spread, which in turn can increase

the perception of glare. To avoid these problems, PerfectAccent reflectors are designed in such a way that they need no front cover to improve color mixing. Furthermore, thanks to the optimized design of the multiple 3D facets, any visible build-up of dust on the reflector surface is minimal.

However, we understand that there are some situations where light fixtures with a front cover are still recommended. For example, in bakeries and food preparation zones where more dust or chemicals are present in the atmosphere. For this reason, the PerfectAccent optical stack also comes with the option of a low-iron glass front cover, which can be ordered when required.

## Deep Dive #4

### Low-iron glass

As we touched upon earlier, front covers can be made from glass or a transparent plastic material. Real glass has a big advantage – it attracts fewer dust particles electrostatically (see Figure 11). It also diffuses the light less than plastic, which makes glass solutions more comfortable on the eye. Moreover, glass is less prone to scratches that can appear during cleaning. That's why the PerfectAccent optical stack is available with an optional low-iron glass front cover.

But why low-iron specifically? Firstly, it keeps the color temperature at its original value (as opposed to standard glass, which can cause a shift to a warmer, more yellow light). But most importantly, low-iron glass enables a higher light output, which optimizes the overall efficacy of the lighting product.



Figure 11: A comparison of dust and scratches on plastic and glass front covers, which were both cleaned with a microfiber cloth before the photo was taken



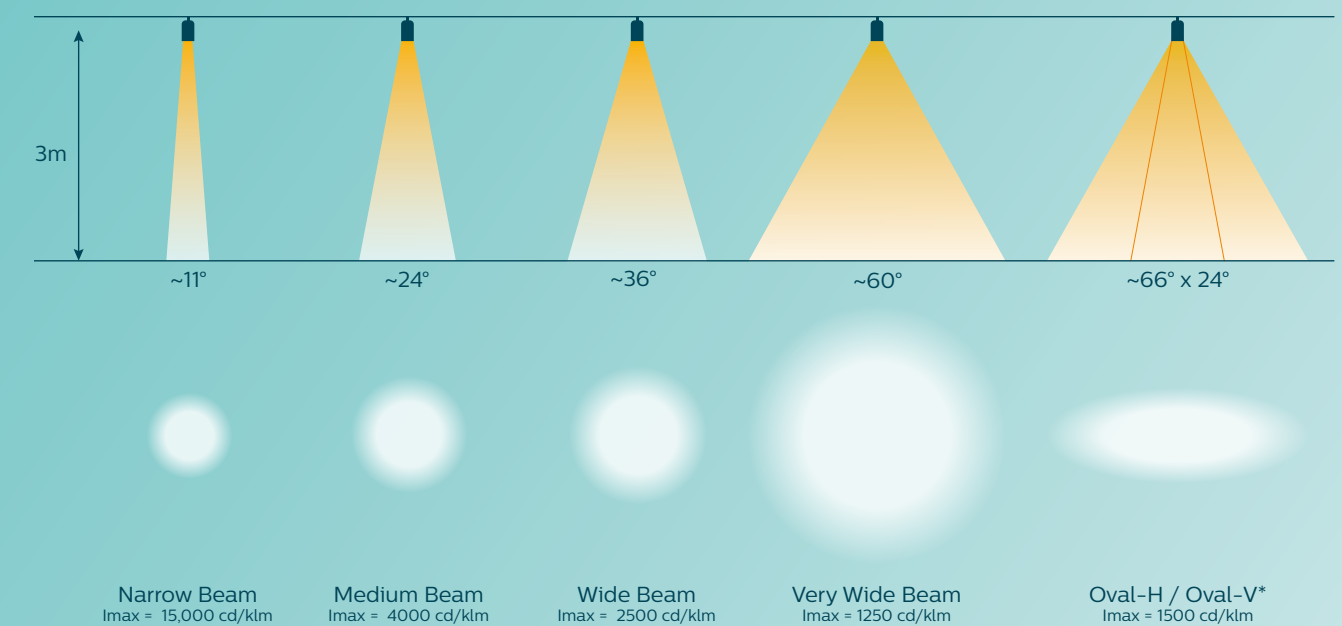


# The next generation of optics

## A choice of beam characteristics

There is also one more point to emphasize when it comes to lighting design; light distribution is just as important as visual comfort. First and foremost, a space should always be illuminated in the best way possible for its intended use - whether that's a fish counter displaying the catch of the day, or a warehouse aisle storing large volumes of stock. With a portfolio of five, well-balanced beam options from narrow to very wide beam, PerfectAccent can optimize the lighting in every application (see Figure 12). This enables retailers to tailor their lighting by selecting the correct beam to address specific needs in store, while enjoying all the other benefits of PerfectAccent outlined in this paper.

Unlike one-size-fits-all solutions, PerfectAccent has the ability to highlight specific products and create different ambiances. The range of beam shapes and lumen packages available within the key spotlight ranges makes it easy to define the right level of intensity. From a narrow beam to create a strong accent on fashion accessories, to an oval beam to optimize the effect on fresh food counters. Polar intensity diagrams based on PerfectAccent metal reflectors with diameter size 66mm. Other photometry is available via [Philips Product Selector](#).



\*Oval beams are created using an additional beam-shaping front lens, which results in small concessions in eye comfort.

Figure 12: The complete PerfectAccent beam portfolio for retail lighting applications



Polar intensity diagrams based on PerfectAccent metal reflectors with diameter size 66mm. Other photometry is available via [Philips Product Selector](#).

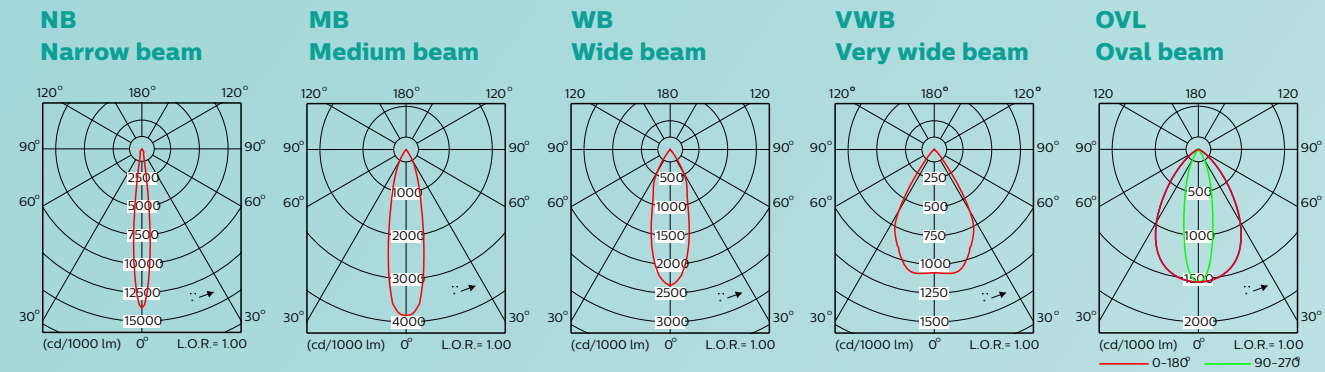
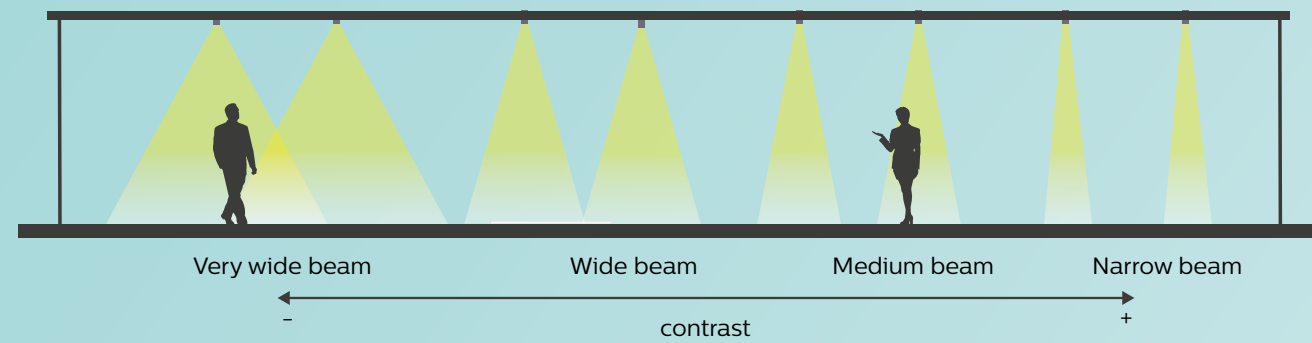
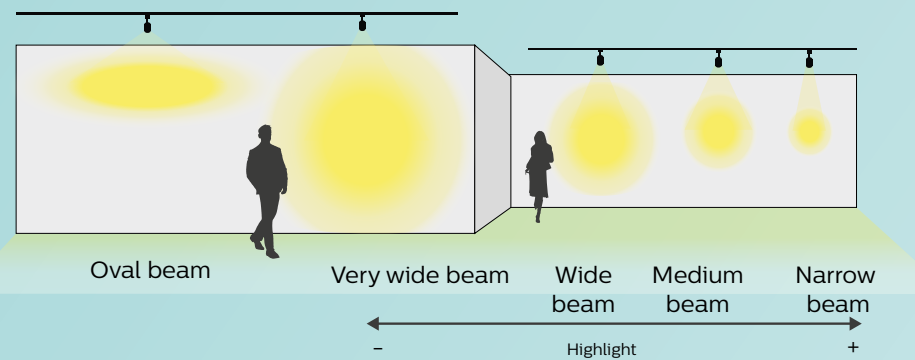


Figure 13: The complete PerfectAccent beam portfolio for retail lighting applications

**Open spaces**

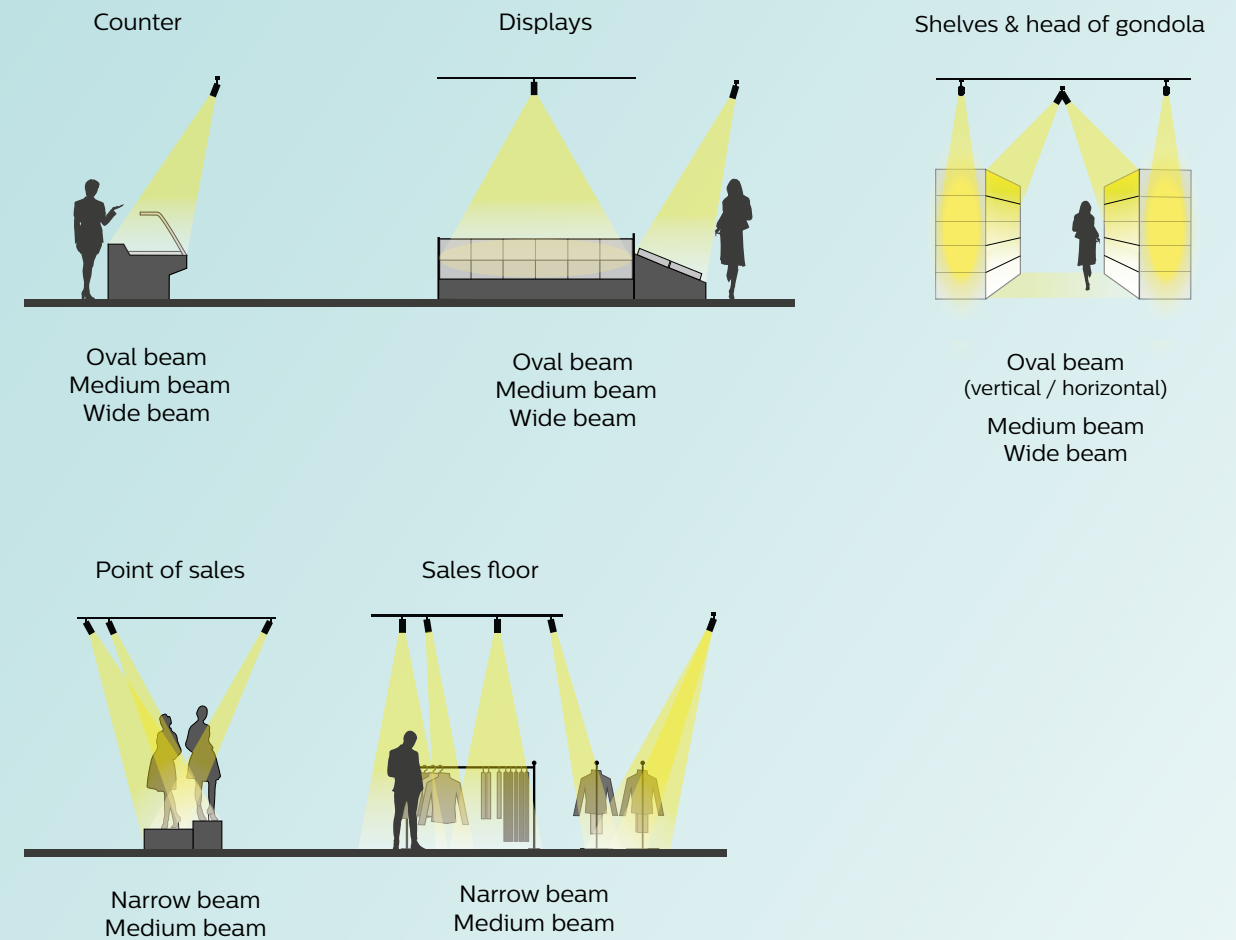


**Wall**



Application area	Optic	Light effect
	NB	strong highlight
Open spaces and Walls	MB	soft highlight
	WB	uniform
	VWB	very uniform
	OVL	focused & uniform

**Retail areas**



Application area	Optic	Light effect
Retail areas • counters • displays • point of sales • sales floor • banners • shelves • head of gondola	NB	strong highlight
	MB	soft highlight
	WB	uniform
	VWB	very uniform
	OVL	focused & uniform



## Interchangeable reflectors

With PerfectAccent, updating or optimizing store layouts is simple too, because these reflectors have the added value of easy integration with products that support the concept of interchangeable optics. This gives many of our most popular lighting ranges the advantage of being updated with a choice of different light beams – from wide beam to narrow beam and back again. This offers retailers the agility

they need to keep their stores fresh and exciting for customers. Unlike products with built-in, fixed optics for life, retailers can continue to switch between PerfectAccent reflectors throughout multiple store refreshments and layout changes. What's more, they can do it quickly and simply, on the spot and without the need for tools.



# Perfecting retail experiences

At a time when online shopping continues to dominate shopping habits, retailers must employ every tactic at their disposal to entice shoppers back into their stores. PerfectAccent provides retailers with the perfect balance between optical efficacy, visual appeal and optimized light distribution – for every different space and application in their store.

PerfectAccent promises retailers five major benefits. They can:



EyeComfort

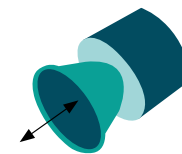
Maximize light quality and enhance shopper eye comfort



Maintain performance, reflectivity and material integrity over lifetime



Optimize efficiency and energy consumption



Choose from a selection of interchangeable light beams



Secure a fast return on investment

This makes Signify unique in guaranteeing retailers the flexibility they need to create exciting store experiences with the accent on visual comfort and optical efficiency. So they can continually delight and surprise shoppers, create exceptional lighting accents and experiences and, ultimately, drive more sales in store.





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