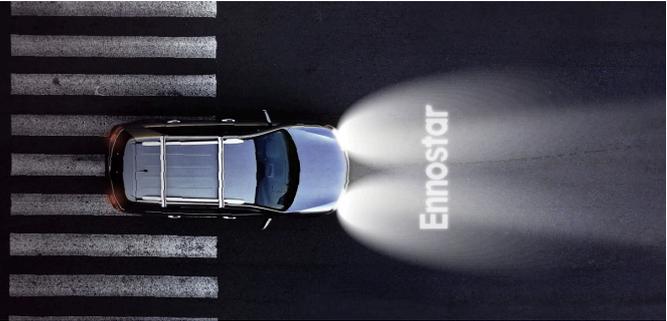Ennostar

**Expert in Comprehensive
Automotive Lighting Solutions**

Ennostar

Editorial

A First For DVN: Audi's A5 Sneak Preview

DVN was invited to join other international media representatives in Munich last week for Audi's press preview of their new Audi A5 model lineup, which replaces the A4/A5 after that model's successful 30-year run. The new A5s are the first to be based on the Premium Platform Combustion (PPC) with partially electrified driver systems and new EE architecture (E^3 1.2). Market launch is slated for this November, with a starting price of €45k.

Lighting is one of the biggest changes marking out these new cars as distinct from the ones that came before. There's new full-width rear lighting, digital OLED signature, a dynamic interaction light, and much more. Read all about it in our extra-long in-depth report this week.

It was really interesting to discuss with media and see what is interesting for them on a new car. Design, engine, efficiency and connectivity are their major topics; lighting they consider only an aesthetic aspect. Its complexity and performance, they do not know or care. I spoke at length with Canadian journalists during my voyage and at the hotel, and they knew nothing of what is ADB. We need to educate them to put more focus on lighting technology! To that end, I invited them to join a DVN event to see our world; for sure they are interested.

Also in this week's DVNewsletter you'll find our synthesis of the **ALE show** last month in China.

Paul-Henri Matha
DVN Chief Operating Officer and Lighting General Editor

In Depth Lighting Technology

All-New Lights on All-New Audi A5
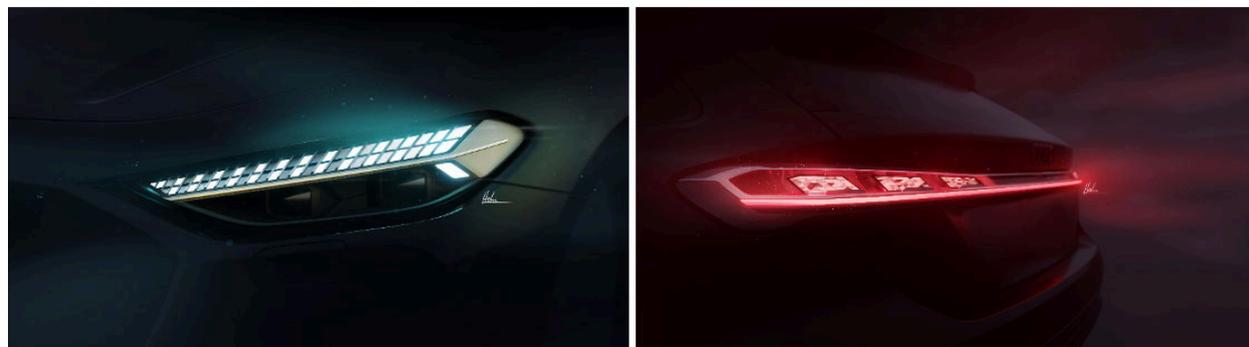
By Paul-Henri Matha, DVN COO & Lighting General Editor

Lighting has long been centrally important at Audi, and lighting design and R&D were part of their sneak-preview reveal of the new A5 model lineup.

The car is totally new, with a 67-mm length increase to 4,829 mm. It has a long wheelbase of 2,900 mm with short overhangs, contributing to good proportions and generous interior space. Audi realized a very efficient design for a combustion/hybrid vehicle, with a drag value of 0.25 for the sedan and 0.27 for the Avant (wagon).

Immediately striking is the full-width rear lamp, like Audi's e-tron models—it is now an Audi-wide brand signature. The car looks wider, and it is (+13mm); it is very well poised on its large wheels.

The front bears a brand-typical design, with a new grille incorporating L-shaped chrome elements with modern headlamp design.

Of course, this is DrivingVisionNews, so I will focus here on the lighting—the rest of the car's details, you can read about in Autocar or Automobile or Motor Trend or whatever

other generalist car publication you favour. So, let's take a look at the A5 lighting systems!
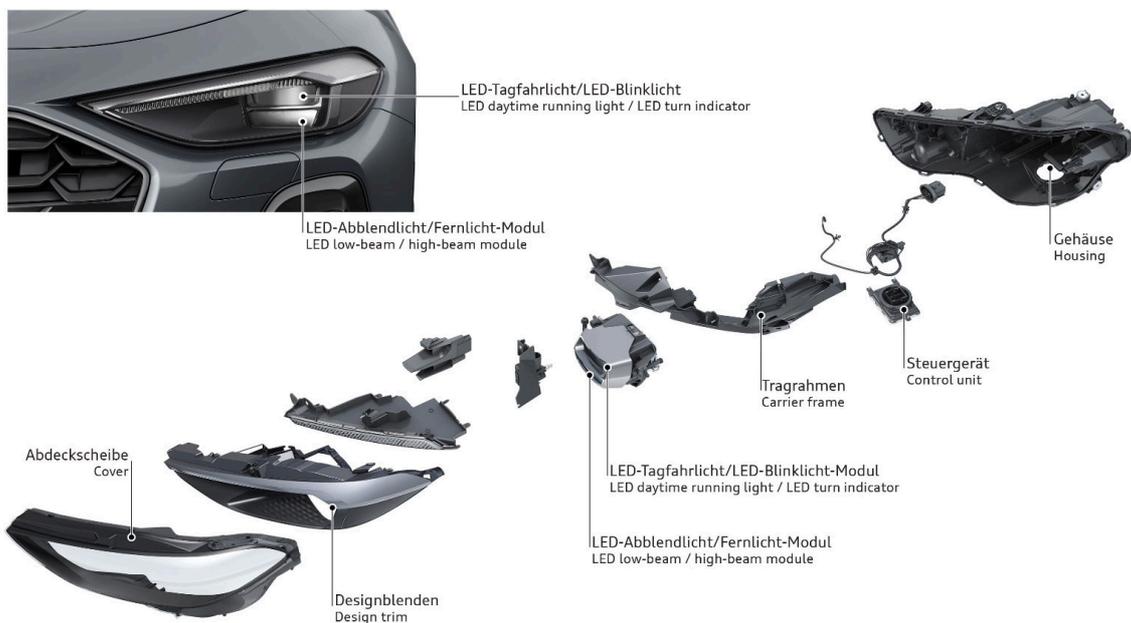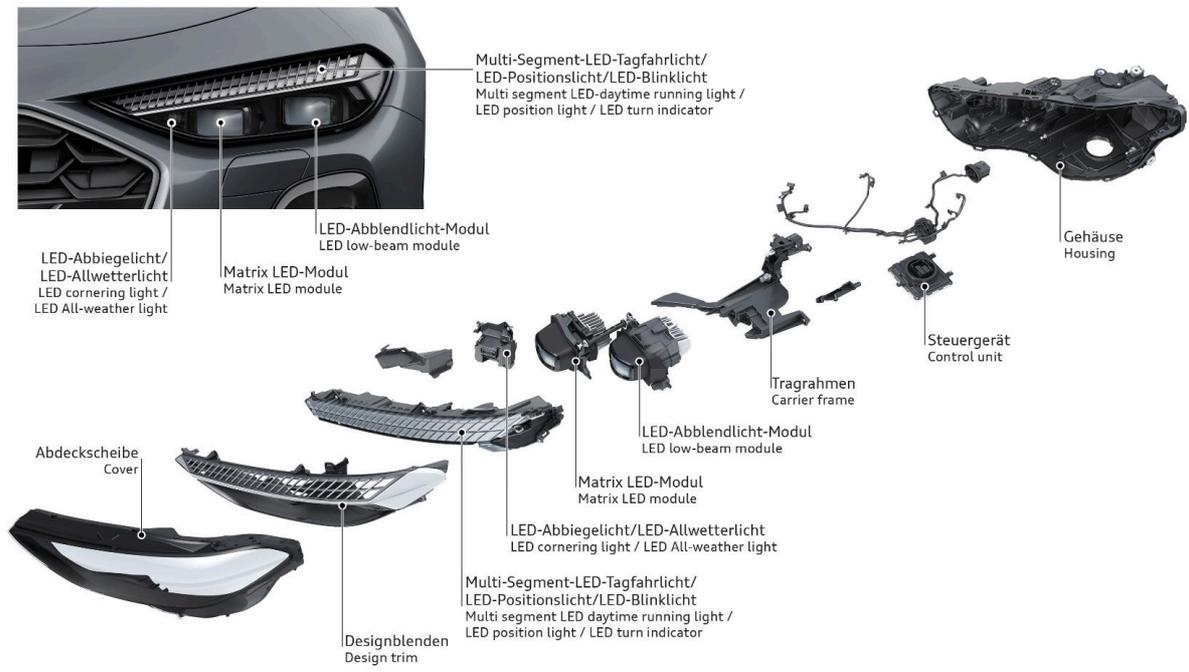
Headlamps

Audi offers three headlighting setups. The base version has full LED headlamps with a BiLED module providing low and high beam. Just above that is a combination DRL-position-turn signal light.

One step up, the middle-spec version has full LED headlamps with a 3-module AFS setup: low beam module (45 mm height), high beam module, and cornering - town - all weather additional lighting module—there are no front fog lamps; their function is comprised by the all-weather mode Audi have been phasing in across their model lineup. This mid version gets a multisegment LED DRL-position-turn signal light.

The top-spec version builds on the mid-spec setup, replacing the high beam module by a 16-segment matrix module.

A headlamp cleaning system is available.

LED-Tagfahrlicht/LED-Blinklicht
LED daytime running light / LED turn indicator

LED-Abblendlicht/Fernlicht-Modul
LED low-beam / high-beam module

Gehäuse
Housing

Steuergerät
Control unit

Tragrahmen
Carrier frame

LED-Tagfahrlicht/LED-Blinklicht-Modul
LED daytime running light / LED turn indicator

LED-Abblendlicht/Fernlicht-Modul
LED low-beam / high-beam module

Abdeckscheibe
Cover

Designblenden
Design trim

Multi-Segment-LED-Tagfahrlicht/
LED-Positionslicht/LED-Blinklicht
Multi segment LED-daytime running light /
LED position light / LED turn indicator

LED-Abblendlicht-Modul
LED low-beam module

LED-Abbiegelicht/
LED-Allwetterlicht
LED cornering light /
LED All-weather light

LED-Fernlicht-Modul
LED high-beam module

Gehäuse
Housing

Steuergerät
Control unit

Tragrahmen
Carrier frame

LED-Abblendlicht-Modul
LED low-beam module

LED-Fernlicht-Modul
LED high-beam module

LED-Abbiegelicht/LED-Allwetterlicht
LED cornering light / LED All-weather light

Multi-Segment-LED-Tagfahrlicht/
LED-Positionslicht/LED-Blinklicht
Multi segment LED daytime running light /
LED position light / LED turn indicator

Abdeckscheibe
Cover

Designblenden
Design trim

Multi-Segment-LED-Tagfahrlicht/
LED-Positionslicht/LED-Blinklicht
Multi segment LED-daytime running light /
LED position light / LED turn indicator

Gehäuse
Housing

LED-Abbiegelicht/
LED-Allwetterlicht
LED cornering light /
LED All-weather light

Matrix LED-Modul
Matrix LED module

LED-Abblendlicht-Modul
LED low-beam module

Steuergerät
Control unit

Tragrahmen
Carrier frame

LED-Abblendlicht-Modul
LED low-beam module

Abdeckscheibe
Cover

Matrix LED-Modul
Matrix LED module

LED-Abbiegelicht/LED-Allwetterlicht
LED cornering light / LED All-weather light

Multi-Segment-LED-Tagfahrlicht/
LED-Positionslicht/LED-Blinklicht
Multi segment LED daytime running light /
LED position light / LED turn indicator

Designblenden
Design trim

For mid- and high-spec versions, you get the multisegment signalling feature, with a reciprocally-incorporated DRL - position - turn signal light and eight different signatures you can change via MMI and the MyAudi app.

Licht-Design 1
Light design 1

Licht-Design 5
Light design 5

Licht-Design 2
Light design 2

Licht-Design 6
Light design 6

Licht-Design 3
Light design 3

Licht-Design 7
Light design 7

Licht-Design 4
Light design 4

Licht-Design 8
Light design 8

Audi's design team worked on every detail in the lamps to give premium perceived quality. One example is the really nice chrome-and-black bezel that enhances the lamp design when all functions are off, thank to a hot stamping film technology (well known in grille applications). All the rest of the lamp is fully dark / black when off, which creates a hidden-headlamp effect.

Front ADAS

The front bumper has two inbuilt radars, a centred short-range one and a long-range one mounted on the right side. No lidars is visible on the car.

Rear lighting

As with the front lighting, three rear lamp versions are available. All are full-LED. The base version lacks any sequential operation. The mid-spec version provides sequential animations. And the high-spec version has Audi's Digital OLED 2.0 technology, similar to that on the Q6 e-tron as previously [covered](#) in DVN ([twice](#)). The A5 system has model-specific OLED design and panels, with 60 segments per OLED panel—the rear position lamp signature is created by 364 individually-controllable segments.

Audi A5

Heckleuchte mit digitaler OLED*-Technologie 2.0
Rear light with digital OLED* technology 2.0
07/24

Gehäuse
Housing

Platinen mit LEDs und Elektronik
Printed circuit boards with LEDs and electronics

Digitales OLED-Panel
Digital OLED panel

Design- und optische Blenden
Design and optical bezels

Lichtscheibe
Outer lens

Digitales OLED-Panel mit 60 Segmenten.
Insgesamt nutzt die digitale OLED-Heckleuchte 364 OLED-Segmente
Digital OLED panel with 60 segments.
IIn total, the digital OLED rear light uses 364 OLED segments

*OLED: Organic Light Emitting Diode

Eight different signatures are available, including the active digital signature, and there are four different communication light scenarios (V2X), again similar to the Q6 e-tron: automated parking mode indicator, proximity indicator, road hazard warning, and exit warning indicator.

Licht-Design 1
Light design 1

Licht-Design 5
Light design 5

Licht-Design 2
Light design 2

Licht-Design 6
Light design 6

Licht-Design 3
Light design 3

Licht-Design 7
Light design 7

Licht-Design 4
Light design 4

Licht-Design 8
Light design 8

*OLED: Organic Light Emitting Diode

The A5 rear lamps are well worth a long look to see the details Audi's team have realized. The stop lamp is behind the OLEDs, which creates a 3D effect with a really nice-looking design. The full-width LED light strip is unusually homogenous in its illumination, made possibly by indirect-reflector optics and an opaline (diffusing) inner lens. Laser welding permits a reduced dark boundary between the body and decklid (or hatchgate) portions of the lamp.

The car has a classic German "parking lamp" function which allows to light the front and rear position lamps on one or the other side of the car alone, by activating the position lamp and turn indicator controls before turning off the engine (not to be confused with the North American "parking lamp" term, which is that region's name for the front position light function). As usual with Audi, they have refined and improved this function in interesting, thoughtful ways: to reduce power draw, the hatchgate or decklid portion of the lamp is not active, and neither is the OLED part of the body-mounted lamp. Only the outer, body-mounted portion of the LED strip is lit. We note that the ECE Parking Lamp function does not have to meet the 4-cd minimum of the ECE Rear Position Lamp function; instead, it has a minimum intensity of just 2 cd (same as the US "tail lamp"/rear position light function), per UN R148-1 §5.3.1—though this is a general remark, made without knowledge of the particulars of the Audi lamps' output.

The rear fog lamp is central just below the Audi logo.
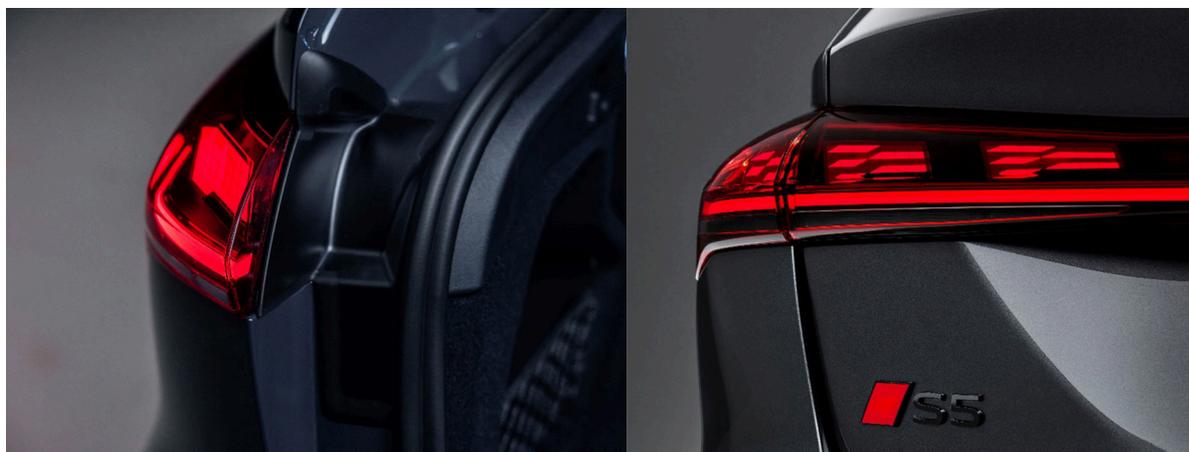
Most intriguingly, the lighting engineers and designers at Audi have successfully applied the same lamp hardware for the sedan and the wagon. That is not an easy task in itself, what with body metal differences, tailgate-slamming tests, and visibility-angle requirements to meet—let alone convincing the powerful body-in-white team. Well done!

Interior lighting

The contour light in the dashboard and doors emphasizes the width of the interior. The indirect light below the MMI panoramic display and in the center console creates a visual floating effect. The premium materials in the doors are illuminated to great effect.

In addition, there is the dynamic interaction light (IAL) with a variety of functions to support the car's interaction with the occupants. It spans the entire interior width by means of a generous strip. 84 LEDs are installed in the light strip, which means it fulfills multiple functions: it sets the scene for the interior. The welcome function indicates when the vehicle is locked and unlocked. It indicates the battery state-of-charge. And the IAL supports safety; for example, the dynamic indicator light is visualized, but the IAL remains an additional display and does not replace a turn signal in the virtual cockpit. The dynamic interaction light is part of the Ambient Lighting Package Plus.

See videos here for the different functions

Interaction light
Different pieces of information are communicated dynamically by means of light strips with 84 LED elements

Interaction light
Different pieces of information are communicated dynamically by means of light strips with 84 LED elements

Interaction light
Different pieces of information are communicated dynamically by means of light strips with 84 LED elements

Interaction light
Different pieces of information are communicated dynamically by means of light strips with 84 LED elements

Interaction light
Intuitive communication at eye level

Another interesting feature, not really connected to lighting technology but which may be used for lighting, is the optional panoramic glass roof with PDLC technology (polymer dispersed liquid crystal) for switchable segmented or full opacity and transparency.
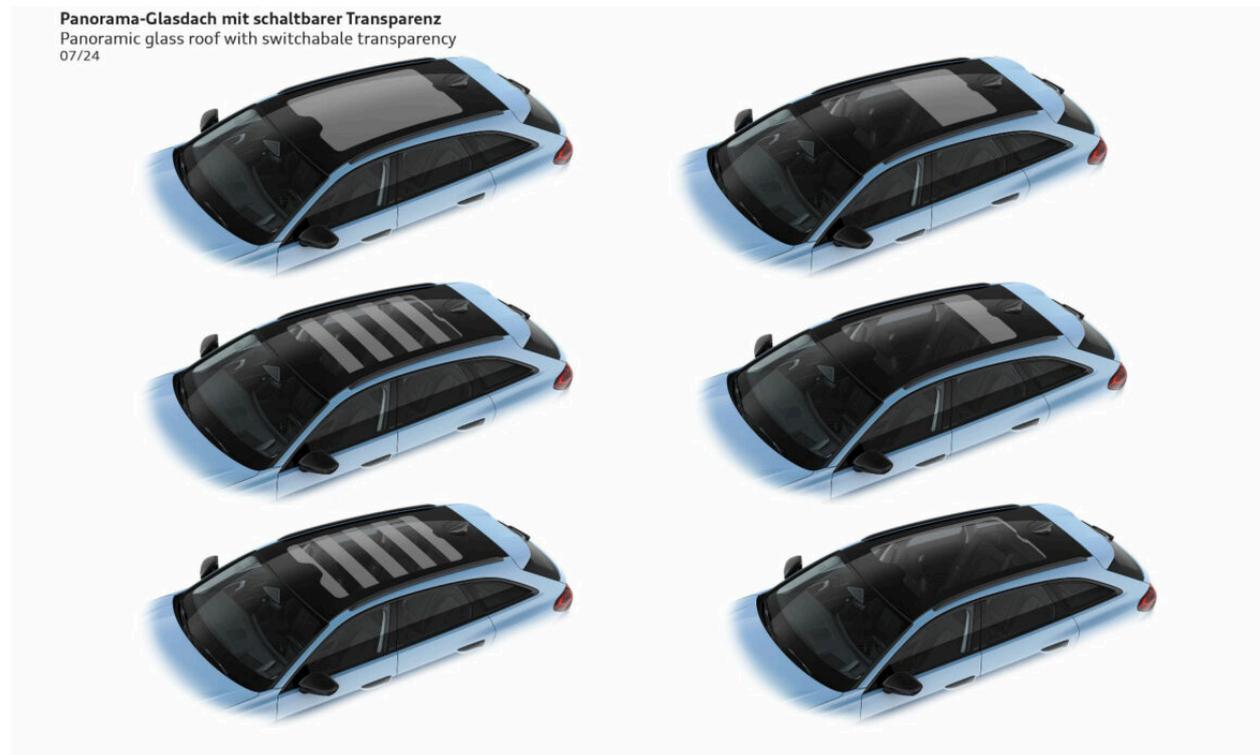
Lamp activation

Audi have defined a lamp activation interface for this new platform: button controls are located on the driver's door with different possible lamp selections (position lamp. auto, all-weather, off). On the front driver display you can see which lamp is selected.

Audi have put together videos of the [front](#) and [rear](#) lighting animations on the new A5.

Lighting News

Automotive LED Market Update
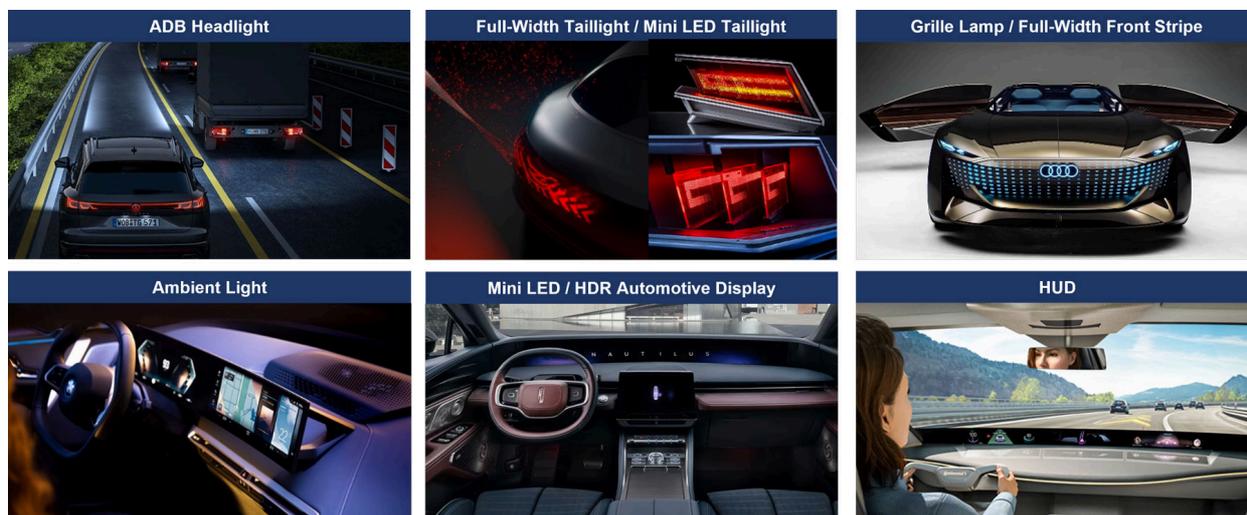
According to TrendForce's 2024 Global Automotive LED Market (Lighting and Display Product Trend) report, there's been steady growth in the vehicle lighting and automotive LED demand for 2024—to USD $37.395bn and $3.445bn, respectively; that's higher than car market shipment performance.

Global LED headlamp equipment rate for conventional passenger cars reached 72 per cent in 2023—the figure for EVs is fully 94 per cent. These two rates are expected to grow to 75 and 96 per cent in 2024, respectively.

TrendForce say the equipment rate of ADB will likely jump to 21.7 per cent in 2028, though this of course is highly regionalized. As micro- and miniLED pixelated modules are increasingly used for ADB, in 2028 their market value could exceed $900m.

Car makers are adopting miniLED automotive displays to provide HDR, local dimming, wide colour gamut, and a curved screen. TrendForce say miniLED POB / POG / COB, and OLED displays will compete for next-generation automotive displays

The panoramic HUD (P-HUD) adopt reflective displays; examples include Continental's miniLED backlit model and BMW's RGB Mini LED display.

The top automotive LED manufacturers include AMS Osram, Nichia, Lumileds, Seoul Semiconductor, and Samsung LED, with these five suppliers having a combined market share over 80 per cent in 2023.

Illuminating the Path to a Software-Define Future

By Matthaeus Artmann, ZKW Advanced Technology Manager, with introduction by DVN's Paul-Henri Matha

Semiconductor Review Europe published last week this interesting paper, and I decided to publish the complete article. In the 2020s, software has become the main stake for automakers and lamp makers, compared to the previous hardware focus —Paul-Henri Matha, DVN

"Through this article, Matthaeus shares his insights on the evolving landscape of exterior automotive lighting. He discusses the transition to LED-based lighting, the challenges of thermal management and the advancements in LED technology. Artmann highlights the importance of integrating high-power drivers and high-bandwidth interfaces to overcome current limitations and the shift towards centralized architectures for software-defined vehicles. He emphasizes the need for automotive suppliers to innovate and collaborate with OEMs to ensure a smooth transition and enhance the functionality and sustainability of exterior lighting systems.

"Looking at the automotive industry for exterior lighting, it is clear, that light-emitting diodes (LED) have become the main photonic element utilized for all known applications, no matter if it's for road illumination or signalling.

More than a decade ago, LEDs started to succeed in well-established light sources such as halogen bulbs and HID lamps. LASER was in vogue for a while, but over time became only a niche technology for very specific use cases in exterior lighting. ZKW played an important role in bringing the first full-LED-equipped headlamp and also in developing a LASER-based application.

"With this big shift to LEDs, some challenges occurred down the road which are still valid nowadays in my opinion. Technology-wise, it was clear from the beginning that LEDs need specific thermal management to optimize lifetime since a headlamp

comprises a very harsh environment with high temperature conditions causing degradation to semiconductors.

"Thermal solutions now look very similar to those from the early beginnings, like FR4-based PCBs on heatsinks with a cooling fan on the back, but advancements like insulated metal substrate (IMS) and copper inlays brought greater flexibility. I see movements that the materials used could change as a matter of sustainability and environmental health requirements, but not soon.

"The transition to LED-based exterior lighting in the automotive industry presents both challenges and opportunities. While advancements in thermal management and miniaturization are ongoing, the integration of high-power drivers and high-bandwidth interfaces, along with a shift towards centralized architectures, will be key to unlocking the full potential of software-defined vehicles.

"Changing to new materials seems tempting but in my humble opinion needs a global approach, as the automotive industry with its very specific requirements on grade and quality has less power to make it happen.

Function-wise, flexibility scales up with the number of LEDs and their size used as OEMs are demanding it and pushing. Headlamps and rear lamps with several hundreds of tiny LEDs are state-of-the-art, but no one knows or sees them. And the trend goes on, with micrometre-sized LEDs on the horizon for much more flexibility. But this comes at the cost of complex LED drivers and interfaces, as well as weight caused by a lot of wires used.

My observation here is that the introduction of smaller and integrated high-power drivers accompanied by high bandwidth interfaces such as CAN-FD and 10Base-T1S is the key to getting rid of these problems. As usual, costs from a BOM perspective are crucial in the beginning, but this argument could be counterbalanced by the fact, that fewer cables and wires are used which reduces overall weight.

"The industry-wide shift to centralized architectures to enable software-defined vehicles (SDV) already affects the design and electrical components for exterior lighting as mentioned before, but more in a second step from my perspective where ADAS, Infotainment and Connectivity are the frontrunning domains.

I see a chance for automotive suppliers such as ZKW among other competitors to already prepare their products in a way, that the transition of exterior lighting to SDV will be smooth. Software has been already an integral part of exterior lighting products, but even if OEMs are claiming software engineering as their sole competence more and more, there are possibilities as OEMs are not immune from failing. The difficulty in my opinion here is to find an open door and be successful and persuade OEMs by bringing added value which they won't have. Together with our shareholder LG, we are investigating doing so.

"Everyone in the automotive industry is talking about greater functionality with software and updates over time—you can see it at related conferences and media news, but everyone should also take care of the hardware needed to realize all the innovative concepts. My future perspective here would be to come up with an all-in-one package consisting of use cases, added value, software and hardware on one hand and on the other hand, investigate in exploitation of existing products/technologies by adding modern capabilities. I am looking forward with an open mind to all the future opportunities."