

New Headlamp Dimension: Liquid Crystal HD Technology Enables Fully Adaptive Light Distribution in Real Time

- **Integration of a Liquid Crystal Display (LCD) in an LED headlamp opens up new paths for automotive lighting technology**
- **So-called LCD headlamps adjust light distribution to different traffic situations in an intelligent and continuous manner in real time**
- **30,000 pixels allow image projections in addition to fully adaptive light distribution**

Lippstadt, June 27, 2017. In the context of the research project funded by the Federal Ministry of Education and Research (BMBF) regarding the fully adaptive light distribution for intelligent, efficient and safe vehicle lighting (VoLiFa2020), lighting and electronics expert HELLA has developed and constructed a headlamp on the basis of a Liquid Crystal Display (LCD) in collaboration with project partners Merck, Institut für Großflächige Mikroelektronik IGM, Stuttgart University, Porsche, Elmos Semiconductor, Schweizer Electronic, and the University of Paderborn. This technology is for example already known in the home entertainment field. "For the first time, we have integrated Liquid Crystal HD technology in a vehicle. Thanks to its great resolution and sharpness of detail, it opens up very new paths in automotive lighting technology", says Dr Michael Kleinkes, Vice President Development Lighting & Innovation at HELLA.

Overall, the new LCD headlamp projects 30,000 pixels onto the road. This allows adjusting the light pattern in an intelligent and continuous manner to various driving situations in real time. "The use of an LC display is a further step towards digitalizing lighting", says Christian Schmidt, Head of Lighting Technology Pre-Development at HELLA. This means: the adaptation of the light pattern will increasingly be determined by software. The driver will obtain the best possible view of the road. Individual segments with e.g. other traffic participants or strongly reflecting street signs can be omitted or dimmed in a targeted manner. Highly complex functions are also conceivable: navigation arrows or lines showing the ideal lane can be projected onto the road. "LCD technology enables functions that will also be relevant to autonomous

driving", says Christian Schmidt. "We will therefore make the technology fit for serial production."

The LC display is the headlamp's key component. It is situated between the LED light source and the projection lens. The display generates a matrix with 100 x 300 pixels that can be individually controlled and dimmed. A camera installed in the vehicle as well as a sensor optically reading distances and speeds (light detection and ranging sensor LiDAR), will forward the ambient information to the headlamp control unit via a processor. This will then direct the individual display pixels up to 60 times per second. 25 high-power LED's arranged in three rows will serve as light source. Each LED's light intensity will be adjusted to the respective lighting situation.

HELLA developed the concept for the LCD headlamp's optical system during the research project. The system requirements of automobile manufacturer Porsche and the Research Institute for Lighting Technology and Mechatronics of the University of Paderborn (L-LAB) served as foundation. Ensuring high system efficiency and a thermal concept guaranteeing the automotive suitability of the module were among the various HELLA tasks. A special liquid crystal was required here, which Merck developed for this purpose. Using this chemical component, the IGM of Stuttgart University developed and built prototype displays. Elmos Semiconductor designed and built innovative electronic semiconductor components, which Schweizer Electronic embedded into the BCP in a completely novel manner("Embedding"). This technology allowed the experts realizing a reliable, efficient and space-efficient control of the LED lighting unit. HELLA provided the integration of the various components into the overall system and developed an interface between lighting control and headlamp. A prototype resulted, which -- integrated into a Porsche Panamera - is currently being tested under realistic driving conditions by test drivers at the University of Paderborn.

Due to increasing traffic volumes and safety requirements, intelligent lighting systems are of increasing importance. LCD technology enables completely new functionalities and opportunities here. And the use is not limited to passenger cars. Other vehicle

categories, such as commercial vehicles or buses also provide meaningful application areas.

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HELLA KGaA Hueck & Co., Lippstadt: HELLA is a family-owned, listed company operating on the international stage and currently employing approximately 36,000 members of staff at more than 125 locations in about 35 countries around the world. The HELLA Group develops and manufactures lighting technology and electronics for the automotive industry and also has one of the largest retail organizations for automotive parts, accessories, diagnostics, and services within Europe. Joint venture companies furthermore create entire vehicle modules, air-conditioning systems and vehicle wiring systems. With more than 6,000 people working in research and development, HELLA is one of the most important innovation drivers on the market. Furthermore, with sales of 6.4 billion euros in the fiscal year of 2015/2016, the HELLA Group is one of the top 40 automotive parts suppliers in the world and one of the 100 largest German industrial companies.

Merck KGaA: Merck is a leading science and technology company in healthcare, life science and performance materials. Around 50,000 employees work to further develop technologies that improve and enhance life – from biopharmaceutical therapies to treat cancer or multiple sclerosis, cutting-edge systems for scientific research and production, to liquid crystals for smartphones and LCD televisions. In 2016, Merck generated sales of € 15.0 billion in 66 countries. Founded in 1668, Merck is the world's oldest pharmaceutical and chemical company. The founding family remains the majority owner of the publicly listed corporate group. Merck holds the global rights to the Merck name and brand. The only exceptions are the United States and Canada, where the company operates as EMD Serono, MilliporeSigma and EMD Performance Materials.

Institute for Large Area Microelectronics (IGM), University of Stuttgart: Since it was founded as “Laboratory for Display Technology” in 1991 the IGM has widened its research scope constantly. Besides thin film transistors (TFTs) based on amorphous and polycrystalline silicon, carbon nano tubes, IGZO, and organic semiconductors its area of research includes flexible LC- and OLED-Displays on metal- or plastic-foils, printed electronics, display drivers and optical signal processing, especially methods to synthesize optical filters. Due to its Europe-wide unique equipment and expertise all process steps from creating photolithographic masks to actuated active matrix displays can be performed directly at the IGM.

Dr. Ing. h.c. F. Porsche AG: Dr. Ing. h.c. F. Porsche AG based in Stuttgart-Zuffenhausen, Germany, is the world's leading manufacturer of exclusive sportscars. In 2016, the company delivered around 237,000 new vehicles to its customers around the world, generating sales of EUR 22.3 billion. The company's operating income sat at EUR 3.9 billion, making Porsche one of the world's most profitable automotive manufacturers. Porsche founded the sportscar segment more than 50 years ago with the release of the iconic 911 sportscar. Further model lines have since followed in the form of the 718 Boxster, 718 Cayman, Panamera, Macan, Cayenne and 918 Spyder. Porsche is also setting milestones when it comes to plug-in hybrid drives: Porsche was the first manufacturer to introduce this technology in high-performance

sportscars (918 Spyder), exclusive saloons (Panamera S E-Hybrid) and premium off-road vehicles (Cayenne S E-Hybrid). What's more, with the tests on the 919 Hybrid prototype, Porsche is already achieving success working on the technology of tomorrow in the LMP1 class of the World Endurance Championship (WEC). This technology is also set to be used in the first purely electric series-production sportscar that will be launched by the end of the decade in the form of the "Mission E". In total, Porsche AG employs a staff of around 28,000 across the globe through 70 subsidiaries. Production facilities have been established in Zuffenhausen (for the 911, 718) and Leipzig (for the Panamera, Macan and Cayenne). The development, design and motorsports departments are based in the Development Centre in Weissach, Germany.

Elmos Semiconductor AG: Elmos develops, produces and markets semiconductors and sensors, primarily for use in the automotive industry. Our components communicate, measure, regulate and control safety, comfort, powertrain and network functions. For over 30 years, Elmos innovations have been bringing new functions to life and making mobility worldwide safer, more comfortable and more energy efficient. Elmos achieved sales of 228.6 million euro in the past financial year. Headquartered in Dortmund, the company employs more than 1,100 people worldwide. Other locations are located e.g. in Detroit, Silicon Valley, Shanghai and Tokyo. The company is listed on the Prime Standard on the Frankfurt Stock Exchange.

Schweizer Electronic AG: Schweizer Electronic AG stands for state-of-the-art technology and consultancy competence. SCHWEIZER's premium printed circuit boards and innovative solutions and services for automotive, solar, industry and aviation electronics address key challenges in the areas of Power Electronics, Embedding and System Cost Reduction. Its products are distinguished for their superior quality and their energy-saving and environmentally friendly features. Together with its partners WUS Printed Circuit (Kunshan) Co., Ltd., Meiko Electronics Co. Ltd. and Elekonta Marek GmbH & Co. KG the company offers in its division electronics cost- and production-optimised solutions for small, medium and large series. Together with its partner Infineon Technologies AG, SCHWEIZER plans to jointly tap the chip embedding market in future. With 787 employees SCHWEIZER achieved sales of 116.1 million euro in Fiscal Year 2016. The company was founded in 1849, is managed by the family and listed at the Stuttgart and Frankfurt Stock Exchanges (ticker symbol „SCE“, „ISIN DE 000515623“).

Universität Paderborn: Paderborn University is the University for the Information Society. Our strong foundation in computer science and its applications, as well as the importance of IT for a growing number of disciplines, are the pillars for this claim. But we want to achieve more: we want to contribute to the scientific and technical development of the information society, simultaneously critically reflecting these developments by taking into account the history, norms and values of our society. To achieve this, we need the spectrum from "hard" sciences to the arts and humanities to complement and learn from each other. Our mission includes a strong international and cultural presence, since the information society is decidedly global and should not remain a purely intellectual undertaking. Our university orchestra, our drama group, and more than 70 different sports, are some of the important university activities that help characterize academic life here in Paderborn. Our five faculties cover a broad range of courses of study in the arts and humanities, business studies, natural sciences, and engineering. We offer 63 degree programs at bachelor and master level. Additionally, teacher education programs play an important role in Paderborn. With over 20,300 students, 247 professors and a library that is open 350 days a year, our compact campus university provides a friendly, green, connected environment with excellent services for student life.

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