

## How Audi's light digitization is pointing the way toward the future

- **Headlight digitization is blazing new trails in safety, design, and communication**
- **Three new functions in Digital Matrix LED headlights that enhance safety and improve the customer experience**
- **Digitizing light technology opens up new possibilities and individualization**

Ingolstadt, May 9, 2022 – Safety and customer satisfaction come first at Audi. They are part and parcel of the success of the company with the four rings. In that context, light technology is steadily growing more important and creating a wider range of possibilities and perspectives, from added safety for the driver, to external communication and individualization. Systematic light digitization is making all of this possible. It is particularly visible in the new Audi A8\*: the forward-looking Digital Matrix LED headlights and digital OLED rear lights raise the customer experience to a whole new level: for the first time in any Audi model, light is completely digitized. The car can be individualized even further through its digital OLED rear lights. The Digital Matrix LED headlights also include three new functions: advanced traffic information, a lane light with direction indicator lights on highways, and an orientation light on country roads. These features not only demonstrate Audi's "Vorsprung durch Technik," they also add value.

"Lighting technology and lighting design have been success factors for our brand for decades, becoming a key area for Audi. This has allowed us to continue setting new benchmarks in the automotive industry," explains Oliver Hoffmann, board member for Technical Development. "The digitization of lighting enables us to offer completely new functions that we can use to increase safety again significantly. For example, in combining the digital OLED taillights with proximity indication, we can communicate with the outside world depending on the situation. In addition, this taillight technology enables our customers to select their taillight signature via the MMI for the first time – something that is only available from Audi."

### **New number one and number two functions in the Digital Matrix LED: the orientation light on country roads and the lane light with direction indicator lights**

We've all been there: it's dark and there is a lot happening on the highway at night.

*The equipment, data and prices specified in this document refer to the model range offered in Germany. Subject to change without notice; errors and omissions excepted.*

*\*The collective fuel/electric power consumption and emissions values of all models named and available on the German market can be found in the list provided at the end of this text.*

The lane light with the orientation light is extremely helpful in a situation like that. It illuminates the car's own lane, helping the driver focus on driving events. The integrated position marking from the orientation light – darkened arrows in a kind of “carpet of light” known as the lane light – predictively indicates the Audi vehicle's position between the lane markers, encouraging safe driving in the center of the lane. With its focus on the car's own lane markers, the lane light with the orientation light on the highway helps, for example, in narrow lanes around construction sites: the illumination is deliberately restricted to the car's lane and not the lanes of the construction site in order to optimally center the driver's focus on the road. Now that the headlight has been digitized, this orientation light is also available independently of the lane light on country roads, which is a new feature. That is the first new function that is made possible in additional driving situations due to digital light technology.

Back to the highway: during lane changes, the lane light brightly illuminates both lane markers, while the orientation light indicates the car's exact position in the lane to give the driver the most support. That is where the second new function comes into play: the direction indicator lights in the lane light. With the blinkers activated, the Digital Matrix LED headlights create a dynamic blinking area on the appropriate side of the lane light. That way, the lane light reiterates and intensifies the signal from the direction indicator lights on the road in front. This means that additional, clear information about the upcoming lane change goes out to traffic in the immediate vicinity. That is one way that Audi is making driving safer for everyone on the road, particularly in heavy traffic. While driving with low beams through curves, in cities, or on highways and when driving with high beams, the still greater precision that light digitization brings makes driving even safer for other road users because it makes it possible to mask oncoming traffic as well as cars that are on the road ahead far more precisely.

### **New function number three: advanced traffic information**

Despite warnings about possible accidents or breakdowns being already available as images via the MMI via data provided by HERE maps, the Digital Matrix LED headlights, including DMD technology – see the explanation below – offer another level of reliability. Apart from a display in the digital instrument panel, the headlights now project a warning indicator on the road in front of the car for about three seconds. A triangle with an exclamation mark inside it is projected from the steering wheel. This means that the driver can keep looking forward on the road and it enables the fastest response time possible in the event of an accident or breakdown in upcoming traffic.

Good to know: there is a new technology with the acronym DMD behind the digitization of the Matrix LED headlights. That stands for digital micromirror device and it has previously been used in video projectors. At its core, is a small chip with around 1.3 million micromirrors, with edges that are a few thousandths of a millimeter long. Using electrostatic fields, each and every one of them can be angled up to 5,000 times a second. Depending on the setting, the LED light is either directed onto the road via the lenses or absorbed for the purpose of masking.

That means the light is not a static beam anymore. Instead, it is like a continuously regenerating video image.

## **Additional highlights**

### **Help that is always welcome: the marking light**

The marking light in the Digital Matrix LED headlights helps recognize pedestrians near the road in the dark. If they are located in front of the car, the night vision assistant recognizes the situation and the marking light highlights the person with targeted illumination. By using that combination, the car becomes as safe as possible for everyone involved.

### **Reflecting personal character: expanded dynamic lighting scenarios**

The expanded dynamic lighting scenarios used when getting in and out of the car, show once again how closely light design and light technology are networked at Audi. Individual lighting effects function as an expression of personal preferences. Customers can select one of five desired lighting effects via the MMI. Those five different projections are available on command thanks to DMD technology (digital micromirror device).

### **Attention in its most beautiful form: digital OLED rear lights**

In 2016, the OLED in the Audi TT RS\* heralded the dawn of a new era in light technology in the automotive industry. It was the first time that organic LEDs (OLEDs for short) were used for taillights. OLED elements are semiconductor-based light surface sources, that produce perfect homogeneity and extremely high contrast values. Their brightness is also adjustable. In addition, the light source can be configured freely and divided into precisely switchable segments. The dynamic lighting scenario was also revealed in the OLED rear lights at the AUDI TT RS\* premiere.

Just four years later, Audi expanded the OLED through digitization in the Audi Q5\*. For the first time, that digitization brought the possibility of changing the taillight signature into the market. That shift was based on OLEDs' core properties: high contrast, the capacity for segmentation, a high degree of light homogeneity, and the smallest possible gaps between segments. Audi is still the only auto manufacturer to offer that and it's even standard equipment in the A8\* with digital OLED rear lights.

Audi light design conceptualizes a specific selection of digital OLED rear light signatures for each Audi model. Only digitization makes it possible to switch rear lights and, as a result, customize the light design. How exactly do the lights work? In concrete terms, the bus system allows each panel in the rear lights and the OLED segment within it to be individually controlled. That way, personal preferences can be implemented via the MMI. For the first time, there are now three selectable rear light signatures that drivers can choose through the MMI in the new Audi A8\*. Customers who opt for an Audi S8\* receive an additional, fourth signature.

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### **At a distance: proximity indication in the digital OLED rear lights increases safety**

The digital OLED rear lights use a proximity indication to grab the attention of other road users. When a car gets close to a stationary Audi, the parking sensors take note of the movement and engage all the remaining OLED segments so that the additional brightness and larger surface area make its presence as noticeable as possible. When the Audi pulls away, the digital OLED rear lights revert to the selected signature. This added safety measure even applies for people on bicycles and scooters: the sensors recognize them too.

### **A look into the future**

#### **Playful entertainment with light-based gamification**

The concept car Audi A6 e-tron concept offers a look at light-based gamification. What does that mean exactly? The progressive Digital Matrix LED headlights project video games on the ground or a wall in front of the car, which allows customers to play while the car is charging. Games that are controlled via a personal mobile terminal device can be used in conjunction with car headlights, which become projectors for video games on smartphones. Opportunities to continuously increase the range of offerings available to customers are constantly under review. That includes the idea of integrating content from movie and game providers in the future.

#### **It's about the curves: flexible digital OLED**

Apart from refining the Digital Matrix LED headlights, digital OLED technology in particular will define the future by not being just a conventional light source. Its development points in the direction of exterior displays, that not only increase safety and enable even more personalization, but are also meant to improve communication with the outside world. However, flexible digital OLED rear lights are a step ahead of that. They have a flexible substrate that allows them to go from a two-dimensional structure to a three-dimensional one. That not only sharpens the form, but it also makes it possible to integrate digital light design within the exterior of the lights, enabling symbol displays for additional communication with the outside world.

An everyday situation: a person in a city wants to cross the street between two parked cars, but they cannot see the road because there is a truck in the way. The digital OLED rear lights not only illuminate the rear section, but also part of the side: If the car has been turned on, it also indicates an approaching vehicle before the person steps into the street, for example.

These kinds of safety-related functions and the possibilities for personalization were and are the exclusive outcome of close collaboration between light technology and light design, as Stephan Berlitz, Head of Audi Lighting Development, explains:

“Those of us on the technology side work hand-in-hand with design in predevelopment as well as with the relevant licensing authorities in the preliminary stages. At Audi, light means safety above all, which means seeing and being seen. And with digitization, we have a lot more possibilities to make cars even safer.”

Cesar Muntada, Head of Light Design, adds: “Light technology and light design are inseparable at Audi. Light is a visible expression of ‘Vorsprung durch Technik.’ We give the car an unmistakable face and sharpen the character of the model and the brand. An Audi must be recognizable at night at the first glance, both from close up and from a distance. So, we stick to a principle that guarantees recognition, but also leaves the space necessary for the character of the particular car.”

How do we guarantee that an Audi will be recognized? With the following principle: all Audi light signatures emphasize the width of the car with distinctive, segmented light elements and accents on the outside. The combination of these segments forms a single body. When it is necessary, Audi’s light designers set all of the light signatures and functions in motion and design them so that they look good both on the car and in the projected digital image on the ground. “By repeating that principle,” Light Design chief Muntada says, “we ensure that an Audi is recognizable.”

### **A productive exchange**

Along with raw personalization, the aspect of immediate communication is another element that is particularly imaginable for the future. The functionality of digital OLED rear lights will have an interactive design. Here’s an example: thanks to extensive networking, an Audi will know about black ice on the road ahead. The car will be able to warn the traffic behind it via its rear lights. By knowing about the danger, it will be possible to adjust speed and distance early enough. As soon as legislators allow, it will also be possible to automatically adjust the digital OLED elements while driving, for instance, to directly inform drivers behind the car about dangerous situations.

### **More than the service life of a car: OLED and lifelong quality**

One question that often comes up about the technology in the digital OLED rear lights is the matter of durability. Audi’s digital OLEDs are designed for the high demands of automotive use. A special material development impedes degeneration by influencing the temperature and encapsulation technology, preventing the OLED elements from coming into contact with moisture. That means the OLED elements match the durability profile and meet the same demands as conventional inorganic car LEDs. Because of this, digital OLEDs have significantly longer service lives than traditional OLED displays, and they do it with much higher light density to meet the challenges of automotive exterior lighting.

### **Larger brake light area: the Mapping light spoiler**

Another kind of technology that offers more safety and communication is the Mapping light that is integrated into the roof edge spoiler. A functional expansion of the third brake light projects the “quattro” logo onto the upper part of the rear window. This not only creates completely new design possibilities for communication, but the accompanying expansion of the brake light area also improves this function’s perception in traffic. The reflection from the spoiler projection light only goes toward the rear, so it is only visible to road users behind the car. The driver does not see this added lighting effect at all. This technology will be on the Chinese market in the summer of 2022 in an SUV model with a combustion engine designed specifically for China. Audi wants to use the projection light in the spoiler worldwide so that it can offer more personalization options in the future. However, customer-designed projections will not be possible for legal reasons.

### **An Audi points the way: digital ground projections from the blinkers**

Communication is the key to success in many fields. In the future, Audi wants to intensify communication between the car and its environment through digital ground projections. The blinker ground projections offer an initial glimpse of that. Three symbols projected onto the street in the front and back inform cyclists, for example, about a lane change or, moreover, warn pedestrians about a turn – a function that offers simplified, clear communication and improved safety.

This kind of communication is intended to pave the way for more expansive projections in the area around the car: that vision includes, for instance, warnings projected onto the road before a door opens. Audi is gradually working on expanding this environmental lighting, but in the process, it is also defining the right scenario for its intended purpose in terms of functionality to ultimately create the optimal added value and not just present everything that is currently possible. That pertains to the fields of safety as well as personalization. The outlook for the latter is part of Audi’s future vision is with customizable ground projections through digitization. In this respect, information and signatures related to the driver are conceivable, however, this should not compromise the privacy.

## **Glossary**

### **Light technology terminology**

#### **Headlights**

##### **Digital Matrix LED headlights with DMD technology**

The Digital Matrix LED headlight can deliver cornering, city, and highway lighting as versions of the low-beam light with exceptional precision. It supplements the high-beam light by masking out other road users with even greater accuracy. DMD stands for digital micromirror device, a chip with around 1.3 million micromirrors that makes projections from the headlights possible. It disperses the light into tiny pixels and makes innovative functions possible, like the lane light, orientation light, and advanced traffic information. These innovations support the driver and increase safety in traffic.

#### **Rear lights**

##### **OLED rear lights**

OLEDs are organic light-emitting diodes that are less than a millimeter thick. Their name is derived from the organic semiconductor material they are made of. A low electric charge of 3 to 4 volts is enough to make the thin layers glow. Unlike point-light sources like LEDs, OLEDs are panel radiators. That means the light is more homogeneous than ever before and can be divided into individually dimmable segments. Optics like reflectors or optical fibers are unnecessary, making OLED units efficient and lightweight. At their debut in 2016, the OLED rear lights in the Audi TT RS had a total of 12 segments per light. In 2017, there were already 16 segments in the Audi A8.

##### **Digital OLED rear lights**

Since 2020, Audi has offered digital OLED rear lights in the Q5\*, making a variety of distinct taillight designs possible with just one type of hardware for the first time. Unlike the OLED rear lights in the TT RS\*, where every light function has its own conduit, the digital OLED rear lights are linked to the electrical system control unit via a bus system. That makes a significant amount of more functions possible. The technology has a larger number of individually controllable segments than the OLED rear lights that premiered in 2016. Three panels are used in one Audi Q5\* rear light and each of them integrates six OLED segments. These can now be randomly activated, with continuous variability of brightness. Digital OLED technology has also been built into the rear lights as standard equipment in the new Audi A8\* since 2021 – eight panels are used, each of which integrates six OLED segments.

*\*The collective fuel/electric power consumption and emissions values of all models named and available on the German market can be found in the list provided at the end of this text.*

Beyond the conventional signaling functions, a communication function is emerging: Audi has integrated a proximity indication into the Q5\* for traffic behind it. That function is now also available for the Audi A8\*. In the future, digital OLED with more than 60 segments per panel will have about ten times as many individually controllable areas. Higher-performing future car electronics and specially developed digital OLED hardware will make that possible. In addition to personalizing light design, the digital OLED can also be used as an indicator in the rear lighting and thus for car-to-x communication. With the permission of the regulatory authorities, rear traffic could be promptly informed of, for instance, localized dangers like slippery spots in the road or the end of a traffic jam. With higher precision, extremely high contrast, and wide variability, the rear lights are gradually evolving into a display.

### **Future technology: flexible digital OLED rear lights**

While it has only been possible to integrate two-dimensional OLED panels into digital OLED rear lights as light sources up to this point, new bendable substrates in flexible digital OLED rear lights are now making curved OLED panels possible for the first time. This new leeway in design creates the possibility for a three-dimensional light design that fits into the body design even better. That means that the usable area for configuration, light design personalization, and communication with the immediate environment will once again be significantly expanded in the future. The core qualities of the technology, perfect homogeneity and high contrast, will remain – even from different perspectives.

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The Audi Group is one of the most successful manufacturers of automobiles and motorcycles in the premium and luxury segments. The brands Audi, Ducati, Lamborghini and Bentley produce at 21 locations in 13 countries. Audi and its partners are present in more than 100 markets worldwide.

In 2021, the Audi Group delivered around 1.681 million cars from the Audi brand, 8,405 sports cars from the Lamborghini brand and 59,447 motorcycles from the Ducati brand to customers. In the 2021 fiscal year, AUDI AG achieved a total revenue of €53.1 billion and an operating profit before special items of €5.5 billion. More than 89,000 people all over the world work for the Audi Group, around 58,000 of them in Germany. With its attractive brands, new models, innovative mobility offerings and groundbreaking services, the group is systematically pursuing its path toward becoming a provider of sustainable, individual, premium mobility.

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**Fuel/electric power consumption and emissions values\*\* of the models named above****Audi Q5**

Combined fuel consumption in l/100 km: 7.5–1.8 (31.4–130.7 US mpg);  
combined CO<sub>2</sub> emissions in g/km: 185–41 (297.7–66.0 g/mi)

**Audi Q5 Sportback**

Combined fuel consumption in l/100 km: 7.6–1.8 (30.9–130.7 US mpg);  
combined CO<sub>2</sub> emissions in g/km: 186–42 (299.3–67.6 g/mi)

**Audi A8**

Combined fuel consumption in l/100 km: 10.8–2.0 (21.8–117.6 US mpg);  
combined CO<sub>2</sub> emissions in g/km: 247–45 (397.5–72.4 g/mi)

**Audi A8 L**

Combined fuel consumption in l/100 km: 10.8–2.0 (21.8–117.6 US mpg);  
combined CO<sub>2</sub> emissions in g/km: 248–45 (399.1–72.4 g/mi)

**Audi S8**

Combined fuel consumption in l/100 km: 10.8–10.7 (21.8–22.0 US mpg);  
combined CO<sub>2</sub> emissions in g/km: 246–245 (395.9–394.3 g/mi)

**Audi TT RS**

Combined fuel consumption in l/100 km: 8.7–8.5 (27.0–27.7 US mpg);  
combined CO<sub>2</sub> emissions in g/km: 200–193 (321.9–310.6 g/mi)

*\*\*The indicated consumption and emissions values were determined according to the legally specified measuring methods. Since September 1, 2017, type approval for certain new vehicles has been performed in accordance with the Worldwide Harmonized Light Vehicles Test Procedure (WLTP), a more realistic test procedure for measuring fuel consumption and CO<sub>2</sub> emissions. Since September 1, 2018, the WLTP has gradually replaced the New European Driving Cycle (NEDC). Due to the more realistic test conditions, the consumption and CO<sub>2</sub> emission values measured are in many cases higher than the values measured according to the NEDC. Additional information about the differences between WLTP and NEDC is available at [www.audi.de/wltp](http://www.audi.de/wltp).*

*At the moment, it is still mandatory to communicate the NEDC values. In the case of new vehicles for which type approval was performed using WLTP, the NEDC values are derived from the WLTP values. WLTP values can be provided voluntarily until their use becomes mandatory. If NEDC values are indicated as a range, they do not refer to one, specific vehicle and are not an integral element of the offer. They are provided only for the purpose of comparison between the various vehicle types. Additional equipment and accessories (attachment parts, tire size, etc.) can change relevant vehicle parameters, such as weight, rolling resistance and aerodynamics and, like weather and traffic conditions as well as individual driving style, influence a vehicle's electric power consumption, CO<sub>2</sub> emissions and performance figures.*

*Further information on official fuel consumption figures and the official specific CO<sub>2</sub> emissions of new passenger cars can be found in the "Guide on the fuel economy, CO<sub>2</sub> emissions and power consumption of all new passenger car models," which is available free of charge at all sales dealerships and from DAT Deutsche Automobil Treuhand GmbH, Hellmuth-Hirth-Str. 1, 73760 Ostfildern-Scharnhausen, Germany ([www.dat.de](http://www.dat.de)).*