

DVN RGB LEDS REPORT

July 2025



Driving Vision News

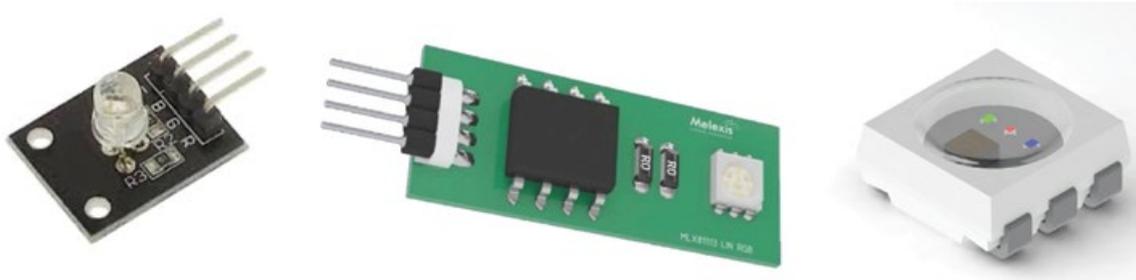
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1. INTRODUCTION

RGB LEDs are more and more used in automotive lighting industry, mainly focused on interior lighting but are now also expanding on exterior lighting application, especially in parking conditions for V2X communication.

From a quite simple electrical interface (4 pins PCB for the 3 LEDs colors + ground), technology has evolved to more complex solutions to be able to simplify calibration and realise sequential animation, from LIN and CAN to intelligent RGB (that drastically simplify the OEM wire system and open to more lighting scenarios sequences).



Hardwire RGB LED module – LIN RGB LED module – Intelligent RGB LEDs

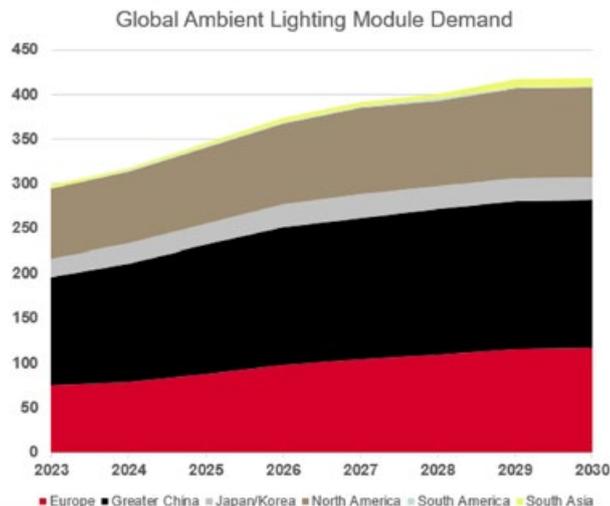
Most of all the new cars including A and B segment vehicle are including multiple RGB modules for interior lighting applications.



Renault 5 RGB LEDs on passenger side cockpit – Nio Firefly RGB LEDs on cockpit and door panels

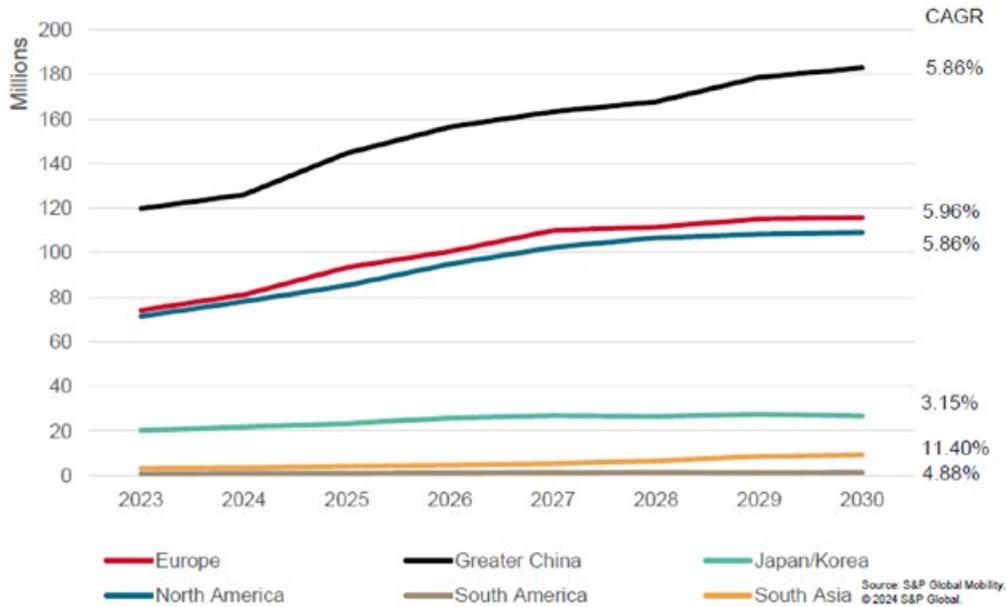
S&P mobility estimates a market size for ambient lighting module of 300 million pieces in 2024, that will extend to 400 million pieces in 2030.

Ambient Lighting Modules Global [million]



Per region, market is clearly dominated by China due to a strong interest in automotive interior wellbeing for Chinese customer, followed by Europe and north America

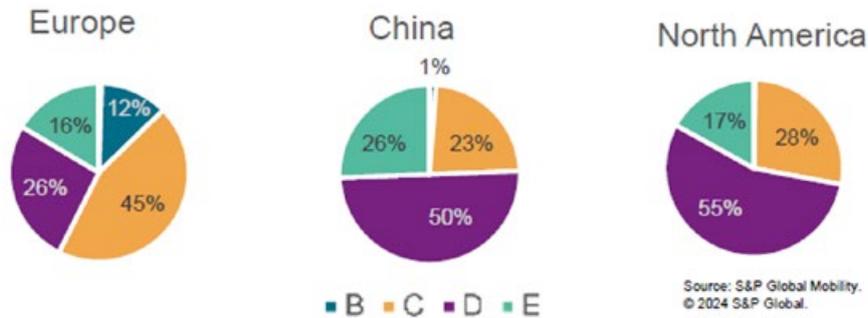
Ambient Lighting Component Demand by Region (million)



Data from S&P Mobility, DVN Tokyo event, June 2025

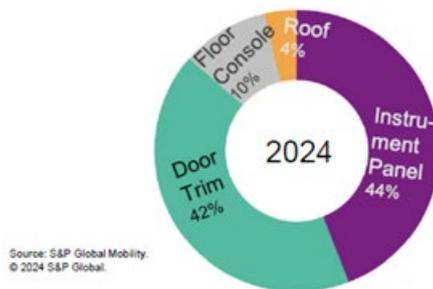
In values, C and D segments are representing most of the component demand, while main location for interior lighting is on instrument panel (cockpit) and door trim (both are representing 85%).

Ambient Lighting Component Demand by Segment 2030 (%)



Source: S&P Global Mobility. © 2024 S&P Global.

Ambient Lighting Position, Global (%)

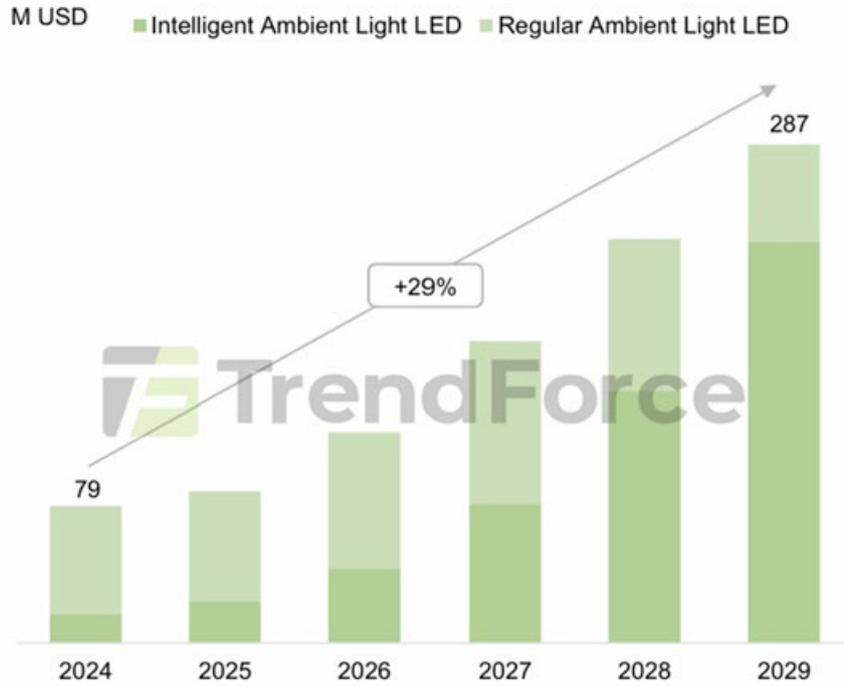


Source: S&P Global Mobility. © 2024 S&P Global.

Data from S&P Mobility, DVN Tokyo event, June 2025

Focusing on the RGB LEDs itself, Trendforce published in June 2025 the estimated automotive RGB LEDs. Regular RGB LEDs market is quite stable (around 75 million USD) while intelligent RGB market is evolving from 0 to 200 million USD in 2029.

2024-2029 (Intelligent) Ambient Light LED Market Scale



With intelligent RGB, it is possible to address multiple light sources in a dynamic sequence without any limitation (number, bandwidth, etc...).



2. RGB LEDS CHARACTERISTICS

2.1 Introduction to colours and LEDs



Colour is life! Colours influence our mood, bring life to art, and tell the story of nature's vibrancy, and we can say that they truly shape how we experience the world.

It is well known for instance that:

- Red is associated with energy, passion, urgency, and could increase heart rate and evoke feelings of excitement or dominance,
- Blue is recognized for its calming and soothing effects, and could promote relaxation and trust but can also be linked to feelings of sadness,
- Green symbolizes harmony and nature, and could foster relaxation and creativity,
- Yellow is bright and cheerful, and can boost mood and optimism, but excessive exposure might cause visual fatigue,
- Purple is often linked to creativity and luxury, and could inspire imagination and introspection.

So recreating colours with a light emission, imitating for instance what nature is doing with a rainbow, has always been a goal, realized for a long time with colored transparent elements as in the stained-glass windows of our magnificent cathedrals, or more recently with filament lamps with colored envelopes.

But we had to wait for the arrival of LEDs to have color light sources that were both compact and covering the entire field of view for multiple applications seeking pleasure from our eyes, and even beyond the visible for many other applications.

The principle of LEDs and so the first ever LED were discovered in 1927 by the Russian Oleg Losev, but the first really practical electronic components appeared in 1962 with the earliest LEDs emitted low-intensity infrared (IR) light.

By selection of different semiconductor materials, single-color LEDs can be made that emit light in a narrow band of wavelengths from near-infrared through the visible spectrum and into the ultraviolet range. The required operating voltages of LEDs increase as the emitted wavelengths become shorter (higher energy, red to blue), because of their increasing semiconductor band gap.

2.2 Definition of RGB LEDs

RGB LEDs are light-emitting diodes that integrate three individual chips in the primary colors red, green, and blue (and for RGB+W a complementary one for improved rendering) within a single package to produce a broad range of colors inside a certain gamut, including white light in a compact format, by combining the brightness of three chips. As each of their elementary red, green and blue LED is always producing light in a defined wavelength, they need electronic circuits to control the brightness and the mix of these colors. They first appeared in the 90's after the development of blue color LEDs, the last color lacking. They are now essential for display, automotive ambient lighting, signage, and decorative lighting applications, and begin to appear for exterior signalling.



2.3 Main RGB families

RGB LEDs can be grouped by power, by their chip orientation, light emitting position or ease-of-use.

- Power classes: For automotive interior, there are power classes of 0.15W for standard RGB applications, 0.5W for specific high spots, and beyond 0.5W eventually for projection.
- Chip orientation can be triangle or linear oriented. Depending on the specific application, one or the other orientation may offer a better color mix.



ams OSRAM OSIRE® E3323 In two different chip configurations

- Light emitting position: Light can be emitted to the top – then we talk about a top-looker), to one side (side-looker) or to all sides (360° side looker).



ams OSRAM OSIRE® E3635 (top-looker) and OSIRE® E5515 (side-looker)

We can also consider three families of RGB LEDs according to their ease of use for the customer, mainly for the efforts for calibration or their targeted applications: Conventional, Mini-RGB, and Intelligent RGB.

- Standard or conventional RGB LEDs, used for basic multi-color lighting needs, including regular RGB and side-illuminated RGB products for automotive interior lighting. Each LED chip (R, G, B) has separate control pins with a shared cathode or anode. They require external drivers for independent color mixing.
- Mini RGB LEDs, suitable for Interactive Screen Displays (ISD), and used in automotive exteriors lighting.
- Intelligent RGB LEDs (also called Smart LEDs or Intelligent RGB LEDs), integrating intelligent control functions for each diode, supporting dynamic lighting effects and personalized settings, with different temperature dimming correction function, suitable for interior lighting of high-end models. They often support serial communication protocols like I2C, SPI, LVDS that are standard physical protocols. ISELED and OSP are using those physical layers and add their specific data link layer, but are not really themselves standard and their benefits include space-saving, precise color calibration, and reduced circuit complexity.

Family	Conventional RGB	Mini-RGB	Intelligent RGB
Features	<ul style="list-style-type: none"> . Discrete Packaging Design . High Brightness 	<ul style="list-style-type: none"> . Miniaturized Chip Size . Enhanced Resolution 	<ul style="list-style-type: none"> . Built-in Driver IC . Smart Control . Simplified Wiring
Application	<ul style="list-style-type: none"> . Basic Ambient Light . Status Light 	<ul style="list-style-type: none"> . Smart Surfaces (Hidden App.) . Extremely Small Spaces . Flexible Modules 	<ul style="list-style-type: none"> . Intelligent Dimming . Customizable Lighting Scenes . Integration with AI Human-Vehicle Interaction
Light-efficiency	Medium	Highest	High
Power-saving	Most Energy-Saving	Regular	Significant Energy Saving
Integration Level	Low	Highest	High
Pros	<ul style="list-style-type: none"> . Products are Mature and Easy to Procure . Low Supply Chain Risk . Energy Efficient 	<ul style="list-style-type: none"> . High Brightness . Undetectable Before Illumination . Thickness Below 0.3mm, Easily Integrated into Interfaces 	<ul style="list-style-type: none"> . Chip Integration, Supports Smart Control . Can Significantly Simplify Circuit Design . High Color Uniformity . Suitable for application requiring either transparency or a very small pitch
Cons	<ul style="list-style-type: none"> . Larger Size, Not Ideal for Space-Constrained Applications . Higher Cost Compared to Mini LEDs . Noticeable Light Loss 	<ul style="list-style-type: none"> . Controlled with Complex Circuit . Difficult to Repair 	<ul style="list-style-type: none"> . High Integration Requirements for Composite Systems . Control Signal Chaining, Single Point Failure Would Affect Subsequent LEDs . Smart Controlled

Mini RGB, thanks to their ultra-thin design and minimized packaging size, are particularly interesting for display on demand, meaning they can be easily integrated into various interfaces. They can for instance remain hidden when not in use and display a variety of effects and graphics when activated.

Specific case of RGB+W LEDs

RGB+W combines Red, Green, Blue, plus White LEDs in one module. Standard RGB systems simulate white by blending colors and they can achieve an accurate white, but with a limited CRI. An added dedicated white channel provides a better CRI particularly to illuminate objects.



Example of RGB+W LED: OSRAM DURIS™ E 5050, GW J9LHS2.4M This 5050 RGBW device is the first 4-in-1 color package for general lighting applications from ams OSRAM. It features industry-compatible performance and form factor. Each chip is individually controlled to enable high customization color options along with tight wavelength and color binning for excellent homogeneity.

Red (612-630 nm)	0.21 W				
Green (565-575 nm)	0.3 W				
Blue (450-480 nm)	0.31 W	9.46 lm	3.15 cd	105 mW	34.9 mW/sr
White	0.29 W				

The big challenge with RGB+W is: which W (Cold. Warm. Neutral). Which CRI (type of phosphor system). And associated cost. The advantage of RGB+W is size, having all in one package.

For automotive, RGB+W was explored for exterior and interior lighting to improve CRI, achieving a CRI between 80 to 90 when RGB LEDs are often limited to a CRI of around 60. Although interest seemed to wane in recent years, recent statements suggest the technology is still interesting for high quality rendering.

Even if the trend has cooled off, its potential for safety-compliant chromatic rendering keeps it relevant.

But in front of all their technical advantage for CRI, these RGB+W LEDs are more expensive, limiting their adoption.

Specific case of RGB LEDs with phosphor

Another family is RGB LEDs using phosphor conversion, but they are relatively uncommon compared to traditional RGB LEDs.

Phosphor conversion involves using a short-wavelength LED (typically blue or UV) to excite a phosphor material, which then emits light at a longer wavelength. This is commonly used in white LEDs, where a blue LED excites a yellow phosphor to produce white light. For RGB phosphor-converted LEDs, each color channel (Red, Green, Blue) would use a different phosphor formulation to emit its respective color when excited by a common excitation source (usually blue or UV).

The advantages are improved color stability over temperature and time, better spectral tuning as phosphors can be engineered to emit specific wavelengths, and higher color rendering that is especially useful in lighting applications where accurate color perception is important.

But the challenges are more complexity requiring precise phosphor engineering for each color, efficiency loss as phosphor conversion introduces some energy loss, slower response time as phosphor decay can limit modulation speed, which is critical in display or communication applications

So their applications are mainly limited to High-CRI lighting requirements where accurate color rendering is more important than fast switching.

An example of these specific RGB LEDs is the Seoul "Sunlike" LEDs allowing an improved white light with no gaps, no peaks in the wavelengths with a good continuity from blue to red.

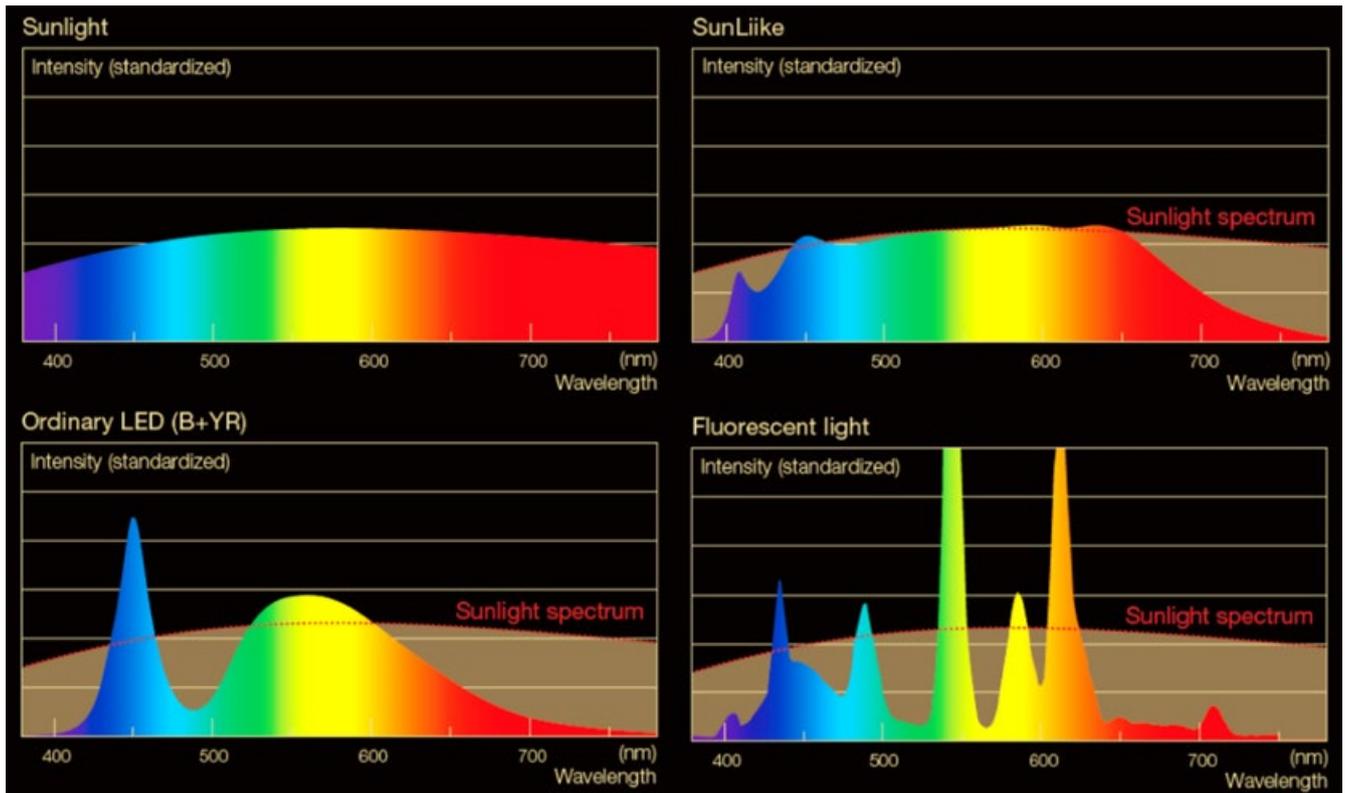
The advantages for users are the perception of beautiful environment, comfort, and they can also be considered healthier with less blue color and more natural light.

Even if an excellent white color is one of the main purposes of this family of RGB LEDs, they can also bring interesting effects for color tuning with their broader wavelength for each basic color.

Example of Seoul Sunlike LEDs:



Spectral comparison of 5000K color temperature



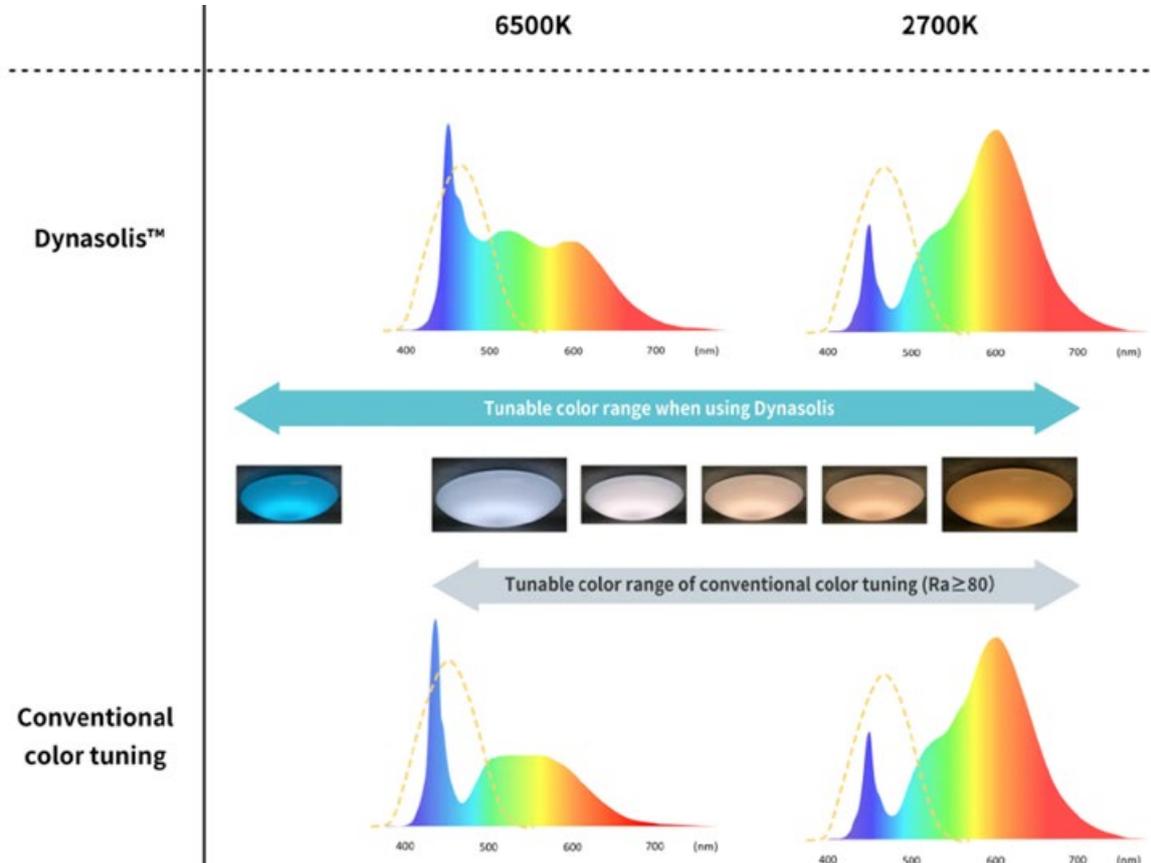
There is for instance an application in the interior of Volvo EX90 where the targets were to have:

- a light closer to a natural environment,
- natural sunlight through the complete journey – day and night,
- a tunable color temperature,
- an increased interaction by changing the color temperature depending on intensity,
- to illuminate all materials and give attention to details without over-illuminating.



Another way to produce tunable colors is the use of two LEDs, one blue and the other red with adapted phosphors. They cannot really be considered as RGB as they cannot produce every color, but they are more intended to produce a light like the natural one produced by the sun changing from an orange color during sunset to a bluer one mid-day, and so helping to follow the natural circadian rhythm.

An example is the Dynasolis Nichia LED with one LED emitting at 6500K and the other at 2700K.



Specific case of Laser diodes RGB

Another potential important family for the future are laser diodes RGB. They are combining high luminance and reliability. Nichia is for instance proposing their QuaLas platform, and is claimed to be the world’s first SMD RGB laser to meet automotive requirements with a wide colour gamut for vivid visuals, a long lifespan to reduce maintenance costs, and compact design for flexible integration across various systems. The Laser technology is particularly well suited for projection applications, that represents currently 80% of the global laser market, only 3% being in automotive applications. But in the future, laser RGB could be used for HUD, enhanced dashboard, entertainment interior projection, laser exterior or interior illumination, or even for headlighting.



Example of exterior laser illumination (Source Nichia)

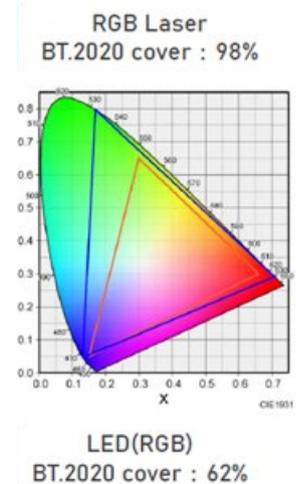
For laser illumination with a fibre optics having an outer diameter of 1mm, a length of 10m is achievable with around 20,000nits and a power consumption of 9,2W with Nichia Qualas.



Laser RGB can naturally be used for entertainment in interior automotive as seen on Aito Model M9 (Source Nichia). Laser projection has several advantages including wide color gamut with clear vividness, and high visibility in daylight due to their brightness.

Comparison between RGB LEDs and RGB laser for projection:

System	LEDs	RGB Laser
Color gamut BT. 2020	Narrow > 62%	Wide > 98%
Light engine	Large Mounting area	Small 30% of LEDs
Projection devices	Medium Size 0.33 inch -	Small Size 0.23 inch -
Optics	Large	Small
Consumption	High	Low



Source Nichia

Projection output : Over 1,000lm

2.4 Main technical characteristics of RGB LEDs

Achieving a *homogeneous and stable color* is a challenge, particularly as LEDs have slightly different emission patterns, the color balance may change depending on the angle of view, even if the RGB sources are in a single package. Color rendering and efficacy are other important characteristics of RGB LEDs. RGB LEDs can so produce white color, and in that case, the best efficacy is achieved with dichromatic LEDs at the price of poor color rendering. Color rendering is optimized with tetrachromatic LEDs but with relatively poor efficacy, so RGB diodes are seldom used to produce only white lighting, phosphor-based LEDs being the most commonly used for that.

2.5 Highlights of past developments

More than twenty years ago, by enforcing the SMD technology also for LEDs, the first RGB LEDs could be designed, finding sufficient space on the substrate to place three chips closely next to each other. Those RGB LEDs have been developed as stand-alone devices. A separate driver has controlled their brightness and the mixed color.

Over these past years, RGB LED technology has made significant advances in brightness, energy efficiency, enhanced binning capability for color accuracy, and reliability. While early RGB LEDs were primarily used for simple decorative lighting, today, with advances in technology, RGB LEDs are capable of complex dynamic lighting effects and precise color control.

About Packaging and Binning, early RGB diodes achieved color mixing by RGB chips in the same package requiring precise alignment and optical design for uniformity and brightness.

RGB Chip Layout were developed with three architectures:

- Cluster, ensuring uniform color mixing, high brightness, seamless transitions, and high-resolution images.
- Linear, allowing flexible installation and consistent lighting over long distances for LED strips and architectural lighting.
- Matrix, maximizing pixel density and color accuracy for sharp, vibrant images.

Color Distribution: Achieving concentrated color distribution was crucial to reduce specification binning, simplify inventory management, and ensure consistent product quality.

The Driver IC Integration into the LED package was another important past development matter, to simplify circuit design, reduce external passive components, and improve reliability and cost-effectiveness. But this integration required to maintain IC function integrity and strong internal bonding wires.

Compactness and miniature designs for space efficiency were other major improvements.

2.6 Future developments

Future developments are planned in the following directions:

Improved color scenarios: Smarter control with Intelligent RGB or ICLED and AI will be able to achieve a better color control, to adapt lighting to driver behaviour, emotions and functional safety. These smarter control systems will become mainstream.

Higher Energy Efficiency: With the accelerating trend of EVs, development of ultra-low-power RGB LEDs and calibration to support EV range optimization.

High-Power LEDs with Thermal Dissipation: Advanced thermal management in high-power RGB LEDs for applications like stage lighting and architectural illumination to prevent overheating.

Compact Design & Cost Efficiency: Miniaturization allowing smaller packages with improved performance and high integration to offer design flexibility, reduced cost, and no interference.

Enhanced Reliability with Wireless Technology: Eliminating wire bonding in LED packaging to improve reliability and reduce failure risks in automotive applications.

Integrated Sensors: RGB LEDs may be integrated with ambient light sensors or cameras to enable adaptive lighting.

Advanced Communication Protocols: Evolution of ILaS® & CAN-FD and Automotive Ethernet for faster data transmission.

See more details about ISELED and OSP in the chapter 7 Electronic Architecture.

2.7 Challenges for RGB LEDS realization and implementation

There are traditional challenges met in every technical product like:

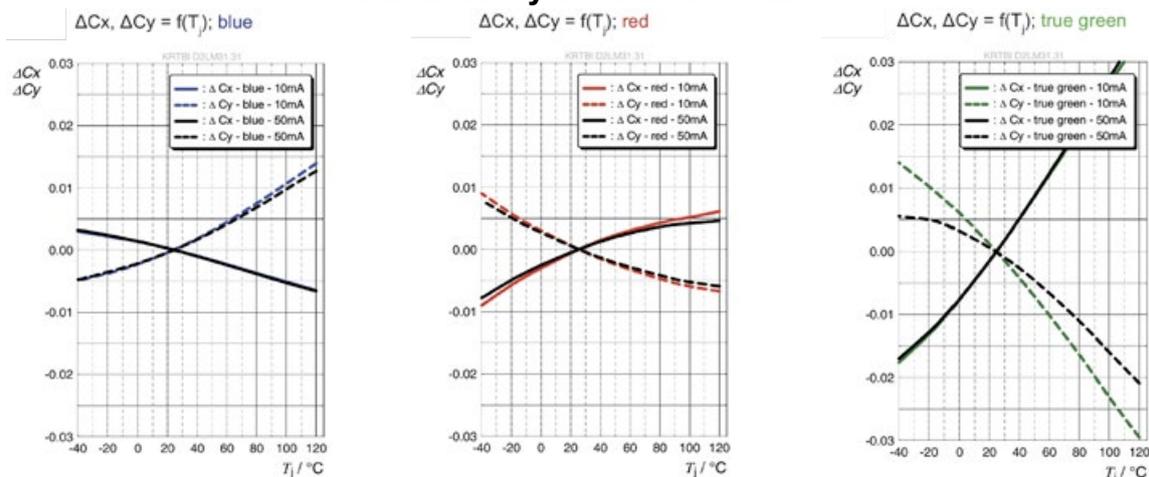
- The need to well understand the market needs and translate those into product requirements.
- The need to control and continuously improve the key technologies, mainly chip technology and packaging technology, with a strong focus on distribution management.
- And the need to ensure the production quality and logistics. This item includes robustness of supply chain but also geo-political aspects.

More specifically for RGB LEDs, the challenges are:

Color Consistency: The color output of an RGB LED is a mixture of red, green and blue light, and the brightness and chromaticity of each color must be precisely controlled. However, due to minor differences in the manufacturing process and material properties of LED chips, the color output and the thermal behavior under different temperatures of LEDs may vary even within the same batch.

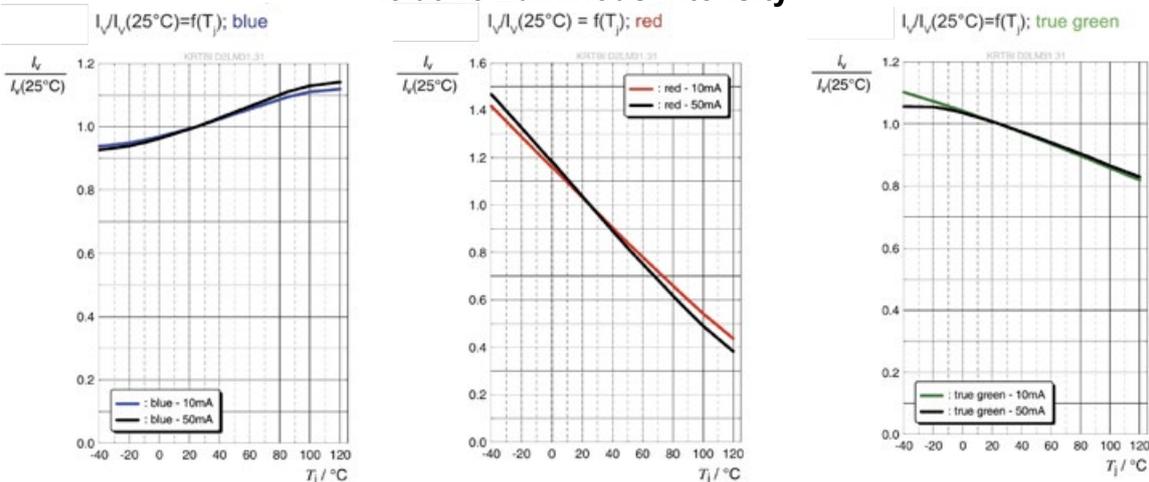
High-temperature color drift problem is particularly difficult as when they are emitting, the conventional RGB LED will introduce heat and lead to increased temperature. The red, green and blue chips at high temperatures have different degrees of brightness attenuation and color drift. The red light is the most affected color. The increase of temperature is so changing the mix of colors. Color consistency must be maintained across production batches and over the LED's lifespan. The intelligence integrated in Intelligent RGB LEDs are particularly helping to produce a better color consistency.

Chromaticity Coordinate Shift



Extract of ams OSRAM KRTBI D2LM31.31 - Evolution of the color of each R-G-B chip according to temperature

Relative Luminous Intensity



Extract of ams OSRAM KRTBI D2LM31.31 - Evolution of the brightness of each R-G-B chip according to temperature

Color rendering refers to how accurately a light source reveals the colors of objects compared to a natural or ideal light source. It is an important factor in lighting design, especially in environments where color perception matters, such as art galleries, medical facilities, photography

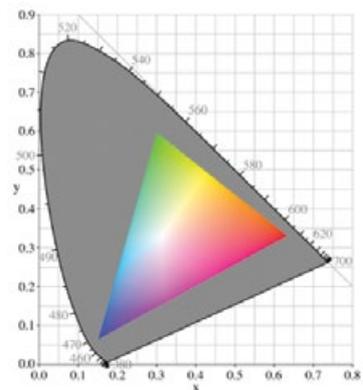
studios and obviously interior lighting. One common metric used to measure color rendering is the Color Rendering Index (CRI), which rates light sources on a scale from 0 to 100, with higher values indicating better color accuracy

Multicolor LEDs without phosphors cannot provide good color rendering (generally <60) because each LED is a narrowband source. LEDs without phosphor, while a poorer solution for general lighting, are the best solution for displays, either backlight of LCD, or direct LED based pixels.

Advanced Color Calibration is Essential for high-precision color control, accounting for temperature changes and aging, with potential AI and software advancements.

Color gamut: The gamut of an RGB LED light source is defined as a triangle within the color space. The gamut depends on the color points of each individual LED, and a larger triangle means more colors available.

Calibration is needed for color gamut, as for the white point.



Temperature Compensation: Besides the variation of colors due to the self-increase of temperature during operation, in automotive interiors, temperature variations across different installation locations further complicate color stability, making uniformity even more difficult to achieve.

Good thermal management or even better, the use of temperature-corrected Intelligent RGB are needed to avoid temperature problems for color and efficiency. Advanced Color Calibration is essential for high-precision color control, accounting for temperature changes and aging, with potential use of AI for the optimization. These advanced Intelligent RGB LEDs, for instance featuring 16-bit PWM, enables precise color tuning to compensate for bin variations and color shifts caused by temperature changes, with color calibration completed in just seconds.

The temperature compensation is particularly critical for high-power RGB LEDs, and it requires structure design with advanced materials for heat dissipation to ensure reliability.

RGB bin management: Ensuring consistent color uniformity output across mass production requires a precise binning process. For RGB LEDs, this challenge is even greater, as maintaining color consistency at both the diode and module levels is complex. In relation to the color consistency and color rendering, customers have different requirements for RGB LEDs. Some high-end customers may require very strict bin grading, while ordinary customers may accept larger standards, making it difficult to standardize the bin grading scheme. In order to meet different customer requirements, the production line needs to be highly flexible, which increases the complexity of production.

Group	Dominant Wavelength ²⁾	
	min. λ_{dom}	max. λ_{dom}
RED		
JP	620 nm	625 nm
MT	623 nm	629 nm
RW	627 nm	632 nm

TRUE GREEN

JP	524 nm	529 nm
LR	526 nm	531 nm
PU	529 nm	534 nm
RW	531 nm	536 nm
U3	534 nm	541 nm

BLUE

51	449 nm	453 nm
3C	451 nm	456 nm
AF	454 nm	459 nm
DH	457 nm	461 nm
FK	459 nm	463 nm
HM	461 nm	465 nm
KP	463 nm	467 nm
MS	465 nm	470 nm
QV	468 nm	473 nm

Extract of ams OSRAM KRTBI D2LM31.31 – examples of Bins for each color

Efficacy, or lumen per watt, is one of the challenges particularly to achieve more efficient green LEDs. The theoretical maximum for green LEDs is 683 lumens per watt (it is even used for the definition of a lumen), but few green LEDs exceed even 100 lumens per watt. Besides that, blue and red LEDs approach their theoretical limits.

Mini-LED Integration: Challenges include precise alignment and integrating complex driver circuits within a tiny footprint space, and it needs innovative and precise manufacturing processes.

Intelligent Packaging Design: Incorporates real-time data monitoring, environmental sensors, and adaptive lighting controls to balance innovation with sustainability.

Wire and Semiconductor Integration: Enhances reliability, miniaturizes packaging, and reduces costs by incorporating wire-removed semiconductor technology.

Supply Chain and Scalability: Ensuring robust supply chains and scalable production processes to meet growing demand, addressing material availability, manufacturing capacity, and quality control.

Electromagnetic Interference (EMI) to avoid signal interference in Smart RGB solutions.

Cost control: Now, specifically as the amount of ambient light points is increasing per car and per application inside of a car, the big challenge is to get both unit and system cost down.

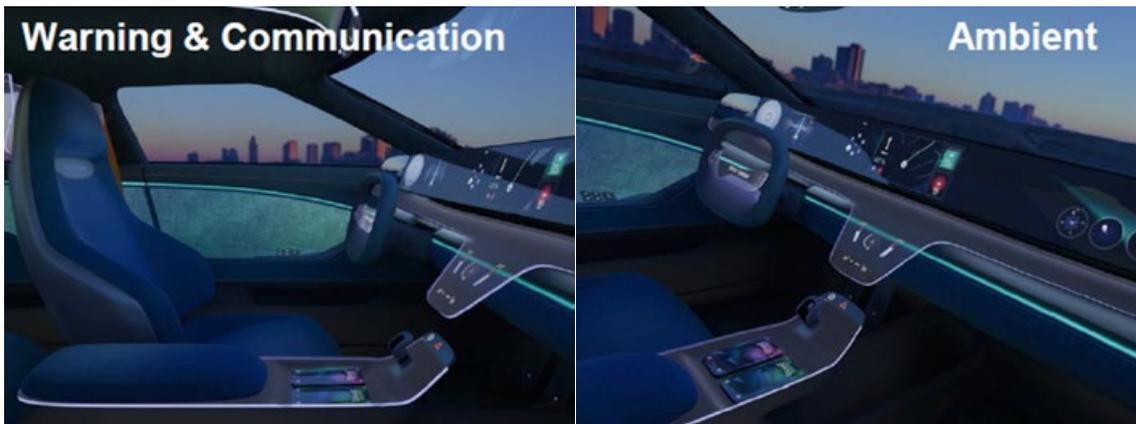
Handling unit cost reduction is a clear target for each LED manufacturer. But more difficult is the subject of system cost as there are a lot of system costs at tier 1s associated with the following three subjects:

- Calibration – as each LED chip is individual, each RGB LED needs to be optically characterized.
- Color correction / temperature compensation
- Physical integration cost:
 - reduction of size of board in width and thickness to save space and reduce cost of board
 - reduction of number of layers to support cost effective bendable constructions (e.g. 1 or 2-layer flex, or foils).

In particular, component cost of an intelligent RGB LEDs are typically higher than a comparable BOM of a standard RGB LED plus the cost for the RGB channel of a separate driver. However, a cost comparison on system level, considering calibration cost, cost of substrate width and number of layers, is showing the commercial benefit of intelligent RGB LEDs for a dedicated application.

Communication protocols: Another challenge that will be described in detail in the chapter Electronics architecture, lies in the lack of standardization for communication protocols between LEDs through LED IC. While protocols exist such as ISELED, LED manufacturers like Osram and Dominant (OSP protocol) or Nichia have also introduced their own open protocols. However, a unified solution that the industry can adopt universally has yet to emerge.

2.8 Intelligent RGB LEDs – RGB LEDs with integrated intelligence



Examples of applications of Intelligent RGB for Warning, Communication, or Ambient light (Source ams OSRAM)

Intelligent RGB LEDs are offering a very competitive solution for dynamic communication or ambient applications. They allow integration of pre-calibration, temperature compensation and standard addressability in one embedded ASIC and such reduces space and thickness of the used substrate. The first applications started in the Asian market and first designs including this technology are prepared in other regions.

Currently, the number of individually addressable dynamic ambient (RGB) light points inside cars is increasing significantly. In parallel this increase becomes true for exterior applications, while here the focus is on the legally allowed colors, not that much on RGB. Intelligent RGB is by nature more expensive compared to high multichannel driver ICs managing standard RGB LEDs and the available LED types on Intelligent RGB are today still limited compared to traditional driver/LED combination. But the amount of available Intelligent RGB is growing fast. Conversely, Intelligent RGB is simplifying wiring and PCB with all LEDs in a row instead of LEDs in parallel.

In this context, Intelligent RGB will become the first choice for dynamic light applications, while RGB will stay the first choice for static applications.

Typically, an Intelligent RGB is co-packaged with an IC that features three LED drivers, a serial bus interface supporting, a temperature sensor and on-chip memory.

For Intelligent RGB, several evolutions are already starting now:

- Currently in early adoption, Intelligent RGB's potential is driving increased uptake as semiconductor advancements make components more affordable and reliable. The demand for enhanced in-cabin experiences and brand differentiation is accelerating their adoption.
- Over half of luxury vehicles now feature intelligent lighting systems with multi-color, customizable options that improve safety and comfort. Ambient lighting that adapts to driving modes or the driver's mood creates immersive experiences.
- This trend is expanding to mid-range models. As costs decrease and integration simplifies, broader adoption across vehicle segments is expected. It is expected that by 2030, over half of interior automotive lighting systems will incorporate Intelligent RGB technology, driven by consumer demand for personalized experiences and continuous innovation.

So, Intelligent RGB technology will revolutionize automotive lighting, becoming a standard feature by 2030 and transforming vehicle interiors.

3. COLORIZED LIGHT BY MONOCOLOR LEDES OR BY RGB LEDES COMPARISON: ADVANTAGES AND DRAWBACKS

When a specific color is needed, for instance in interior a high beam indicator will always be blue and a turn indicator signaling typically green, using RGB color mixing may result in poor color stability due to process variations. In that case, mono-color or converted white LEDs are a perfect fit offering optimal stability.

If a full-color or dynamic effect with color changes within a certain gamut are required, RGB LEDs are the best solution. Achieving the same effects with monocolour LEDs would result in higher overall costs and would require more space to accommodate three times the number of LEDs. Consequently, for interior applications such as ambient lighting, or for exterior dynamic lighting, RGB LEDs are better suited as they can offer a full color range and dynamic effects.

Conversely, for external applications regulated like taillights, single-color LEDs are typically used to meet legally mandated color requirements.

Category	Criteria	Monocolour LED	RGB LEDs
Applications		Simple Function like indicator lights Static function with Fixed Color like static Ambient lighting	Dynamic Color Mixing, Varying Ambient Light, Functional Safety Applications Customizable Effects
Pros	Color	<ul style="list-style-type: none"> . Provides Precise, Stable and Consistent Color . The Simplest PCB Design. 	<ul style="list-style-type: none"> . Wide Color Spectrum for Dynamic lighting (millions of different hues through color mixing) . Lower Cost than iRGB (<50pcs)
	Complexity and Cost	<ul style="list-style-type: none"> . Relatively Low Cost for Basic Application, particularly single-color needs 	<ul style="list-style-type: none"> . Space-saving for RGB-in-1 Package
	Energy Efficiency and Space	<ul style="list-style-type: none"> . Good energy efficiency 	
Cons	Color	<ul style="list-style-type: none"> . Limited Color Flexibility and Coverage 	<ul style="list-style-type: none"> . Color Consistency Challenges
	Complexity and Cost	<ul style="list-style-type: none"> . Complex Design and more expensive for Multi-color Systems . Voltage sensitive 	<ul style="list-style-type: none"> . Complex Drive Circuit, particularly without iRGB . Higher thermal management requirements
	Energy Efficiency and Space	<ul style="list-style-type: none"> . More Space and Components for Color Mixing 	<ul style="list-style-type: none"> . Difficulty in LEDs binning.

So, RGB LEDs are primarily focused on interior lighting rather than exterior applications. This is largely due to regulatory restrictions that currently do not permit multicolour lamps for exterior use, except for specific scenarios such as parking mode. Additionally, there is the strong demand for more reliable light sources with higher power output to ensure visibility during the day, as current RGB solutions are limited to 0.5W, which is insufficient for many exterior needs.

The alternative solution to RGB light sources is so the use of discrete colour LEDs, all based on blue diodes with different phosphor conversion for each colour. The main advantage of this approach is to simplify the colour shift management by delivering consistent performance even at high temperatures, eliminating the need for individual PWM adjustments for each LED. Discrete colour LEDs also overcome power limitations, making them more suitable for exterior applications. Additionally, there is no need to add a fourth LED to obtain a real white colour (RGB-W solution) as this can be easily handled with broader colour gamut management. This combination of benefits makes discrete colour LEDs an attractive option for exterior lighting in automotive applications.

4. RGB LEDS MAKERS

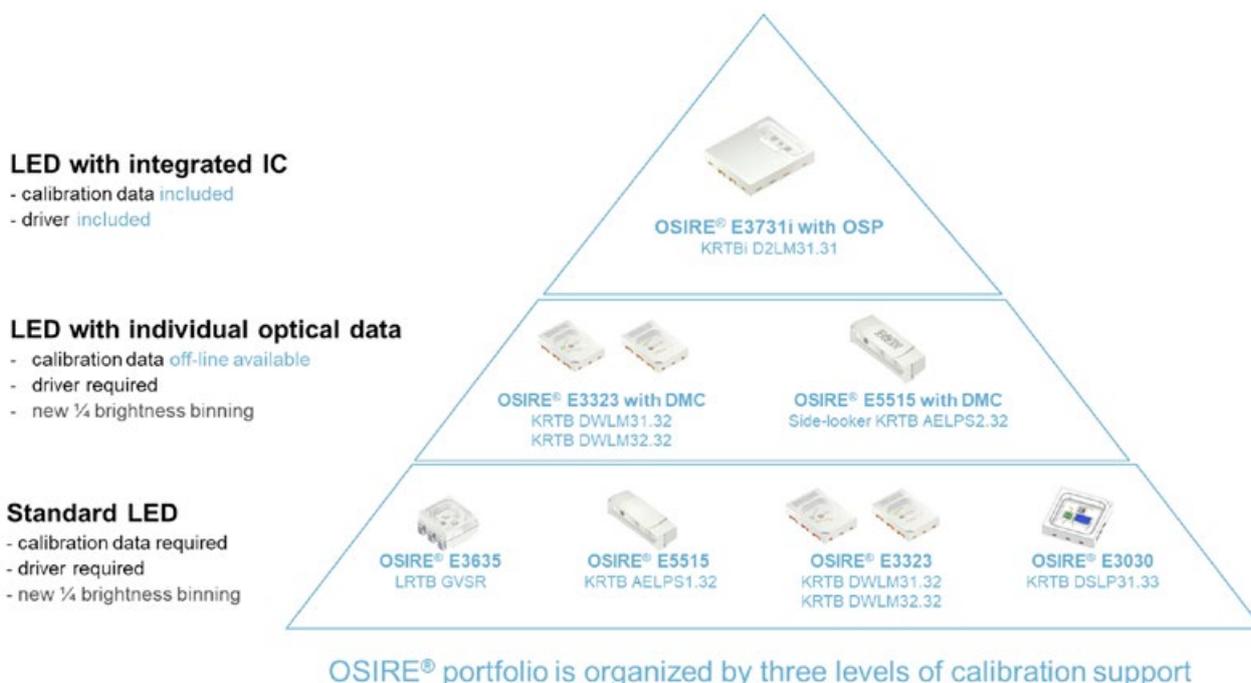
ams OSRAM

ams OSRAM is a leader for light sources and sensors, with 19,700 employees and 3.4 billion revenues in 2024, headquartered in Premstaetten/Graz, Austria and Munich, Germany.

They have a very large portfolio of every source including many color LEDs and multi-color RGB LEDS.

To address cost aspects and allow tier 1 to make an appropriate choice, ams OSRAM has set up an RGB LED product portfolio under the brand OSIRE®. The portfolio is organized as pyramid, starting with standard RGB devices on the bottom, RGB devices with additional data in the middle and intelligent RGB devices on the top.

ams OSRAM structuration of their RGB LEDS



The use of RGB LEDs might impose some extra effort in calibrating each module. ams OSRAM offer RGB products with optical measurement data available by scanning a QR-Code, which is unique for every RGB LED and can then easily be used to pre-calibrate the module. Furthermore, using their “intelligent” RGB LED, each LED includes a driver-and communication IC, which communicates its specific optical data as well as temperature back to the MCU. This enables on-the-fly real time calibration to the exact color point at every temperature without the need of the burden of pre-calibration on module level. ams OSRAM have so a large pallet of LEDs for the various requirements of the different applications, whether monochrome, white or RGB available.

ams OSRAM had developed a short video to demonstrate the principle of dynamic light applications that may be used for decorative purposes, here showing smooth color animation at the inside of the doors.

Intelligence built into every LED

The development of the new intelligent LED draws on the extensive capabilities of ams OSRAM in optical technology and IC design and fabrication. The OSIRE™ E3731i is a high-performance RGB LED co-packaged with an IC that features three LED drivers, a serial bus interface supporting the OSP, a temperature sensor and on-chip memory.

Each intelligent RGB LED is characterized at the factory, and its optical performance data are stored in the LED's on-chip memory. This makes it easier for automotive manufacturers to perform end-of-line calibration of interior lighting systems, and to achieve very high optical uniformity and consistency across arrays of hundreds of OSIRE™ E3731i LEDs.

The OSIRE™ E3731i is now qualified to the latest AEC-Q102 Annex 3 standard.

As OSP is open and is not defining applications features, several ones are possible. To support this capability ams OSRAM developed besides the intelligent RGBi called OSIRE E3731i, a stand-alone driver, called SAID. SAID enables an extension of the network to go beyond dynamic ambient applications: it allows a customer to add single colors, other types of RGB devices (like RGB side-looker), sensors and actuators into the same network. For ams OSRAM, SAID demonstrates their slogan "OSP is for dynamic light applications and more", as with OSP, any microcontroller can transmit instructions to modulate brightness and color individually to each LED. OSP is available for use license- and royalty-free by any car, LED, lighting system or microcontroller manufacturer. Hermann Senninger, Senior Product Manager of ams OSRAM, said: 'Dynamic lighting promises to add value to cars by combining changes in color and brightness with pulsing, breathing or moving light effects, for decorative or functional purposes. The OSIRE™ E3731i and OSP enable dynamic interior lighting to be implemented with a simpler architecture, fewer components, less wiring and at lower system cost. These benefits are attracting customers world-wide. OEMs from all regions, Asia, NA and Europe, have selected our solution. The cars are on the street.'

Characteristics of the OSRAM OSIRE™ E3731i, KRTBI D2LM31.31



Parameters

Color of emission		Red (612-630 nm)	Brightness	Φ_V	1.77 lm
		True Green (513-545 nm)		I_V	0.61 cd
		Blue (450-480 nm)		Φ_E	9.59 mW
			I_E	3.3 mW/sr	
Beam angle	α	120 °	Operating temperature	$T_{op \text{ min.}}$	-40 °C
				$T_{op \text{ max.}}$	110 °C
Dimension	l	3.7 mm			
	w	3.15 mm			
	h	0.65 mm			

APT



The company was founded in Hong Kong in 2003 (Advanced Photoelectric at HKUST) Apt has developed many advanced core technologies including flip-chip LED technology, advanced white LED packaging photo-conversion technology, advanced LED integrated packaging, etc. Meanwhile, APT has developed a series of competitive key products, including automotive-grade LED device, automotive electrical module and intelligent automotive lighting system; new backlight device and module for high color gamut and slim LCD display, Mini LED display device and module, high-end lighting device and module used for indoor & outdoor lighting, intelligent lighting, horticultural lighting, UV/IR and other special lighting.

Examples of RGB LEDs:



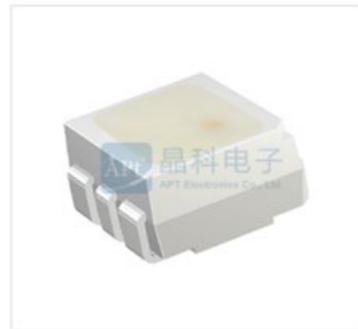
3030

RGB EMC 3030 Package



3528 RGB

RGB 3528 Package



PLCC-6 RGB

RGB PLCC-6 Package

Product details of 3528 RGB LED:

Series	Model	Power	Forward Current Typ.	Luminous Intensity Typ.	Wavelength Typ.	Forward Voltage Typ.	Size
 PLCC-6	AJ3-TC.SNO	0.06 W	20 mA	1500 mcd	622 nm	2.1 V	3.5×2.8×1.8 mm
		0.06 W	20 mA	3250 mcd	525 nm	3.0 V	3.5×2.8×1.8 mm
		0.06 W	20 mA	670 mcd	469 nm	3.1 V	3.5×2.8×1.8 mm

Brightek



Brightek Optoelectronic Co., Ltd. specializes in providing high-quality LED and sensor packaging, and optoelectronic solutions, with a strong focus on automotive and consumer electronic sensing applications. Founded in 2001 and headquartered in Taiwan, Brightek has established subsidiaries and sales offices in Shenzhen, Nantong, Kunshan, and Tianjin in China, expanding its market reach to over 60 countries worldwide. They are involved in automotive products like Automotive Occupancy Monitor, System Driver Monitor, System Ambient Lighting Interior and Lighting Exterior, these activities representing 40% of their global sales. They are also involved in Consumers products and sensing.

Examples of standard RGB LEDs from Brightek:



TOP LED 3030 RGB



TOP LED 3433



TOP LED 3528



TOP LED 3433 RGB

Brightek has also developed several ISELED RGB LEDs that they are calling now ICLED.



SIDE-VIEW ICLED 5525

3500 mcd
 With white calibration
 8-16 bits PWM, **54mA (Total)**
 Temperature sensing
 -40~110°C



3838 EVO

4000 mcd
 With white calibration
 8-16 bits PWM, **54mA (Total)**
 Temperature sensing
 -40~125°C



3233 ECO

3000 mcd
 With white calibration
 14 bits PWM, **40mA (Total)**
 No temperature sensing
 -40~110°C

Example of Brightek Intelligent RGB LED 3233: Main characteristics:

Part Number	Emitter Color	Wavelength	Electrical Power	Forward Current (I_f)	Luminous Flux (Φ_v)	Luminous Intensity(I_v)	
PV3233CMTCM20601	Red	612-630 nm	0.15 W	11 mA	- lm	560 mcd	120 °
	Green	565-575 nm		12.7 mA	- lm	1300 mcd	
	Blue	450-480 nm		5.9 mA	- lm	140 mcd	
	White	-		31 mA	- lm	2100 mcd	

Examples of Brightek ICLEDs applications:



Source Brightek

Calibration of RGB LEDs is a challenge and recently Brightek presented their UPP system: COLORbrate the Colors Within Seconds.

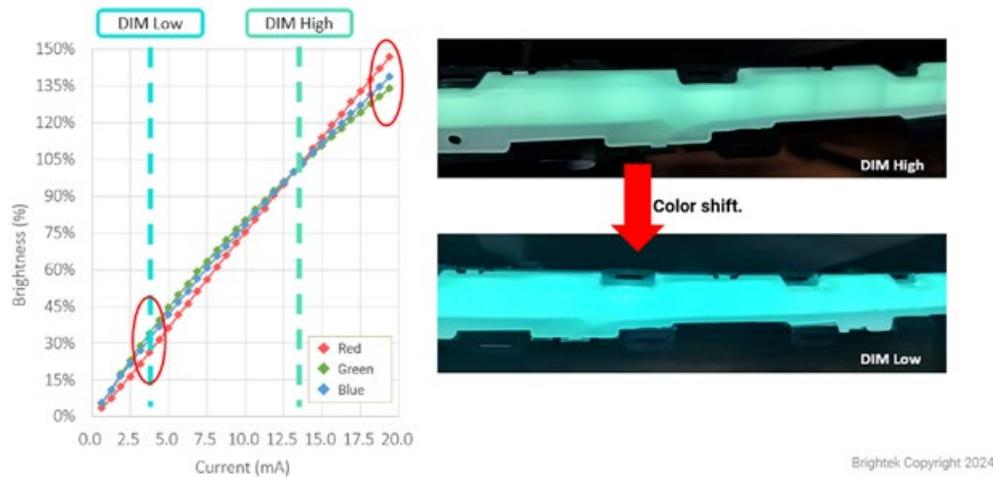


In automotive lighting, below are the possible Challenges in RGB LED Calibration:

- **Non-linear Brightness Adjustments:** Adjusting LED brightness isn't straightforward. When designers modify current levels to change brightness, RGB components don't respond in a predictable, linear way. This can lead to color inconsistencies, especially when brightness varies.
- **Temperature-Induced Color Shift:** LEDs are sensitive to temperature changes. In automotive environments, where temperatures vary widely, LED colors tend to shift, compromising intended colors and uniformity.
- **Module Surface Effects:** RGB LEDs emit light through various module surfaces, and different surface materials can alter the perceived color. When multiple LEDs interact with various textures, it's difficult to maintain a uniform appearance.

Brightek's Ultimate PWM Program (UPP) software is aiming to achieve rapid, reliable color calibration by transforming the complex task of RGB LED alignment into a streamlined process. Rather than relying on time-consuming manual adjustments, UPP uses an advanced algorithm that converts the X/Y axis on a CIE color system into precise Pulse Width Modulation (PWM) settings, enabling highly accurate color adjustments across LEDs.

- R/G/B color behavior is **nonlinear** across various currents.



This conversion process is critical for achieving uniform color output across multiple LEDs on the same surface or light bar. By mapping each LED's color precisely to the target coordinates on the chromaticity scale, UPP try to ensure every LED displays the same color—even if LEDs have slight variations in manufacturing, as per Brightek states, with an impressive 99% accuracy.

How UPP Calibrates Colors?

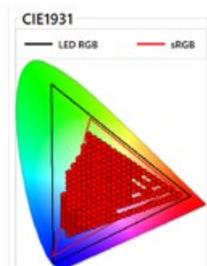
- **Converting Chromaticity Coordinates to PWM:** UPP translates the X/Y values on a CIE color coordinate into corresponding PWM signals. PWM allows the software to control the RGB intensity levels precisely
- **Uniform Color Across All LEDs:** Once the PWM settings are calibrated, every LED on the same surface or light bar will display a consistent color, even if individual LEDs naturally emit light with subtle variations.
- **Adaptable for Complex Installations:** For Automotive Lighting where LEDs often interact with different surfaces, materials, and module designs, UPP's PWM-based approach can be a good solution.

UPP aim to bring designers below benefits:

- **Save Time:** UPP's swift calibration process, by using Brightek superb EVO 3838 ICLED, is 5X faster than traditional methods
- **Achieve Greater Precision:** With high-fidelity algorithms, UPP delivers 99% accuracy in seconds using EVO 3838 ICLED- Ensure Long-Term Reliability: Managing both brightness and temperature-induced color shifts.

**Maximize Accuracy,
Minimize Time**
EVO iCLed Accelerates
Calibration Time
and Perfect Your Colors

Performance Index	<i>EVO</i>	Other Brand Smart LED
Total Colors Calibrated	256	256
Total Calibration Duration	29 min 47 sec	2 hours 31 min
PWM Tuning Accuracy	99.06 %	42.54 %
Average Regression Count	0.19	11.49
Total Regression Count	48	2942
Total Calibration Retries	0	92



5X Faster, 99%+ Accuracy

Dominant



DOMINANT Opto Technologies is one of the leading light-emitting diodes (LEDs) manufacturers in the world. They were established in 2000, and have expanded globally, with 6 regional offices working in close proximity to key design centers located in Europe, the United States, China, Japan, South Korea and India to provide professional sales and technical support. They have 2800 employees, including 230 in R&D.

They have a product portfolio that ranges from low to high-intensity LEDs with a wide range of color spectrum for interior applications e.g. instrument cluster, infotainment system, climate control, switches and ambient lighting as well as exterior applications e.g. headlamp, tail lamp, rear combination lamp, central high mounted stop lamp and license plate lamp.



They also produced RGB LEDs, with hereafter some details about some of them.

Picture	Category	Part No.	Size LxWxH (mm)	Color	IF Rated (mA)	Wavelength	Brightness Typ	VF Typ (V)
	SpicePlus Multi Color	S6RTB-EHG	3.0x3.0x0.7		150	625nm 525nm 460nm	23.5lm 39.8lm 8.2lm	2.40 3.05 3.20
	SpicePlus Multi Color	S6RTB-THG	3.0x3.0x0.7		200	625nm 525nm 460nm	30.6lm 51.7lm 10.7lm	2.50 3.20 3.30
 NFND	SpicePlus Multi Color	S8RTB-VHG	3.0x3.0x0.7		150	625nm 525nm 460nm	9000mcd 9000mcd 2850mcd	2.30 3.30 3.30
 NFND	SpicePlus Multi Color	SKRTB-FHG	2.1x2.0x0.7		20	625nm 525nm 465nm	850mcd 1800mcd 285mcd	2.20 3.00 3.00

They recently launched a smart embedded digital driver RGB LED claimed to be the world's brightest.

These products are compatible to ISELED® communication link integrated systems. The seddLED3.4 is pre-calibrated to D65 White Color Point at 2000mcd, while the seddLED3.5 is emitting 60lm. Since these products are pre-calibrated, they have no disparities and therefore the added manufacturing advantage of zero flux binning.

Dominant also join OSP Ecosystem in 2024 with A3H device which is the first OSP-compliant intelligent RGB LED from DOMINANT.

seddLED3.4



A3D-MHG-2000-1

- Pre-calibrated D65 White at 2000mcd
- Operating Temp: -40°C to 110°C
- Daisy chaining, max. 4079 RGBs per system
- Full Color Spectrum as per CIE Standard.
- Dimension: 3.6x2.8x0.65mm

seddLED3.4



seddLED3.5



A3E-THG-60-1

- Pre-calibrated to D65 White @ 60lm
- Operating Temp: -40°C to 110°C
- Power Consumption: Typ 1.5W @ Tj 85°C
- Full Color Spectrum as per CIE Standard.
- Dimension: 6.0x6.0x1.22mm
- Low Thermal Resistance Rthjc: typ 7K/W

seddLED3.5



Liteon

LITEON is a trailblazer in the field of LED technologies and the first listed electronic company in Taiwan. They are a world-leading provider of optoelectronic semiconductor components and power managements modules.

They have large footprint with their headquarter in Taiwan and sales locations in USA, Europe, China, Japan and Singapore.

They have more than 30,000 employees and are world number one for photocouplers, and number two for power supplies.

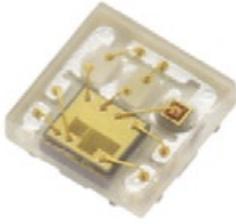


They have large series of LEDs covering the main needs in automotive lighting:



Main characteristics of some of their top view RGB LEDs series:

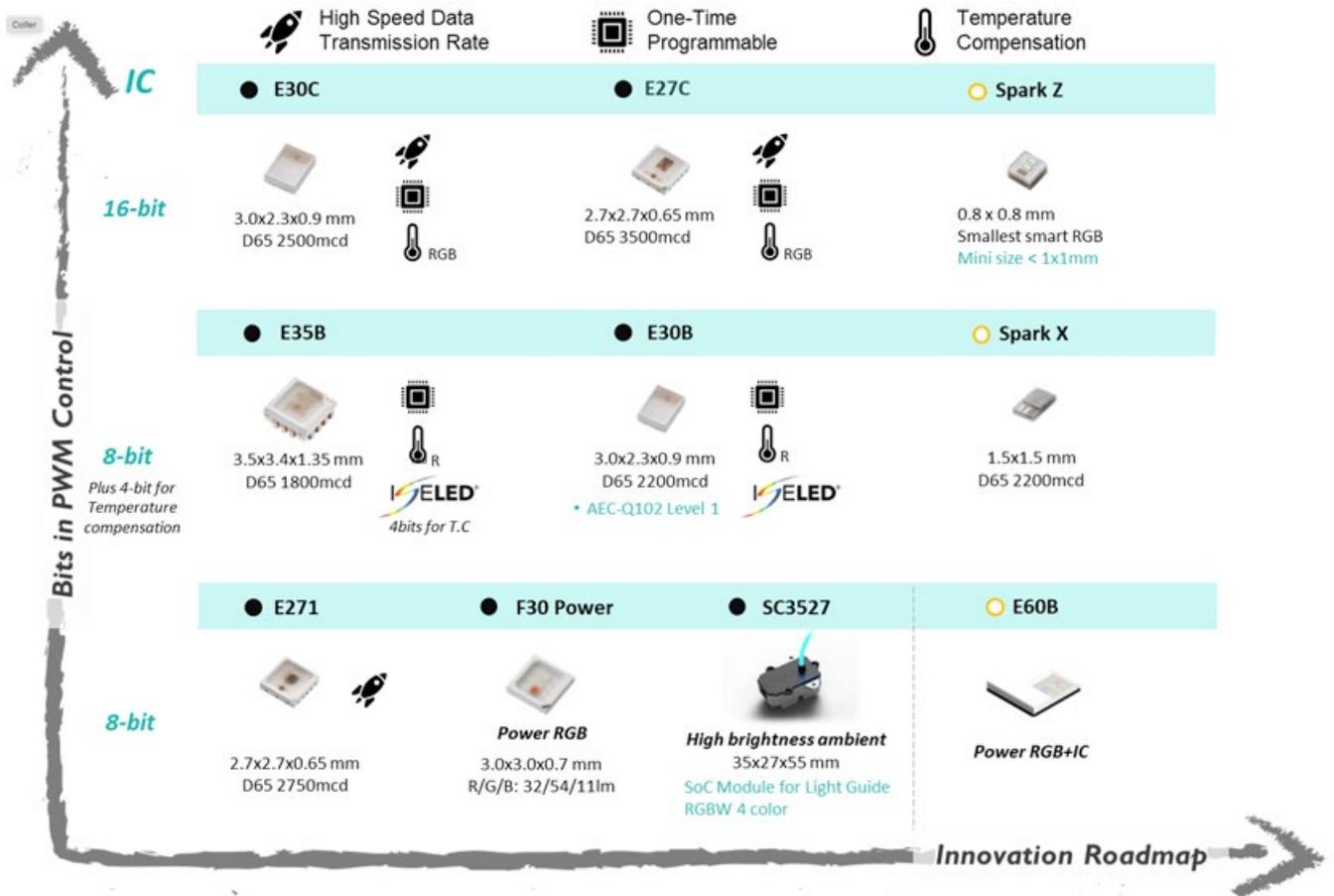
Part No	Outside Dimension	Color	Dominant Wavelength	Luminous Intensity
LTST-B32JEGBK-AT	1.0(L)x1.0(W)x0.65(H)mm	Red/Green/Blue	Red:616-628 nm /Green:519-537 nm / Blue:464-479 nm	Red:26-65 mcd /Green:122-303 mcd / Blue:22-66 mcd
LTST-C28NBEGK-2A	1.0(L)x1.0(W)x0.25(H)mm	Red/Green/Blue	Blue:465- 475nm/Red:618- 628nm/Green:525- 535nm	Blue:18-45mcd/Red:28- 71mcd/Green:112- 280mcd
LTST-C28NBEGK-DF	1.0(L)x1.0(W)x0.25(H)mm	Red/Green/Blue	623 / 466 / 525	B/R/G: 20mcd/45mcd/118mcd @ 1.7mA/1.7mA/1.7mA
LTST-C32JEGBK-KG	1.0(L)x1.0(W)x0.65(H)mm	Red/Green/Blue	R:618-630nm,G:520-52 9nm,B:464-473	R:71-140mcd,G:520-52 9nm,B:464-473



Currently, they have IC embedded RGB LEDs with their E133 series:

Part No	Outside Dimension	Color	Dominant Wavelength	Luminous Intensity
LTST-E133CEGBK	1.3(L) x 1.3(W) x 0.4(H) mm	Red/Green/Blue	623/528/470	100/300/50
LTST-E133HEGBK	1.3(L) x 1.3(W) x 0.4(H) mm	Red/Green/Blue	623/528/470	100/700/130

And they are pursuing the development of these intelligent LEDs with increased performances through the following roadmap:



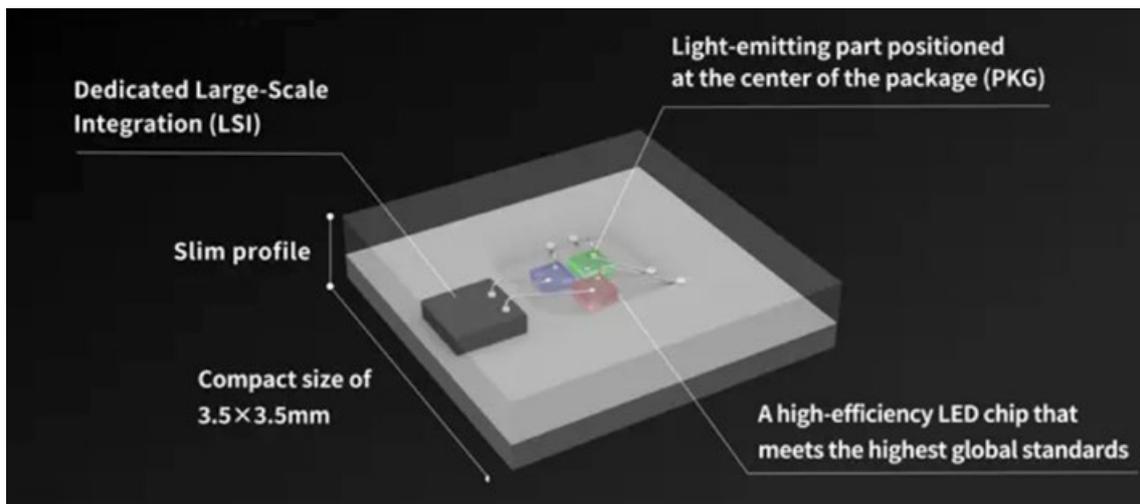
Nichia

Nichia was founded by Nobuo Ogawa to utilize limestones in his hometown of Tokushima for the production of calcium compounds used in pharmaceutical materials. Nichia expanded its product range from calcium compounds to phosphors, LEDs, Laser Diodes, cathode materials for Lithium-ion batteries, and magnetic materials.

Nichia is proposing monochrome LEDs with their 573 series, 313 series, and 438 series.



Blendlite™-i : The Nichia RGB light source equipped with an LED driver IC.



Blendlite™-i is an RGB LED which incorporates a dedicated driver IC specially designed for automotive interior lighting with the following key features:

- Equipped with a high-efficacy LED chip that meets the highest global standard,
 - Equipped with a low-power consumption and high-performance LSI (RGB driver IC),
 - With an open protocol that has high compatibility with existing controllers, which makes it user-friendly,
 - With the LSI (RGB driver IC) also designed to fit within a square package,
 - Achieving high color reproducibility by minimizing color variation,
- And with the qualification AEC Q102 prepared.

Blendlite™-i will assist in creating comfortable and safe automotive interiors by offering high color quality, simple circuit design, and low power consumption. All of these features are becoming increasingly required for automotive interior lighting.

Laser diodes RGB:

Nichia is putting many hopes in their laser RGB LEDs for applications like colored road projections, window/ Dashboard projection, roof projection, or HUD.



Road Projection



Window/Dashboard Projection



Roof Projection

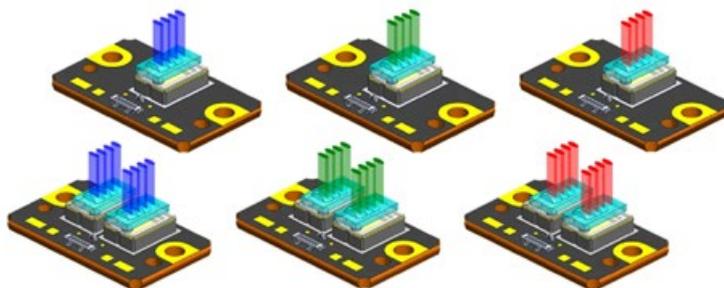


HUD (Heads-up Display)

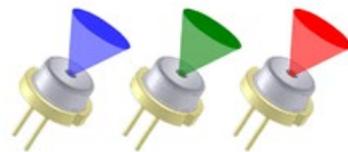
Source Nichia

With their QuaLas and TO-CAN packages paired with advanced technologies like MEMS mirrors and digital micromirror devices, these diodes enable high-efficiency and high-performance solutions for exterior and interior projections, as well as head-up displays. The diodes offer a wide colour gamut for vivid visuals, a long lifespan to reduce maintenance costs, and compact design for flexible integration across various systems.

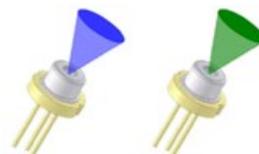
Automotive QuaLas™



TO-CAN(Multi-mode)



TO-CAN(Single-mode)



Example of laser characteristics for color DLP projection:

Item	4 chips / color			8 chips / color		
	Red	Green	Blue	Red	Green	Blue
Tm	25 degC					
Color Temperature	6,503K					
λ	643	525	450	643	525	450
Po	4.8 W	6.4 W	10.6 W	9.6 W	12.8 W	21.2 W
Duty	63.4%	26.4%	10%	63.4%	26.4%	10%
PKG-Out Luminous Flux	1,260 lm			2,520 lm		
PJ Optical Efficiency	35 %			35 %		
PJ-Out Flux	441 lm			882 lm		

Source Nichia

Discrete colour LEDs

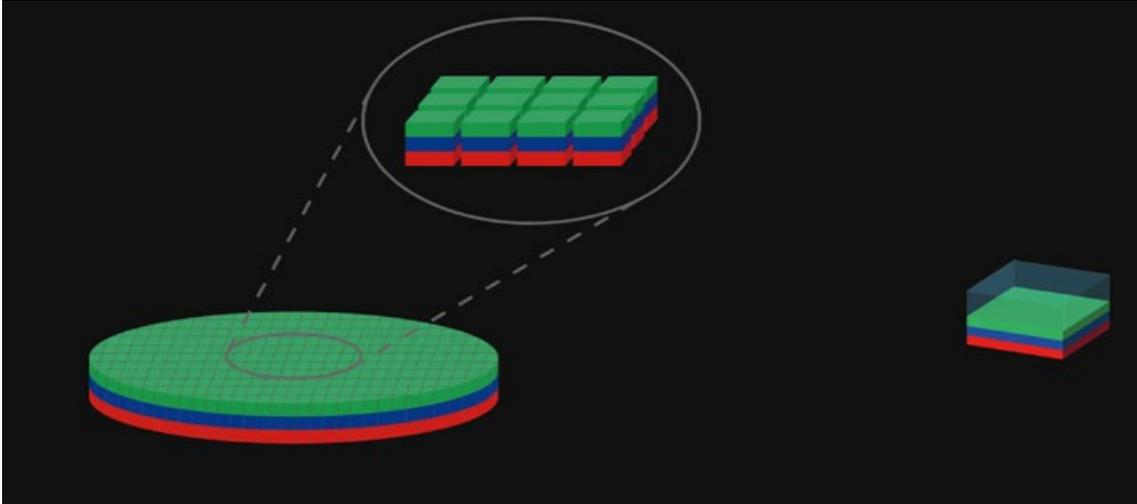
“As alternative to RGB LEDs, Nichia is working on the use of discrete colour LEDs, all based on blue diodes with different phosphor conversion for each colour. The main advantage of this approach is to simplify the colour shift management by delivering consistent performance even at high temperatures, eliminating the need for individual PWM adjustments for each LED. Discrete colour LEDs also overcome power limitations, making them more suitable for exterior applications. Additionally, there is no need to add a fourth LED to obtain a real white colour (RGB-W solution) as this can be easily handled with broader colour gamut management. This combination of benefits makes discrete colour LEDs an attractive option for exterior lighting in automotive applications.”

Extract of DVN interview with Xavier Denis, Technical Head at Nichia Europe (DVN Interview: Nichia’s Miniaturization, Integration, Sustainability - DVN)

Seoul Semiconductors

Seoul Semiconductor is an important LEDs maker from Korea, established in 1990 and specialized in LEDs. Their sales are around \$1 billion putting them at the third position in the worldwide market.

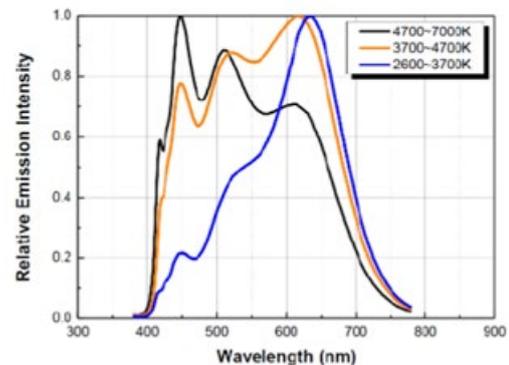
They have developed different technologies including their “Wicop” or “Wicop +” for no wire and no package.



In the domain of RGB LEDs, they have developed their “Wicop Pixel” technology, that they claimed to be the world’s first real RGB one-chip technology for implementing a Micro LED display based on the WICOP technology, which uses no wires.

Another specific RGB LEDs produced by semiconductor is their “Sunlike” LEDs that are based on a blue purple emission LEDs with three kinds of phosphors to produce more continuous wavelengths from blue to red for improved and more natural white light.

Part No.		3030		3014	
		STW9C2LB-SA		STW9E12WE-SA	
Color		SunLike		SunLike	
Image					
Dimension	mm ³	3.0 x 3.0 x 0.65		3.0 x 1.4 x 0.52	
Forward Current	mA	typ.	65 / 100	65 / 150	
Forward Voltage	V	typ.	3.0		
Luminous Flux	lm	typ.	22.7 (6.9 cd)	19.8 (6.5 cd)	
CCT	K	2700 ~ 6500			



5. BENCHMARK OF CURRENT SOLUTION IN AUTOMOTIVE EXTERIOR

The front end of the **Lynk & Co Z10** is equipped with 224 RGB LEDs. The 256 lighting colors available respond to a strong market trend for more design identity and information on the front fascia.



Both front & rear solutions are handled by Melibu solutions (front lamp Valeo and rearlamp Forvia Hella).



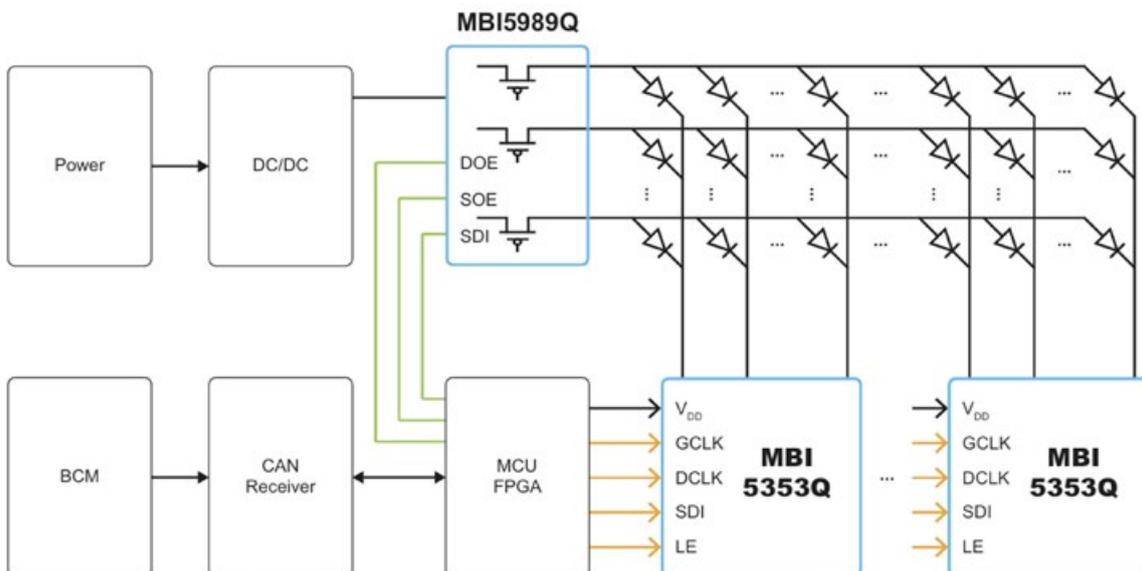
Lotus Eletre rear charging lamp (80 RGB LEDs – Odello rearlamp)



Rivian R1 front and rear (OPmobility lamps) with RGB LEDs



IM Motors L6 rear ISD with RGB LEDs (lamp from Liaowang). LED IC is from Macroblock (SPI communication). What is remarkable with the RGB LEDs is the fact they are compliant with tail lamp and turn indicator regulation (photometry including light intensity and colorimetry).



6. BENCHMARK OF CURRENT SOLUTION IN AUTOMOTIVE INTERIOR

Brightek solutions (ICLED 3535)



Inova solutions



Car Model:

- Kia Carnival (2021)
- Hyundai Grandeur (2022)



This block features four images showcasing interior ambient lighting. The top-left image shows a close-up of a white interior panel with a glowing pinkish-red LED strip. The top-right image shows the front interior of a car with white leather seats and a dashboard illuminated with warm orange light. The bottom-left image shows a close-up of a white interior panel with a glowing blue LED strip. The bottom-right image shows the front interior of a car with a steering wheel and dashboard illuminated with warm orange light.

Car Model:

- Rolls Royce Spectre (2022)
- Mini Countryman (2023)
- Mini Cooper (2024)
- Mini Aceman (2024)



This block features four images showcasing interior ambient lighting. The top-left image shows the front interior of a Rolls Royce Spectre with white leather seats and a starry headliner. The top-right image shows the front interior of a Mini Countryman with a steering wheel and dashboard illuminated with blue light. The bottom-left image shows the front interior of a Mini Cooper with a steering wheel and dashboard illuminated with blue light. The bottom-right image shows a close-up of a car's interior panel with a glowing blue LED strip.

Car Model:

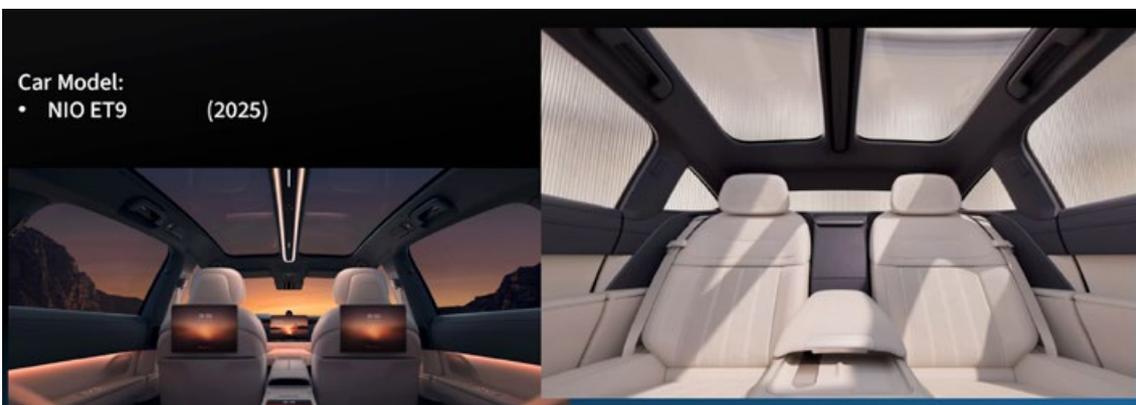
- BMW i7 Series (2022)
- BMW XM (2022)
- BMW i5 Series (2023)
- BMW 1 Series (2024)
- BMW X3/X4 (2024)
- BMW X5/X6/X7 (2024)



This block features four images showcasing interior ambient lighting. The top-left image shows the front interior of a BMW i7 Series with a steering wheel and dashboard illuminated with blue light. The top-right image shows the front interior of a BMW XM with a steering wheel and dashboard illuminated with blue light. The bottom-left image shows the front interior of a BMW i5 Series with a steering wheel and dashboard illuminated with blue light. The bottom-right image shows the front interior of a BMW 1 Series with a steering wheel and dashboard illuminated with blue light.

Car Model:

- NIO ET9 (2025)



This block features two images showcasing interior ambient lighting. The left image shows the front interior of a NIO ET9 with a steering wheel and dashboard illuminated with blue light. The right image shows the front interior of a NIO ET9 with white leather seats and a dashboard illuminated with blue light.

7. SOLUTIONS FOR ELECTRONIC ARCHITECTURES WITH RGB LEDES

LIN is currently the major communication interface controlling RGB LEDs but has reached the limits. It can only be used for classical ambient lighting applications. With some tricks the number of responders per bus can be extended, standard small animations with pre-defined ID are also possible. But overall, the potential use cases are quite limited.

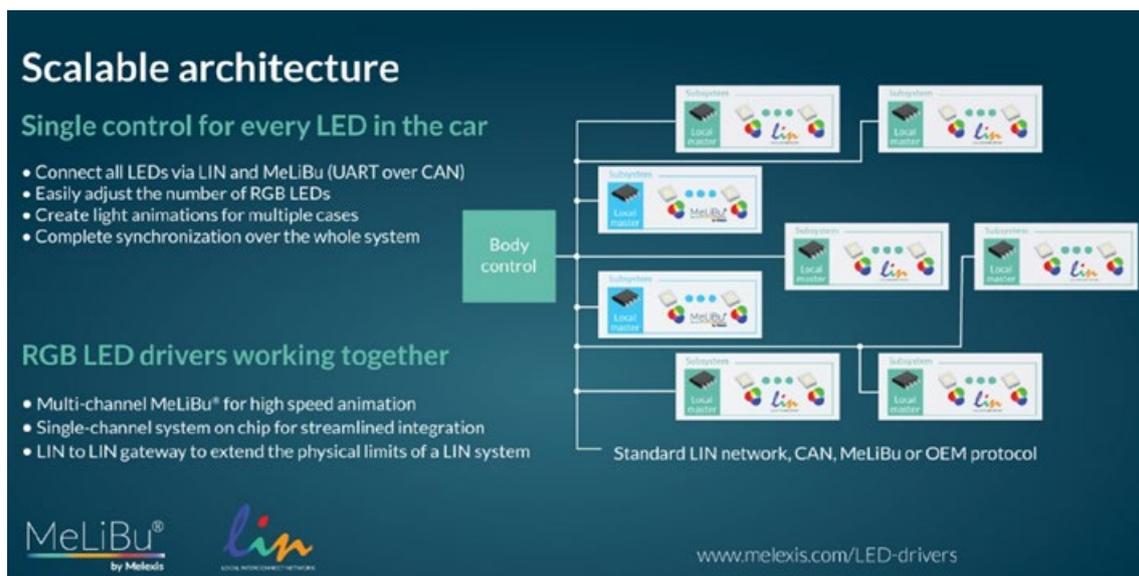
Standard CAN configuration with a max of 16...32 members in a multi commander system is limited for lighting applications where hundreds of members with synchronization of the LEDs are needed. Therefore only a few applications have used a standard CAN in the past.

The dynamic application with a lot of LEDs resulted in different new communication interfaces. They allow optimized control of standard and intelligent RGB LEDs. These solutions are already set up to work also with the future vehicle electronic architecture which will concentrate more and more control in central electronic units communicating via Ethernet. The below described solutions can be connected to an Ethernet endpoint.

A. One solution also used for other applications is communication via UART using the standardized CAN hardware with an optimized linear configuration which removes the CAN nodes limits. With this the number of devices to be controlled can be extended to around 200 at one physical CAN FD.

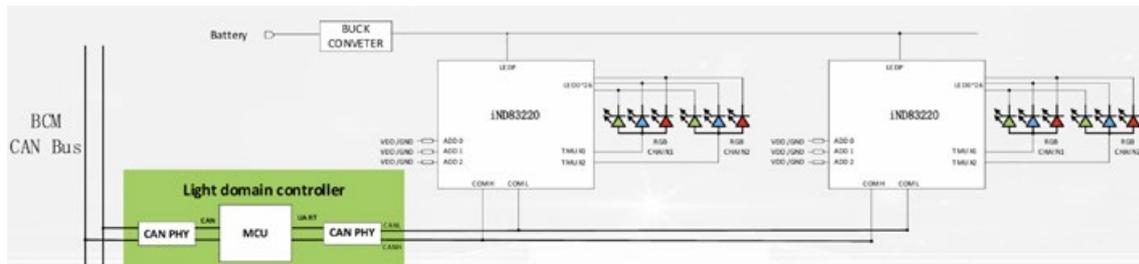
A big advantage of this solution is that it can work with the existing standard Multi-channel LED driver. Several companies have already solutions in production using UART over CAN as communication interface:

Melexis with their MeLiBu protocol offer free licenses to create an industry standard for interior and exterior lighting. The bandwidth needed can be scaled up and down easily depending on the application. The simple protocol makes it usable for a wide range of applications from single LED up to very high channel numbers. The protocol enables fast (up to 4 Mbit/s), precise lighting control. It uses a real bus configuration, which assures effective use of the available bandwidth.



Indiemicro has designed an UART over CAN protocol called ELINS. This works up to 2Mbps bandwidth using CAN PHY. The protocol is technical wise more like LIN protocol (one master, multi responders). It supports high bandwidth to achieve better dynamic animations, but still low cost compared to the standard CAN FD protocol as it doesn't need a crystal.

Also other applications use UART over CAN for exterior lighting applications without the target to create a standard.



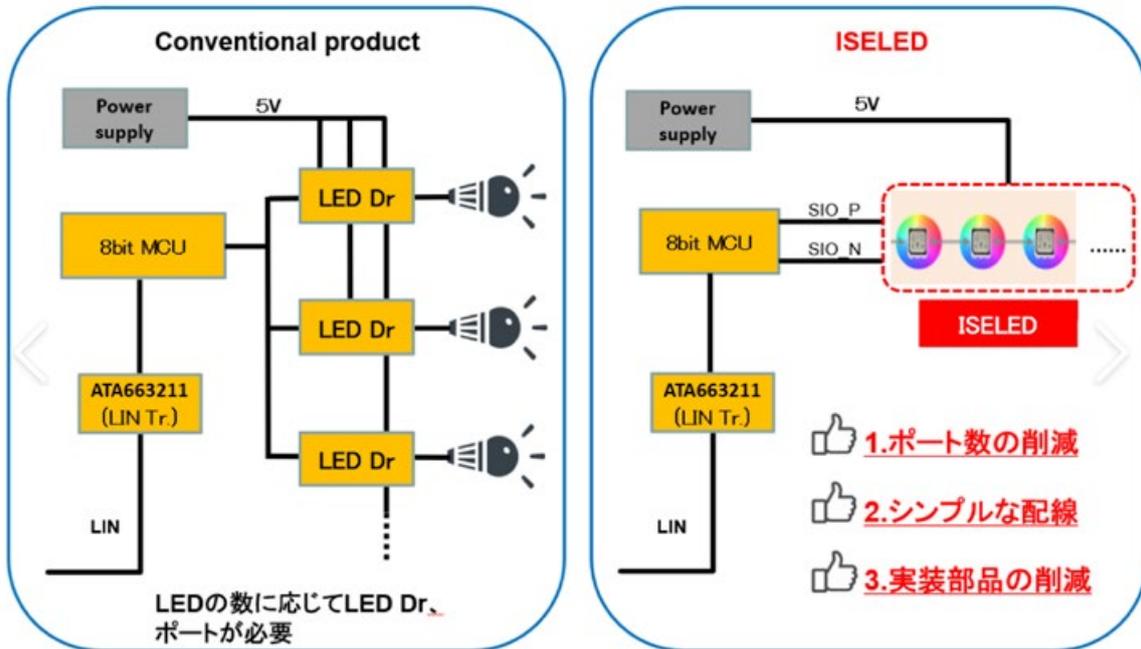
B. Inova with their ISELED and ILaS technology as well as Osram offering their OSP protocol (based on LVDS transceivers) have designed a communication which is used in a configuration where all LEDs are connected in series. Both solutions can be used as a global lighting system in the car by adding additional components and are perfectly fitting Intelligent RGB LEDs allowing the optimized usage of applications with extended amount of Intelligent RGB LEDs and integrating also sensors. The evolution of ISELED is towards technological expansion for innovative applications, high power, and exterior automotive use.

By enabling innovation for dynamic light applications OSP is also expanding the number of parties using it in their application.

The differences on protocol level between ISELED 1.0 and OSP 1.1 are:

- Osram offers the usage of OSP free of charge, Inova asks for license costs towards suppliers implementing their protocol on chip level
- OSP is slightly faster, has more net-date throughput,
- OSP has a defined layer 3 description, and such allows any user to implement its own application on top while ISELED integrates one dedicated solution (D65 calibration).
- OSP is announced to be brought to ISO for standardization.

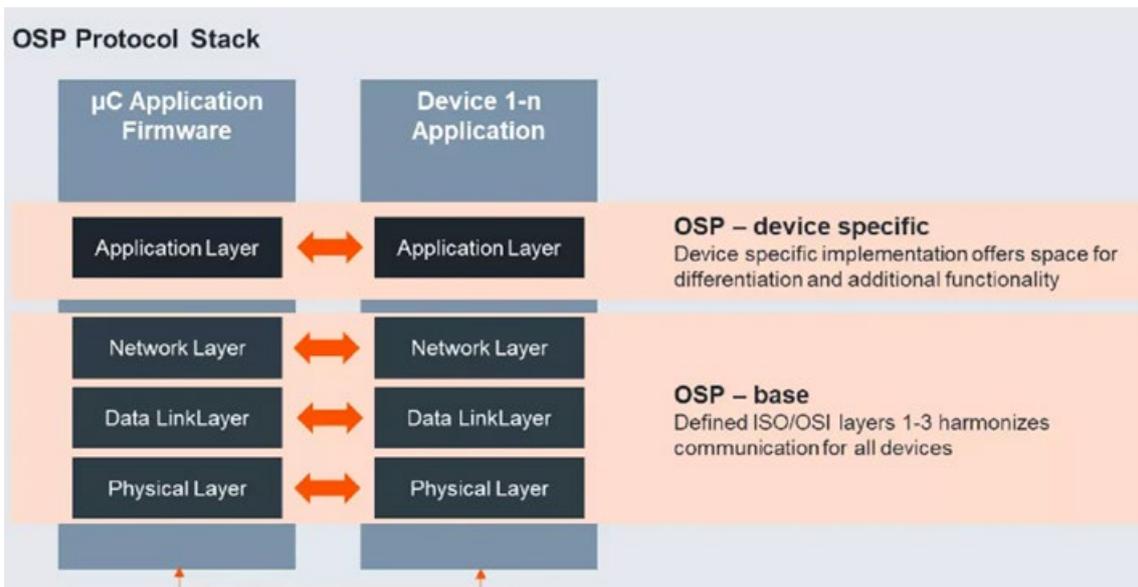
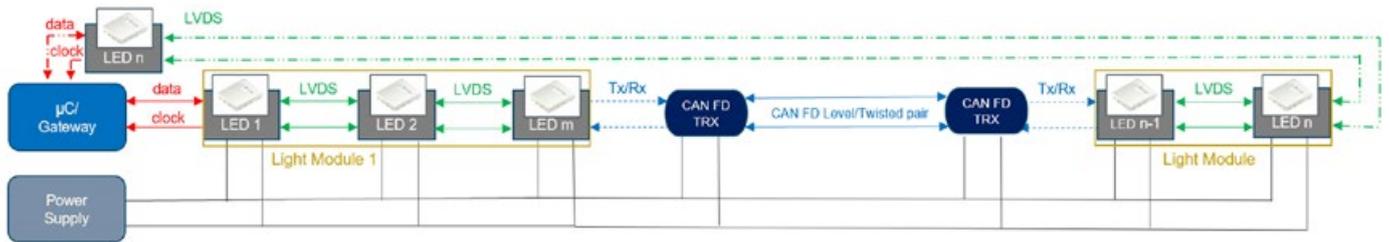
ISELED is mainly suitable for automotive interior lighting, offering advantages such as multi-supplier support, low cost, simple calibration, and flexible architecture. It has higher standby and peak currents but benefits from a straightforward production process without requiring OEM or Tier1 calibration.



ISELED is gathering a complete ecosystem including Lighting tier1, LED manufacturer and LED IC semiconductor companies.



OSP is ideal for automotive exterior and interior lighting, providing high performance, low standby current, and low sleep mode current. It allows a variety of applications to be run, allowing high accurate color compensation or very simple ones. Overall, it supports long-distance light control and multiple Intelligent RGB strip connections.

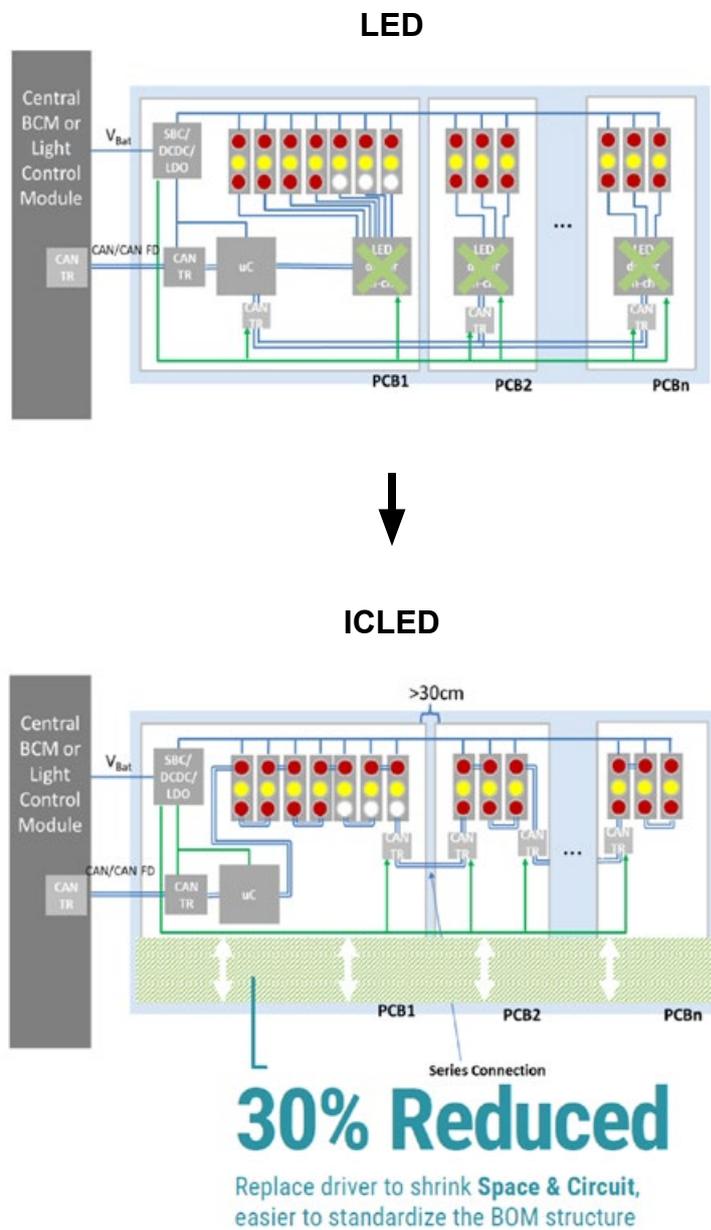


Brightek has a mixed solution of both. They have on one side Intelligent RGB LEDs fitting to the ISELED bus. In parallel to this they have developed an Intelligent RGB LED chip called “ICLED” which can be controlled via CAN FD.

The connection of Intelligent RGB LEDs in series as done by Inova, Osram and Brightek helps to reduce the size of the PCB and the wiring effort.

Further LED manufacturers announced to enter the market with Intelligent RGB functionality based on OSP. They will extend the availability of OSP products in general, make the market for OEMs more attractive. They will presumably differentiate in the type of RGB calibration, brightness, color range, and of course, cost.

- Integration of single-color points and sensors and actuators will come with dedicated new devices and extend the number of use cases further. For example, interaction necessary for smart surfaces may be supported with dedicated devices. OSP is supporting these use-cases already today.



8. INTERIOR LIGHTING OEM OVERVIEW

EUROPEN BRANDS

MERCEDES-BENZ

FIRST IMPRESSION

Mercedes-Benz has established itself as a leading OEM in interior lighting experiences. No other brand has pushed the boundaries of illumination in terms of both quality and quantity. The EQE and EQE SUV are no exception, delivering an exceptional automotive lighting experience.

TECHNOLOGY

The EQE features a row of RGB LED strips for direct lighting, enabling dynamic lighting functions across various use cases. Users can choose from a wide selection of atmospheric lighting themes (up to 64 colors) and animations that enhance user feedback (e.g., temperature adjustments, volume changes) and support safety features linked to ADAS. Indirect lighting is achieved through dual LED light guides, which allow for color mixing but offer less advanced animation capabilities.

INNOVATION

The innovation lies in the behavior of the lighting and its ability to push boundaries in dynamic interaction and user experience (*MBUX*).

DESIGN

The lighting design follows a traditional approach, combining both direct and indirect light fixtures. The direct lighting (main illumination) wraps around the instrument panel (IP) and front cabin, strategically placed in highly visible locations to support safety functions, ambient themes and user feedback.

Positioned underflush to the upper IP trim, these lights remain visible both at night and during the day due to their placement in a shadowed area. A secondary, indirect light fixture is located below the *Hyperscreen*, emphasizing its presence and creating a floating effect, reinforcing the technology-centric interior design. Additional lighting elements include illuminated air vents, armrest + seat outline illumination and courtesy lights (footwell, map pocket/ storage and reading lights). The overhead console (OHC) has a premium feel, enhanced by indirect, illuminated patterns around the control unit, giving it a lighter, floating aesthetic.

For vehicles without the *Hyperscreen*, an optional laser-cut, backlit décor is available.

Overall, lighting is used to convey elegance, technology and a lightweight, premium feel.

USP

Signature Lighting Colors. Mercedes-Benz has successfully leveraged interior lighting as a brand identity strategy, much like Ferrari's signature red exterior. Shades of blue, turquoise, and purple are consistently featured in official images of production vehicles and concept cars, reinforcing the brand's distinct aesthetic.









BMW

FIRST IMPRESSION

BMW focuses on driver-centric interior lighting, blending technology, sportiness and luxury. The brand's "Welcome & Goodbye" animation, ambient illumination and dynamic effects create an immersive experience that enhances both functionality and emotional appeal. BMW's interior lighting is designed to complement its signature driving-focused cockpit, ensuring a balance of ambiance and intuitive interaction.

TECHNOLOGY

BMW integrates advanced RGB LED technology to deliver dynamic ambient lighting tailored to different driving scenarios. The BMW Interaction Bar, a crystalline light strip spanning the dashboard and door panels, introduces an innovative approach to lighting by incorporating touch-sensitive controls. Up to 15 selectable colors and multiple pre-set themes allow for full customization, while lighting animations provide visual feedback for functions like climate control adjustments, door locking, and driver assistance alerts. BMW also employs contour lighting that highlights key interior elements, enhancing depth and texture while maintaining a refined, premium atmosphere.

INNOVATION

BMW's interior lighting system is deeply integrated with the iDrive and BMW OS 8 interfaces, making it more than just a visual element—it serves as an interactive communication tool. Dynamic lighting cues respond to real-time driving conditions, with pulsing red warnings for potential collisions, flashing door panel lights for exit warnings, and subtle animations for lane departure alerts. *My*

Modes, BMW's intelligent customization system, adapts lighting, display themes and sound to match driving styles—Expressive Mode introduces bold, dramatic lighting, while Relax Mode shifts to warm, calming hues. BMW also offers "Caring Car" wellness programs, where ambient lighting syncs with music, climate, and even fragrance settings to create holistic in-cabin experiences like "Vitalize" and "Relax".

DESIGN

BMW's lighting design is both functional and aesthetic, emphasizing driver engagement while enhancing the sense of space and luxury. The Interaction Bar serves as both a design statement and a functional control surface, seamlessly integrated into the dashboard for a futuristic look. Door panel contour lighting, customizable ambient accents, and floating center console illumination create a sense of depth and motion within the cabin. Footwell, storage area, and overhead console lighting ensure visibility without being intrusive. For models equipped with the Panoramic Sky Lounge, embedded LEDs within the glass roof produce a starlight effect, adding a unique atmospheric element to nighttime driving.

UNIQUE SELLING POINT (USP)

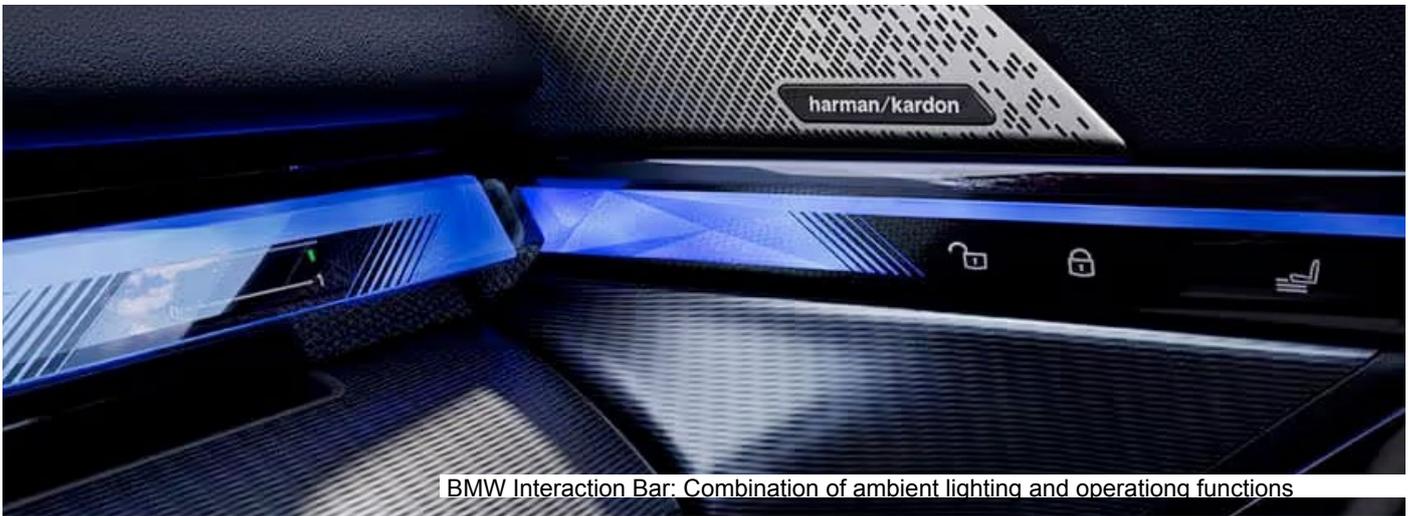
Dynamic Interaction Lighting – BMW has positioned interior lighting as a key part of its intelligent vehicle experience, merging aesthetics with functionality. Unlike traditional ambient lighting, BMW's system provides real-time feedback, interacts with iDrive, and enhances emotional engagement. The BMW Interaction Bar, door panel alerts and *My Modes* settings create a futuristic and personalized lighting experience, reinforcing the brand's reputation for innovation and performance-driven luxury.

YouTube

Autogefuhl Starting Animation: <https://www.youtube.com/shorts/Wg2WWho0IsGg?feature=share>

Autogefuhl Hazard Lights: https://youtube.com/shorts/Tjn8RnZSkbl?si=L_Ad3br5VF-DLgGA

Modern Motoring Ambient Themes: <https://www.youtube.com/shorts/NsN7MPPr8lf4>



BMW Interaction Bar: Combination of ambient lighting and operation functions





BMW Neue Klasse (2025 onwards)



VOLVO

FIRST IMPRESSION

Volvo's Interior Lighting approach focuses on decoration and ambience, highlighting opulent veneer panels. The lighting colors are adjusted to the brand's statement of Scandinavian minimalism and emphasizing warmth and luxury. The smaller cars which more product design feel, get stronger color choices.

TECHNOLOGY

Volvo is using large backlit and ultra thin *hidden lit* veneer surfaces. These ultra thin veneers have a perforated foil on the backside, only letting light through in certain areas. The light source is a large lightguide that achieves a homogeneous lighting output.

INNOVATION

Backlit veneers have been on the automotive market for some time and have been consistently improved. Lighting output (lumen), packaging space (thinner and thinner) as well as surface quality, off-state appearance and costs have been the major challenge for most brands but with an evergrowing demand for innovative lighting solutions it seems to become

DESIGN

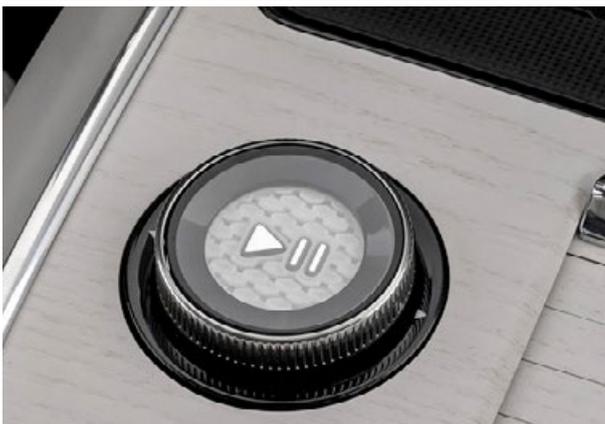
The new electric models EX90, ES90 and the large MPV EM90 share the backlit veneer design approach. While the execution is similar, the pattern used differs for every car. On the EX90 it's a diamond, on EM90 and ES90 it's a stripe-dot pattern design. The default illumination color for the European EX90 is a warm white while the EM90 which is aimed at

the Asian market has a colder white illumination temperature.

Smaller, decorative elements like rotary knobs are being backlit to mimic illuminated crystals.

UNIQUE SELLING POINT (USP)

Ambient lighting mimics natural sunlight, subtly enhancing the interior's colors and textures, while soft illumination in cup holders and storage compartments ensures effortless visibility in low-light conditions.







AUDI

FIRST IMPRESSION

Audi has established a distinctive interior lighting philosophy—one that seamlessly blends traditional lighting technologies with precision execution. Their approach utilizes a combination of direct light strips for functional communication and secondary, indirect ambient lighting that accentuates their fragmented interior design language (e.g., screens and layered panels). This interplay creates a visually striking “floating” effect for screens and trim elements.

TECHNOLOGY

Audi uses RGB light LED strips for their direct lights, Audi integrates RGB LED strips for their direct lighting elements and light pipes for indirect ambient illumination. The multi-LED setup enables dynamic movement, supporting advanced animations (eg mimicing indicator lights) and lighting themes.

Audi’s premium models offer extensive customization, allowing users to select from a broad spectrum of colors and lighting modes, contributing to a more immersive and personalized cabin experience.

INNOVATION

While Audi is not setting new industry benchmarks in interior lighting innovation, their execution is exemplary. They prioritize a refined, well-integrated lighting approach - precisely positioned, thoughtfully calibrated and never overdone. Their lighting solutions focus on functionality, user experience and aesthetic harmony.

In newer models, Audi has explored interactive lighting features, including adaptive brightness and

scenario-based illumination that enhances in-car ambiance depending on the driving mode or time of day.

DESIGN

A key design feature of Audi’s lighting strategy is the continuous direct light strip wrapping around the upper instrument panel (IP), seamlessly integrated near the windscreen. This element is consistently present in newer models such as the A6 and Q5, where it serves as an communication interface for both driver and passenger.

Another defining trend within Audi’s interior lighting is the indirect illumination of their expansive DIM/ Central Display. By using bright, high-contrast lighting below the screen, Audi enhances the perception of a floating display, a feature of their tech-focused interior design. This visual effect is also featured in China-exclusive models and upcoming concept vehicles like the Audi E (2025).

In line with their fragmented design language, Audi strategically highlights specific surfaces, such as the upper door trim panel with soft indirect lighting. This feature creates depth, adding to the brand’s layered aesthetic.

Audi is known for its sophisticated yet neutral interior color palette—favoring shades of grey, black, and white—paired with high-quality materials. In contrast, their ambient lighting introduces vibrant blue and turquoise hues, reinforcing their brand identity as a technology- and innovation-driven automaker. This contrast enhances the high-tech, futuristic feel of Audi interiors.

UNIQUE SELLING POINT (USP)

YouTube:

Moscarblog <https://www.youtube.com/watch?v=zMzxufuLXA8>







ROLLS ROYCE

FIRST IMPRESSION

Rolls-Royce interior lighting is the benchmark in luxury, craftsmanship and bespoke elegance. Unlike brands that use lighting primarily for function or technology-driven aesthetics, Rolls-Royce treats illumination as an art form - designed to create an ambiance of serenity and exclusivity.

TECHNOLOGY

The *Starlight Headliner* is crafted by hand in a process that can take up to 16 hours for standard designs - or weeks for fully bespoke constellations. Each fiberoptic strand is meticulously perforated through the leather or alcantara headliner, with individual fibers cut and positioned to replicate real star patterns. Advanced laser-cutting and pinhole techniques allow for perfect light diffusion, ensuring a natural twinkling effect.

INNOVATION

The Starlight Headliner is a innovation that merges fiber-optic technology with hand-crafted precision.

DESIGN

The Starlight Headliner is a masterpiece of bespoke craftsmanship and elegant design. Each headliner is handcrafted, creating a seamless and luxurious finish. The placement of up to 1,600 individual lights is carefully mapped to create realistic constellations, twinkling effects like eg. shooting star animations. The ambient glow enhances the cabin's depth without being overwhelming, creating a quiet and immersive atmosphere. With fully customizable star

patterns, the Starlight Headliner is a true artistic expression, making every Rolls-Royce interior a one off art piece of light and luxury.

USP

Almost any customer illumination request can be fulfilled. Cars are one off art pieces that are bespoke made for every customer. The team can make interior lighting requests possible where other brand only offer a limited amount of pre-made lighting solutions.

YouTube

Smithsonian Channel <https://www.youtube.com/watch?v=lpKeVxzPSuA>







RANGE ROVER

FIRST IMPRESSION

The indirect lighting creates an inviting and modern atmosphere. The seamless integration of light with premium materials enhances the cabin's elegance, making every drive feel exclusive.

TECHNOLOGY

Range Rover is using a mix of RGB LED Strips, light guides and point lights for an immersive indirect lighting experience.

Up to 30 colors, 4 intensities of light and 6 pre-set mood lighting configurations can be chosen from.

Cars feature three-zone lighting, while Accent and Background lights are RGB colors, the footwell lights are white lights only.

INNOVATION

-

DESIGN

Indirect lights are used in the IP/ Dashboard area as well as on the armrest of the doors, lower console storage, IDOs, map pockets and footwell area for first and second row equally.

The 6 lighting configurations *Standard*, *Dynamic Red*, *Sunset Orange*, *Ocean Blue*, *Ultra Violet* and *Forrest Green* give a choice of pre-set mood colors, but a customisable option is available as well.

Youtube

Planet Car News <https://www.youtube.com/watch?v=Gv2K4m7TADs>







RENAULT

FIRST IMPRESSION

Renaults new retro inspired EV lineup show a distinctive Interior lighting that take many cues from the exterior graphics and patterns. While the Lighting technology might be standard, the emphasis on graphical lighting execution is spot on with the rest of the vehicle.

TECHNOLOGY

Direct Lights, achieved through backlighting milky diffusers. RGB light sources with up to 48 customizable interior ambient lighting colors through its *MultiSense* system

INNOVATION

Packaging illumination in small vent outlets. Taking the complexity of HVAC outlets into consideration (adjustability, airflow, mechanics, etc), adding a light source into the vent bezel is a complex packaging challenge.

DESIGN

The interior lighting sets a modern, relaxing atmosphere. The lights are often designed to reflect the concept's playful and youthful character.

The air vents in the new Renault EV models are integrated with direct ambient lighting. It accents the air vents' edges, giving them a stylish and sleek look and creating the visual connection to the exterior foglights and DRLs.

Light fixtures are placed along key areas such as

the dashboard, door handles, and footwells, offering gentle illumination that enhances the interior ambiance without being overwhelming.

The interior lighting can adjust to the car's driving mode or the time of day.

USP

A design connection between the DRL graphics and interior lighting, creating a seamless, graphical statement that links the exterior and interior illumination for a bold, unified look.

YouTube





Twingo E-Tech Concept (2025)



OPEL

FIRST IMPRESSION

Opel provides subtle and functional interior illumination in their lineup.

TECHNOLOGY

Opel utilizes RGB LEDs for their main interior lighting, with the added capability of dynamic functions. It enables the lights to adapt to different settings and create a more personalized experience for the driver and passengers.

INNOVATION

The Pixel Box is a standout innovation, offering a translucent glass surface with edge-lit technology.

DESIGN

Opel interior lighting is designed to enhance both aesthetics and functionality. The direct lights on the IP of the 2025 Grandland can be customized with up to 7 colors. The main light strip is an acrylic light bar that stretches over the IP, interrupted by the DIM and CSD screens. The light bar is reminiscent of the exterior DRL design.

The Pixel Box is an illuminated storage compartment located beneath the dashboard. This compartment has a translucent glass surface that is edge-lit to provide a subtle glow to the storage space.

White indirect lights on the mid-IP and door panels, both front and rear, accentuate the interior design at night.

Additional footwell, map pocket, and reading light illumination are available on newer models as well.

An optional panoramic roof reading light bar is available.

USP

Pixel Box stands out as a unique illuminated storage compartment, which enhances the car's atmosphere while providing practical storage illumination. It is an example of how Opel merges design with functionality.

Youtube

SupercarTV <https://www.youtube.com/watch?v=sb7zHcvoN4E&t=302s>



PEUGEOT

FIRST IMPRESSION

Peugeot is getting a showcar feel for their ambient lighting theme into production vehicles. Using large interior surfaces as a canvas for indirect lighting sources creates a very layered, spacious and modern look to their interiors.

TECHNOLOGY

Both direct and indirect lighting technologies are being used by Peugeot. RGB LEDs with 64 color options. Dynamic lighting is possible as well as the mo

INNOVATION

Peugeot is combining their indirect lighting with innovative target materials as seen on the e-5008 and e-3008.

DESIGN

Peugeot is using both Direct and Indirect lighting techniques for their illumination themes. For bigger cars like the e-5008 or e-3008, indirect lights highlight a layered theme and create impression of a visually lighter interior with floating panels, visually dividing the upper from mid IP. The CSDs floating effect is supported by a light source illuminating the surface below. For smaller, funkier models like the e-208, direct light strips are used to accentuate the sporty, youthful design language.

Looking at the Inception Concept from 2023, we can see both illumination techniques being used. Indirect lighting to create a layered, open design expression

and direct lights to highlight bold design statements like the circular steering wheel elements.

Peugeot is offering for some cars customizable ambient lighting with up to eight color options, enhancing the cabin's atmosphere

Dynamic lighting or ADAS supported lighting is not available on current Peugeot models.

USP

Peugeot's driver focused i-Cockpit adjusts the ambient lighting to match the drivemode setting selected. The drive mode default color can be personalised in the menu.

YouTube







NORTH AMERICAN BRANDS

FORD

FIRST IMPRESSION

Ford's latest approach to interior lighting is a well executed theme that complements the interior styling, enhancing the overall driving experience.

TECHNOLOGY

RGB LED strips with 7 to 10 color options on the Capri and Explorer E.

Ford uses traditional illumination techniques, such as direct and indirect lighting with optical light pipes.

All lights are static and do not allow for dynamic movement.

INNOVATION

-

DESIGN

Ford uses its interior lighting to accentuate design features like the floating upper IP island on the new Capri and Explorer E. For this, direct lights create a sharp border around this interior design element lifting it visually from the mid-IP.

A similar approach can be seen on the Expedition, where direct light wraps around the lower IP trim and continues onto the doors, further highlighting the speakers on mid-IP. A small chamfer below the direct light catches additional stray light, creating an effect of both direct and indirect lighting.

Indirect lights on the new EV models, the Capri and

Explorer E, accentuate the mid-door panel, creating a wraparound feeling and connection between the door and IP. These indirect lights make use of dedicated target surfaces for illumination, resulting in a more controlled lighting design.

Additional indirect lighting on the central console illuminates a chamfer below, visually lifting the top part of the console from the lower section. This technique of using light to enhance the layering of volumes breaks up an otherwise heavy center console and makes the design appear "lighter."

USP

Ford's integration of indirect and direct lighting accentuates key interior features, setting their design apart.

Youtube

SDA Dan Cars <https://www.youtube.com/watch?v=hGga-2JpQio>

CMA's Williamsburg <https://www.youtube.com/watch?v=Syiq4gpv9ew>







CADILLAC

FIRST IMPRESSION

With a choreographed start animations, passengers are welcomed into the new Cadillacs that feels both futuristic and refined. The soft glow highlights the vehicle's premium materials, while a dynamic interplay of light and shadow enhances the contours of the cabin.

TECHNOLOGY

RGB LED strips are used for direct lighting, RGB light pipes for indirect lighting, as well as backlit panels. Cadillac offers up to 126 ambient colors within either a dual- or tri-zone lighting setup.

Dynamic lighting enhances both aesthetics and functionality with welcome animations, real-time drive mode adjustments and pulsing alerts for ADAS warnings. Some models offer a music mode, reacting in real-time to the sound.

Lights can adjust brightness and color temperature based on external conditions, time of day or user preferences.

INNOVATION

ADAS is supported through the interior lights, enhancing safety and awareness. It provides visual alerts for driver attention, lane departure, collision warnings and blind spot monitoring, using subtle color changes and pulses. The light can also assist with parking, rear cross-traffic alerts and *Super Cruise*, where the steering wheel illumination indicates hands-free driving status. The intelligent use of ambient lighting ensures a safe and intuitive

and immersive driving experience.

DESIGN

Vistiq, Lyriq and Optiq use direct lights to accentuate their interior cabin. The sharp illumination contrast gives a modern and technological feel to the car.

Decorative backlit patterns are used on door panels and IP decor trims. Patterns are precision-cut into trim materials like metal, wood or acrylic, allowing light to shine through.

A Lower zone of the ambient lighting consists of indirect/ mood lights. The lights consist of footwell lights, map pocket and storage illuminations.

Reading lights are also available and function as ingress/egress lights.

USP

Vistiq, Lyriq and Optiq offer a lighting experience that enhances comfort and contributes to the user's overall well-being. The integration of lighting modes designed to reduce stress and fatigue adds another layer of exclusivity to the brand's interior lighting experience - its artful integration enhances luxury, elegance and innovation.

Youtube

Allcarnews <https://www.youtube.com/watch?v=6ZnmwNN-2Gs>





Optiq (2025)



CHINESE BRANDS

ZEEKR

FIRST IMPRESSION

From their initial models, such as the X and 007, ZEEKR introduced 3D lighting elements and crystal-like structures that add depth and sophistication to vehicle interiors. Recent releases have further evolved this approach, incorporating patterned illumination that create a more premium ambiance.

TECHNOLOGY

ZEEKR uses a combination of RGB LED strips and light pipes to achieve dynamic color mixing and ambient effects. The LED strips support advanced animations and a broad spectrum of colors, while the light pipes, primarily used for indirect lighting, offer dual-color capabilities. Drivers can select from 64 colors and predefined themes via the vehicle's menu, a feature expected to have an even wider variety of options available through OTA updates.

The OHC lighting is dimmable and can be switched between warm and cold white color temperatures. Its using a touch sensitive area for its interface.

INNOVATION

Going beyond traditional illumination techniques, ZEEKR explores new aesthetics by integrating illuminated crystals and indirectly lit patterns. For instance, 007 and 7X feature a *Music Mode* synchronizes lighting fixtures with the car's audio, creating an engaging and immersive environment.

The true innovation lies in the expressive lighting design of the vehicles.

DESIGN

ZEEKR's lineup showcases two prominent design philosophies:

3D Lights/ Crystals: Models like the Zeekr X, 007 and MIX incorporate three-dimensional lights that add depth and illuminate physical interior shapes, contributing to a refined and luxurious feel.

Pattern Illumination: Vehicles such as the Zeekr 7X or Mix utilize indirect and direct lighting on patterns behind a lens, creating visual depth and a premium aesthetic. The outer lens may feature intricate patterns, adding a sophisticated detail that aligns with the vehicle's overall design ethos.

In 7X and MIX, materials on illuminated surfaces are treated with reflective paint, enhancing light dispersion and emulating upscale materials.

UNIQUE SELLING POINT (USP)

ZEEKR positions itself by moving away from standard illumination techniques, such as direct light pipes or simple indirect lighting to embrace innovative and refined solutions. Through these advancements, ZEEKR not only enhances the aesthetic appeal of its vehicles but also elevates the overall driving experience, setting new standards in automotive interior lighting.

YouTube

Autogefuhl <https://www.youtube.com/watch?v=my3KtQYiKlg>

ZeekrNepal <https://youtube.com/shorts/fPaNAI21hME?si=6AZRX6iuHW0G3gnk>

T K https://www.youtube.com/watch?v=5qasU_wNzrY







LYNK&CO

FIRST IMPRESSION

Just like its sister brand, Lynk&Co is pushing the benchmark in automotive lighting expression. Their innovation driven approach to interior lighting can be seen with their latest Infinity Light integration. The high tech appeal of the light fixtures go well with the otherwise tech driven, minimalist interior design of the brand.

TECHNOLOGY

Lynk&Co is using a variety of illumination technologies in their lineup. RGB LED Strips, with up to 256 colors, light guides and spot lights are the basis for their light fixtures.

The *Infinity Light* Technology uses reflective mirror technology to create a seamless, floating light effect. This works by embedding LED strips behind specially designed reflective panels and light-guiding materials that diffuse and amplify the illumination. Instead of direct LED exposure, the light bounces off multiple layers of mirrors and diffusers, creating a smooth, continuous glow without visible light sources. This not only enhances the aesthetic appeal but also ensures a softer, more evenly distributed ambient lighting effect, reducing harsh glare while maintaining a futuristic and immersive cabin atmosphere.

INNOVATION

Infinity Lighting is a unique innovation in interior lighting, setting Lynk & Co apart from other brands. No other manufacturer has utilized this technology or pushed the boundaries of illumination aesthetics to this extent. Considering the packaging requirements needed to create such an effect, it's

impressive to see Lynk & Co driving innovation in production lighting to this level.

DESIGN

Lynk & Co's ambient lighting design uses different lighting techniques across their various cars. The most distinctive one, the Infinity Light, can be seen in models like the newly released 02. Other illumination executions, like a backlit pattern behind a tinted lens have been introduced on the 900 and 08, with the latter featuring an additional backlit mesh around the door tweeter.

Other distinctive lighting features include backlit rotary knobs that emphasize the high-tech feel of the 900, as well as indirect lighting used to frame and float the tweeter, as well as the cantrail island.

A soft glow separating panels like the the upper and mid-door panels on 900, add an extra luxurious and sophisticated feel to the car.

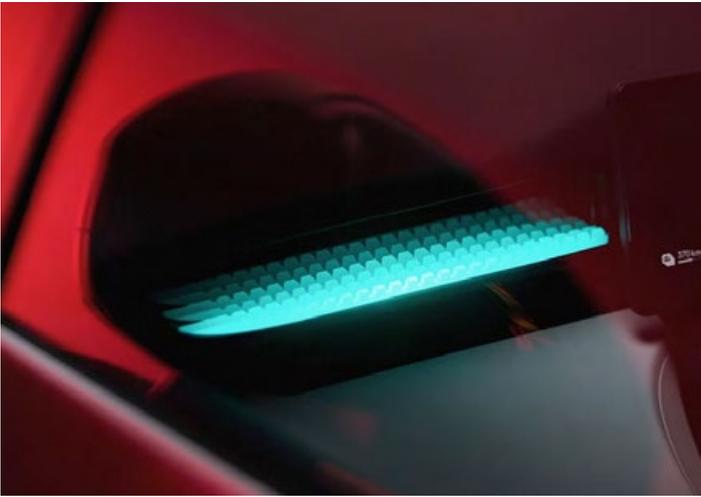
Storage, cupholder, and reading lights round off a holistic lighting experience for the entire lineup.

UNIQUE SELLING POINT (USP)

The USP lies in the seamless integration of advanced Infinity Light Technology and customizable ambient lighting, creating a modern, futuristic and immersive illumination experience. Key features include dynamic lighting that adapts to different driving modes and customizable colors that enhance both ambiance and comfort. These elements combine to deliver a highly engaging and premium interior environment that not only elevates the aesthetic appeal of the vehicle.







XIAOMI

FIRST IMPRESSION

Ambient lighting is integrated as a subtle design element, with slim LED strips accentuating key lines along the dashboard, doors, and air vents. The lighting complements the minimalist layout and large central displays, contributing to a modern, cohesive cabin environment.

TECHNOLOGY

RGB dynamic LED Strips with up to 256 colors and adjustable brightness.

Lighting is indirect, with illuminated trim elements along the dash, door panels, footwells, and air vents.

INNOVATION

Xiaomi extends its interior lighting experience with ambient lighting kits designed to attach directly to the vehicle's central screen. These accessories allow owners to personalize their cabin lighting, adding adaptable, plug-and-play ambient effects.

DESIGN

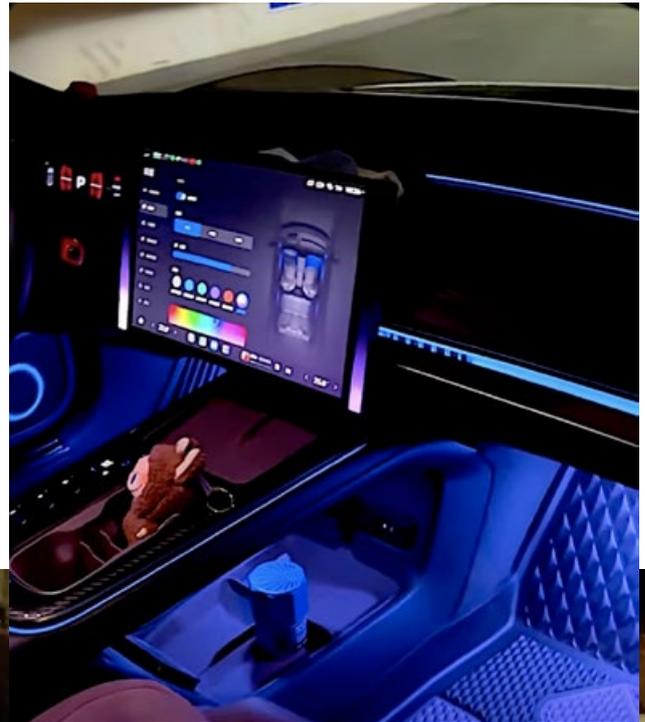
The lighting design is based on wrap-around accents that follow the contours of the dashboard and door trims. It visually broadens the cabin and highlights its clean, uncluttered surfaces. Materials such as textured fabrics and matte finishes help diffuse the lighting evenly, creating an understated illumination effect throughout the interior.

USP

Xiaomi offers a customizable, ecosystem-driven lighting experience, combining factory ambient systems with accessories like the screen-mounted light bars. This gives users flexibility to personalize their cabin environment, blending integrated and add-on lighting features that respond to music, drive modes, and personal preferences.







NIO

FIRST IMPRESSION

NIO's interiors embrace a refined, minimalist design language, where ambient lighting subtly enhances the clean cabin architecture and reinforces the vehicle's calm, high-tech atmosphere

TECHNOLOGY

Multi-zone RGB ambient lighting with up to 256 colors, dynamic effects and illumination themes that can be customized via the central touchscreen interface or voice assistant, NOMI.

Mostly Indirect lighting on pattern (soft trim/ hard plastics) with some direct light strips.

INNOVATION

Use of light as an atmospheric tool rather than just decorative trim. The ET9's "Skyline Light Strip", a continuous horizontal ambient light extending across the dashboard, dynamically shifts color based on vehicle mode or driver preference.

Features like *Music Sync Mode* allow lighting to pulse in rhythm with audio playback, while *Mood Lighting Scenarios* adjust ambient settings based on time of day, drive mode, or occupant mood — integrating biophilic colors and gradients that reduce visual fatigue during long drives.

DESIGN

NIO's interior lighting blends sleek ambient light strips with subtle indirect lighting to create a calm, spacious atmosphere. Horizontal lights enhance

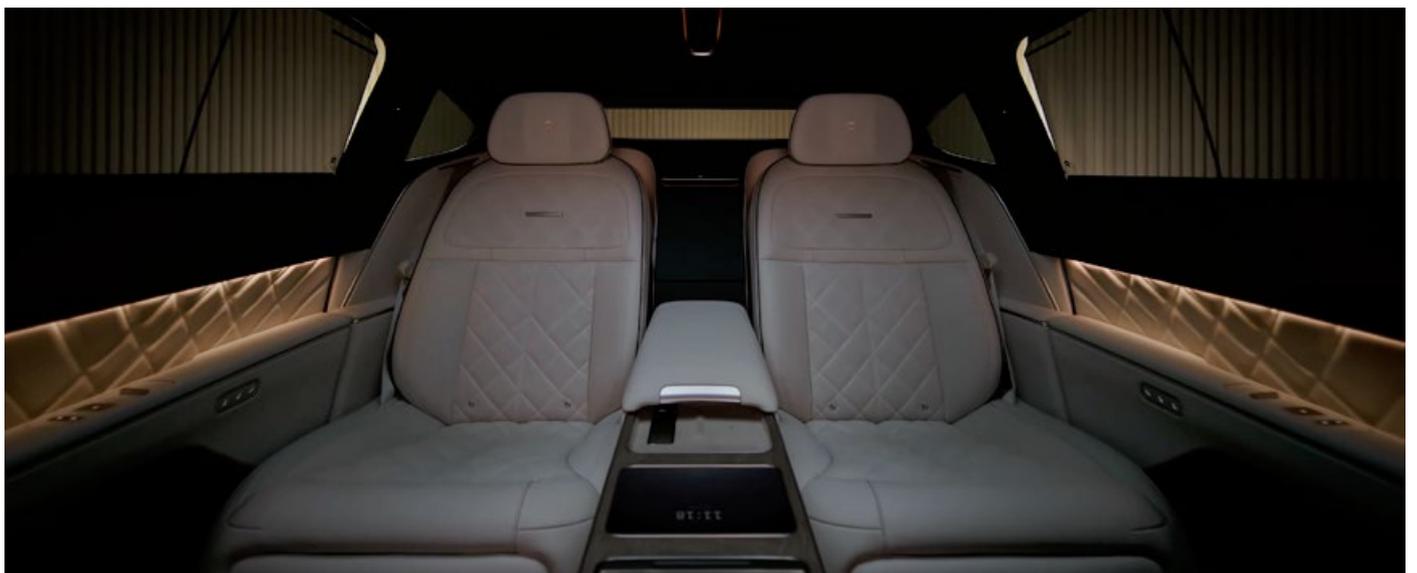
the cabin's contours, enhancing minimalist design, while soft patterns on textured surfaces add depth and warmth. Paired with diffusing materials, this lighting design offers a modern, inviting ambiance that reflects NIO's focus on tech-forward comfort.

USP

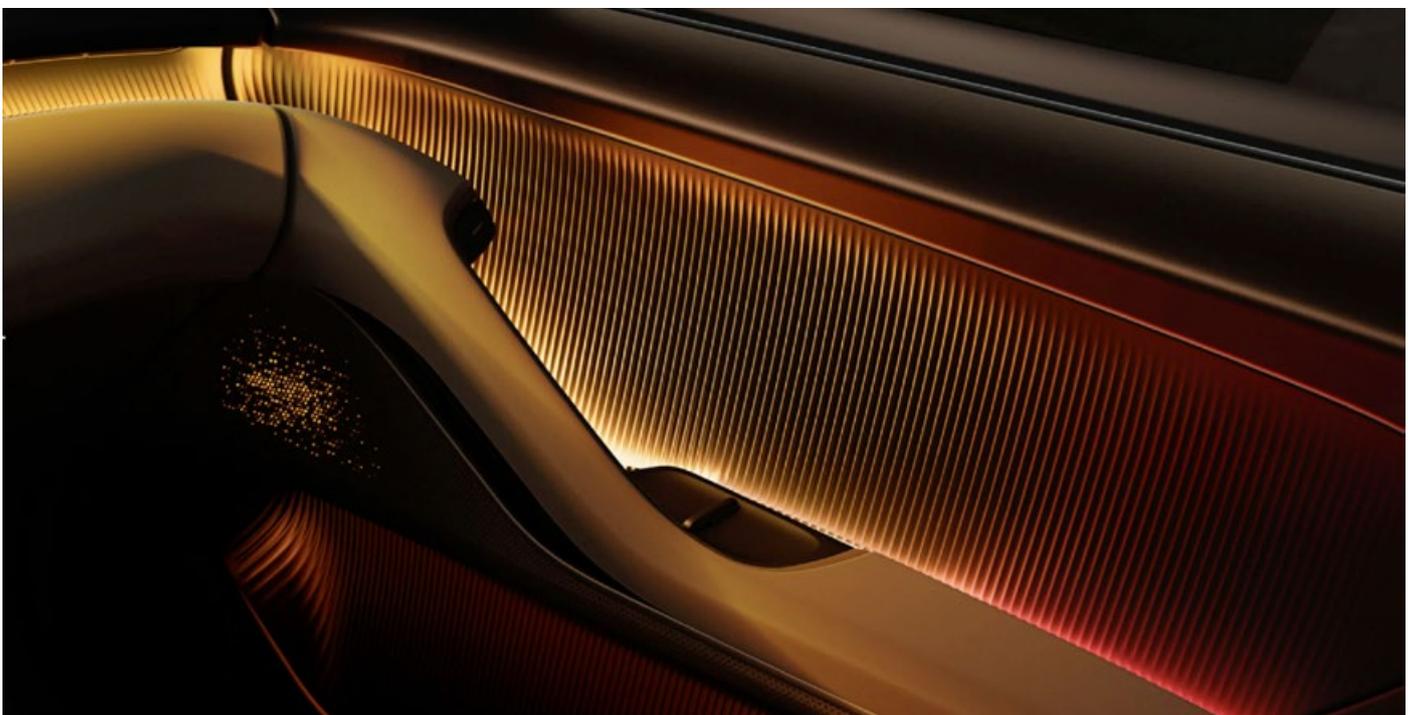
NIO's approach emphasizes wellness and user comfort through adaptable ambient lighting that responds to driving modes, moods, and user preferences. This seamless integration of technology and design elevates the in-car experience, making each journey more immersive and emotionally connected.

YouTube

NIO Fan <https://www.youtube.com/watch?v=qHveDcQ6uiY>
311 autoGlobal <https://www.youtube.com/shorts/Uw-zdeTIHeU>







BYD

FIRST IMPRESSION

Ambient lighting is thoughtfully integrated along key cabin surfaces, subtly highlighting design lines and enhancing perceived space. It adds warmth and refinement to otherwise tech-focused, minimalist interiors.

TECHNOLOGY

Multi-zone RGB ambient lighting with up to 256 colors, dynamic effects and illumination themes that can be customized via the central touchscreen..

A mix of Indirect light fixtures with backlit pattern illumination.

INNOVATION

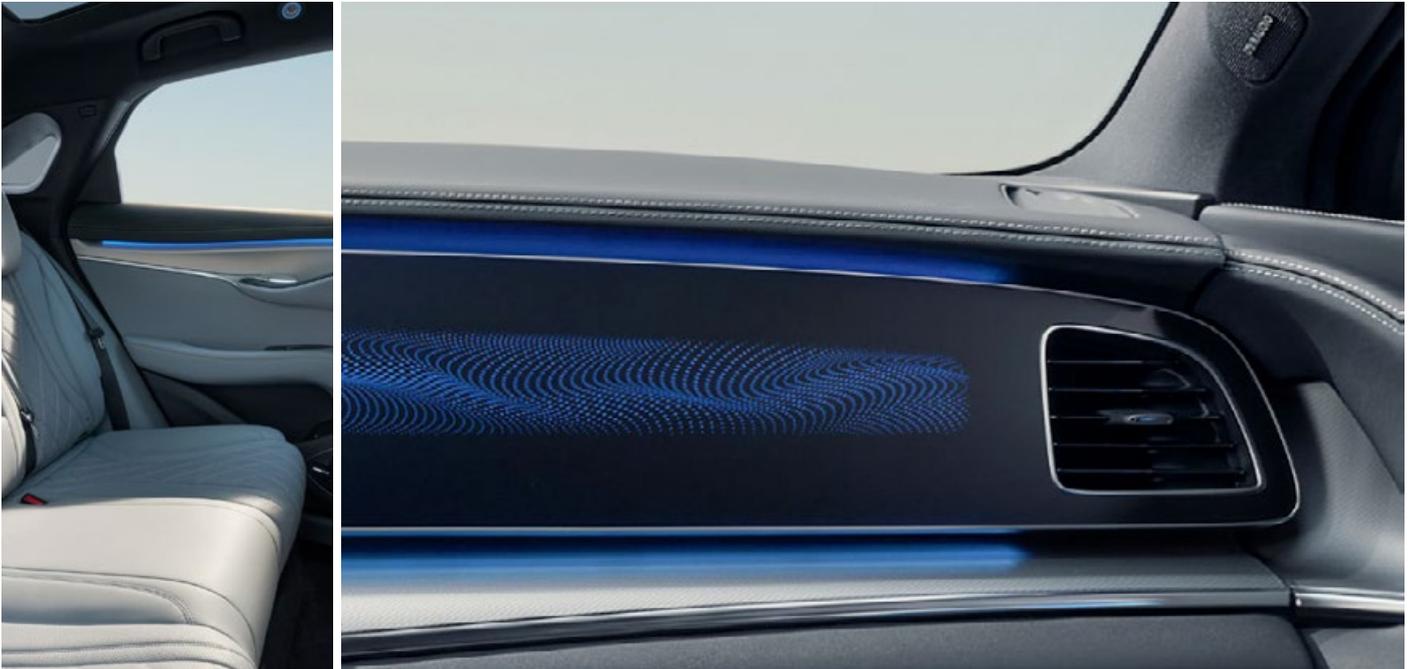
BYD uses ambient lighting as both a visual feature and a functional aid. It adjusts in response to drive modes and vehicle functions — providing visual cues for performance settings or charging status.

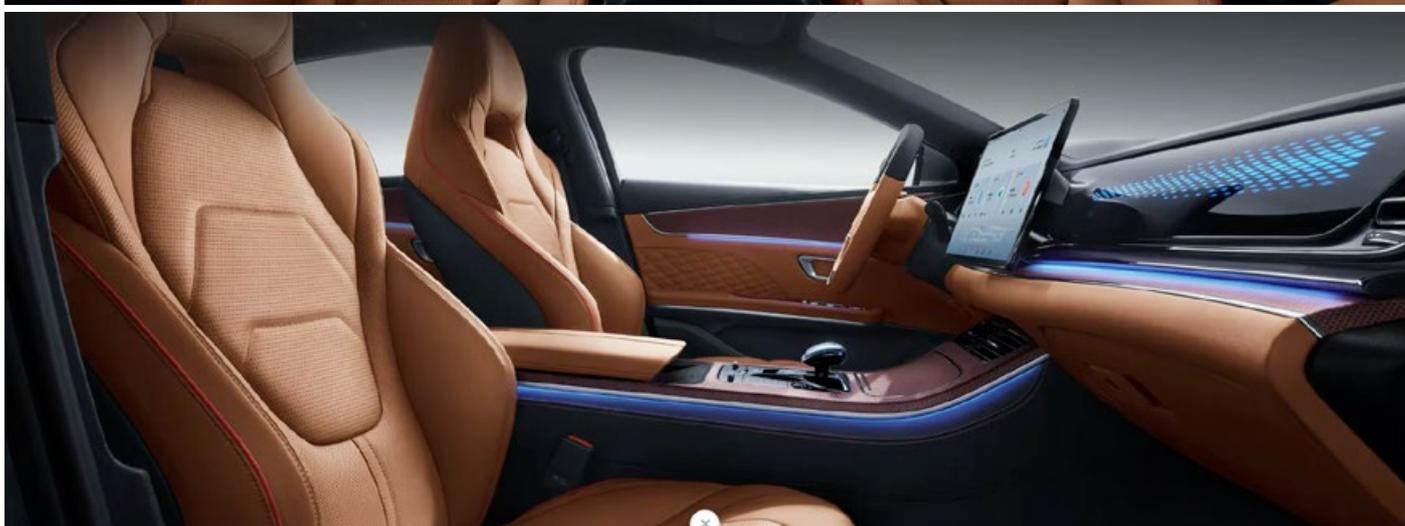
DESIGN

The lighting design in BYD vehicles emphasizes horizontal lines and soft, indirect illumination. It follows the dashboard and door contours, visually widening the cabin and complementing clean surface materials.

Backlight graphics create depth, while the indirect lights enhance a calm atmosphere without overpowering the interior layout.







IM MOTORS

mirror to attach to the backrest of the front seat.

FIRST IMPRESSION

IM Motors' use of indirect illumination complements their interior design philosophy of modern elegance, while also reinforcing the brand's identity as a premium Chinese EV manufacturer.

TECHNOLOGY

RGB LED strips provide indirect lighting throughout the cabin.

Over 30 colors to choose from, along with pre-set themes for ambience.

Both static and dynamic lighting options are available.

INNOVATION

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DESIGN

The lighting design across the brand's models maintains a consistent theme. There's no illumination on the IP due to the wide CSD, but indirect lighting is featured on the front and rear doors, illuminating luxurious decors. Additionally, IM Motors includes footwell, reading, and map pocket lighting.

Some OHC include a surrounding soft light.

USP

Unique illumination ad-ons can be purchased eg. reading lights for the 2nd row passengers or vanity

Youtube

he interface Cars https://www.youtube.com/watch?v=jyvW_6-_S18&t=4s







DEEPAL

FIRST IMPRESSION

Deepal has created a sophisticated and customizable atmosphere within its vehicle interiors through advanced ambient lighting systems.

TECHNOLOGY

RGB LED strips for indirect, direct, point, and backlit pattern illumination with dynamic function.

Backlit patterns through speaker mesh.

64-color ambient lighting system with various pre-set lighting themes to choose from.

INNOVATION

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DESIGN

Deepal uses a variety of interior lighting techniques. The most common is indirect lighting, featured in models such as the S07, S09, and L07.

On the *S09*, the indirect lighting separates the upper and mid-IP sections and stops at the end of the IP.

On *S07* the indirect lighting strip sits lower, between the mid and lower IP volumes. Positioned beneath the large CSD, the light is only interrupted by the steering column before continuing into the doors, where it stops at the midrange speakers.

On the *L07*, the indirect lighting reflects off the

chrome trim of the IP vent. It appears visually disconnected in the center due to the CSD.

Indirect lighting around the tweeter/window switch panel on the *S09* enhances the premium feel. Additional lighting in the map pockets and hidden IDO cups contributes to a holistic and luxurious interior experience.

The *L07* features a backlit pattern behind the tweeter speaker mesh, present in both the front and second-row seating areas. Illuminated crystals below the CSD add a nice, premium touch to the car.

Deepal's ambient lighting can synchronize with music, enhancing the in-car experience by creating an environment that reacts to the audio being played.

USP

Deepal's backlit speaker mesh enhances both aesthetics and functionality beyond conventional ambient lighting systems.

Youtube

Deepal Galax Rayong <https://www.youtube.com/watch?v=N-FDdW9dr7w>







JAPANESE BRANDS

NISSAN

FIRST IMPRESSION

Nissan has been exploring the connection between indirect lighting and patterns (e.g., Murano Glass), creating a well-balanced theme for their interior lighting experience.

TECHNOLOGY

RGB light strips, light pipes, and a combination of direct and indirect illumination.

64 customizable colors for static ambient lighting.

Pre-set color themes with customization options for further personalization.

INNOVATION

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DESIGN

Nissan maintains consistency in their interior lighting execution. Both the Murano and Qashqai feature a mix of direct and indirect lighting elements.

In the 2025 Murano, a direct light sitting under the upper trim of the IP creates a soft glow that reflects off the dashboard uniquely developed trim (*Murano Glass*). The piece itself is made of a 2K pattern and a thin layer of transparent material. The illuminated trim, visually divides the upper and mid panels of the IP. The light strip flows into the doors, where it transitions into a direct light.

On the center console, a direct light accentuates the

storage area in the Murano and the gear selector in the Qashqai. This U-shaped light frames the switch pack and bounces off surrounding materials dipping it into a soft glow.

Qashqai and Murano both feature a similar lighting setup, but with unique executions of the lighting fixtures, patterns and tailored to each vehicle's interior design.

USP

Murano Glass is a unique finsher material, inspired by traditional Venetian glass craftsmanship. It features a 3D pattern that interacts with ambient lighting, creating a visually appealing interior trim.







TOYOTA

FIRST IMPRESSION

The interior lighting in the Toyota C-HR and C-HR+ is clean and functional, with sharp illumination strips that highlight key areas like the dashboard and door panels. It creates a modern atmosphere without being overly flashy.

TECHNOLOGY

RGB LED Light Guides for direct lighting and RGB point lights for IDO, storage, map pockets, and footwell illumination.

Up to 50 illumination colors that can be selected through the menu.

INNOVATION

ADAS illumination support, including ODW (Open Door Warning).

Temperature change indication through illumination color adaptation. For example, turning up the heat will make the light temperature warmer, and vice versa.

DESIGN

Toyota's latest production vehicles feature a geometric and accentuated interior lighting theme. The illumination is crisp and enhances the distinctive interior design features at night.

Three ambient lighting themes: Comfort, Natural, and Dynamic, each providing a distinct mood with different color combinations.

In addition to mood lighting, it provides helpful feedback on temperature control or a warning when opening the doors about approaching traffic in blind spots.

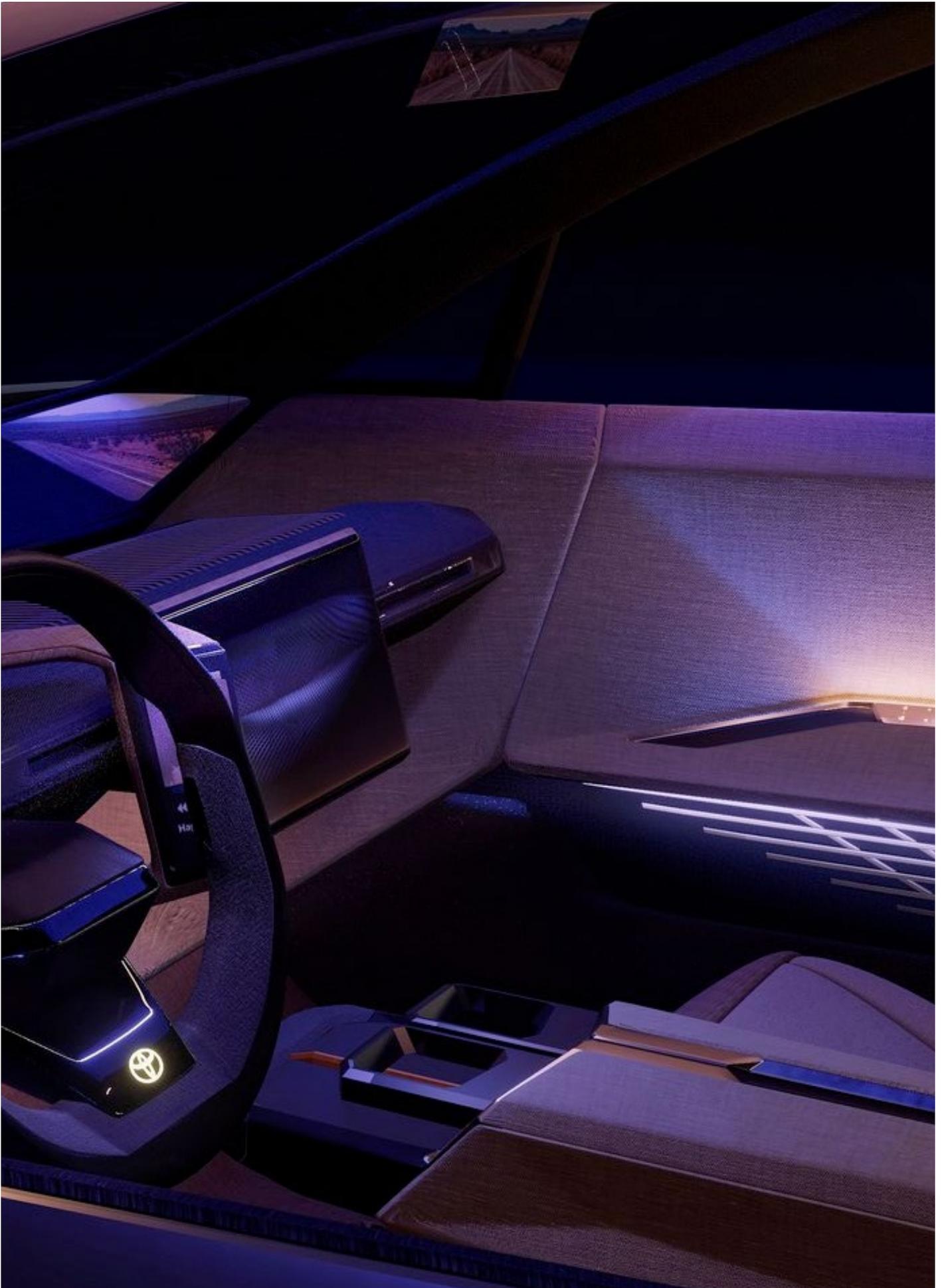
The IDO illumination helps find the door lever at night, a feature Toyota has also explored in their FT-3e concept.

Youtube

Toyota Europe https://www.youtube.com/watch?v=iHaFoNMy_Zk







HONDA

FIRST IMPRESSION

Honda's interior lighting combines practicality with a modern aesthetic.

TECHNOLOGY

RGB LED light guides, used for indirect lighting Point lights for storage, footwell, and reading lights.

INNOVATION

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DESIGN

The indirect lighting in the e:Ny1 splits the mid and lower IP. It's a separate decorative piece with a designed target surface that reflects the light evenly and in a controlled manner.

Secondary lights in the front map pockets, roof, and footwell round off the lighting experience.

5 preset ambient lighting themes

8 ambient lighting colors to choose from

The interior lighting of the *0 SUV* and *0 Salong* Concept convey a sense of futuristic sophistication. In both concepts, the lighting theme plays a key role in creating an atmosphere that is both welcoming and immersive. The use of direct and indirect illumination techniques accentuates the interior design while adding depth. A strong focus is placed on highlighting floating elements, like the CSD that spans the entire width of the IP and the armrest

panel.

The overall use of vibrant illumination colors, indirect lights that create a floating effects and direct lights that contour the 'tub', give a modern, techy interior lighting outlook for future Honda models.

USP

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Youtube

he interface Cars https://www.youtube.com/watch?v=jyvW_6-_S18&t=4s







KOREAN BRANDS

KIA

FIRST IMPRESSION

KIA's approach to interior lighting delivers a clean, contemporary ambient experience that complements the brand's minimalist interior design language. The lighting subtly enhances perceived quality, comfort, and the overall user experience.

TECHNOLOGY

RGB LED strips with dynamic lighting function and preset color themes.

KIA employs a mix of direct and indirect lighting techniques, using optical light guides and diffused surfaces to achieve a soft, even glow.

Lighting remains predominantly static, with limited dynamic functionality reserved for specific interactions, such as welcome scenarios or drive mode transitions on concept models.

INNOVATION

KIA's EV3 and EV2 Concepts show interactive ambient lighting features subtly linked to vehicle functions such as charging, voice interaction, and drive mode indication.

DESIGN

Interior lighting in the latest Kia models accentuates design features like the clean horizontal instrument panel and sculpted door trim.

On the K4, a direct light strip separated the mid from the upper IP.

On the EV3, the most distinctive accent illumination is the door grab handle light. It emphasizes a modern and unconventional graphical interior treatment.

On the EV2 concept, indirect lighting softly washes over dedicated surfaces on the door panels and dashboard, creating a cohesive wraparound effect that visually unites the cabin volumes.

Additional indirect lighting below the floating center console and door pockets enhances functionality while maintaining a clean, decluttered appearance. The subtle glow helps to visually "lift" components, reinforcing KIA's layered design philosophy.

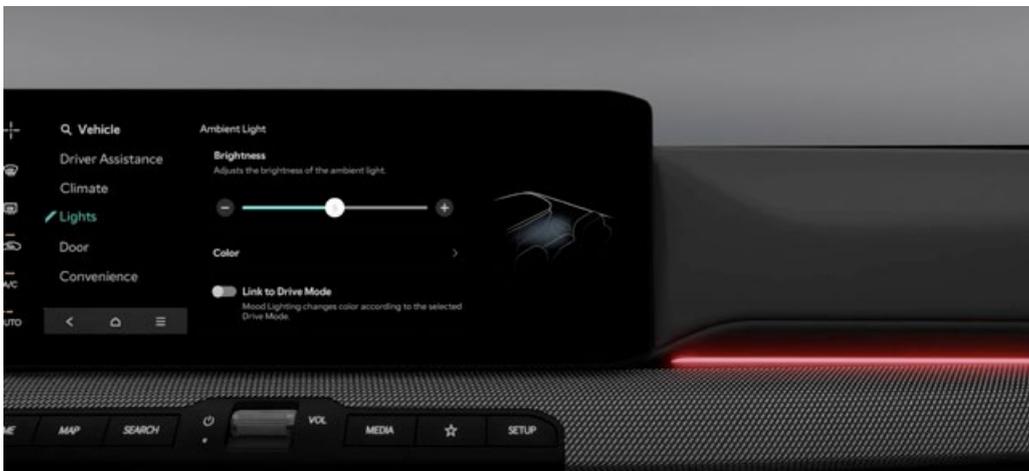
Lighting colors in both production and concept vehicles are carefully curated to harmonize with interior trim and materials, contributing to a sophisticated, calming environment.

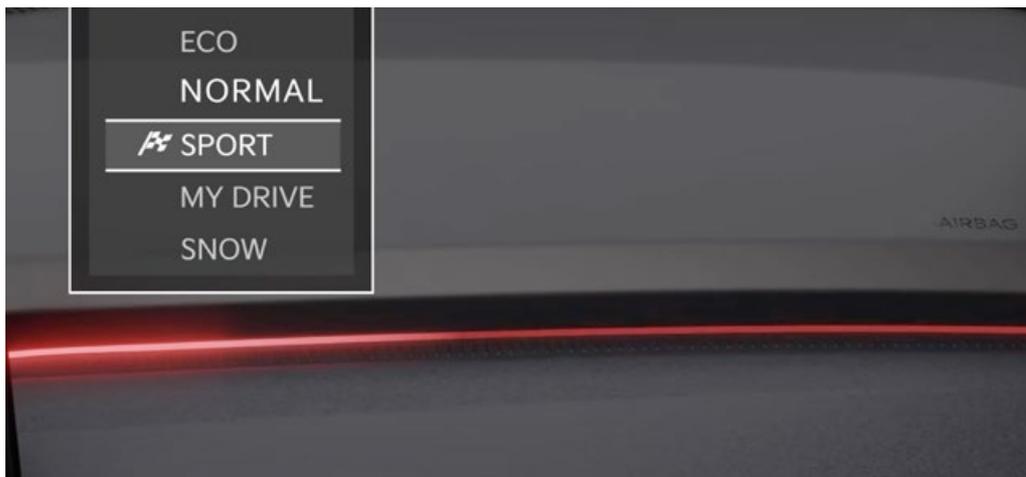
YouTube

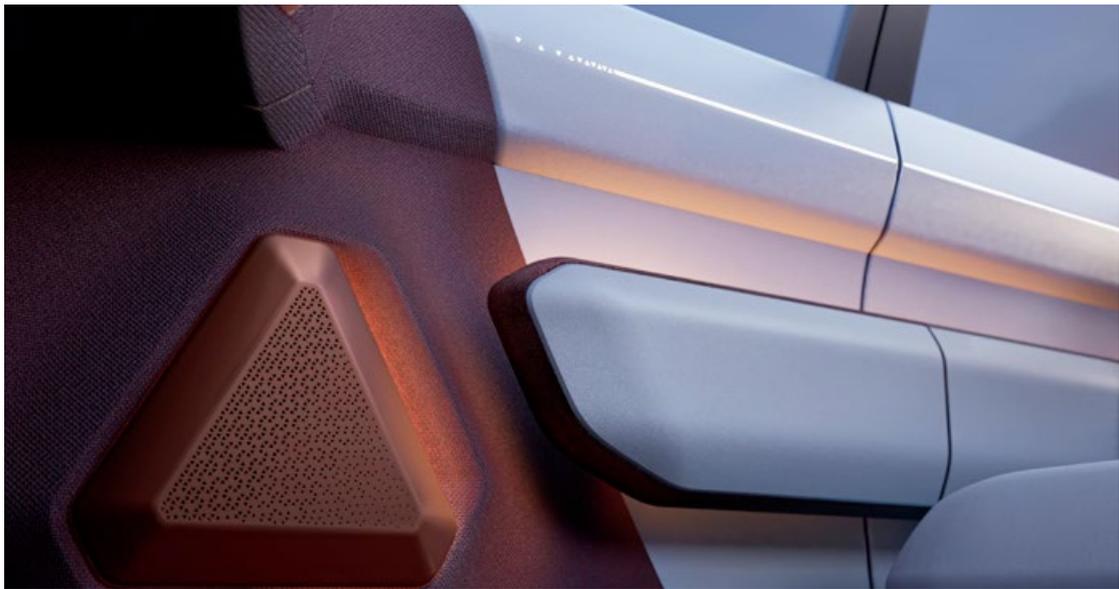
Kia How To <https://www.youtube.com/watch?v=MgWbLrqmuPM>

Kia How To https://www.youtube.com/watch?v=kdWpWJx_cN8

Cars Media https://www.youtube.com/watch?v=_3hKFzNOovw







HYUNDAI

FIRST IMPRESSION

Hyundai's interior lighting design feels like a breath of fresh air. Despite using traditional illumination technology, the integration of 3D patterns and innovative materials on target surfaces creates a unique and modern lighting expression.

TECHNOLOGY

RGB light strips, light pipes and point lights are used to bathe the interior in colorful hues. The use of direct (IP) and indirect (Doors, Footwell) is mixed within the car.

Two-zone ambient lighting with 64 colors per zone, resulting in 4096 possible color combinations.

Multiple pre-set themes enhance customization.

INNOVATION

Hyundai is pushing design boundaries in its concept cars, where light plays a central role in design. Inspired by product design and home furniture lighting, the approach brings a fresh perspective to automotive interiors.

DESIGN

Indirect lighting on the IP and door frame panels, add layers of depth. The two-tone illumination between the upper and lower cabin immerses the interior in vivid hues.

The lighting complements the interior geometry, reinforcing Hyundai's strong branding message.

By integrating lighting as a key design element, Hyundai targets a youthful customer base and creates a striking visual identity.

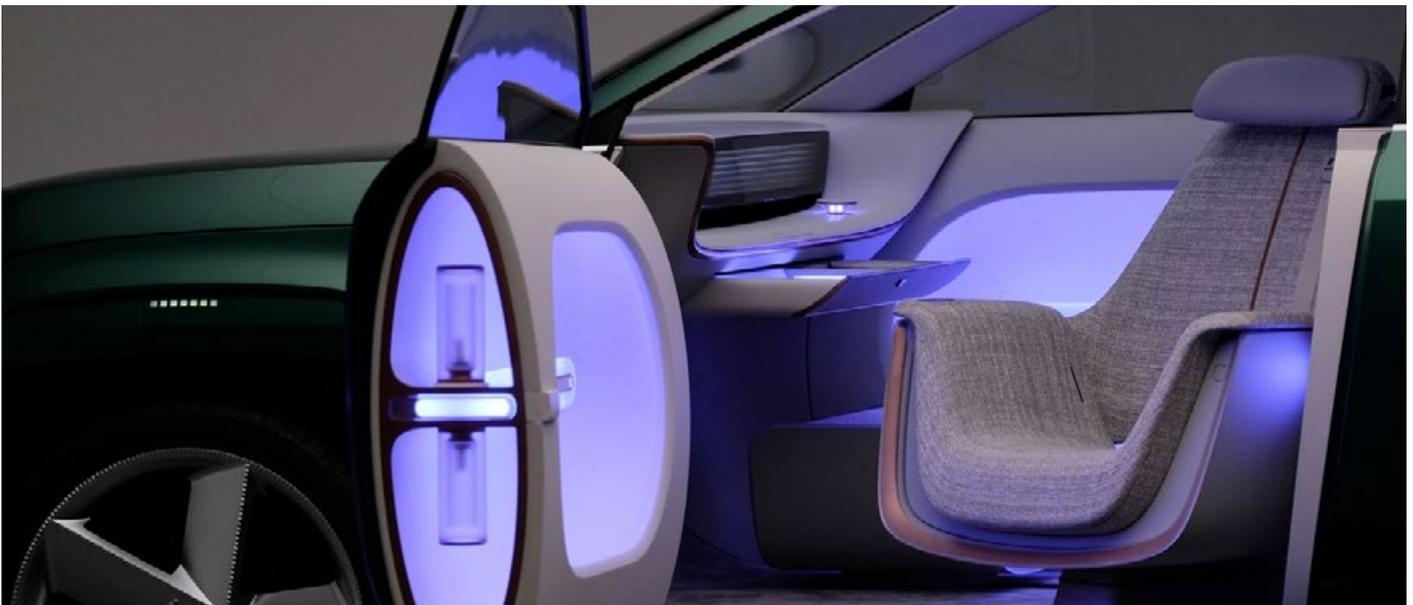
The interplay of simple yet timeless patterns and light results in dynamic light and shadow effects. Hyundai has carefully considered lighting in the design process, ensuring it feels integrated rather than aftermarket. The interior's design becomes even stronger when illuminated.

USP

The combination of lighting, materials, patterns and placement of light, creates a unique interior lighting experience in models like the Ioniq 6. The illumination reinforces Hyundai's brand identity as a youthful, modern brand with a bold and distinctive lighting statement







GENESIS

FIRST IMPRESSION

Genesis interior lighting allows you to immerse yourself in a sophisticated cabin atmosphere, accentuating the interior's luxurious design.

TECHNOLOGY

RGB light strips, light pipes, and a combination of direct and indirect illumination.

64 customizable colors for static ambient lighting.

Pre-set color themes with a customization option for more personalization.

DESIGN

Genesis uses a blend of direct and indirect lighting to create a holistic and immersive experience.

Direct lighting highlights functional details such as cup holders, enhancing usability.

Indirect lighting supports the interior design language, emphasizing depth and elegance.

IP lighting enhances the feeling of width, seamlessly wrapping into the door panels for a more immersive effect.

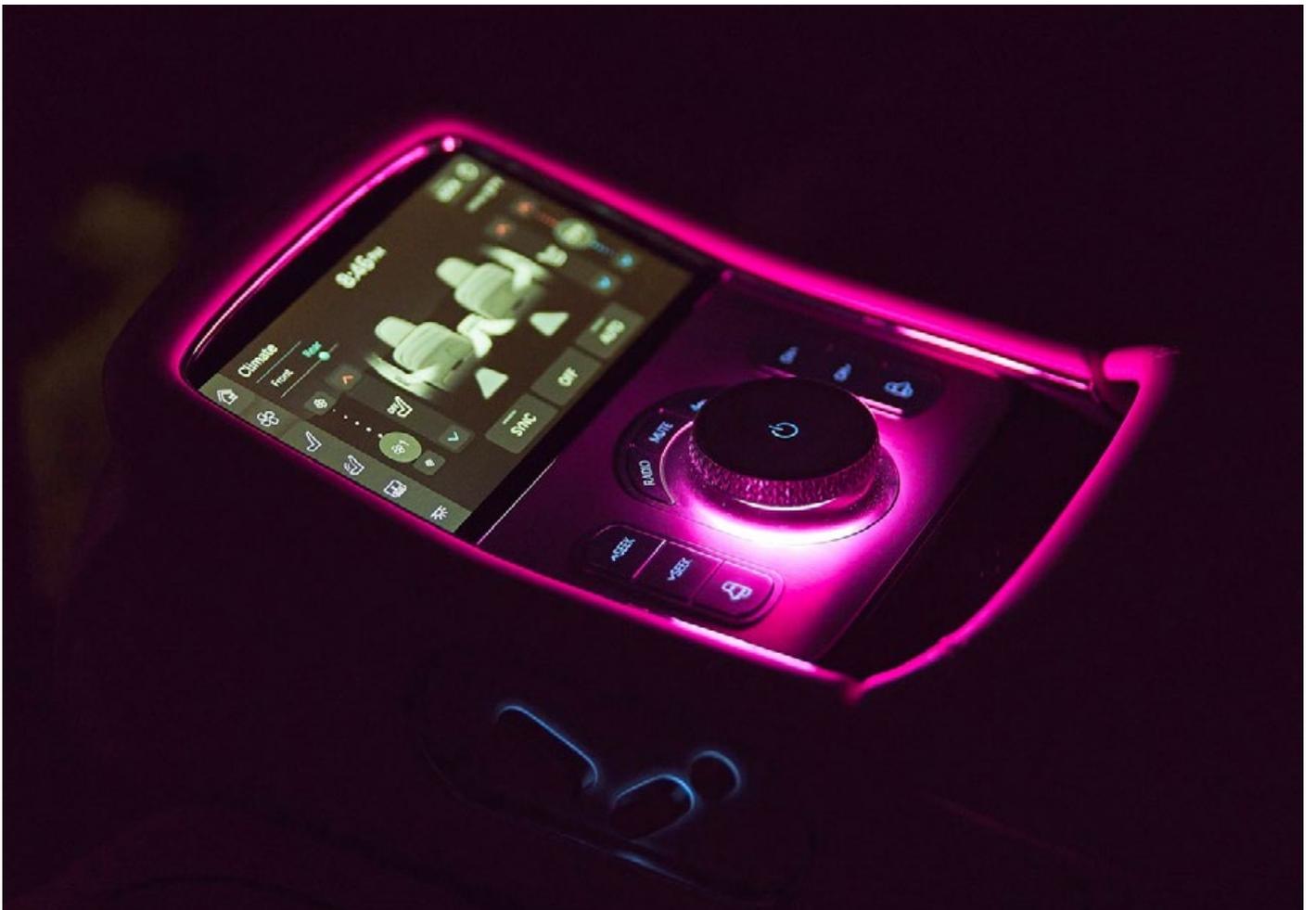
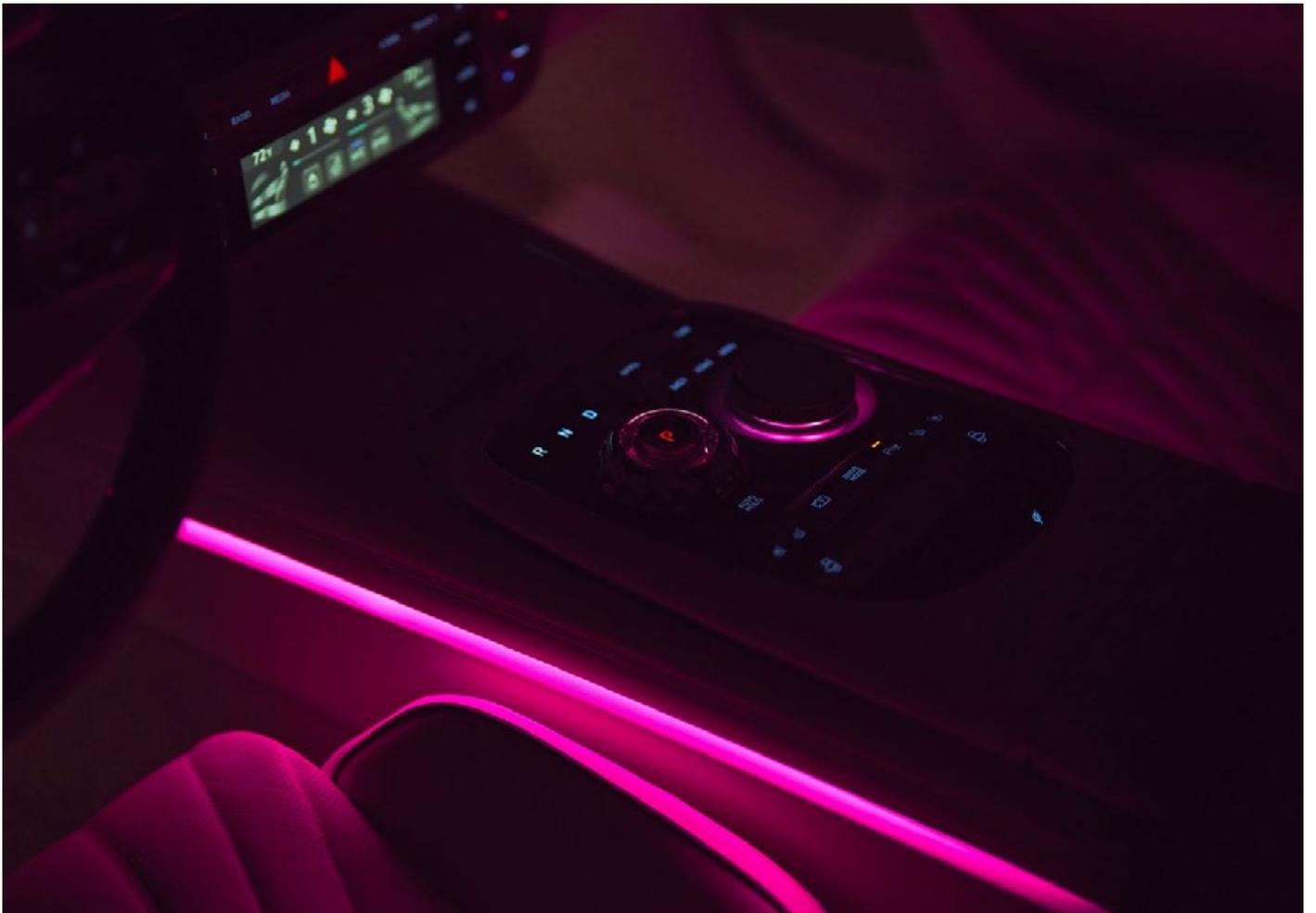
Center console lighting divides the volume into two, giving the design a lighter, more refined appearance.

Backlit decorative panels on the doors add a premium and sophisticated touch.

USP

Mood Curator, with preset themes designed to elevate the overall ambiance by combining lighting with customizable scents.







BIOGRAPHIES



Paul Henri Matha – DVN CEO

Technical Leader, Exterior lighting, Volvo cars, Sweden
2018 to 2023
Lighting Expert, Renault Group, France, Romania, India
2000-2018
Started in 2000 in Automotive Lighting field
SIA Vision President
ISAL board member
IFAL board member
Former GTB WG-I Chairman
SAE lighting group member



Thomas Fröhlich

Thomas Fröhlich started his professional career in Bosch on basic research for autonomous driving in 1989. Soon he joined the lighting division of Bosch to work on lighting electronic design. After joint venture with Magneti Marelli he took over in 2002 the worldwide responsibility for R&D and project management on lighting electronic added by body electronics. To extend the business of Automotive Lighting to new fields he built up design and management activities on new business fields like interior lighting and LiDAR sensing. Starting 2020 he took over the responsibility in Marelli for product management of lighting and exterior sensing. Since mid-2022 Thomas has retired and is now supporting DVN as consultant.



Jean-Paul Ravier

Jean-Paul Ravier graduated from ISAE SUPAERO and IAE Paris. He worked for over 41 years at Valeo, including 29 years at Valeo Lighting where he held a variety of management positions first in IT and finance, and then in R&D, projects, and innovation, including in Japan from 2005 to 2009 at Ichikoh as a board member and managing director. He retired from Valeo in 2013. Shortly thereafter he was appointed chair of the ELS program (Embedded Lighting Systems) for Advanced Master training and Research in Lighting at the Institut d'Optique Graduate School, ESTACA and Strate School of design. He held that position through the end of 2017 and is now Senior Advisor for DVN.

Robert Striedieck

Robert (38) is an automotive interior and lighting designer with 10 years of OEM experience. Most recently, he led the development of interior lighting experience design at Zeekr, creating immersive in-car experiences. Prior to that, he held roles at Lynk&Co and Aston Martin. Originally from Germany, he now lives in Gothenburg, Sweden.

www.noevd.com

LIST OF MAIN DVN MONTHLY REPORTS

Main reports launched in 2008-2020

Koito company profile
China lighting market
The Wonderful World of Passenger Car lighting
Tier 2 and 3 contribution on automotive lighting
ZKW company profile
Simulations in automotive lighting
Mercedes-Benz profile
LED technologies in automotive lighting
LEDs Thermo-Electrics
Interior Lighting
BMW and lighting
Lighting and ADAS
Materials in lighting
Laser Head lighting
Automotive lighting Regulations worldwide
Israeli Startups
Jaguar Land Rover and lighting
Engineering companies involved in lighting
Japanese lighting market
Status of w/w Regulations
Korea Lighting Market
SL Corp profile
ADB/Matrix Beam
India Car Industry and Lighting Market
Vision of lighting 2025-2030
Automotive lighting Regulations worldwide
Vehicle Lighting in USA
New ADB technologies
Interior Lighting
Camera technologies
Varroc profile
Volkswagen profile
US automotive lighting industry
Materials in Vehicle Lighting
The Future of Exterior Lighting
IAA Frankfurt Autoshow
DVN Munich WS
GENEVA Autoshow
US Lighting
Marelli AL Profile
50 years Light Styling
ADAS and Lighting

Main reports launched in 2021

Evolution of LEDs
New Models July-October
2020 Audi Lighting & ADAS
Lighting in development countries
ADB Update
DVN Shanghai WS
Innovations in Rear Lighting
Global Landscape of Automotive LED Suppliers

Reports launched in 2022

Technologies presented in CES 2022
Laser light automotive lighting
ISAL report
DVN US workshop
Worldwide Demographic Development
Models launched May to August
DVN Shanghai report
VISION congress
Paris Autoshow + last Vehicle models
L.A. Autoshow

Reports launched in 2023

CES Report
TU Darmstadt Lighting Institute
DVN Paris Workshop
Universities and Lighting
MLA Technology
Models launched in H1-2023
DVN Tokyo Workshop ISAL Report
DVN US Workshop
Osram Company Profile
DVN Shanghai Workshop

Reports launched in 2024

CES
New cars of the semester
DVN Munich Workshop
OLED Technology
Beijing Autoshow
Display Week
2024 DVN Detroit Workshop
ALE, June 2024
Indian vehicle lighting market
DVN Pune Workshop summary
New cars 2024
Nichia company profile
Test houses
Shanghai DVN event summary

Reports launched in 2025

CES and Bharat Mobility Global Expo
DVN Munich event summary
Dekra testhouse
SPE Plastics in Electric
& Autonomous Vehicles (EAV)
Auto Show Shanghai

DVN ecosystem and scientific community

DVN is a reference in the world of Lighting, Interior comfort and Lidar

Car Makers

Audi
Avatr Technology
Bentley
BMW
Ferrari
Ford
Ford Otosan
General Motors
Genesis
Hero MotoCorp
Honda
Hyundai
Jaguar-Land Rover
Kia
Lotus cars
Lucid Motors
Mazda
Mercedes-Benz
Mitsubishi Motors
Nio
Nissan
Renault
Rivian
Seat
Stellantis
Subaru
Toyota
TVS
SAIC Volkswagen
Volvo Cars
Zoox

System Suppliers and Tier 1s

Adient
Anruì
Appotronics
Aspöck Systems
Braslux
Cepton
Ceres Holographics
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Muth Mirror Systems
Nordic Lights
Odelo Farba
OPmobility
Panasonic
Polycontact
Prettl group
Rehau
SL Corporation
SMR Automotive
Stanley
The Lighting Consultants
Toyota Boshoku
Uno Minda
Valeo
Varroc
Weidplas CH
Xingyu
Zanini
ZKW
Zodiac

Light Source Suppliers

ams OSRAM
APT Electronics
Brightek
Dominant Opto Tech.
Everlight Electr.
HC Semitek
Kyocera SLD Laser
LG Innotek
Liteon Technology
Lumileds
Nichia
OLEDWorks
Refond
Samsung LED
Seoul Semiconductor

Tier 2s and service providers

A2Mac1
Ascorium
AML Systems
Ansys
ASAP
ASYST Technologies
Auer Lighting
BASF
Bluebinaries
Brightview Technologies
Capgemini
CLM Search
Coindu
Covestro
Dajac
DBM Reflex
Delo

Die haptiker GmbH
Docter Optics
Dow
Edag
Elmos
Endego
Ennostar
Euro Moulders
EV Group
Flow Dry Technology
Focuslight
Fusaware
Grewus
HJ Optics
Huawei
Idemitsu
Infineon
Inova Semiconductors
Instrument Systems
Integrity
Joysonquin
Leonhard Kurz
L.E.S.S.
LMT
Luminus
Mektec
Microvision
Maxell Frontier
MD Group
Melexis
Microchip
Microrelleus
Mitsui Chemicals
Mocom
Nalux
NBHX Trim
Oerlikon
ON Semiconductor
Pininfarina
Polyrise
Preh
Ray Group
S&P Global Mobility
Sabic
Schott
Seaborough
Seoyoneh-Ewha
Shihu
SP3
Sunny Automotive Optech
Suzhou Senbo
Synopsis
TechnoTeam
Toshiba lighting
TQ Technology
Uni Tooling
Ventura
W Research Company LLC
W.L. Gore & Associates
WLOPT
X2F
Xunchi

Universities, NGO and labs

Alliance for Automotive Innovation
ARAI
Automotive Research Association of India
BMDV
Bundesministerium für Digitales und Verkehr
CATARC
China Automotive Technology and Research Center
CEA Leti
Darmstadt university
DEKRA
Department for transport, UK
DTI
Danish Technological Institute
DVR
Deutscher Verkehrssicherheitsrat - German Road Safety Council
Estaca
École supérieure des techniques aéronautiques et de construction automobile
Fraunhofer (FEP, IAP, ILT, IMS)
Fudan university
GTB
Hannover Leibniz
Hochschule Aalen
Hochschule Magdeburg-Stendal
Icahn School of Medicine at Mount Sinai
Light and Health Research Center
ICAT
International Centre for Automotive Technology
Idiada
Institut d'Optique
JASIC
Japan Automobile Standards Internationalization Center
KBA
(Kraftfahrt-Bundesamt)
KATRI
Korea Apparel Testing & Research Institute
KIT
Karlsruhe Institute of Technology
Kotsa
Korea Transportation Safety Authority
LCOE
Laboratorio Central Oficial de Electrotecnia
L-LAB
MLIT
Ministry of Land, Infrastructure, Transport and Tourism
NHTSA
National Highway Traffic Safety Administration
OICA
International Organization of Motor Vehicle Manufacturers
Pacific Northwest National Laboratory
Phabulous
RDW
RISE Research Institutes of Sweden
Sapphire STS
SMMT
Society of Motor Manufacturers And Traders
SMVIC
Shanghai Motor Vehicle Inspection Certification
TNO
Traficom
Transport Canada
UMTRI
Université Gustave Eiffel
UTAC
VDA
Verband der Automobilindustrie
VEDECOM
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