

# LED

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# Review

LpR

The Global Information Hub for Lighting Technologies and Design

Jan/Feb 2023 | Issue

95

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# Z H A G A A W A R D S

## SMART CITY SENSORS

Submit your  
application  
by 3 March  
2023

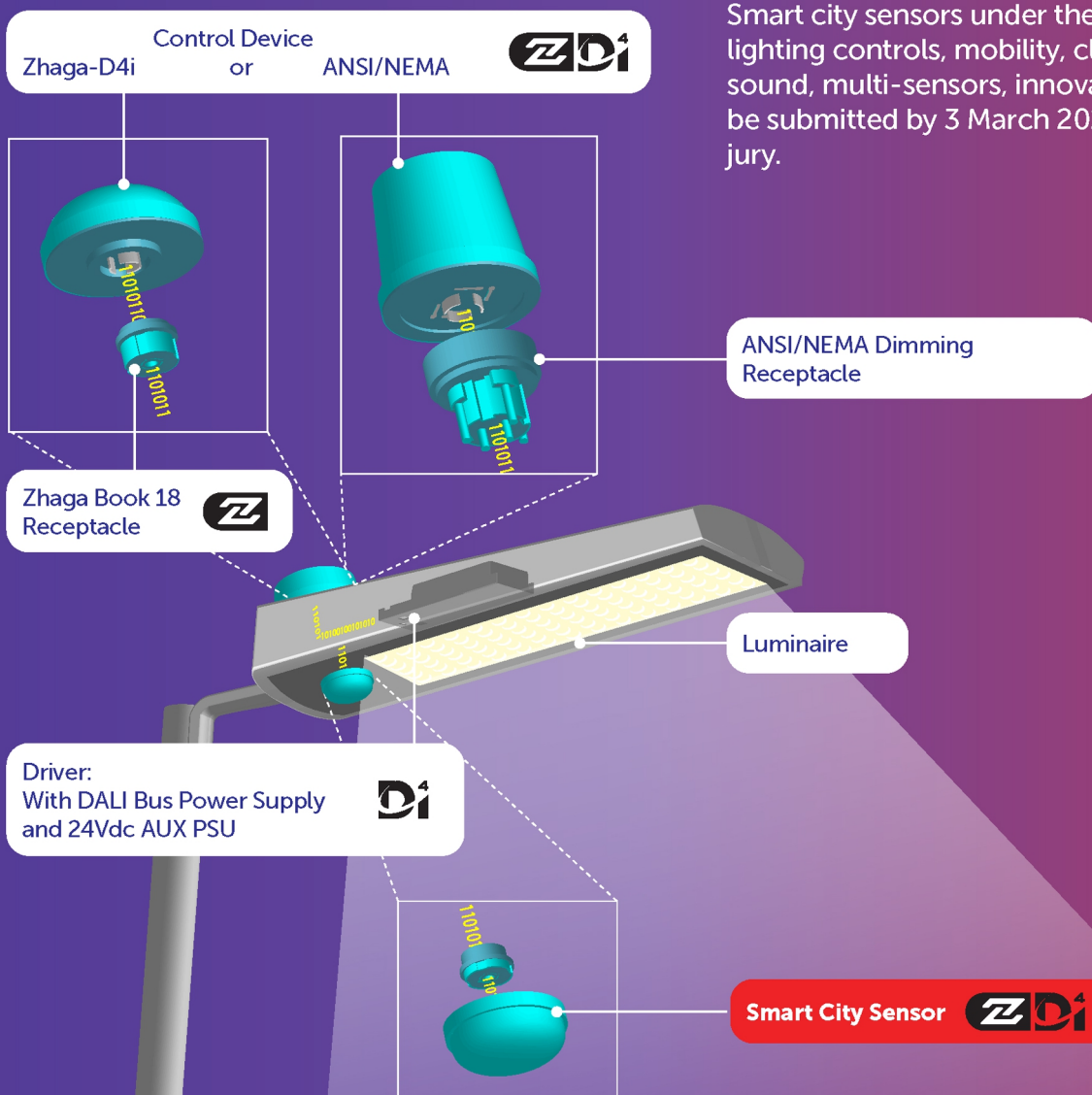
### Zhaga Smart City Sensor Award

The Zhaga Consortium is launching the global Zhaga Smart City Sensor Awards to encourage and recognize excellence in smart city sensors that can be installed on streetlights using the new Zhaga Book 18 standard and will be suitable for Zhaga-D4i certification.

Sensor manufacturers who win an award will receive international public recognition. Students and researchers are eligible for a 2000€ prize.

The underlying premise of the Zhaga Smart City Sensor Awards is that the streetlight is the ideal and perhaps lowest cost place from which to perform many smart city sensing tasks.

Smart city sensors under the following categories: lighting controls, mobility, climate, pollutants, sound, multi-sensors, innovation and research, can be submitted by 3 March 2023 to the international jury.



Find out  
more



Smart City Sensor **ZDI**



# Photophyll™ Select LEDs

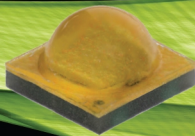
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# Holistic Design Approach



Lighting design is an essential aspect of modern buildings and has come a long way in recent years. As technology has advanced, lighting has become increasingly integrated into building designs and is more sustainable, and more focused on the needs of people.

**Fully integrated lighting:** Lighting design is no longer a standalone element in modern building design. Instead, lighting is integrated into the overall design of a building, working in conjunction with other systems such as heating, ventilation, and air conditioning (HVAC). Lighting is used to create a cohesive look throughout a building and enhance the functionality of other systems. Building designers can make more efficient and effective spaces by integrating lighting with other systems.

**Sustainability:** As the world becomes more environmentally conscious, sustainability is increasingly important in lighting design. This means that lighting designers are looking for ways to use energy-efficient lighting systems and reduce overall energy consumption.

**Human-centric lighting:** Lighting designers are also focusing more on the needs of people when it comes to lighting. This means that they are designing lighting systems tailored to the needs of the people using them. For example, lighting in offices may be designed to help improve productivity, while lighting in homes may be designed to create a relaxing atmosphere.

**Intelligent systems with data:** Finally, lighting is becoming increasingly more intelligent with lighting systems that can gather data and respond to it in real time. For example, a lighting system may detect when a room is unoccupied and automatically turn off the lights, or it may adjust the lighting levels in response to the time of day or the weather outside. Overall, these trends in lighting design are helping to create more cohesive, sustainable, and people-friendly buildings. As technology continues to advance, we can expect to see even more exciting developments in lighting design in the future.

And now it's time to sit up and be inspired by the compelling articles in the LpR#95. We wish you all the very best for the new year!

Yours Sincerely,

Siegfried Luger

Luger Research e.U., Founder & CEO  
LED professional, Trends in Lighting, LpS Digital & Global Lighting Directory  
International Solid-State Lighting Alliance (ISA), Member of the Board of Advisors  
Member of the Good Light Group and the European Photonics Industry Consortium

A large graphic of numerous thin white lines radiating from a single point on the left, forming a semi-circular shape that fills the upper half of the page. The background is a gradient from light blue at the top to yellow at the bottom.

# Dynasolis™ Light so Dynamic

**Dynasolis™** is a completely new LED tuning solution that regulates circadian rhythms by simultaneously adjusting color temperature (2,700K – 10,000K) and melanopic illuminance via Azure-colored light. While maintaining 90+ CRI and high efficacy, Dynasolis refreshes you upon waking up, activates you during the day and relaxes you at night.

The logo for the LpS Digital Awards 2022 features a stylized blue circular graphic on the left, composed of concentric arcs. To its right, the text 'LpS DIGITAL AWARDS 2022' is stacked vertically in a bold, black, sans-serif font.

**LpS**  
DIGITAL  
AWARDS  
2022

**Dynasolis™** is a winner of the LpS Digital Award 2022 in the Product Category. For more information visit <https://www.nichia.co.jp/en/>

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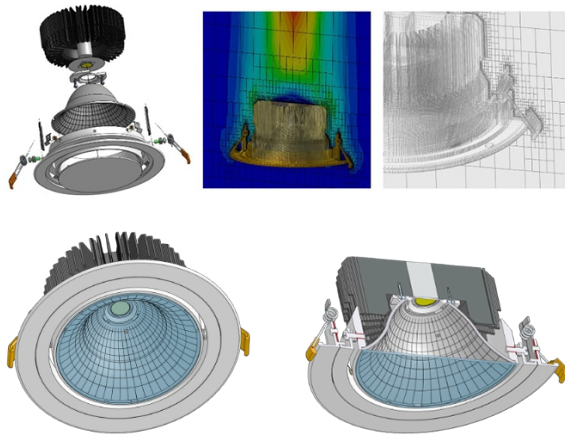
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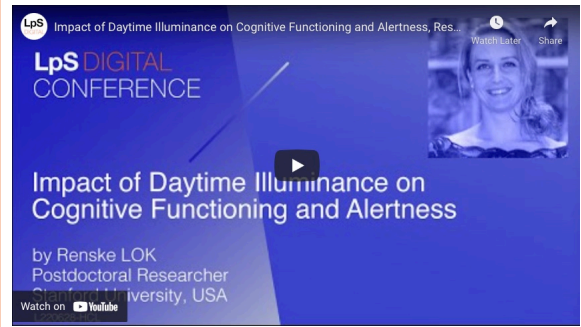
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## Fariyal KHANBABI

**Fariyal Khanbabi is the CEO at Dialight, a global leader in industrial LED lighting technology. Khanbabi brings over a decade of C-suite experience to her role, having formerly worked as CFO at Harvest Energy and Britannia Bulk, LTD. Having spent her entire career in the technology space, Khanbabi has become accustomed to being the only woman in the room and thus has proven to be a strong advocate for women in the workplace, especially in the manufacturing space.**

## More Durable, Safer and Sustainable

LED lighting remains a powerful solution for industrial companies to decarbonize the industrial sector. As the most efficient lighting source on the market, LED fixtures can drastically reduce energy consumption and slash carbon emissions by 2/3 compared to legacy lighting. Additionally, because LED fixtures contain no mercury or toxic materials, they are safer for the environment. LED fixtures are more durable and longer-lasting compared to conventional lighting, especially in harsh environments. They offer an unmatched combination of efficiency and safety by virtue of their instant-on capabilities and compatibility with advanced controls such as occupancy sensors and daylight harvesting equipment. LED lighting manufacturers have been in a race to the top for maximizing Lumens per Watt (LPW) efficiency to differentiate their products. In pursuit of this metric, many companies have sacrificed other key performance factors, such as thermal management, power supply life and even removing lenses, exposing LEDs to harsh environmental conditions, sacrificing optical control, and reducing the functional life span of the fixture. As lighting manufacturers run out of runway for maximizing LPW as a differentiator, they're now turning to new solutions to add value for customers. In the coming year, we expect to see these five LED lighting trends shape the industrial space:

**Increased popularity of warmer color temperatures.** One of the key benefits of LEDs is their crisp, near-daylight color temperature. However, the large amount of blue light in the spectrum unnaturally brightens the night sky, contributing to light pollution. The International Dark-Sky Association has begun recommending lights with a "warmer" color temperature to reduce night-sky impact, and manufacturers are working to produce compliant products with optics to deliver precise light placement where it's needed most.

### **Maximizing fixture life through component innovation.**

Manufacturers will return to building

products for long-life performance with optimized power supplies, mechanical housings and electrical components suited for industrial conditions to reduce the need for frequent maintenance and replacement. Some will redesign their products with easy-access wiring components for future upgradeability, helping to maximize the customers' investment with future-ready products.

**Cradle-to-grave sustainability.** LED lighting manufacturers will be more mindful of the Global Warming Potential (GWP) of each material used in fixture construction. To meet increasingly stringent demands for sustainability, designers will optimize the materials used to reduce GWP both upstream and downstream with more earth-friendly materials and recyclable fixtures.

**Better protection for fixture integrity and investment.** VOCs, reactive gases and corrosive materials wreak havoc on even the most robust lighting. We'll see manufacturers protect their products with advanced coatings and innovative components that guard against these harsh materials to extend the life of the fixture and expedite the customer's ROI.

**Increasing transparency in manufacturing.** Manufacturers understand the importance of validating sustainability claims and the need to provide data that supports their customers' supply chain ESG metrics. We expect more manufacturers to pursue third-party credentials such as Environmental Product Declarations that quantify the carbon produced in the manufacture of their products. These assessments also provide detailed reporting to measurably support customers' energy efficiency and carbon reduction goals.

As heavy industry comes under increased pressure to reduce carbon impact and operate more sustainably, LED manufacturers will continue to innovate, delivering more durable, safer and sustainable products. ■

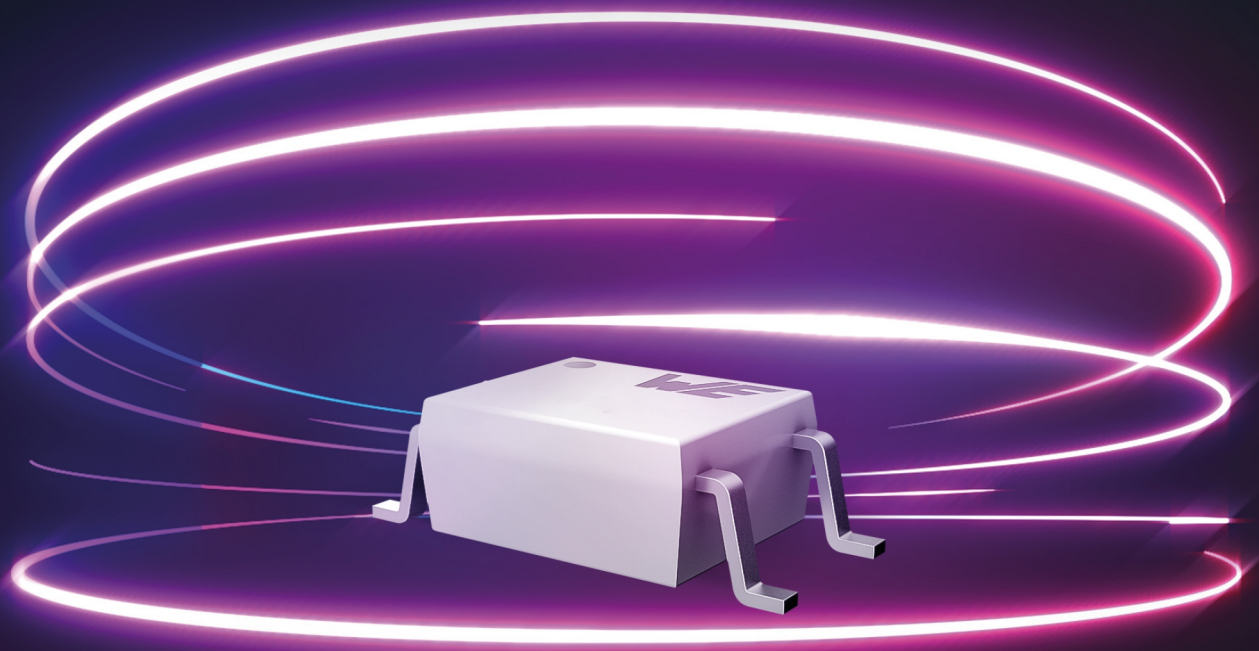
F.K.



WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

**PERFORMANCE.**  
**RELIABILITY.**  
**SERVICE.**

## Optocouplers by Würth Elektronik



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### Optocouplers by Würth Elektronik

With the new optocouplers, Würth Elektronik presents one of the latest additions to its optoelectronic product portfolio. The innovative design features a coplanar structure and high-grade silicon for total internal reflection. The coplanar design ensures the isolation gap stay fixed during the production process and provide perfect isolation and protection for your application. The total internal reflection provide stable CTR over the whole temperature range and high CTR even at low current operation.

Provided in all industry standard packages. Available with all binnings ex stock. Samples free of charge: [www.we-online.com/optocoupler](http://www.we-online.com/optocoupler)

### Highlights

- Innovative coplanar design
- High grade silicon encapsulation
- Copper leadframe for high reliability
- Stable CTR over whole temperature range
- High CTR in low current operation



DIP-4



SOP-4



LSOP-4

#OptocouplersbyWE

## The LIT Lighting Design Awards 2022 Winners Have Been Announced

<https://litawards.com/winners/>

Zurich, Switzerland – The LIT Lighting Design Awards was created to recognize the efforts of talented international lighting product designers and lighting designers. The program celebrates creativity and innovation in the fields of lighting products and applications.

The jury panel composed of 43 talented and experienced professionals, Architects, Interior Designers, Academics and media representatives in the lighting industry have selected the winners of the 6th Edition of the LIT Awards. The program received over 650 submissions from 51 countries, all designs have been evaluated based on their own merit.

The range of work is astonishing, L'Observatoire International was awarded the "Lighting Design of the Year" title for the Hermès' collections at Milan Design Week 2022 and Expolight won the "Lighting Product Design of the Year" award for the Chandelier in the B14 UNIT. City business space.

In the young talent categories, Owen Fernando Patia, a student at California College of The Arts received the prize of "Emerging Lighting Designer of the Year" with AQUA and Elsa Gil Benito, a student of ESNE, Escuela Universitaria de Diseño, Innovación y Tecnología won the "Emerging Lighting Product Designer of the Year" for Ma-Ka Lighting System.

"At the LIT Lighting Design Awards, we strive to support and promote inspired projects and innovation by professional and emerging designers from around the world; assembling in one platform outstanding projects from Brazil to Canada, Germany and Thailand." said Program Director, Astrid Hébert. "This program will continue to showcase Lighting Product and Lighting Design excellence."

Introduced in 2018, the Lifetime Achievement Awards has recognized Lighting Designers, Lighting Product Designers and other professionals in the Lighting Industry, whose contributions are inspirational. Patrick Woodroffe is celebrating a career of over 40 years, lighting rock concerts, operas, ballet, architecture, and special events, and Dave Kavanagh, Senior lighting and industrial designer at Planet Lighting in Australia, are awarded the LIT Lifetime Achievement Awards for their impressive design contribution to the International lighting community.

The Spotlight Prize is awarded to an organization, association, project, or initiative that carries out remarkable work for its

community and has a major contribution to the Lighting Industry. The LIT Design Awards is thrilled to announce that "The Studio School of Design (SSD)" in New York City is receiving the 2022 Spotlight prize for its engagements towards education accessibility, diversity, and inclusivity. Launched in the spring of 2021, SSD is a 501c3 Not-for-profit community organization, seeking to provide equitable and inclusive low-cost classes in lighting design both online and in-person to a wide-ranging pool of talented and motivated students.

Other honorees in the Lighting Design category included Liska with Hallgrímskirkja in Reykjavík, Iceland, CLL. Concept Lighting Lab won with the One & Only Mandarin hotel, SEAM Design is awarded with the MahaNakhon Tower: Ritz-Carlton Residences, in Light Art Project, Light is More won with the Pavilion of Moonlight Horizon and Bruno Ribeiro with Vibrance; Tillotson Design Associates, Licht Kunst Licht and Beijing Leuchte Lighting Design received multiple prizes.

Winners in Lighting Product Design included Maytoni with Maya, John Cullen Lighting is awarded in the Deck and Step Lights category with Lecco Floorwasher, BuzziSpace with BuzziChip, Pharos Architectural Controls for their newly developed "Full management of lighting installations from anywhere, with any device" and ambience with the LEGO Linear Luminaire.

Winners will receive extensive publicity over the next year to present their achievements to a global audience. Their designs will be featured in the annual Book of Design, which will be distributed worldwide, and they will also receive the LIT Lighting Design Awards certificate and badge of achievement, as well as a year-round profile in the LIT Awards Online Directory. To view the full list of the LIT Lighting Design Awards 2022 winners, check [litawards.com/winners](https://litawards.com/winners/). ■

## Broadcom Business & Innovation

[www.broadcom.com](https://www.broadcom.com)

Broadcom is a leading global technology company that designs and develops semiconductor and infrastructure software solutions. The company has a significant presence in the LED market, offering a range of products for various applications including general lighting, automotive lighting, and backlighting for displays.

Broadcom's LED products are designed to be energy efficient and offer long lifespan, making them a popular choice for a variety of applications. The company's general lighting LED products are used in a range of indoor and outdoor applications, including

residential, commercial, and industrial lighting. These products are available in a range of wattages and beam angles, making them suitable for a variety of lighting needs.

In the automotive lighting market, Broadcom offers a range of LED products for use in both exterior and interior lighting applications. The company's exterior lighting products include headlamps, tail lamps, and fog lamps, while its interior lighting products include cabin and instrument panel lighting. These products are designed to be durable and reliable, making them well-suited for use in the demanding automotive environment.

Key Figures:

- Net revenue (FY21) 27.5 Billion USD
- R&D investment (FY21) 4.9 Billion USD
- Patents (FY21) 19,000+
- Segments 25% Infrastructure Software, 75% Semiconductor Solutions

In addition to its general lighting and automotive lighting products, Broadcom also offers a range of LED products for use in backlighting applications. These products are used in displays for TVs, laptops, and mobile devices and are designed to provide high-quality, uniform lighting across the display.

Broadcom's LED business is supported by an intense research and development (R&D) program, which focuses on improving the efficiency and performance of the company's LED products. This includes developing new materials and manufacturing processes that can help to improve the efficiency of the LEDs, as well as developing new designs and configurations that can help to optimize their performance.

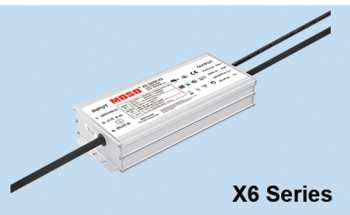
New Product Highlights:

- Pyroelectric Sensor Product Portfolio (AFBR-S6) for gas detection and analysis, and for infrared fire/flame detection.
- Current and Voltage Sensors (ACPL-C72x and ACPL-C877) for motor drives, solar, wind power converters, ESS, power battery market and for bus-bar current sensing.
- Infrared and UV LEDs for industrial light curtain, elevator door sensor, transportation barrier doors, surveillance system, gesture sensing, home appliances, disinfection, fluorescence, curing, horticulture and others.

In addition to its R&D efforts, Broadcom also invests in partnerships and collaborations with other companies in the LED industry. This helps the company to stay at the forefront of LED technology and enables it to bring innovative new products to market more quickly. Broadcom's LED business is a vital part of the company's operations, with a strong focus on energy efficiency and long lifespan. The company's products are used in

**FAST  
DELIVERY**

**Road Lighting LED Driver**



**X6 Series**

**Road Lighting LED Driver (DALI-2&D4i)**



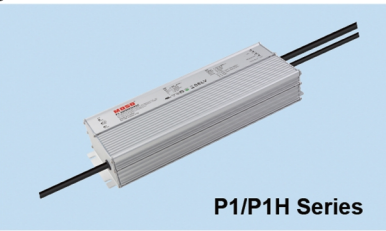
**U7 Series**

**Landscape Lighting LED Driver**



**V6E Series**

**Horticulture Lighting LED Driver**



**P1/P1H Series**

**Industrial Lighting LED Driver**



**G6 A12 / M / D / C Series**

**Stadium lighting and high mast lighting LED Driver**



**S6 Series**

**Technology Innovation and Product Supremacy**

MOSO Electronics Corp. Website: [www.mosopower.com](http://www.mosopower.com) Tel: 400-889-0018

a range of applications, including general lighting, automotive lighting, and backlighting for displays, and are supported by a robust R&D program and partnerships with other industry players. ■

**ams OSRAM Signs Agreement To Sell Its Entertainment Lighting Business Clay Paky to ARRI AG**

[www.arri.com/en](http://www.arri.com/en)

ams OSRAM (SIX: AMS), a global leader in optical solutions, announced that it has entered into a definitive agreement to sell its Clay Paky entertainment lighting business to Germany based ARRI AG. The transaction is subject to customary closing conditions.

Clay Paky, established in 1976 and acquired by OSRAM in 2014, is headquartered in Seriate, Italy and is recognized as a leading global provider and worldwide reference brand in the professional high-end entertainment lighting market. Clay Paky has strengthened its technology leadership through LED- and Laser based portfolio extensions, and offers an innovative, award-winning portfolio of moving body and moving mirror projectors,

color-changers, followspots, projectors and various lighting effects. Clay Paky is a leading partner for the world's most renowned entertainers, global events, and theaters.

ARRI AG, headquartered in Munich, Germany, is a leading designer and manufacturer of camera and lighting systems as well as system solutions for the film, broadcast, and media industries, with a worldwide distribution and service network.

"The acquisition of Clay Paky is a strategic, long-term investment into our lighting business," said ARRI CEO Dr. Matthias Erb. "Clay Paky enjoys premium recognition in the entertainment lighting market while ARRI is recognized as a premium manufacturer in motion picture and broadcast lighting. This premium position of the two brands shows that both companies are an ideal match and can further expand their respective businesses under the unified parent company."

Dr. Wilhelm Nehring, EVP Business Unit Digital at ams OSRAM commented: "ARRI AG is an ideal new home for the Clay Paky team in Seriate and all around the world. ARRI's global footprint, strong technology track record and market understanding will offer a very attractive long-term perspective for Clay Paky and their customers."

"We are very happy to be joining the ARRI family. Both companies have a leading

position in their field, thanks to a deep market knowledge, innovation power and customer understanding. We both share a rich heritage of, and unconditional passion for technology and innovation in a professional industry that fascinates thousands of people around the world. Together with ARRI, we will continue to deliver on our vision – to create the best in class lighting equipment, services and offer world level reference products to an even broader customer base," said Marcus Graser, Managing Director of Clay Paky.

With this agreement, ams OSRAM implements the last of the divestments which the company had communicated to pursue following the acquisition of OSRAM. ams OSRAM will continue to focus on the high technology semiconductor business and its automotive & specialty lamps business and the announcement represents a further milestone in the implementation of ams OSRAM's strategy to focus on core technology areas in illumination, visualization, and sensing and to divest businesses that are not core to the company's strategy.

For more information on ARRI AG please visit [arri.com](http://arri.com). For more information about ams OSRAM please visit our website at [ams-osram.com](http://ams-osram.com).

*About ams OSRAM*

The ams OSRAM Group (SIX: AMS) is a global leader in optical solutions. By adding

intelligence to light and passion to innovation, we enrich people's lives. This is what we mean by Sensing is Life.

With over 110 years of combined history, our core is defined by imagination, deep engineering expertise and the ability to provide global industrial capacity in sensor and light technologies. We create exciting innovations that enable our customers in the automotive, consumer, healthcare and industrial sectors maintain their competitive edge and drive innovation that meaningfully improves the quality of life in terms of health, safety and convenience, while reducing impact on the environment.

#### About ARRI

ARRI is a global player within the motion picture industry, employing around 1,200 staff worldwide. Named after its founders August Arnold and Robert Richter, ARRI was established in Munich, Germany, where the headquarters is still located today. Other subsidiaries are in Europe, North and South America, Asia, and Australia.

The ARRI Group consists of the business units Camera Systems, Lighting, and Rental, all dedicated to connecting creativity and future technologies for moving images. ARRI is a leading designer and manufacturer of camera and lighting systems as well as system solutions for the film, broadcast, and media industries, with a worldwide distribution and service network. The portfolio includes digital cameras, lenses, camera accessories, archive technologies, lamp heads, and lighting accessories. Along with offering exclusive technologies, ARRI Rental's first-class services and equipment provide camera, lighting, and grip packages to professional productions around the world.

The Academy of Motion Picture Arts and Sciences has recognized ARRI's engineers and their contributions to the industry with 19 Scientific and Technical Awards. ■

## Legrand Announces Acquisition of Encelium Advanced Lighting Management

[encelium.com/](https://encelium.com/)

Legrand®, a world leader in electrical, digital infrastructure and connected solutions, has announced its acquisition of Encelium, an Ontario, Canada-based manufacturer of advanced commercial lighting controls.

The acquisition of Encelium brand and products, which takes effect immediately, comes as part of Legrand's ongoing global strategy to further strengthen its position in the

commercial lighting control sector. A leader in this category, Encelium is already an integral component within thousands of buildings, supporting the needs of occupants, tenants, and facilities managers through people-centric lighting and energy efficiency. Encelium will become an integral addition to Legrand's Building Control Systems division, thanks to its in-fixture control options, site lighting, and DALI controls. It joins Legrand's portfolio of market leaders such as Legrand Wattstopper, Legrand Shading, and Vantage. Together, this collective of brands is poised to develop and support a broader range of new solutions to meet the ever-changing demands of agents, partners, specifiers, and contractors alike.

"We have a demonstrated history and proven track record of what can be made possible for innovation, quality and customer service when we invest in and acquire the right products and solutions," said Andrea Lamieri, General Manager, Legrand's Building Control Systems business. "The synergy with Encelium was evident from the start – not only from a product and innovation standpoint, but from their 'people first' approach that drives their innovation, and their commitment to enhancing the experience of everyone that comes in contact with their products."

This milestone also brings tremendous opportunity for both parties. With scaling made possible by a multi-billion dollar brand, Encelium will now be able to expand both its expertise and capabilities to deliver more innovative lighting solutions to the marketplace than ever before.

"We look forward to providing Encelium customers with access to expanded control solutions from Legrand, including the comprehensive digital lighting control platform which extends to DLM motorized shading, and delivers on code-ready solutions," said Lamieri. "In turn, we're excited to offer Legrand customers access to an expanded portfolio of solutions that features the signature technology-driven, people-focused Encelium Experience."

#### About Legrand and Legrand, North and Central America

Legrand is the global specialist in electrical and digital building infrastructures. Its comprehensive offering of solutions for commercial, industrial, and residential markets makes it a benchmark for customers worldwide. The Group harnesses technological and societal trends with lasting impacts on buildings with the purpose of improving life by transforming the spaces where people live, work and meet with electrical, digital infrastructures and connected solutions that are simple, innovative and sustainable. Drawing on an approach that involves all teams and stakeholders, Legrand is pursuing its strategy of profitable and responsible growth driven by acquisitions and innovation, with a steady flow

of new offerings—including products with enhanced value in use (faster expanding segments: data centers, connected offerings and energy efficiency programs). Legrand reported sales of EUR 7.0 billion in 2021. The company is listed on Euronext Paris and is notably a component stock of the CAC 40 and CAC 40 ESG indexes. (code ISIN FR0010307819). <https://www.legrand.us/> ■

## Zhaga Smart City Sensor Awards Submission Date Extended

[www.zhagastandard.org/zhaga-smartcitysensor-awards.html](https://www.zhagastandard.org/zhaga-smartcitysensor-awards.html)

The Zhaga Consortium launched the global Zhaga Smart City Sensor Awards in mid-September to address the needs for innovative sensors of the many cities that have installed Zhaga-D4i certified streetlights. The awards encourage and recognize excellence in smart city sensors that can be installed on streetlights using the Zhaga Book 18 standard and are suitable for Zhaga-D4i certification. The submission date has now been extended. Sensor manufacturers, innovators as well as universities and students are encouraged to submit their applications by 3 March 2023.

Numerous discussions at recent events like the Light+Building in Frankfurt, the Street and Area Lighting Conference in Dallas and the Smart City Expo World Congress in Barcelona have identified a significant number of sensor makers that did not previously know about the awards and would benefit from more time to prepare their submissions. Therefore, the submission deadline has been extended.

The Zhaga Consortium is also taking this opportunity to remind sensor manufacturers and other potential respondents that submissions for products in development are not only allowed but strongly encouraged.

Over the last 7 years, the Zhaga Consortium has created and further developed a new universal platform for streetlighting connectivity by offering Zhaga Book 18 titled "Smart interface between outdoor luminaires and sensing / communication modules" to the market. This platform allows streetlights to be the backbone of smart cities.

Streetlights are regularly positioned, secure, powered and in a great location for many sensing tasks and for communications. Zhaga's Book 18 takes this further by standardizing the mechanical interface, intra-luminaire communication protocol and power budget for control devices. Zhaga also creates a new market opportunity for smart city sensors. With over 200 families of Zhaga-D4i luminaires from some of the world's leading manufacturers already

certified, streetlights become the cheapest and most practical way for city-wide deployment of smart sensors.

Zhaga Book 18 brings standardization to sensors that can be installed on streetlights. The D4i protocol brings common communication. The Zhaga-D4i program, supported by logo use, offers the comfort of a global certification regime. The relatively recent Book 18 Edition 3 also opens up this opportunity to those parts of the world that are more comfortable with ANSI/NEMA-based lighting controls, yet who still wish to add Zhaga-based smart city sensors to streetlights.

Commercial participants who win an award will receive international public recognition via an article in a leading lighting publication and via Zhaga social media channels. They will also be entitled to make specific reference to the awards in marketing material. Students and researchers from recognized educational institutions are eligible for a EUR 2000 prize. Runners-up will receive a digital certificate.

Smart city sensors under the following categories: mobility, climate, pollutants, sound, lighting controls, multi-sensors, innovation and research, can be submitted to the international jury by 3 March 2023. The winners will be announced in April 2023.

The Zhaga Smart City Sensor Awards are explained in detail here: <https://www.zhagastandard.org/zhaga-smart-citysensor-awards.html>

For further information, please contact Axel Baschnagel, Marketing Communications, <mailto:marcom@zhagastandard.org>. ■

## First Book 20 Control Devices Earn Certification

[www.zhagastandard.org](http://www.zhagastandard.org)

Zhaga Book 20 defines a smart interface between an indoor LED luminaire and a sensing/communication module or control device. Book 20 brings together complementary specifications from the Zhaga Consortium and the D4i specifications from

the DALI Alliance. Certified control devices can carry the dual logos of Zhaga and D4i which together indicate interoperability. Osram is the first company which has earned the Zhaga-D4i certification for a number of their control devices.

In the LED luminaire the module or control device connects to the LED driver, and typically provides sensory inputs or enables communication between network components.

The Osram product families QBM D4i Z, QBM D4i LS/PD Z and QBM D4i LS/PD HB Z have been Zhaga-D4i certified and can now carry the Zhaga-D4i certification logo.

This family of devices is equipped with a Qualified Bluetooth Mesh wireless interface, ensuring connectivity to D4i drivers, together with light and presence detection enabling light harvesting functionalities.

Zhaga Book 20 provides a simple way to add control devices to luminaires by providing a standardized interface between them. The combination of complementary specification for mechanical fit, digital communication, and connection interface ensures interoperability for components from multiple suppliers. This combination helps enable smart luminaires that are easily upgradable to take advantage of the rapid developments in digital networking technology.

For further information, please contact Axel Baschnagel, Marketing Communications, <mailto:marcom@zhagastandard.org>.

### About Zhaga

Zhaga is a global association of lighting industry members. Zhaga standardizes interface specifications for LED luminaire components, including LED light engines, LED modules, LED arrays, holders, electronic control gear (LED drivers), connectors, sensor and/or wireless communication modules and associated devices. The Zhaga interface standards enable multi-vendor ecosystem of interoperable products. To create trust in the interoperability of products from multiple vendors Zhaga has a certification and logo-program executed by third party test houses. Through its focus on interoperability, Zhaga contributes to circularity lighting via

smart, connected lighting and serviceable luminaires, supporting the UN Sustainable Development Goal 11 for sustainable cities and communities. Zhaga has set up a partner and liaison program, working with recognized Standards Development Organizations and Alliances to maximize synergies, leverage external expertise and global acceptance. For more information, visit [www.zhagastandard.org](http://www.zhagastandard.org). ■

## All Blue Light is Not Created Equal, Exposure to the Right Blue is Critical for Optimizing Circadian Rhythms

[www.circadian.com/circadian-light-research-center](http://www.circadian.com/circadian-light-research-center)

One of the excuses the lighting industry uses to avoid addressing the harmful effects of blue-enriched LED lights at night is “circadian science is not yet mature.” Now a publication in PNAS from Harvard’s Brigham and Women’s Hospital has resolved one of the last remaining contradictions in the science – what color blue is responsible for the health effects? Start 2023 off in the best light, with details from the Circadian Light Research Center on exposure to the right blue light.

Dr. Martin Moore-Ede, director of the Circadian Light Research Center explains: “Over the past 20 years, exposure to blue-rich light at night, and too little blue-rich light during the day, has been linked to dozens of serious health disorders caused by circadian rhythm disruption, including sleep disorders, depression, obesity, diabetes, cardiovascular disease, and several hormone-sensitive cancers including breast and prostate cancer. But which blue? Royal blue, sky blue, aqua?”

The first studies in 2001 pointed to 460 nm royal blue. But the photobiologists studied people in the dark given short (less than 90 minutes) exposures to monochromatic (single-color) lights.

These early studies hardly represented how people use lights in the real world. To better understand blue light effects, the Circadian



### XLamp® Pro9™ LEDs – 15% Higher Efficacy

New Pro9 XLamp LEDs improve the output, efficacy and size of LED luminaires in commercial applications requiring high quality light. Pro9 LEDs have the industry’s highest operating temperature rating of 105°C. All Pro9 LEDs share the same mechanical and electrical characteristics to upgrade to higher CRI with no change in performance and minimal redesign. 2700-4000K CCTs, 90 & 95 CRIs available.



[cree-led.com](http://cree-led.com)

Light Research Center team studied people working under normal office lighting. In 2020 they reported the key color that had to be controlled in healthy lighting was 477 nm sky blue, near the 479 nm peak sensitivity of the melanopsin circadian photopigment in the eye. The 460 nm royal blue sensitivity only applied to the dark-adapted eye, but in the normal light-adapted conditions of workplaces and homes, the blue light most essential to control was sky blue, near 480 nm light.

In 2022, the Harvard study confirmed the explanation was correct. During the first hour of light exposure, 460 nm royal blue is the key circadian clock resetting signal, but after that, approximately 480 nm sky-blue light is the circadian time cue. They resolved the contradiction by studying 99 dark-adapted human volunteers receiving 6.5 hours of monochromatic light exposures instead of the previously studied 90 minutes. The reason for the difference between short versus long light exposures is that the cones in the retina are triggered when people first see light. Still, that effect fades away in the first hour, leaving the melanopsin-containing retinal ganglion cells in the retina, driving the sustained response to blue light as long as the lights remain on.

The key to human health is for the lighting industry to remove all 438–493 nm blue light from every LED light used after sunset but add plenty of 480 nm blue light to every fixture and light bulb used during the daytime hours. If not replaced with circadian lighting, people only prolong the ill-health caused by the indiscriminate use of blue-enriched lights. Circadian Blue Light is the narrow band of blue light (between 438–493 nm) that synchronizes our circadian rhythms during the day and disrupts them at night

**Circadian Light Research Center**  
Dr. Martin Moore-Ede, a former professor at Harvard Medical School, and his research team built this medical research center to identify and develop optimal health circadian lighting. With funding from the National Institutes of Health and other supporters, they designed and operated a light-controlled medical research center with a fully spectrally-controlled workplace and residential lighting to study human volunteers living and working at all hours around the clock.

**Martin Moore-Ede M.D., Ph.D.**  
For over 40 years, Dr. Moore-Ede has been a leading world expert on circadian clocks and the health problems caused by electric light at night. As a professor at Harvard Medical School (1975 – 1998), he led the team that located the suprachiasmatic nucleus, the biological clock in the human brain that controls the timing of sleep and wake. He pioneered research on how circadian clocks regulate the timing of body functions. Since 2010, he has led the Circadian Lighting Research Center team that identified the key blue signal that synchronizes circadian clocks

and developed patented LED lights, which provide circadian-optimized light across day and night based on comprehensive medical research. The effectiveness of these circadian-modulated lights in improving health and well-being has been validated by installing them in the 24-hour operations of Fortune 500 companies and hospitals. He has published over 180 scientific articles and authored ten books, including the best-selling books, *The Clocks that Time Us*, and *The Twenty-Four Hour Society*. His forthcoming book is *The Light Doctor: Why You Must Change Your Lights Now to Protect Your Health*. ■

## Melanopsin Vision: Sensation and Perception Through Intrinsically Photosensitive Retinal Ganglion Cells

[www.cambridge.org/core/elements/melanopsin-vision](http://www.cambridge.org/core/elements/melanopsin-vision)

Intrinsically photosensitive retinal ganglion cells (ipRGCs) are the most recently discovered photoreceptor class in the human retina. This Element integrates new knowledge and perspectives from visual neuroscience, psychology, sleep science and architecture to discuss how melanopsin-mediated ipRGC functions can be measured and their circuits manipulated. It reveals contemporary and emerging lighting technologies as powerful tools to set mind, brain and behavior.

Life has been evolving on this planet for some 3.5 billion years. For a good portion of that time (depending, for example, on atmospheric conditions), life has been exposed to the regular and alternating pattern of light and dark caused by the Earth's 24-hour rotation on its axis as it orbits the sun. It is perhaps unsurprising then that light is one of the most powerful drivers of behavior – light influences the way that we think, feel, and act.

The study of these effects of light has a long and rich history that is rooted in medicine. The ancient Greek physician Hippocrates built a solarium and prescribed sunbaths to manage a variety of disorders. The Roman scholar Aulus Cornelius Celsus recommended that sufferers of sickness or melancholy (depression) live in light-filled houses, especially in winter. More recently, Florence Nightingale argued that 'Where there is sun, there is thought', and that hospital wards should be brightly lit, ideally by sunlight. Contemporary medicine now recommends light exposure as a first-line treatment against both seasonal and non-seasonal depressions.

Our understanding of the detection of light is often discussed in relation to an aspect of perception known as 'image-forming' vision mediated via the rods and three cone

photoreceptor classes and their classical post-receptor pathways. Image-forming vision includes the sensory and perceptual aspects of visual experience such as color, form, or motion, usually discussed in the context of the neurotypical individual. However, lighting also drives diverse aspects of the human experience through setting physiology, arousal, cognition, and mood; responses that are classified as 'non-image-forming'. While these non-image-forming pathways can drive conscious awareness, many of these responses occur over timescales that are much longer than the momentary changes to which our visual perceptual awareness is tuned. This requires a mechanism with a fundamentally distinct temporal tuning to that of the classical visual pathways.

The modern study of non-image-forming vision is grounded in the scientific method and draws strongly from the fields of neuroscience, sleep and circadian sciences, and experimental and applied psychology. Its study has undergone a recent renaissance, where modern psychophysical and neuroscience methods have converged to identify the specialized visual circuits that serve non-image-forming vision and that originate in the retina of the eye. This fifth human photoreceptor class is located in the inner retina and termed the intrinsically photosensitive retinal ganglion cells (ipRGCs). Phototransduction initiated by the intrinsic melanopsin photopigment expressed by ipRGCs was initially shown to have a unique, characteristic temporal response: a slow onset followed by a sustained depolarization that is maintained even after the stimulating light is switched off. In addition to their unique intrinsic photoresponse, ipRGCs extrinsically mediate signals originating in outer retinal rod and cone photoreceptors. The ipRGCs therefore possess temporal characteristics suited to sensing both transient changes in light but also day-length changes.

These non-image-forming pathways project to over a dozen diverse efferent brain targets, and in this Element we evaluate the current state of knowledge for these functional melanopsin pathways that set pupil size, perceptual vision, circadian rhythms and sleep/wake transitions, and arousal, mood, and cognition. We focus on delineating findings in primates (including humans) from those of other model organisms. Indeed, these non-image-forming signals appear fundamentally entwined with the human condition and we discuss lightscapes that not only serve image-forming vision, but that target non-image-forming physiology to positively modify health and behavior. Physiologically targeted electric light sources have future applications as 'photoceuticals', with therapeutic effects analogous to those of pharmaceuticals and designed with similar considerations concerning disease specificity, dosage, and timing. Given the new

developments in the understanding of ipRGCs and their image-forming and non-image-forming projections, we provide a contemporary account of the importance of light and melanopsin function for brain, mind, and behaviour. ■

## New Color-Converted Laser Module

[www.crytur.cz/](http://www.crytur.cz/)

ams OSRAM (SIX: AMS), a global leader in optical solutions and optical device manufacturer Crytur have revealed that ams OSRAM's PLPT9 450LB\_E blue laser diode and new phosphor conversion technology from Crytur are combined in the latest MonaLIGHT laser module.

Crytur's MonaLIGHT B01 module produces a narrow beam of non-coherent, high-power visible light which can be much more efficiently coupled into an optical fiber or light guide than light from LEDs. The module is based on a powerful blue laser diode – the ams OSRAM PLPT9 450LB\_E, a 5W laser in a TO90 metal can – behind a special transmissive phosphor converter produced by Crytur. Unlike conventional phosphor converters, which scatter a laser beam, the Crytur phosphor shapes the beam to a narrow angle as well as converting the diode's blue light to a broad-spectrum visible light output (spectral bandwidth: 500nm-650nm).

The MonaLIGHT module offers peak luminous intensity up to 7000 cd unattainable by LED technology, with wall plug efficiency of at least 80lm/W at luminous flux 1100 lm. The module's beam has a narrow 8° viewing angle and a very low étendue < 0.2 mm<sup>2</sup>sr. Ideal for space- or weight-constrained applications, the MonaLIGHT module is just 12 mm in diameter and 24.1 mm long, and weighs 18 g. Compared to conventional laser modules, the MonaLIGHT offers substantially higher optical efficiency at lower cost. In contrast to other modules, the MonaLIGHT module's output has no unwanted speckle effect.

'The breakthrough in phosphor technology achieved by Crytur takes full advantage of the high luminous intensity of the PLPT9 450LB\_E laser diode, enabling the MonaLIGHT module to generate a specific color and high efficiency which are ideal for many applications. To produce a powerful light output with excellent characteristics from such a small and light module is a seriously impressive technical achievement,' said Jörg Heerlein, EMEA Head of Product Marketing at the visualization and sensing business line of ams OSRAM.

Modular architecture enables for custom configurations: The MonaLIGHT's modular structure enables Crytur to configure the output to meet specific customer

requirements. Customer-specified optical components such as bandpass spectral filters, light guides and lenses can be built into the module. The high level of integration enables customers to build very compact and highly efficient optical assemblies. This makes the module ideal for use in many applications, including scientific instruments such as visible light or fluorescence microscopes, machine vision systems, and head-up displays in avionics systems.

The MonaLIGHT B01 module is available worldwide via authorized distributors of Crytur products. The laser diode PLPT9 450LB\_E is available in production volumes directly from ams OSRAM and from authorized distributors. ■

## Nichia Expands the Portfolio of Its H6 Series – Focus on the Quality of Light

[led-ld.nichia.co.jp/en/product/lighting\\_h6.html](http://led-ld.nichia.co.jp/en/product/lighting_h6.html)

Nichia, the world's largest LED manufacturer and inventor of high-brightness blue and white LEDs, is pleased to announce the addition of NFCWJ108B-V4H6 and NFDWJ130B-V4H6 to its H6 Series portfolio, two new COB types with significantly increased output.

It became accepted in the industry that the trade-off between achieving high lumen efficacy and high CRI / TM-30 was difficult to overcome. However, the H6 Series of LEDs capitalizes on Nichia's 50+ years of phosphors and LED expertise and technology, in combination with TriGain® Technology from Current. This powerful combination led to a technology breakthrough, overcoming the trade-off between efficacy and CRI, by delivering the industry's highest joint-boost in color quality and efficacy. The existing COB-V4H6 Series offers 5W, 9W and 16W class, and is mainly used for light bulbs, spotlights, and downlights. With the addition of 30W and 44W class to the portfolio, these products can now be used for lighting in spaces where high output is required, such as stores and facilities with high ceilings.

In addition to the high efficacy, H6 Series enables the reproduction of colors with high fidelity and beautifully illuminates facial expressions. These key features can be demonstrated in the various indoor spaces where the importance of quality of light is focused including residences, shops, offices, and healthcare facilities. Nichia believes that the adoption of H6 Series, both COB and 757 Series, can contribute to improve the daily comfort of our lives.

Nichia continues to develop products that are useful to society. ■

## LUXEON XR-HL2X and XR-5050 HE Standard Modules Provide a Faster Path to Lighting Solutions

<https://lumileds.com/>

Utilizing two of Lumileds most popular and powerful LEDs, the company has released two new standard integrated modules, LUXEON XR-HL2X and LUXEON XR-5050 HE. Both offer lighting engineers a faster, simpler way to realize powerful, highly efficient lighting solutions. Standard optics are available for all the new boards, and both offer typical efficacy of 184 lumens per Watt.

### LUXEON XR-5050 HE

With light output exceeding 8600 lumens at 184 lumens per Watt, ≤ 3SDCM color control, and 70, 80, and 90CRI options across the CCT range, LUXEON XR-5050 HE is a highly efficient solution. Both indoor and outdoor lighting, such as architectural, historical, high bay, pedestrian and roadway and sports lighting, can be realized more quickly and efficiently with the new LED boards from Lumileds.

"The energy crisis is top of mind for all and every advance is important. LUXEON XR 5050 HE delivers the efficacy in a robust format with proven LUXEON 5050 HE LEDs in a format that speeds time to market," said Benjamin Khoo, Product Manager. "With immediate availability of standard optics and drivers, this is perhaps the most efficient and appropriate solution for high output energy saving fixtures."

### LUXEON XR-HL2X

For typical light output levels ranging from 1400 to 2800 lumens, in 3000 and 4000K, 70CRI, with board level color control ≤ 5 SDCM, the LUXEON XR-HL2X is an excellent selection. The standard 8-up, 12-up, and 16-up boards use the Zhaga footprint and are compatible with off-the-shelf drivers, optics, and heat sinks. For many low bay and outdoor area lighting solutions, LUXEON XR-HL2X is exactly what is needed and eliminates the need to design and test boards and configurations.

Both of the new standard solutions use factory selected LEDs for color and performance consistency mounted on an MCPCB substrate that provides thermal efficiency and mechanical robustness. Both have UL8750, ENEC, CE, and UKCA approbations.

Complete product information and datasheets for LUXEON XR-5050 HE and LUXEON XR-HL2X LED can be found at <https://lumileds.com/>.

### About Lumileds

Lumileds is a global leader in OEM and aftermarket automotive lighting and accessories, camera flash for mobile devices, MicroLED, and light sources for general illumination, horticulture, and human-centric lighting. Our approximately 7,000 employees operate in over 30 countries and partner with our customers to deliver never before possible solutions for lighting, safety, and well-being. To learn more about our company and solution portfolios, please visit <https://lumileds.com>. ■

## Lumileds Expands LUXEON 2835 Commercial with 14 New Parts

<https://lumileds.com/>

Lumileds released 14 new 3V parts in its LUXEON 2835 Commercial portfolio that deliver higher flux and efficacy to enable rapid upgrading of existing solutions and design of new lighting solutions. The new parts are available in all standard CCTs from 2700K to 6500K.

Today, Lumileds offers over 150 different LUXEON 2835 LEDs in white across CCTs of 1800K to 6500K and CRIs of 70 to 95 – all at various light output and efficacy levels selected to address the needs of a broad customer base. And Lumileds 2835 portfolio includes 21 color LEDs including direct and phosphor converted options.

For the latest 14 part expansion, 0.2V voltage bins and 3- and 5-step simplify system design. Reliability is proven through extensive testing including High Temperature Operating Life, Moisture High Temperature Operation Life, Powered Temperature Cycle Test, A-A Thermal Shock, Temperature Cycle, and Power Switching. We believe LUXEON 2835 to be the most reliable LED in its class available today.

“Each year, LUXEON 2835 Architectural, Commercial, and Color LEDs are some of the highest volume products in part because we continuously develop options based on our customers’ specific needs and objectives in the professional and consumer lighting segments,” said Ryan Dong, Product Manager. “This allows us to engineer 2835 LEDs that deliver superb, in application price to performance results and offer unmatched reliability for in market end customer satisfaction.”

LUXEON 2835 LEDs are immediately available through Lumileds global distribution network. More product information, datasheets, and purchasing information is available at Lumileds website, <https://lumileds.com/products/mid-power-leds/luxeon-2835-commercial/>. ■

## Luminus Releases Salud COBs

[www.luminus.com](http://www.luminus.com)

Luminus Devices has expanded its human-centric lighting portfolio with the introduction of the Salud COBs. These recently released COBs have high R9 values, high melanopic/photopic ratios, and 90 CRI minimum in warm CCTs that enable users to meet WELL Building requirements.

In addition, these LEDs possess exceptionally long color stability, excellent optical emission uniformity, as well as color over angle consistency, and superior thermal conductivity for uniform heat spreading. The Salud COBs are ideal for directional lighting applications, thus complementing the existing line of Salud midpower products and Salud CCT tunable modules.

As many public spaces have opened back up with health and wellness as a key consideration, the Salud technology that is incorporated into these COBs enables building and lighting designers to meet the WELL Building requirements for high melanopic lux in the vertical plane without having to over-light the environment and without having to use cool, blueish CCTs like 6500K. Salud technology helps create a healthy, productive, and comfortable environment which is ideal for offices, schools, factories, shops, and public spaces. With typical R9 values in the 90s, Salud technology has especially high red color rendering to produce vibrant red tones, as well as healthy skin tones, and therefore, an increased ability to more accurately diagnose medical conditions including sepsis and cyanosis.

David Davito, COB Product Line Director, Illumination at Luminus adds, “As our industry learns more about the importance of healthy lighting, our Salud line has been recognized as the ideal option to deliver high melanopic lux in warm CCTs and 90 CRI quality of light. The new Salud COBs are the perfect complement to our Salud midpower line to enable customers the ability to offer a full suite of directional, linear, and panel lighting options.”

All Salud™ products are now available through Luminus’ authorized distributors.

For a full list of features, applications and benefits visit [https://download.luminus.com/datasheets/Luminus\\_Salud\\_COB\\_Product\\_Data\\_Sheet.pdf](https://download.luminus.com/datasheets/Luminus_Salud_COB_Product_Data_Sheet.pdf).

### About Luminus Devices

Luminus Devices develops and markets solid-state lighting solutions (SSL) to help its customers migrate from conventional lamp technologies to long-life and energy-efficient LED illumination. Combining technology originated from the Massachusetts Institute of

Technology (MIT) with innovation from Silicon Valley, Luminus offers a comprehensive range of LED solutions for global lighting markets as well as high-output specialty lighting solutions for performance-driven markets including consumer displays, entertainment lighting and medical applications. Luminus is headquartered in Sunnyvale, California. For additional information please visit [www.luminus.com](http://www.luminus.com). ■

## Toshiba Develops Transparent Photoluminescent Phosphor for LED, Sensing and Security Printing Applications

[www.toshiba.com/](http://www.toshiba.com/)

TOKYO—Toshiba Corporation (TOKYO: 6502) has unveiled a technology breakthrough in photoluminescence, a novel phosphor that delivers excellent solubility in polymers or organic solvents, where it is transparent and colorless under visible light, and that emits persistent red-light emissions under UV light, with excellent color purity and a luminescence six times that of current phosphors. These characteristics open up many potential applications in areas that include LED lighting, displays, deep UV sensing, security printing, and pesticide residue testing.

A phosphor is a substance that absorbs energy from a light source, such as UV or visible light, and releases that energy by emitting colored light. Phosphors are commonly used in LED lighting and displays, and in security printing. However, in the field of mini- and micro-LED lighting and displays, where the chips used are very small, the inorganic phosphors typically used have a limited color reproduction capability and luminescence intensity. These phosphors are also insoluble and exist as fine particles, and when used in security printing, printed patterns become faintly visible, depending on the angle of view and light exposure. Toshiba’s new phosphor overcomes these problems.

Toshiba has focused its photoluminescence research on novel lanthanide luminescent complexes. The company has developed a proprietary molecular design method, and used this to bind the ions of a standard Eu(III) luminescent complex with two or more phosphine oxide structures, including a branched tetraphosphine tetraoxide ligand recently discovered by Toshiba. This created a new structure that is highly soluble, with excellent transparency, and that successfully increases luminescence intensity to achieve high color purity and durable emission. The molecular design method also has the potential to create phosphors that emit





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# EPREL Guidelines

## Have you registered your lighting products on the European Product Database for Energy Labelling (EPREL)?

LightingEurope is now making available to all companies our guidelines on how to comply with the EPREL registration obligations for lighting:

- ▲ What needs to be uploaded by when?
- ▲ Who should upload information?
- ▲ How do you upload information?

Covering the requirements in the new EU energy labelling rules for light sources (Regulation (EU) 2019/2015), including the changes introduced by the Omnibus Amendment (Regulation (EU) No 2021/340).

**Discover more at**  
**[www.lightingeurope.org](http://www.lightingeurope.org)**

different colored light when applied to different luminescent complexes.

Researchers from Toshiba presented the technology and showcased red LEDs and fluorescent films as applications at the 29th International Display Workshops (IDW '22) 4 from December 14 to 16. A paper covering the technology was published on the IDW' 22 website. Toshiba will soon begin to provide samples of the phosphor and fluorescent films and explore partnerships for applications in many areas, including the lighting, display, printing and chemical industries. The company aims to start mass production in 2025.

#### About Toshiba Corporation

Toshiba Corporation leads a global group of companies that combines knowledge and capabilities from over 140 years of experience in a wide range of businesses—from energy and social infrastructure to electronic devices—with world-class capabilities in information processing, digital and AI technologies. These distinctive strengths support Toshiba's continued evolution toward becoming an Infrastructure Services Company that promotes data utilization and digitization, and one of the world's leading cyber-physical-systems technology companies. Guided by the Basic Commitment of the Toshiba Group, "Committed to People, Committed to the Future," Toshiba contributes to society's positive development with services and solutions that lead to a better world. The Group and its 120,000 employees worldwide secured annual sales of 3.3 trillion yen (US\$27.4 billion) in fiscal year 2021. Find out more about Toshiba at [www.global.toshiba/ww/outline/corporate.html](http://www.global.toshiba/ww/outline/corporate.html). ■

## Introducing Our New Light Engine The Stonehenge Series

<https://edison-opto-landing-pages-01d736.webflow.io/light-engine>

Stonehenge Light Engine Module series is a surface mount, high-efficiency optical integrator matrix assembly. The modules are fully compatible with various high-lumen density LEDs such as white, RGBW, dual color, and more colors in one.

The Stonehenge module setup has a powerful LED matrix that is surface mounted by a specified number of LEDs, assembled with module optics to form an efficient yet high-power module.

In addition, they have a high thermal conductive board for highly efficient heat management. Our glass type Federal 5050 chip has independently controllable LEDs allowing for extraordinary levels of uniform

color mixing. Several color choices are available among the wide variety of options.

In addition, we provide color-customized services, PC lime, or Cyan. Their small dimensions enable higher flexibility and provide optimal optical design. Our patented lenses are 20% higher than the efficiency of traditional lenses. Stonehenge Light Engine Module series has a narrower beam angle than ordinary surface light sources (COB, for instance), uniform color mixing, high efficiency, convenient use, and maintenance.

Edison has specially developed high CRI Federal 5050 for scenes that require more real color, such as profile spotlight. The modules of the series would be the optimal choice for customers to choose from to create a dazzling stage and film lighting effects. We, Edison Opto, carefully tested products to achieve reliable and optimal performance, giving you an extraordinary LED experience.

#### Company Description:

Edison Opto from New Taipei, Taiwan, was built in 2001 as the parent company and Subsidiary Edison Opto USA Corp. to service North American based customers. The company's mission is to deliver customers a complete LED product line from components to modules as an integrated design manufacturing service to support customers and manage every issue while designing LED lighting products. ■

## Automotive Forward Lighting - OBF X

[www.led-professional.com/all/automotive-forward-lighting-obf-x](http://www.led-professional.com/all/automotive-forward-lighting-obf-x)

The new era for LED forward lighting, which is emerging with the introduction of the OSOLON Black Flat X, builds on the successful platform of the existing OSOLON Black Flat family of products. OSOLON Black Flat LEDs are widely recognized to be the first surface-mount LED light sources to be used in automotive forward lighting. OSOLON Black Flat LEDs get their name from the package style: the black package provides for high contrast of 1:200, and the flat surface-mount package can be mounted on a PCB using standard assembly equipment.

Automotive LEDs have proved their value in forward lighting for several years at the premium end of the market. Compared to the traditional halogen lamp technology which dominated the headlamp market earlier in the 21st century, LEDs:

- Offer higher efficiency, helping to reduce a vehicle's fuel or electrical energy consumption
- Give a much longer – in fact almost unlimited – operating lifetime, avoiding the

need for periodic lamp replacement, and reducing the risk of driving with a failed lamp

- Provide more flexibility to differentiate the design of the headlamp. Car makers can use LED-based headlamps to create unique styling which reflects the character of the vehicle and the manufacturer's brand.
- Enable more precise beam control in projection lens-based headlamp designs

The value of efficiency, performance and design freedom applies just as much to mid-range and budget vehicles as to premium cars. But system cost has proved to be a barrier to adoption: legacy halogen-based forward lighting benefits from longstanding economies of scale and low unit cost. Now, however, the introduction of new, hyper-efficient automotive LEDs, the OSOLON® Black Flat X series from ams OSRAM, marks the crossing of a cost/performance threshold. This new LED achieves even higher levels of both luminous flux output and efficacy than earlier OSOLON Black Flat products. This enables automotive OEMs to substantially reduce the amount of material and number of components in a forward lighting unit that the cost of an LED-based headlamp becomes competitive with that of a conventional halogen unit, while offering the superior features, reliability and performance for which LED technology is well known.

#### Breakthrough in output and efficacy

The new era for LED forward lighting, which is emerging with the introduction of the OSOLON Black Flat X, builds on the successful platform of the existing OSOLON Black Flat family of products. OSOLON Black Flat LEDs are widely recognized to be the first surface-mount LED light sources to be used in automotive forward lighting. OSOLON Black Flat LEDs get their name from the package style: the black package provides for high contrast of 1:200, and the flat surface-mount package can be mounted on a PCB using standard assembly equipment. The new OSOLON Black Flat X is based on the latest version of the ams OSRAM InGaN-based UX3 chip architecture. The UX3 provides excellent reliability, high optical power output and good thermal performance.

Building on this platform, the OSOLON Black Flat X benefits from various enhancements, including a larger light emitting area of 1.15 mm<sup>2</sup> per chip, as well as lower thermal resistance than the ceramic packages used in competing automotive LEDs. In addition, the new products are characterized by outstanding uniformity of color over angle.

These new features result in superior operating characteristics: each OSOLON Black Flat X LED chip produces 460 lm at a drive current of 1 A. Higher luminous flux is combined with higher luminous efficacy: in the single-chip KW HHL631.TK variant of the OSOLON Black Flat X series, power

consumption is just 3.2 W when producing luminous flux of 460 lm.

The OSLO Black Flat X is available in 1-, 2-, 3-, 4- and 5-chip variants, all housed in compact, surface-mount packages. For instance, the single-chip OSLO Black Flat X is supplied in a black flat package which measures just 3.75 mm x 3.75 mm. Extending the inherently good thermal performance of their packages, the OSLO Black Flat products are highly compatible with aluminum metal-core PCBs (MCPCBs). In all versions even up to the 5-chip product, the reliability of the complete LED board assembly is excellent thanks to the closely matching coefficient of thermal expansion of the LED's metal leadframe and the MCPCB. In addition, as each chip is individually addressable, the LED output can be dynamically adapted to take account of any drop in battery voltage when the car's start-stop function is activated.

*Higher output leads to system cost savings*

The high brightness of the new OSLO Black Flat X helps to transform the cost:performance equation for automotive manufacturers. Now, a target flux value can be achieved with fewer chips, lowering the bill-of-materials cost of a forward lighting system. This cost advantage is heightened by the high efficacy and low thermal resistance of the surface-mount OSLO Black Flat X. Manufacturers are now able to realize forward lighting unit designs which require no heatsink, relying solely on the heat dissipation provided by the metal-core PCB (MCPCB) on which the LEDs are mounted. This new possibility has been demonstrated by a reference design developed by ams OSRAM, and based on the use of OSLO Black Flat X LEDs for the daytime running light (DRL), and the low-beam and high-beam headlamps. This reference design is a reflector-based headlamp, but the same heatsink-less approach could equally be deployed in a projection lens-based design.

In this reference design, the low-beam headlight is realized with two dual-chip OSLO Black Flat X LEDs, each mounted on its own aluminum MCPCB with its own reflector. The high-beam headlight has a single dual-chip OSLO Black Flat X LED and reflector. The DRL is realized with one single-chip OSLO Black Flat X LED and reflector. The design also includes a turn indicator, to provide a complete forward lighting unit. Driven at 700 mA, the OSLO Black Flat X LEDs dissipate heat via the MCPCB to free air, with no heatsink or fan. Total dissipated heat is 9.65 W. This system remains safely inside its operating limits even when exercised in ambient temperature conditions outside the housing of 70 °C.

The headlights and DRL produce light output compatible with automotive lighting standards: at a junction temperature of 150 °C and a drive current of 700 mA, each OSLO Black Flat X chip produces 270 lm. In

these conditions, it consumes 2.0 W, and dissipates 1.15 W of thermal power.

The ability of a forward lighting unit based on OSLO Black Flat X LEDs to operate with no heatsink or forced-air cooling offers several important benefits:

- Lower system cost, due to the elimination of a heatsink assembly from the bill-of-materials
- Reduced weight
- Space saving

In addition, operation at a low drive current of 700 mA means that drive components with a lower power rating, and a lower unit cost, may be specified. OSLO Black Flat X LEDs meet all the requirements of automotive production standards: they are AEC-Q102 qualified, offer Class 3B corrosion resistance, and are PPAP compatible.

*New opportunity to extend adoption of LEDs in headlamps*

The introduction of the OSLO Black Flat X series, makes it possible for automotive lighting manufacturers to implement new designs for forward lighting units which reap the key benefits of LED technology – long lifetime, high efficiency and reliability – while limiting system cost to a level comparable with that of conventional halogen-based designs.

With the OSLO Black Flat X, new designs can eliminate the heatsink and simplify thermal design, leading to a new generation of LED-based forward lighting units which are competitive on cost but offer high performance and reliability. ■

## Novel Technology to Increase Pot Life of Silicones Used in LED Components

[www.joanneum.at/en/materials](http://www.joanneum.at/en/materials)

Improved formulation for a Silicone elastomer can lead to significantly reduced production costs for LED components. JOANNEUM RESEARCH is looking for partners in the LED, phosphor and PDMS market to exploit the potential of this technology.

Most LED components use special silicones (PDMS) as matrix for the color conversion phosphors, or as the favorite material for primary optical lenses attached to the LED package. In LED production, two component systems of such elastomers are preferred. Upon mixing of the two components the curing process of the silicones starts almost immediately, and the mixture usually has a pot life limited to a maximum of few hours at room temperature. This poses significant practical and technological limitations for its use, especially in LED production, where additional

color conversion phosphors are added to the mixture.

The mixtures have to be produced out of the pristine silicone components and the phosphors in situ at the site of the LED package manufacturer. Usually, the premixed formulation has to be transferred immediately to small cartridges and stored in small portions in refrigerators, which requires a comparatively high labor effort. When used in production of LED components, the viscosity of the mixture has to stay within certain limits. Due to an early viscosity increase caused by the persisting curing reaction in the cartridge a considerable amount of the color conversion mixture has to be discarded in the production process, generating waste and unnecessary high production costs.

The most popular types of silicones require Platinum (Pt)-catalysts to support the curing reaction. To slow the reaction down temporarily, some additives like amines and other compounds can be used, which complex the active metal-center of the catalyst (e.g., Pt) and inhibit the crosslinking for a certain time. However, the inhibition of silicone curing is often only partially reversible because the inhibitors cannot be removed entirely. As a result, the final crosslinked elastomer will have different properties compared to non-inhibited materials. Moreover, even partial removal of common inhibitors requires high temperatures, well beyond 100 °C. Therefore, these systems are not suitable for production of LED components today.

JOANNEUM RESEARCH has developed a novel method to stabilize PDMS elastomer systems that does not show the drawbacks of state-of-the-art inhibitors. Using this technology, the pot time of silicon mixtures (including color conversion phosphors) can be extended to several months and beyond. This is reducing the processing efforts and increasing the yield of color conversion material in LED-production considerably. After deposition, normal curing occurs at temperatures even below 80 °C (which is used for curing of common PDMS in LED components), leading to a fast and complete curing. No change of optical properties of the PDMS and the LED is observed. A specific advantage of this approach is that the modified silicones can be mixed with color conversion phosphors in rather large batches, increasing the accuracy and consistency of the color conversion pastes.

The novel technology is patent pending. JOANNEUM RESEARCH is looking for partners in the LED, phosphor and PDMS market to exploit the potential of this technology.

Contact: Prof. Dr Paul Hartmann, <mailto:Paul.Hartmann@joanneum.at> ■

# Leader in Optical Solutions – Alessandro CILANO, Head of Global Product Marketing Illumination, ams OSRAM

**Alessandro CILANO:**

“Horticulture LED and sensor solutions from ams OSRAM enable highest energy efficiency in plant growth with most advanced uniformity and spectral optimizations at the lowest overall system cost and premium lifetime .”

LED professional was pleased to talk to Alessandro CILANO at electronica in Munich. ams OSRAM is a global leader in optical solutions. They offer a unique product and technology portfolio for sensing, illumination and visualization: From prime-quality light emitters and optical components to micro-modules, light sensors, ICs and related software.

**LED professional:** Thank you for taking the time to talk to us. We would like to jump right in and ask you about the highlights that ams OSRAM is presenting here at electronica. Specifically, what new innovations will be coming up by the end of this year?

**Alessandro CILANO:** We are very happy to be here at electronica. It's the first time we are able to meet people face to face again since the pandemic. I'm happy to say that attendance has been very good. I represent the Business Line, Illumination, and from our side we have two focus topics presented here. One is horticulture lighting where we showcase our flexible and efficient design solutions for top-/inter-lighting and vertical farming applications for greenhouse and indoor farming. The other is displaying UV-C treatment solutions to deactivate, for example, viruses and pathogens in the air, in water and on surfaces.

Our demos showcase our latest UV-C and horticulture products and solutions. For example, our leading Hyper Red 660 nm technology offers the market the most efficient LEDs for horticultural applications.

In addition, we now have an incredible advantage, in that we are able to combine LEDs with sensors to offer even more value to our customers.

Similarly, for UV-C, which is a growing market, and one of our focus applications, we are showing our latest LED and sensor portfolio.

But illumination is not just about horticultural lighting and UV-C treatment. Our core business and strength is general and industrial lighting, and that includes LEDs - in all power classes addressing applications - ranging from outdoor lighting, e. g. street lighting, tunnel lighting or stadium lighting, and of course indoor lighting to standard industry applications in the realm of signaling, airfield runway lighting, to solutions for smart homes.

**LED professional:** Another thing that we think our readers will find quite interesting is the combination of sensor technology, with key experts from ams and the lighting experts from Osram. Will we be seeing more combinations of sensor technology and smart systems in the future?

**Alessandro CILANO:** Yes. As ams OSRAM we offer customers one stop solution possibilities from emitting to sensing. We see excitement and interest from customers, as well. Lighting is a market that has existed for many years and has, in some areas more than others, reached a certain level of maturity. The space for innovations is highly competitive, with intricate and high-end solutions. It is not always about lumens per watt at a certain cost, but rather it becomes increasingly important to offer customers value in more ways than others. We believe that offering more value is an area where ams OSRAM excels.

Energy consumption is and will remain a topic for everyone. Take smart light-

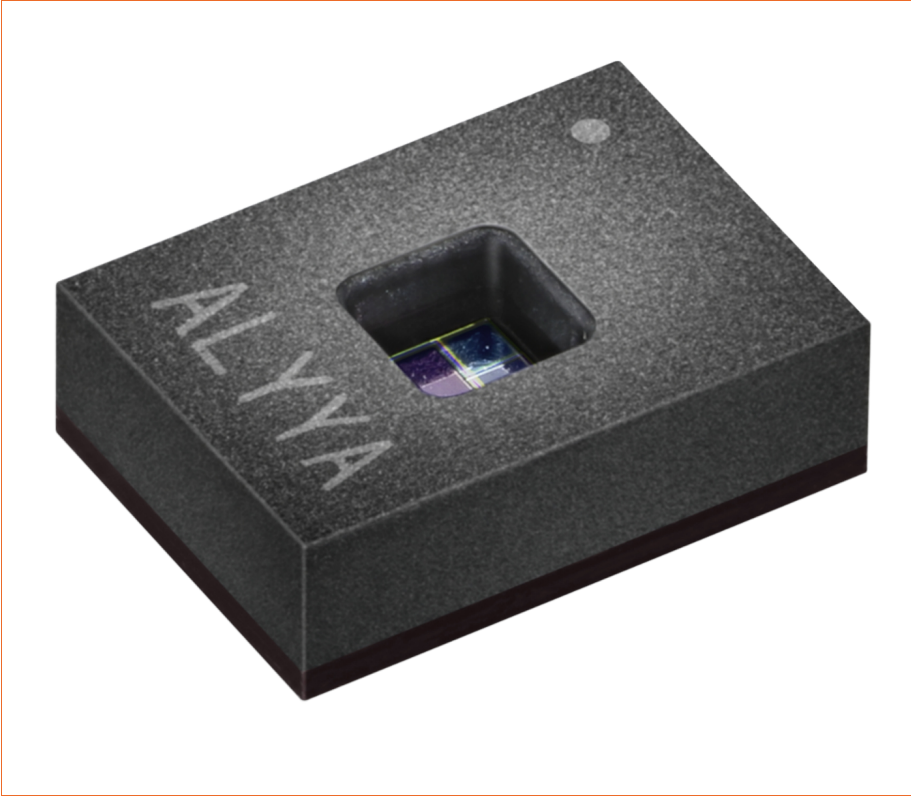
ing as an example. Be it street lighting, connected lighting or horticultural lighting. You can add sensors to measure the spectrum and fine tune your illumination system to perform as efficiently as possible. An important key parameter considering the target of making systems comply to specific energy saving standards, for example.

*“From UV-C LED treatment to Horticultural lighting and General Lighting applications, we have one of the most exceptional portfolios of high-quality and innovative products in the market.”*

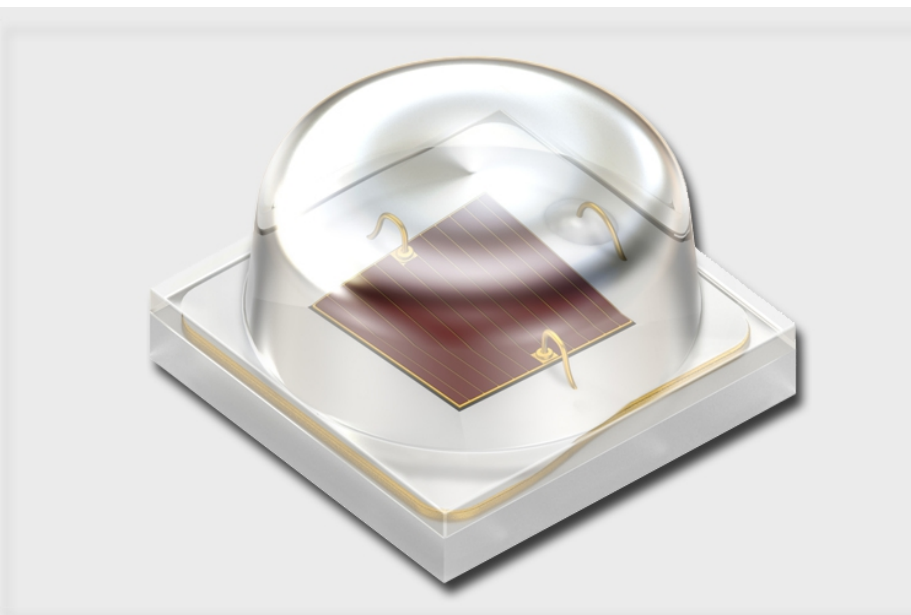
ALESSANDRO CILANO, AMS OSRAM

Another example - UV-C is used for various kinds of disinfection, and ams OSRAM offers a UV-A-/B-/C- CMOS-sensor that is the only one currently available on the market. In fact, it was officially launched at electronica. This combination gives us the possibility to make the best use of the LED technology, which is still quite new. The sensor measures the radiation at UV-A, UV-B UV-C wavelengths improving performance, saving power and giving better value.

We are truly excited about it.



The AS7331 is a three-channel sensor which uses interference filters to produce precisely characterized responsivity to radiation in the UV-A (315nm-410nm), UV-B (280nm-315nm) and UV-C (240nm-280nm) wavelength bands. The filters also provide excellent rejection of interference from ambient visible and near infrared light sources. The AS7331 features an internal temperature sensor to support temperature compensation of measurement outputs. Digital measurements of radiant intensity are supplied in up to 24-bit resolution via a 16-bit I2C interface output.



The optics of the OSLON® Square Batwing emit a unique pattern of light that looks like wings, which allows horticulture lighting customers to simplify designs and increase efficiency. The 140° beam angle and rectangular shape of light distribution enables higher uniformity and optimum utilization of space in greenhouses. The wider angle also allows for a larger distance between the luminaires, which can reduce the number of fixtures.

Several of our customers are confirming this interest in a combined LED and sensor offering and are very eager to engage with us on co-creating their products. This gives us the possibility to make the best use of the technology, which is pretty new. For example, the UVC and the sensor can really hype together to maximize the benefit of the LED technology.

We are very excited about it. Yesterday I met a customer from the horticultural field who told me he was very interested in talking to us because we not only supply the LED but there is also the possibility of innovation, which will become really key in horticulture.

*“Lighting is more than illumination. It gives our built spaces a personality – inside and outside. It impacts our creativity and well-being throughout the day and offers us comfort at night. It helps plants grow in a controlled environment, allowing more sustainable food production. It can even purify our indoor spaces and life-supporting processes – like the air we breathe or the water we drink. All of this is made possible by advanced lighting solutions using controllable LEDs paired with sensor technology.”*

ALESSANDRO CILANO, AMS OSRAM

**LED professional:** How do you see the global market for LED lighting solutions? For example, Europe has very high recommendations and specifications in regards to quality and so on in general lighting – what do you think the market tendencies will be in the coming years for general lighting?

**Alessandro CILANO:** There is still a request to increase efficiency and improve cost, but we see increased interest in, for example, miniaturization and color

quality, which would enable customers to redesign their products and increase value. And of course, our products are always designed according to the highest quality and reliability standards. In this regard, as you mentioned, there can be some regional differences, but the main difference is on the application level. Taking street lighting as an example- in particular for safety. This is an application area with the highest standards and requirements which we lead with our High-Power White LED portfolio.

**LED professional: In closing, can we ask about your professional career? How did you come to work for ams OSRAM?**

**Alessandro CILANO:** I have been working for the company for sixteen years, in various roles in sales and marketing specifically in the illumination LED area. Today I am in the Business Line where I head Global Product Marketing for the Business Line Illumination. I am excited to learn and help create a portfolio that

includes both LED and sensors and help bring this innovation to the world addressing new applications.

**LED professional: Thank you very much.**

**Alessandro CILANO:** You're welcome! ■

**About ams OSRAM**

The ams OSRAM Group (SIX: AMS) is a global leader in optical solutions. By adding intelligence to light and passion to innovation, we enrich people's lives. This is what we mean by Sensing is Life.

With over 110 years of combined history, our core is defined by imagination, deep engineering expertise and the ability to provide global industrial capacity in sensor and light technologies. We create exciting innovations that enable our customers in the automotive, consumer, industrial and healthcare sectors maintain their competitive edge and drive innovation that meaningfully improves the

quality of life in terms of health, safety and convenience, while reducing impact on the environment.

Our around 22,000 employees worldwide focus on innovation across sensing, illumination and visualization to make journeys safer, medical diagnosis more accurate and daily moments in communication a richer experience. Our work creates technology for breakthrough applications, which is reflected in over 15,000 patents granted and applied. Headquartered in Premstaetten/Graz (Austria) with a co-headquarters in Munich (Germany), the group achieved over EUR 5 billion revenues in 2021 and is listed as ams-OSRAM AG on the SIX Swiss Exchange (ISIN: AT0000A18XM4). [ams-osram.com](https://ams-osram.com)

[ams-osram.com/support/partner-network](https://ams-osram.com/support/partner-network)



ams OSRAM has launched a new Global Partner Network of design consultancies, module suppliers and supporting component manufacturers to accelerate customers' time to market and facilitate new business opportunities, while taking advantage of the latest optical and sensor technologies. Partners are selected based on their technical expertise, solution offering and track record of working with customers to co-create new products. The Global Partner Network encompasses the hardware, software, tools, services, and know-how required to quickly capitalize on today's megatrends without huge investment.

# LpS Digital Summit – Keynotes, Panel Discussion, Awards

LED professional published by Luger Research e.U.

**This year's LpS Digital Summit under the motto of "Experience the Future of Light" took place on December 7th. The program consisted of keynotes from Ourania Georgoutsakou from LightingEurope, Aleksandar Nastov from Samsung, Dr. Rene Wegh from Signify, and Professor Dr. Robert F. Karlicek, Jr. from Rensselaer Polytechnic Institute, a panel discussion and the LpS Digital Awards ceremony. Siegfried Luger, Head of Luger Research e.U., hosted the event. Luger Research e.U. – Institute for Innovation – is the event organizer in collaboration with their publications LED professional, Trends in Lighting and the Global Lighting Directory.**

The "LED professional Symposium", or "LpS" for short, started as an annual physical event in Austria in 2011. However, due to circumstances caused by the pandemic, it has been held digitally for the past three years. Light and lighting experts from over 30 countries from companies like Acuity Brands, Amerlux, ams OSRAM, Aspoeck, Bartenbach, BJB, Broadcom, Current, DeltaLIGHT, Etap Lighting, Fulham, Future Electronics, Gewiss, Ledvance, Legrand, LichtKunstLicht, LightingEurope, Louis Poulsen, Lund University, Nichia, Panasonic, Regent, Rensselaer Polytechnic Institute, RIDI, Samsung, SBB CFF FFS, Silanna, Schreder, Signify, SIMON, Tridonic, UL, Wago, Zumtobel registered for this year's event.

The event was recorded and can be viewed in full via LpS Digital: <https://led-professional-symposium.com/live-connect/>.

## KEYNOTES

The keynotes addressed current lighting topics and highlighted the latest trends:

### Lighting Future – Challenges and Opportunities by Ourania Georgoutsakou

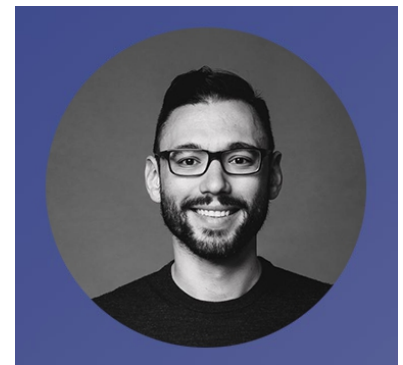


Future lighting: the challenges are also the opportunities, if only we look at them in the right light. Europe's lighting industry will continue to have to deal with the impact of a global pandemic, as well as a war on the European continent, now, and clear signs of changes to established geopolitical relations. Demand for energy savings, a strong EU policy push for sustainability, upcoming product restrictions and an accelerated renovation wave are all opportunities to install better lighting for people and the planet. While it's not always easy to do so in times of change, as long as we remain true to what our industry is fundamentally about – making our surroundings beautiful, making them easy and safe to navigate – the future of lighting will be bright.

Ourania Georgoutsakou joined LightingEurope, the voice of the European Lighting Industry, as Secretary General in April 2017 with 15-years of experience advocating for membership associations. Ourania worked for five years as Director, Public Policy Europe for SEMI, the global trade association representing the manufacturing supply chain for the semiconductor and related industries. She liaised with SEMI member companies and EU decision-makers to create a balanced regulatory environment

and to promote Europe's global competitiveness. Previous to that, Ourania Senior Policy Coordinator at the Assembly of European Regions in Brussels and Strasbourg for ten years, where she worked directly with elected regional politicians to help shape and implement EU policies. During her career Ourania has worked on several issues, from the EU Lisbon Treaty to the EU services Directive, and from health and social policy to environmental rules and e-innovation. Ourania holds degrees in Economics and European Law.

### Outdoor Lighting: Saving Potentials with Latest LED Technologies by Aleksandar Nastov



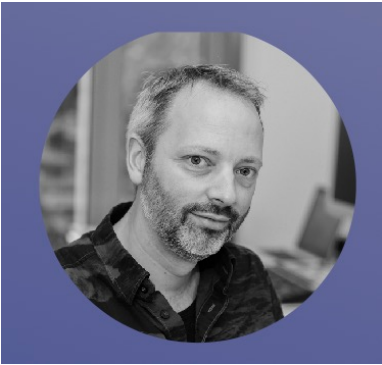
Aleksandar Nastov is Senior Manager at Samsung Semiconductor Europe, LED. He leads the introduction of products and the development of new business opportunities. Samsung LED entered into a large number of new application areas, especially with new and industry leading technologies.

### Melanopic Lighting Systems by Dr. Rene Wegh

Light is the most powerful regulator of our circadian rhythm. The fact that we spend, on average, more than 90% of our time indoors in dim light conditions causes circadian misalignment, which in turn can cause sleep disorders and other negative health effects. To prevent this we should optimize indoor lighting, in particular, by providing melanopic light i.e. cyan-enhanced light during the day, as cyan light is most effective in stimulating the circadian rhythm. The



melanopic light sources as proposed by Signify were presented, and trade-offs with, for example, CRI and luminous efficacy were discussed.



Dr. Rene Wegh is topic leader in the field of solid-state light sources at Signify, formerly Philips Lighting. In that role, he is overseeing the field and driving innovations of SSL sources. He has a 15-year track record on development of spectral engineering innovations at Philips Lighting/Signify, ranging from various remote-phosphor platforms, in the early days, to high-CRI and Human Centric Lighting spectral solutions in recent years. He holds a Ph.D. in chemistry from Utrecht University on the topic of luminescence spectroscopy of lanthanide-based phosphor materials. He joined Philips in 1999, starting at the corporate Research lab where he worked on various topics, including color filters for LCDs and light-emitting electrochemical cells for lighting, before moving to Philips Lighting in 2006.

**Lighting Could be Much Smarter by Professor Dr. Robert F. Karlicek, Jr.**



An unrealized promise of LED lighting involves developing lighting control systems that always place the “right light where and when it is needed.” This talk explored how evolving spatially and spectrally tunable lighting systems can be combined with evolving sensing platforms, novel control methods, and machine learning to create autonomous lighting control methods that recognize how to “sculpt” lighting spectral and spatial distributions that dynamically

and autonomously optimize illumination based on the control system’s ability to sense occupant location and activity. It was proposed, that with continued development of occupancy/light sensor systems with embedded intelligence, future lighting systems will be able to control themselves for improved energy savings and human wellness.

Dr. Robert F. Karlicek, Jr. is a professor of Electrical, Computer and Systems Engineering, and the Director of the Center for Lighting Enabled Systems & Applications (LESA) and co-Director of the Institute for Energy, Built Environment and Smart Systems (EBESS), both at Rensselaer Polytechnic Institute. Prior to RPI, he spent over 30 years in industrial research and R&D management positions related to optoelectronics, telecommunications and lighting system development with corporations including AT&T, Bell Labs and General Electric. He obtained his Ph.D. in Physical Chemistry from the University of Pittsburgh and has over 56 peer reviewed technical papers and 48 U.S. patents.

**PANEL DISCUSSION**

The panel discussion with the keynote speakers highlighted the key trends in the lighting and illumination world and incorporated questions from the attendees.

The panelists developed essential summaries during the discussion:

- Lighting must be increasingly linked with the heating, ventilation and air conditioning world to achieve the best building solutions. The overriding goal is to achieve solutions that span all businesses. It’s a building approach rather than a lighting approach.
- Sustainability stays a crucial topic ranging from durability, recyclability, and modularization.
- Human Centric Lighting is becoming even more important.
- Intelligent systems require data for processing. Therefore, sensor technology, data acquisition and processing, and cloud systems are essential.

**AWARDS**

This year, the LpS Digital Awards were presented in four categories: Products, Sustainability, Scientific Paper and Achievement Awards, and the winners are:

- Product Award: Nichia’s Dynasolis
- Product Award: Samsung’s LH502D

- Product Award: LEDiL’s YASMEEN
- Product Award: ams OSRAM’s DALI PRO 2 IoT
- Product Award: EnOcean’s STM550
- Sustainability Award: TE Connectivity’s LUMAWISE Motion Sensor
- Scientific Best Paper Award: Dr. Eric VIREY from Yole Group
- Achievement Award: Jan DENNEMAN from the GoodLightGroup

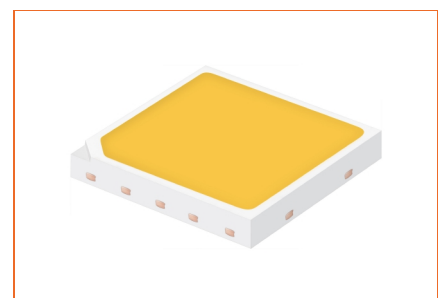
**Product Award: Nichia’s Dynasolis**

Statement of the Jury: “The connection between health and light is increasingly recognized in greater depth and will become even more significant in the future. The Dynasolis innovation is an entirely new LED tuning solution that regulates circadian rhythms by adjusting melanopic illuminance and color temperature while maintaining high CRI and efficacy. It is the combination of the energizing azure (sky blue) and a peaceful, calming warm white hue focusing on the non-visual element that truly addresses HCL. Applications range from medical, office, education and even residential.”



**Product Award: Samsung’s LH502D**

Statement of the Jury: “In Europe, more than 50% of outdoor lighting systems are outdated. There are safety, security and consumption issues. The LH502D shows high performance in multiple core reliability tests with an increased lifetime. The new 3-layer anti-sulfurization ceramic coating technology with a 5050 LED package offers improved performance with reduced costs to support investments for new and retrofit installations – especially for harsh environments such as streets- and tunnel lighting.”



**Product Award: LEDiL's YASMEEN**

Statement of the Jury: "YASMEEN zoom is a zoom optic family that enables new lighting possibilities thanks to its flexibility and adaptability. YASMEEN zoom optics are unique, as they have been designed with no axially moving parts. Luminaires can be made smaller, are easier to design, and fit into existing track light concepts. YASMEEN zoom optics can be used for compact retail lighting luminaire designs that demand the flexibility of easily adjusting zoom optics in a single luminaire. YASMEEN zoom optics also support sustainability: there's no need to replace and possibly dispose of luminaires."

**Product Award: ams OSRAM's DALI PRO 2 IoT**

Statement of the Jury: "DALI PRO 2 IoT is a lighting control technology with an integrated IoT gateway and open REST/ MQTT API provide access to cloud applications, thus enabling IoT use cases. Luminaire information, energy consumption and maintenance data can be pushed to the cloud. The Energy Monitoring and Maintenance Assistant (EM/MA) cloud service enables facility managers to monitor their lighting installations, gain insight into individual energy consumption areas, identify maintenance needs and making system updates remotely. This enables energy and cost and investment (replacements) savings."

**Product Award: EnOcean's STM550**

Statement of the Jury: "The STM 550 multisensor family combines temperature, humidity, lighting, acceleration, and magnetic contact sensors in a small case. The

multisensor is for the EnOcean wireless standard and for Bluetooth® systems and can be used for IoT and digitized building applications. An integrated solar cell supplies the sensor itself with energy for uninterrupted operation over several days with little or no light. STM 550 operates completely maintenance-free. It can also be integrated into a wide variety of assets and therefore can be used where the data is needed: on walls, ceilings, windows, doors, furniture, active devices, and objects. The multisensor has an integrated NFC interface for configuration and commissioning."

**Sustainability Award: TE Connectivity's LUMAWISE Motion Sensor**

Statement of the Jury: "LUMAWISE is a new motion sensor designed to bring sustainability and efficiency to street lighting architecture. With detection zones up to 30x6 meters and strong infrared sensing capabilities, LUMAWISE Motion Sensor can light the way, even in harsh environments. Enabling energy savings from dimming or even turning off a luminaire while still being able to react to motion and bring a luminaire to full brightness for safety and security reasons. LUMAWISE Motion will fit into the Zhaga-D4i ecosystem, which is the new standard for smart cities. It works as a standalone control device or in combination with Zhaga-D4i photocell or communication node for greater levels of controls. The sensor is a pluggable device, with the standard Zhaga book 18 interface for an easy upgrade."

**Scientific Best Paper Award: Dr. Eric VIREY from Yole Group**

"Will MicroLEDs Revolutionize the Display Industry?", LpR94, Nov/Dec 2022, p46-51. Statement of the Jury: "The lecture gives a profound overview of technology at the edge of commercial implementation. It describes various aspects, both commercial and technological. It shows hurdles and chances and compares them with competing technologies (LCD, OLED)."

**Achievement Award: Jan DENNEMAN from the GoodLightGroup**

Statement of the Jury: "Jan Denneman has dedicated over 40 years of his professional career to developing and promoting the lighting sector. He has initiated several international consortia, like the Global Lighting Association, Zhaga, the Connected Lighting Alliance, and LightingEurope. He also founded the GoodLightGroup, where he serves as Chairman."



He is passionate about light and health, and rethinking lighting again."

Finally, Siegfried Luger congratulated all the winners of this year's awards and thanked the participants and speakers. In closing, he announced the LpS Digital Summit 2023. ■

# LpS DIGITAL AWARDS 2022



## Product Award



# Dynasolis

NICHIA

Circadian Rhythms  
LED Tuning Solution

Siegfried Luger, Organizer  
December 7, 2022

The logo features the text 'LpS DIGITAL AWARDS 2022' in a clean, sans-serif font. To the left of the text is a stylized graphic consisting of three concentric, overlapping circles in shades of blue and white, resembling a signal or a digital interface element.

# LpS DIGITAL AWARDS 2022

A white laurel wreath graphic with the year '2022' centered within it.

2022

Product Award

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**LH502D**

SAMSUNG

LED Solution for  
Outdoor Lighting

A stylized blue ink signature of Siegfried Luger.

Siegfried Luger, Organizer  
December 7, 2022

# LpS DIGITAL AWARDS 2022



Product Award



**YASMEEN**

LEDiL

Beam Control Zoom  
Optics Family

A stylized signature in blue ink.

Siegfried Luger, Organizer  
December 7, 2022

The logo features the text 'LpS DIGITAL AWARDS 2022' in a sans-serif font. To the left of the text is a stylized graphic consisting of three concentric, overlapping circles in shades of blue and white, resembling a signal or digital wave.

**LpS**  
DIGITAL  
AWARDS  
2022

A laurel wreath graphic with the year '2022' centered inside it.

2022

Product Award

**DALI PRO 2 IoT**

ams OSRAM

Lighting Control  
IoT/Cloud Gateway

A stylized blue ink signature of Siegfried Luger.

Siegfried Luger, Organizer  
December 7, 2022

# LpS DIGITAL AWARDS 2022



## Product Award



# STM550

EnOcean

Multisensor Family  
for Digitized Buildings

A stylized signature in blue ink.

Siegfried Luger, Organizer  
December 7, 2022

The logo features the text 'LpS DIGITAL AWARDS 2022' in a clean, sans-serif font. To the left of the text is a stylized graphic consisting of three concentric, overlapping circles in shades of blue and white, resembling a signal or digital wave.

**LpS**  
DIGITAL  
AWARDS  
2022

A white laurel wreath graphic with the year '2022' centered within it.

2022

Sustainability Award

**LUMAWISE Motion Sensor**

TE Connectivity

Sensor for Sustainable  
Street Lighting Architecture

A stylized blue ink signature of Siegfried Luger.

Siegfried Luger, Organizer  
December 7, 2022





**LpS**  
DIGITAL  
AWARDS  
2022



Scientific Best Paper Award

**Dr Eric VIREY**

YOLE GROUP

Will MicroLEDs Revolutionize  
the Display Industry?



Siegfried Luger, Organizer  
December 7, 2022

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**LpS**  
DIGITAL  
AWARDS  
2022

A white laurel wreath graphic with the year '2022' centered within it.

2022

Achievement Award

**Jan Denneman**

GoodLightGroup

Lifetime Contribution  
to the Light Sector

A stylized blue ink signature of Siegfried Luger.

Siegfried Luger, Organizer  
December 7, 2022



# LpS DIGITAL AWARDS 2023


At the annual LpS Digital Summit (December 2023), the LpS Digital Awards will be presented in four specific categories.

## AWARD CATEGORIES 2023

Product Award  
Sustainability Award  
Scientific Paper Award  
Achievement Award



**SUBMIT  
YOUR  
PROPOSAL**



[www.LpS-Digital.global](http://www.LpS-Digital.global)  
[info@lps-digital.global](mailto:info@lps-digital.global)

# Covestro Headquarters

Raoul HESSE, Founding Partner at Lichtvision Design



Raoul HESSE is a Founding Partner at Lichtvision Design. He graduated as an electrical engineer from the Technical University in Berlin, and initially worked as a designer. Since 1997 he has been managing light planning projects at Lichtvision and overseeing the innovative Visual Media and Control Systems divisions.

*“Constantly mastering the newest technical innovation is what I find the most challenging and rewarding aspect of our work.”*

RAOUL HESSE, LICHTVISION DESIGN

## Covestro

Typology: Office Headquarters

Scope of Work: Artificial Lighting

Completion: 2021

Location: Leverkusen, Germany

Size: 23,181 m<sup>2</sup>

Client/Owner: Covestro Deutschland AG

Tenant/User: Covestro Deutschland AG

Project Lead: Lichtvision Design; Raoul Hesse, Design Director and Claudio Rojas Wettig, Project Manager

Architect: Henn

Interior Designer: Kinzo

MEP: M&P Group

Photographer: Covestro

## Covestro Project Links

[Lichtvision](#) | [Henn](#) | [Kinzo](#)

Formerly a division of Bayer AG, Covestro has developed into a leading global DAX-listed company. The Covestro Main Office Building designed by Henn forms part of the new corporate campus. A high-tech polymer company, Covestro creates materials used in every aspect of modern life, from green energy to healthcare to electronics to its own building interior. The building is constructed of two-story modules with facade setbacks. The open floor plans allow for flexible collaborative working. For this purpose, Kinzo created the spaces with function and environment in a colorful design. Common areas surround the workspaces for over 700 employees. The challenge of these modern often lounge-like interiors for lighting design is on the one hand to achieve the office standards and on the other hand to support the interior design with lower light levels and less uniformity. We kept track of the design ideas and developed an appropriate lighting layout. Mr. Henn wanted to integrate the lighting into the architecture as far as possible. And so we did - especially the ground floor with the lobby and the central atrium. The colorful spaces designed by Kinzo requested a more visible approach of the light sources emphasizing the collaborative working atmosphere.

A large central atrium at the midpoint of the spine serves the Covestro Group as the building's "town hall" in which all employees can meet or attend events. High power narrow beam downlights integrated in the curved shape of the atrium's connection to the office floor ceilings properly light the open space. The surrounding light lines accentuate the geometric shape of the air space. These light lines have a well-defined width of about 10 cm - hence not minimized. They also follow the triangular shape of the cores with elevators, stairs, corridors and washrooms. The lightlines emphasize the geometric layout of the atrium and the shift of the building layout from floor to floor.

The lighting control scheme reflects with addressable and dimmable luminaires the open space layout of the floors. Even with a fixed current layout for the working spaces all luminaires can be reassigned and grouped differently when needed.

An important aspect of the working space design is the ability to be adjusted to the changing needs of Covestro. Downlights, distributed as an open pattern across the ceilings, illuminate circulation areas and connect the colorful themed worlds of Kinzo, each of which has its own integrated lighting fixtures. According to the different functions and designs of the areas, the lighting design was adapted; e.g. tables for stay or meeting with pendant luminaires, workshop area on the ground floor with open studio ceiling with pendants and tracks with spot lights, meeting area in the airspace with additional downlights as well as reception with a luminous ceiling.

## BIM and Sustainability

The form of the concept phase on the lighting design was transferred to a BIM-model. The documentation of lighting design was created in a BIM process. We built our own model. The architectural and MEP models were linked. In addition to integrated planning with visualization and collision checking, the quantity and cost calculation as well as the creation of plan sets (reflected ceiling plans) were realized in this way. The prerequisite for a smooth and consistent workflow is a uniform set of parameters for the lighting fixture families. We provide these via a set of in-house luminaire families. The established BIM process supports sustainable design and moves towards a circular economy. With the development of a sustainable workplace strategy and creating a new type of work environment we headed for a network that unites architecture and user culture. People from different departments are encouraged to come together more effortlessly and efficiently - meeting more casually and collaborating more directly. ■

<https://www.lichtvision.com/en>



Lichtvision on LinkedIn

**LICHTVISION**  
DESIGN



Flexible workplaces with color full interior in open space area.





Covestro Headquarters constructed of two-story modules with facade setbacks.



Daylit Atrium, the central meeting place for events, celebrations and announcements.





NEW YORK  
LOS ANGELES  
MADRID  
LONDON  
PARIS  
MILAN  
ROME  
BARCELONA  
AMSTERDAM  
BRUSSELS  
ZURICH  
VIENNA  
MUNICH  
FRANKFURT  
STUTTGART  
DUBLIN  
ATHENS  
ISTANBUL  
MOSCOW  
MADRID  
LONDON  
PARIS  
MILAN  
ROME  
BARCELONA  
AMSTERDAM  
BRUSSELS  
ZURICH  
VIENNA  
MUNICH  
FRANKFURT  
STUTTGART  
DUBLIN  
ATHENS  
ISTANBUL  
MOSCOW





Places to meet around the daylight Atrium with café counter; in the background stairs connecting two floors directly.

# Wireless Lighting Networks: Comfort and Intelligence for Workplaces

Matthias KASSNER, Vice President Product Marketing at EnOcean

**The transition from legacy lighting solutions towards LED lighting served as a major disruption of a well-established market. It led to a wave of modernization thanks to significant energy savings and short return on investment. The first phase of the transition was driven by LED-based lighting which uses approximately 75% less energy and lasts 25 times longer than traditional incandescent lighting. The US Department of Energy estimated that the full transition to LED lighting could save about 348 TWh of electricity in the United States alone. This is the equivalent of the annual electrical output of 44 electric power plants (1000 MW each) and represents cost savings of more than 30 billion US Dollars at today's electricity prices.**

The second phase of the transition is focused on the use of lighting control systems based on sensor information to provide additional energy savings of 20-50%. It is often observed that office buildings remain lit when nobody is there at the weekends and in the middle of the night. This can be effectively avoided by using lighting control systems. Many of these lighting control systems will use wireless communication between the lights and the sensors which enables quicker installation and flexible adaptation. The deployment of such large-scale wireless networks opens additional opportunities for the collection and analysis of a wide range of additional sensor data such as space utilization or air quality. From intelligent lighting control based on environmental and occupancy data, it is therefore only a small step to lighting networks that provide detailed building operation insights based on sensor data.

## Use Cases

One key motivation for providing operation insights is the trend to more flexible working schemes that has accelerated dramatically during the Covid pandemic. Mixed home / office working schemes have become the new norm leading to much less predictable office space utilization. Studies underline this, stating that 87% of large companies want to rely on hybrid work in the future [1] and 60% of companies want to switch to desk sharing [2].

As a result of these flexible work trends, optimizing the required office space has become increasingly important. If employees work on average one day per week from home, then a company could

reduce office space by up to 20%. Considering the high cost of workplaces (up to 10 000 EUR per year per employee), it is obvious that remote working provides huge cost optimization potential. Realizing this optimization potential requires monitoring of the actual utilization to determine the office space required for effective working.

The highest focus, however, should not be on office space and equipment, but rather on the employees by providing a healthy, motivating, and efficient work environment. Reducing the time spent for locating available workstations, meeting rooms, or assets allows employees to work more efficiently. Good air quality, height-adjustable desks, and extended climate control are key factors to improve employee well-being.

It is important to focus on these basic steps of the pyramid first before proceeding further up to nice-to-have factors such as after-work bar, games, and entertainment for more fun in the office (Figure 1).



Figure 1: Employee satisfaction can be improved by providing a modern, flexible, healthy, and efficient work environment.

## Technology and Solutions

Effectively addressing the use cases discussed above requires the combination of sensors to measure and report the necessary parameters with a suitable infrastructure that can receive, transport, and export the data to an end application or to the cloud.

To achieve the flexibility required for shared office installations, the focus must be on minimizing installation and set-up time in order to make adjustments – such as office layout changes – easy to implement. Wired sensor solutions have significant disadvantages in such scenarios.

Wireless sensors can be flexibly placed at different measuring points such as walls, desks, doors, windows or on machinery such as HVAC units and even on mobile assets to provide location tracking functionality. In many cases, wireless sensors are powered by batteries. However, this is not ideal as battery-powered sensors require relatively high maintenance in terms of battery replacement. Although battery replacement might seem a relatively straight-forward process, the overhead of traveling to the installation site, locating the device, replacing the battery, testing the device, and documenting the process dramatically increases the labor cost and administrative overhead. The use of batteries also creates hazardous waste that pollutes the environment.

The use of self-powered, battery-free wireless sensors which are powered by energy-harvesting of ambient movement, light, or temperature fluctuations eliminates these disadvantages. Wireless, energy-harvesting devices operate completely maintenance-free and can be flexibly placed in the entire building, also in areas that are difficult to access for maintenance. The use of wireless, maintenance-free sensors, therefore, enables quick installation and reconfiguration. Key design criteria for deploying such sensors are the choice of wireless protocol and the selection of a suitable IoT infrastructure for data transport. We will discuss different options for that now.

## Wireless Protocols

The choice of wireless protocol is influenced both by commercial and technology factors. From a commercial perspective, the selected protocol should be an open standard that is used by many companies so that users can choose between different manufacturers and won't be locked into

proprietary solutions. From a technology perspective, the protocol must be suitable for the intended use case with radio distance (radio coverage area) and data rate being key selection criteria.

### Radio Distance and Data Rate

Radio protocol performance is typically characterized by the ability to transmit data over a defined distance with a certain data rate using a specified transmission power. The transmission power is often limited either by system constraints (battery lifetime, available harvested energy) or by radio legislation (defining maximum permitted transmission power levels); therefore, the primary trade-off is between radio range and data rate.

The achievable communication distance is determined by transmission power, the path loss between transmitter and receiver and the receiver sensitivity:

$$TransmissionPower - PathLoss \geq ReceiverSensitivity \tag{1}$$

The free space path loss *FSPL* (in absence of additional obstacles) between transmitter and receiver (expressed in dB) depends on distance *d* (in meters) and radio frequency *f* (in Hertz) as defined by Friis equation:

$$FSPL = 20 \cdot \log_{10}(d) + 20 \cdot \log_{10}(f) - 147.55 \tag{2}$$

From this, we can determine that systems operating at a lower frequency (such as 868 MHz) will be able to communicate over much larger distances compared to systems operating at a higher frequency (such as 2.4 GHz).

The environment in which the radio system operates can significantly reduce the effective radio range compared to free space conditions due to obstacles, walls, or ceilings between sender and receiver. Individual offices with ferro-concrete walls are therefore more difficult from a radio coverage perspective than open office areas or cubicles. These effects must be considered when selecting the installation location for transmitters and receivers, but in general it will be difficult to change the environment in which the radio system operates. In such cases, the only option is to increase receiver sensitivity if a larger area coverage is required.

The receiver sensitivity specifies the minimum required signal strength to achieve a defined bit error rate (BER). For instance, a BER of  $1 \cdot 10^{-3}$  means that no more than 1 out of 1000 bits has been incorrectly received.

The receiver sensitivity can be expressed as the sum of the ambient noise floor (existing noise in the environment), system noise (noise created in the receiver), and the signal to noise ratio (*SNR*) required by the receiver to achieve the specified BER:

$$Sensitivity = AmbientNoiseFloor + SystemNoise + SNR \tag{3}$$

This is conceptually illustrated in **Figure 2** based on a received signal represented by the green curve.

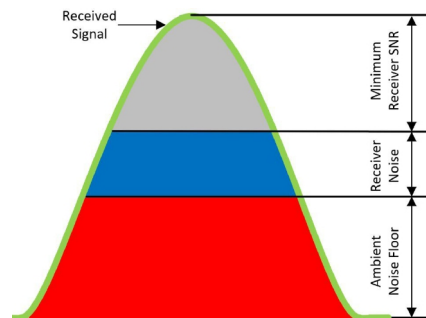


Figure 2: Main factors affecting receiver sensitivity.

The ambient noise floor is usually dominated by thermal noise (unless direct high-power interference exists from other systems) which can be calculated as a product of the Boltzmann constant *k*, the absolute temperature *T* (in Kelvin) and the receiver bandwidth *B* (in Hertz):

$$ThermalNoisePower = k \cdot T \cdot B \tag{4}$$

This formula can be simplified by assuming a temperature of 20 °C (293 K) and expressing the result in dBm:

$$ThermalNoise [dBm@293K] = -173.9 dBm + 10 \cdot \log_{10}(B) \tag{5}$$

From this, we can determine that systems with a low bit rate (and therefore lower required receiver bandwidth) can achieve

higher sensitivity than systems operating with higher bit rates.

From the discussion above, we see that the selection of data rate and operation frequency are key factors defining the achievable communication distance. This allows one class of protocols (such as LoRaWAN®) to be optimized for low data rates covering higher distances, other class protocols (such as Wi-Fi) are optimized for high bit rates over lower distances while a third class of protocols (such as Bluetooth, Zigbee or EnOcean) balances medium distances with medium data rates.

**Figure 3** shows the relation between data rate and typical indoor point-to-point communication distance based on some example radio protocols.

As we can see, covering larger areas requires a significant reduction of data rate and therefore data packet size. Because of the lower data rate, the total number of transmissions also has to be significantly reduced, which means that the transmission interval of the individual nodes has to be increased.

### Congestion and Collisions

Another important aspect in the planning of radio systems is the fact that increasing the number of senders within the radio range of a receiver and increasing the time for which each sender is active (due to lower data rates) will increase the likelihood of collisions. Collisions occur when two or more telegrams arrive at the receiver at the same time resulting in the missed reception of telegrams.

Considering, for instance, a data packet size of 16 byte and a transmission rate of 1 kbit/s, then in total up to 468 packets could be transmitted if the transmission was perfectly timed exactly one after another:

$$\frac{PacketNumber \cdot PacketSize}{DataRate \cdot TransmissionTime} = \quad (6)$$

$$\frac{PacketNumber \cdot 128 \text{ bit}}{1000 \text{ bit/s} \cdot 60 \text{ s}} = 468,75$$

Achieving perfect timing requires time-synchronizing all nodes in a network so that they transmit at a precisely defined timeslot, an approach that is used, for instance, in cellular radio networks. For wireless networks in buildings, perfect time-synchronization is difficult to achieve as nodes might move in and out of the network or initiate transmission at a random

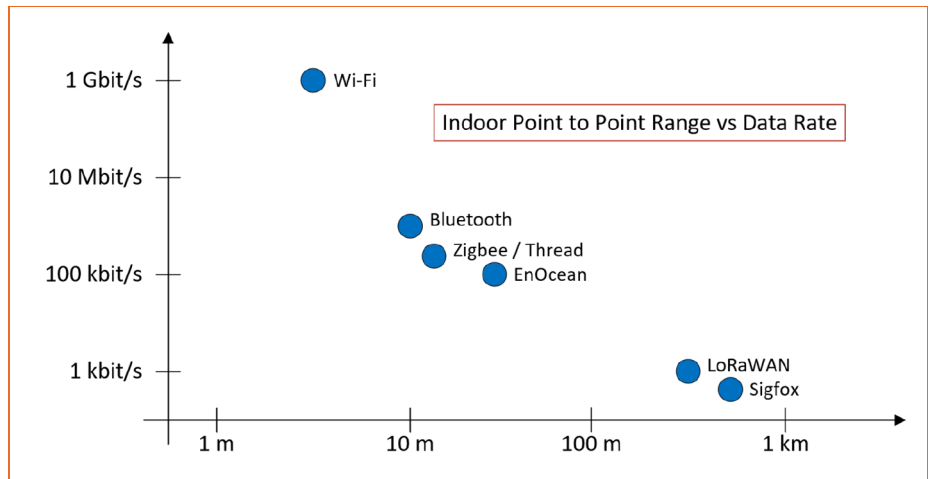


Figure 3: Radio range versus data rate trade-off illustrated based on common protocols.

time based on external events such as a user pressing a light switch or motion being detected. For such use cases, the achievable throughput becomes significantly lower as the likelihood of collisions (where at least two senders are transmitting at the same time) drastically increases. This problem can be illustrated by the analogy of the birthday paradox which explains why in a group of 23 persons the likelihood is more than 50% that at least two persons have the same birthday even though 365 possible birthdays exist. Likewise, there is a likelihood of more than 50% of at least one telegram collision if 26 telegrams of 16-byte length are transmitted within one minute in a radio network with 1 kbit/s data rate.

Attempting to improve the situation by using acknowledged (ACK) transmissions is usually not effective as this would double the number of transmissions (transmitted telegram, received ACK) which decreases the effective throughput. Additionally, due to non-received ACK the data telegram retransmissions increase the total number of telegrams to be transmitted which further increases the number of collisions leading to even more retransmissions. With this approach, an initially small number of collisions can potentially become self-amplifying and lead to an unexpected significant performance degradation even though the maximum network throughput has not yet been reached. The low data rate and the resulting risk of collisions therefore places limits on the application of long-range protocols. Higher data rate protocols are therefore required for many use cases.

The selection of a suitable radio protocol therefore must start with the target use case and the resulting communication parameters. A detailed study done by the

Institut für Gebäudetechnologie (IGT) in Ottobrunn, Germany provides an extensive comparison of radio-based transmission protocols for smart buildings based on different use cases like room occupancy [3].

The choice of radio protocol should also consider the IoT network infrastructure that captures and transports the data reported by the sensors.

### IoT Network Infrastructure

The effort and cost to setup a network infrastructure that transports the sensor data to local applications or the cloud is a key parameter for the commercial success of smart building solutions. An optimized solution must therefore combine a suitable radio protocol with an infrastructure that can be quickly and cost-effectively deployed or reused. Three key options for such network infrastructure will be discussed now.

#### Dedicated Wireless Gateways

Traditionally, wireless sensors would require dedicated wireless gateways to collect and forward sensor data. This approach allows optimizing the gateways for cost and radio performance but creates the need to deploy dedicated devices requiring power and network connection. Having to deploy dedicated devices is not desirable due to cost and installation effort; minimizing the number of required gateways by increasing their coverage area therefore becomes an appealing option.

Another concern for the deployment of dedicated gateways is the required access to an IP network infrastructure to transport the data. Obtaining such access is often critical in existing installations with strict IT security guidelines. This issue can be mitigated by deploying gateways with in-

tegrated LTE modems, but the resulting recurring cost might make such an approach less attractive.

Wireless infrastructures based on dedicated gateways is therefore most suitable if the required number of gateways is limited and access to an IP network is available. For other cases, the reuse of existing infrastructure such as access points or lighting networks should be considered.

### Wi-Fi Access Points

Wi-Fi access points providing wireless internet and local network connectivity can now be found in practically all commercial buildings. They are often set up to cover overlapping zones of up to a 10-meter radius to achieve a good balance between required equipment density and achievable data rate. Having an existing network with high node density and IP connection makes Wi-Fi access points an appealing choice as IoT network infrastructure.

Two key concerns are often raised when using Wi-Fi access points. The first concern is data security, as both the network traffic and the network configuration are highly sensitive. Therefore, it is required to strictly isolate the existing data flow within the IP network as well as the configuration interface of the Wi-Fi access point from the IoT sensor data transport.

The second concern is radio interference. Wi-Fi access points transmit with high duty cycle and high transmission power in the 2.4 GHz and 5 GHz bands which makes reception of data telegrams from IoT sensors in these bands difficult. Both concerns can be addressed by using a different radio protocol such as EnOcean radio protocol in the Sub GHz radio band which can be supported by a dedicated receiver such as a USB stick or a plug-in card. This approach allows tunneling of the received sensor data to a user-selected network

destination (local or cloud) without the need for local processing. It is thereby possible to completely isolate the IoT sensor data domain from the network and configuration domains.

**Figure 4** shows an example of a Wi-Fi access point with a dedicated IoT sensor network receiver.



Figure 4: Using already existing Wi-Fi access points for IoT networks eliminates the need to install additional data network infrastructure.

### Lighting Networks

As discussed in the introduction, the transition from traditional lighting to LED lighting to connected LED lighting has triggered a wave of innovation that enables use of lighting systems as IoT data networks. High node density coupled with readily available power and wireless connectivity make lighting fixtures ideal nodes of such IoT data network.

Balancing high data rates with large area coverage is typically achieved by implementing mesh networks where radio messages from the sender are forwarded via relay nodes to the receiver. This approach is illustrated in **Figure 5** where a message from the sender node (blue) is transported via several relay nodes (grey) to the receiver node (green).

Data transport in mesh networks will often occur along several paths in parallel

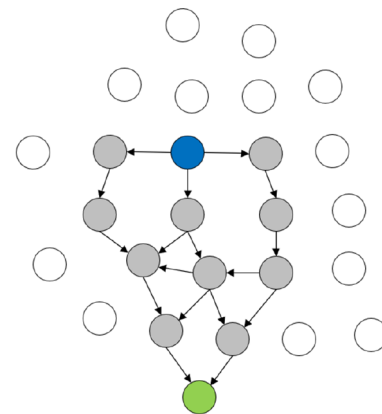


Figure 5: Message transport in mesh networks.

which increases the likelihood of reaching the destination at the cost of increasing the overall network traffic. The simplest approach for the implementation of such mesh networks is the so-called flooding mesh where a received message is forwarded by the relay node to all nodes in its neighborhood.

We can see from **Figure 6** that this simple approach ensures that the message from the sender will reach the receiver, but at the cost of creating a lot of additional and unneeded network traffic. Reduction of the network traffic is usually achieved by limiting the maximum number of relay hops over which a message is transported from sender to receiver and by avoiding retransmitting a message again that had been retransmitted previously.

In many applications, the maximum number of relay hops is called "Time to Live" or TTL in short and implemented by allocating a TTL counter field in the message payload. The TTL counter is set by the sender node to the maximum number of relay hops and decreased by each relay node upon forwarding the message. When the TTL counter in a received message is zero,

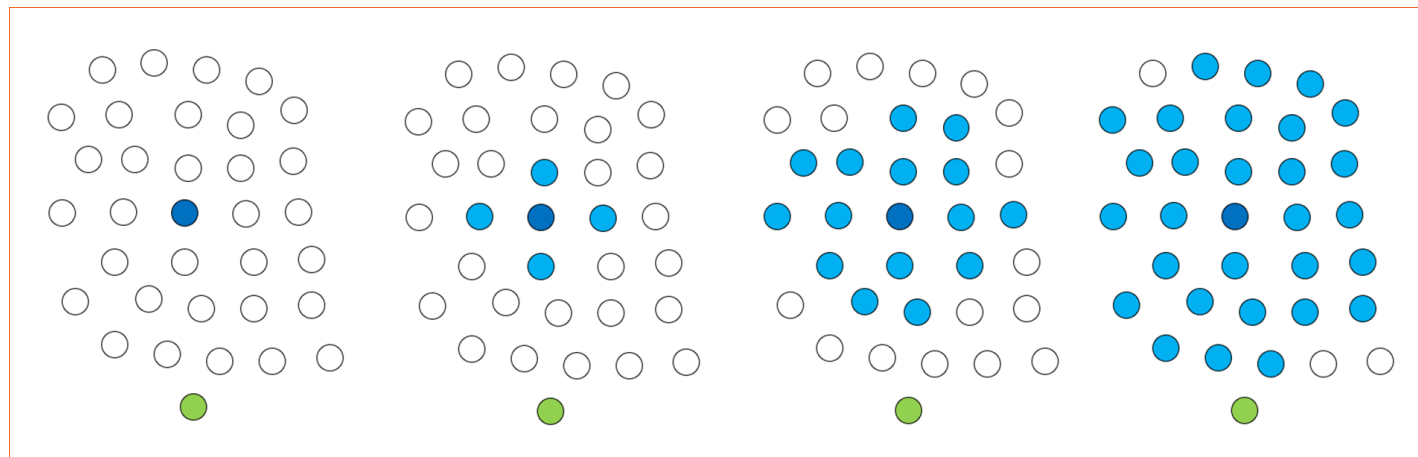


Figure 6: Message propagation for flooding mesh networks.

then this message will not be forwarded anymore.

Avoiding retransmission of previously retransmitted messages is usually achieved by allocating a dedicated cache to identify previously retransmitted messages based on unique characteristics such as sender address, receiver address, message signature, or checksum. If a received message matches these characteristics, then it will not be forwarded again.

More complex network and routing mechanisms such as time-synchronized transmissions and directed forwarding can be used to further optimize the overhead for the message transport. Even for the most optimized implementation, mesh networks will inherently require a higher data bandwidth to enable the necessary telegram retransmissions. Mesh networks therefore must balance a high data rate (to allow retransmissions) with sufficient communication distance (to minimize the amount of relaying that is required). Bluetooth protocol which combines the data rate of 1 Mbit/s with a communication distance of 10 meters is therefore a popular choice for the implementation of mesh networks with sensor data.

For applications with very frequent transmissions, additional processing must be implemented to optimize the network traffic. This is especially true for asset tracking use cases where thousands of devices can be continuously transmitting within the radio range of a single receiver. Considering typical update rates between 300 milliseconds and 3 seconds for asset tracking, it becomes clear that forwarding all received telegrams via a mesh network to a central instance (for instance, a server) for processing is not an option. Instead, the receiver node (at the edge of the mesh network) should do as much processing by itself as possible so that only meta-information (such as device location, device status and timestamp of last message) is provided to the server upon request. Because the required processing steps are executed at the edge node rather than by the central server, this approach is called “edge processing”.

Edge processing will also decrypt and authenticate received sensor messages to ensure that only authenticated information can enter the network. This decentralized processing mechanism dramatically reduces the required data traffic in the network and the processing requirements for the server. The combination of dense lighting networks with edge processing in the lighting nodes therefore enables a wide range of new applications for mesh networks connected to a server or to a cloud.

## Server, Cloud, and Applications

As discussed in the previous sections, sensor data can be transported in different ways to a central server or cloud instance for further processing. The selection of the transport infrastructure depends on existing installations (IP access points, wireless lighting networks) and the specific requirements of the target application.

To maximize the usability of the captured sensor data, the use of industry-standard, open, and extensible protocols such as MQTT and REST and a unified data representation such as IAP is required to enable a unified representation of all available data. Having access to all available data enables common, well-known use cases – such as asset tracking or building automation – but also use cases nobody might have thought about before.

During the recent Covid pandemic, occupancy data could not only be used to control building automation (such as turning off the light when a room is unoccupied), but also to schedule disinfection and cleaning on demand. This was possible for installations that provided open access to available data. It is therefore important to already think of data as money during the specification phase for new networks and define the required architecture to get access to that valuable resource.

## Use Case Examples

We will now describe two implementation examples which illustrate key use cases.

### Lighting System With Sensor Functionality (Koopman)

Koopman Interlight is a Dutch company specialized in lighting and lighting control systems for the professional installer market. Koopman has developed a high-end wireless light control system called Interlight Thing which creates a mesh network of the lighting nodes based on INGY technology, which enables the connection with sensors and controls such as energy-harvesting wireless EnOcean wall switches and solar-powered sensors.

Using this networked lighting system in their headquarters (**Figure 7**) was a natural choice as it enabled not only to control the lighting system manually and automatically according to different scenarios, but also to capture, transport, and process information from a scalable number of sensors according to application requirements.

Network installation and configuration was quick thanks to the combination of wireless control and intuitive setup based on a dedicated commissioning application available for smartphones and tablets.

Apart from automated lighting control, Koopman wanted to optimize the control of the HVAC system for the showrooms based on the status of their doors and windows. Heating and especially cooling consume a lot of energy which will literally be thrown out of the window if HVAC sys-



Figure 7: Koopman Interlight headquarters in Utrecht, Netherlands. Copyright: Koopman Interlight.



tems are active while a window or door is open.

Koopman therefore installed energy-harvesting wireless STM550B sensors that monitor and report the status of the doors and windows and report those together with the measured temperature and humidity status.

The combination of a smart, extensible mesh lighting network with energy-harvesting sensors therefore provides both an easy-to-use lighting system and automated heating and cooling control based on energy-harvesting sensor data for an area with highly flexible utilization (Figure 8).

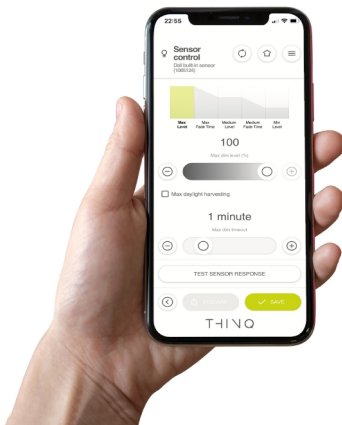


Figure 8: Koopman's Thing app allows constant control over the lighting in the entire building. Copyright: Koopman Interlight.

### Smart Spaces for Efficient Use of Resources (T-Systems MMS)

T-Systems Multimedia Solutions is one of the leading providers of smart spaces solutions that enables flexible workplace management. The solution allows employees to select their workstation using an employee app or the Intranet based on real-time occupancy status throughout the entire office space. The facility management team can use the administration dashboard to dynamically define and adapt utilization rules such as COVID-19 compliance (number of people in the space / per room) or energy-saving utilization rules where floors or areas will be unused during periods with low occupancy. Additionally, they can create and release reservations for individual workstations or areas and monitor occupancy to schedule services (such as cleaning) based on actual utilization.

The occupancy information is gathered by solar-powered wireless sensors from EnOcean that can be quickly set up and operate maintenance-free. This data is collected either by wireless gateways or by Wi-Fi access points and provided to

an IoT platform based on Microsoft Azure which provides a digital twin of the physical building.

This solution collects data on the number of people in the room or building, the rooms used, and the temperature and air quality. It then correlates this information with capacity utilization figures or energy consumption. Based on historical data, forecasts are made for the future capacity utilization of the space, thus giving facility management a flexible planning tool.

### Conclusion

The emergence of wireless lighting control networks allows addressing the challenges of modern workplaces without the need to install additional data network infrastructure. The required data can be provided by wireless, self-powered sensors which are quick to install and operate maintenance-free.

Key use cases such as space utilization monitoring allow optimizing the use of buildings and enable more effective work due to utilization-based service scheduling. Employee satisfaction can be improved by providing a modern, flexible, healthy, and efficient work environment while facility managers will gain access to an unparalleled level of data providing real-time insights in the building status.

Data is the basis for all these use cases and data therefore needs to be considered as money. Lighting control networks can provide access to that money; make sure to select a lighting control network provider that maximizes your returns. ■

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#### AUTHOR: Matthias KASSNER

Before joining EnOcean in 2013, Matthias Kassner worked at Texas Instruments (TI) for 12 years in different positions, from SW Developer and Wireless Field Application Engineer to EMEA Product Marketing Manager for TI's Application Processor portfolio. At EnOcean, he leads the product market team responsible for defining EnOcean's energy harvesting solutions which deliver IoT sensor data that make our daily lives smarter, more comfortable and sustainable.

#### About EnOcean

EnOcean is the leading global provider of maintenance-free sensor data solutions for building automation and smart spaces. The data generated by the company's solutions enables smarter, healthier, more comfortable, and more sustainable environments. EnOcean self-powered wireless sensors deliver the needed data in real time completely maintenance-free thanks to the patented energy harvesting technology. Being wireless and maintenance-free makes EnOcean solutions highly flexible – they can be placed anywhere, are easy to install, and highly flexible as no wiring is required. The company believes in modern, open, and standard-driven ecosystems and offers IoT solutions with EnOcean, Bluetooth® and Zigbee radio. EnOcean provides a complete offering from energy harvesting sensors to cloud-based software and intuitive configuration tools which make the company's solutions easy to use and quick to deploy. Over 350 leading product manufacturers worldwide are relying on EnOcean solutions to build differentiated products. The solutions are field-proven – they are in operation for more than 20 years and have been installed in more than one million buildings around the world.

To learn more, please visit <https://www.enocean.com>.

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TUNABLE WHITE TECHNOLOGY INTRODUCTION OF ON-BBL TUNABLE WHITE TECHNOLOGY

## Introduction of On-BBL Tunable White Technology

In a traditional tunable white solution with a combination of warm white LEDs and cool white LEDs, the chromaticity point moves linearly on the xy chromaticity diagram, while the black body locus (BBL) is curved. Due to the curvature of the BBL, especially under 3000 K CCT, the emission color withdraws from "white" with a certain range when adjusting the emission color, and it is impractical to prolong the range of correlated color temperature (CCT) toward 2000 K CCT. Tomokazu Nada, Managing Director at ZIGEN Lighting Solution, proposes a new "On-BBL Tunable White" technology that makes the chromaticity point draw an upward curve along the BBL by 2-channel control. This technology expands the possibilities of tunable white LEDs by allowing the CCT range to be set from 2000 K sunset color.

### Introduction

After LED technology was adopted in lighting, a tunable white feature that can adjust emission color from warm white to cool white was provided in various lighting applications. And now, a tunable white feature is being increasingly adopted for circadian rhythm lighting.

Generally, emission colors of tunable white LEDs are achieved with a combination of a warm white LED and a cool white LED. The generated chromaticity points are located on the straight line between the chromaticity points of light source.

On the other hand, the set of white points draws an upward curve called the black body locus (BBL), on which the chromaticity points of natural light, like the sun, fire and stars are located. Thus, the farther away the chromaticity points of the two light sources are, the more difficult it is for the chromaticity points of the mixed light to follow the BBL.

For example, if a warm white LED is 2000 K CCT and a cool white LED is 5000 K CCT and both are located on the BBL, the generated chromaticity points in the middle range are more than 7 steps away from the BBL, as shown in Figure 1. Such chromaticity points are no longer "white".

In order to keep an emission color white, a chromaticity point of a tunable white LED is

required to trace the BBL on the xy chromaticity diagram as closely as possible. For this reason, a color range of a tunable white is usually set to the range where the BBL is relatively linear on the xy chromaticity diagram, such as from 2700 K CCT to 6500 K CCT or a narrower range.

However, these days, dim to warm LED technology is becoming popular in lighting and people are now aware of the importance of the 2000 K CCT Sunset Color for comfort and sophisticated lighting effects. Not only that, 2000 K color is said to be very important for circadian rhythm [1]. Thus, it is ideal to implement 2000 K CCT in tunable white lighting applications, despite the problem of the chromaticity point.

One technology to solve this problem is RGB+W LED solution.

Note that W (white color) is necessary on top of RGB (red, green, blue) for a lighting application. Because the spectrums of the RGB LED are separate from each other, the combined spectrum and color quality of the generated light become poor. This means that RGB solutions cannot be used for general lighting applications. By using the RGB+W solution, the chromaticity point can be set at the farthest point on the xy chromaticity diagram, including along the BBL by controlling each R, G, B and W LED output. However, when using the RGB+W solution, each LED output must be precisely controlled to generate

a white color. Therefore monitoring intensity from each LED and adjusting output is necessary during operation. The monitoring and adjustment of each LED output is quite complicated and costs are high. Thus, most tunable white LED solutions have, so far, used a combination of warm white LEDs and cool white LEDs, but this is still a compromised solution.

In this article a new technology of tunable white, which starts from 2000 K CCT without the problem of the chromaticity point, even by 2-channel control is presented.

### Basics of Color Mixing

A white LED device typically emits with a single CCT and is stable over temperature or current, because

- The wavelength of emission light from a blue LED chip is less susceptible to heat and operating current.
- Phosphor is improved to emit stable spectrum over temperature.

And stable emission color is actually one of the advantages of LED lighting. On the other hand, for achieving tunable white characteristics, it is necessary to arrange at least two sets of white LEDs with different color temperatures (typically, a combination of warm white LEDs and cool white LEDs). By adjusting the current balance between

the two sets of white color of the mixed

The chromaticity point of the mixed light can be expressed by the following formula, using the chromaticity point  $(x, y)_{warm}$  and the luminous intensity  $L_{warm}$  of the warm white LEDs, the chromaticity point  $(x, y)_{cool}$  and the luminous intensity  $L_{cool}$  of the cool white LEDs.

In practice, the chromaticity point of the mixed light can be expressed by the following formula, using the chromaticity point  $(x, y)_{warm}$  and the luminous intensity  $L_{warm}$  of the warm white LEDs, the chromaticity point  $(x, y)_{cool}$  and the luminous intensity  $L_{cool}$  of the cool white LEDs.

$$(x, y)_{mixed} = \frac{(x, y)_{warm} \cdot L_{warm} + (x, y)_{cool} \cdot L_{cool}}{L_{warm} + L_{cool}} \quad (1)$$

As can be seen from the above formula, the chromaticity point of the mixed light moves linearly between the chromaticity points of the cool white LEDs and that of the warm white LEDs.

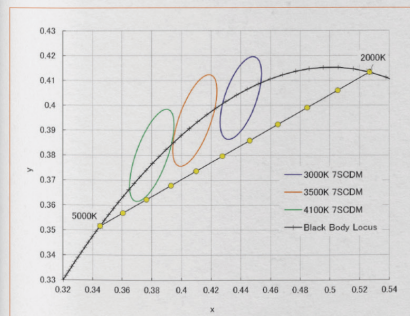


Figure 1: Chromaticity points by conventional tunable white LED together with Mac Adam Ellipse (step-7) on the xy chromaticity diagram

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# Luminaires Performance Simulation

Alex FISCHER, Product Manager at SIMSCALE

**LED luminaires and luminaires are complex devices whose performance and lifetime depend on many dynamic phenomena and properties, including heat transfer, fluid flow, vibration, and material properties. Notwithstanding the intricacies of optical properties and components, LED design's thermal and structural aspects require specialist design tools used throughout the product life cycle. Traditionally, desktop simulation software is used to model the 3D CAD model of a luminaire, for example, and for analyses in physics-based simulation tools such as computational fluid dynamics (CFD) and finite element analysis (FEA). Heat transfer studies are critical to ensuring adequate thermal performance by replicating the conductive, convective, and radiative transport mechanism of thermal energy. This is then used to predict temperatures and simulate various cooling strategies and components, including heat sinks, fans, and natural ventilation. Recent advancements have profoundly shifted the legacy product development workflow. Cloud computing has allowed engineers to collaborate in real-time, access advanced simulation capabilities earlier in the design process, obviate costly physical prototyping, and avoid expensive hardware costs. The virtually unlimited computing power and scalability of the cloud mean that deploying these capabilities across an entire distributed engineering organization is now considered a preferred strategy.**

## Advancements in Simulation Technology

Additional benefits of cloud-native simulation for LEDs include access to 3D parametric scenarios analyses, where an engineer can generate numerous CAD variants of a design and subject all of them to study in parallel, without any impediment to time and computing resources. The value added is the ability to fully explore design space and disqualify poor design candidates earlier in the development process. Common bottlenecks to simulation have been CAD importing and the numerical discretization of that model (meshing). Both consume much time and require esoteric intervention (usually). The advent of advanced physics solvers and novel meshing algorithms, such as the immersed boundary method (**Figure 1**), means that engineers spend less time making their CAD models simulation-ready and more time on insight-driven design. Application programming interfaces (APIs) further amplify the toolkit available to LED designers and enable third-party CAD, analysis, optimization, and parametric design tools to talk to each other. They can then leverage each others' core competencies, in a recent trend towards 'cooperation' between technology firms.

The Immersed Boundary (IBM) analysis type allows for the simulation of heat transfer between solid and fluid domains by exchanging thermal energy at the interfaces between them. IBM is based on a cartesian grid, in which the geometry gets immersed. Therefore, it is resilient to geometrical details and does not require CAD simplification, even for very complex models. The IBM simulations are based on cartesian meshes that are more robust than other types. These only resolve some parts separately, as in a body-fitted meshing approach but refine the cartesian grid towards geometrical and topological details and immerse the geometry into it. Salient features of this approach include:

- Very flexible mesh sizing from very coarse to very fine for all levels of CAD complexity.
- Automatic defeaturing of small geometrical details.
- Perfect hexahedral meshes.
- Mesh refinements are physics-based instead of geometry-based.

The following case study examines the IBM approach on an LED fixture.

## A Case of an LED Fixture

Using spring clips, a standard LED down-light fixture is attached to a false ceiling. Simulation is helpful for several design parameters. Firstly, the thermal performance of the heat sink itself is essential to get right. Most LED luminaires use natural convection and aluminum heat sinks for thermal management. Secondly, the placement of the light needs some consideration. The void between the false ceiling and the actual ceiling level is narrow, with no deliberate ventilation or cooling. Ambient conditions in voids can be simulated by replicating the entire room/false ceiling level in simulation tools to assess the minimum height needed for adequate ventilation and LED temperature. This obviates the need for costly environmental test chambers. The mounting type (ceiling, wall, angled) can also be quickly compared.

The LED fixture or the luminaire consists of a chip on board (COB) with a heat sink or cooling element. Various heat sink designs, configurations, and fin types are simulated for thermal comparison. In this case, the heat sink has wave-like fins that often require CAD cleanup and preparation before proceeding to the simulation stage. IBM is robust to all geometry types and can accurately mesh and simulate complex CAD models without CAD pre-processing. This is often the most considerable advantage of using immersed boundary methods. IBM added to the parallel simulation capabilities of the cloud means that engineers can run hundreds of design variations simultaneously to minimize the materials/costs of the LED fixture whilst meeting thermal performance standards. Radiation effects are included to evaluate the effect of surface emissivity and specialist coatings for the heat sink material. Simulation results can be extracted for a system (fixture), assembly (board), or component (chip).

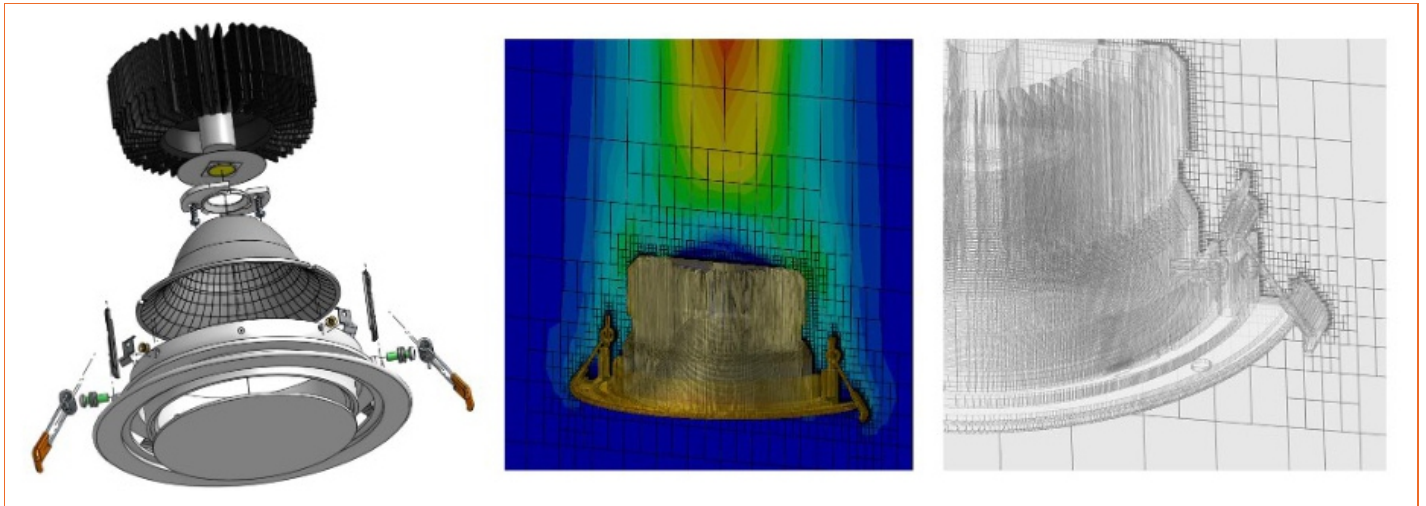


Figure 1: (Left) A detailed CAD model can be used directly for the IBM simulation without having to do geometry simplifications. (Middle) A close look at the Cartesian meshing applied in the IBM analysis. (Right) The mesh refines the Cartesian grid towards geometrical and topological details and immerses the geometry into it.

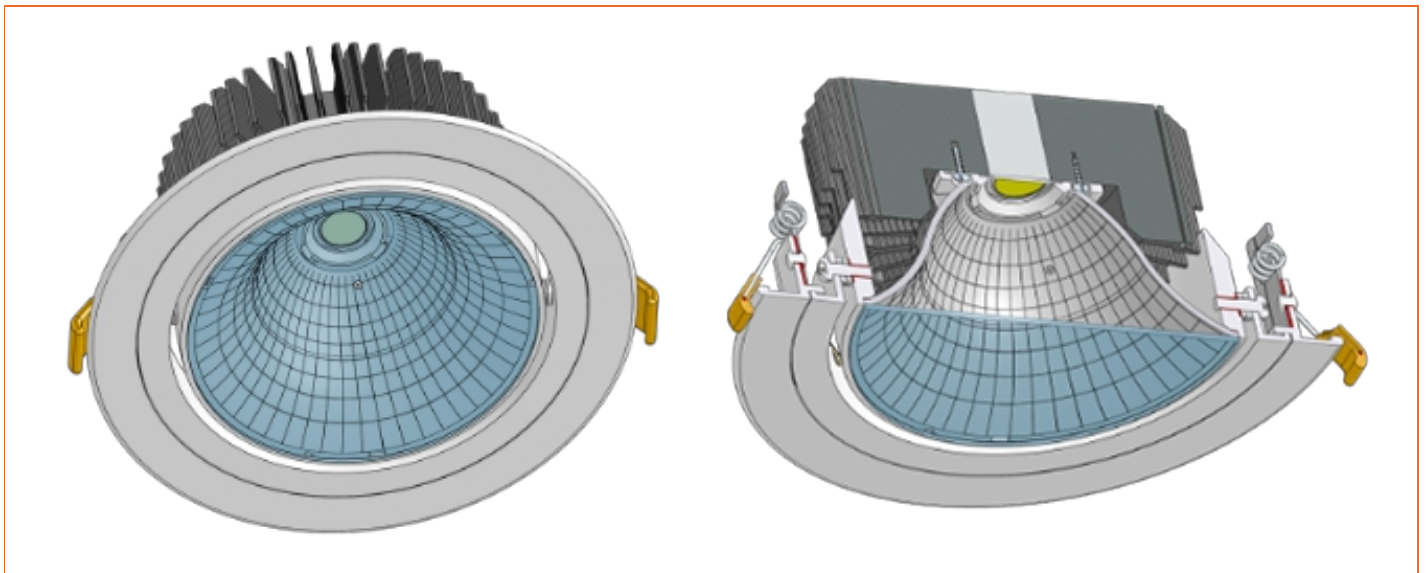


Figure 2: CAD model of the LED fixture (left) and with cut section view (right).

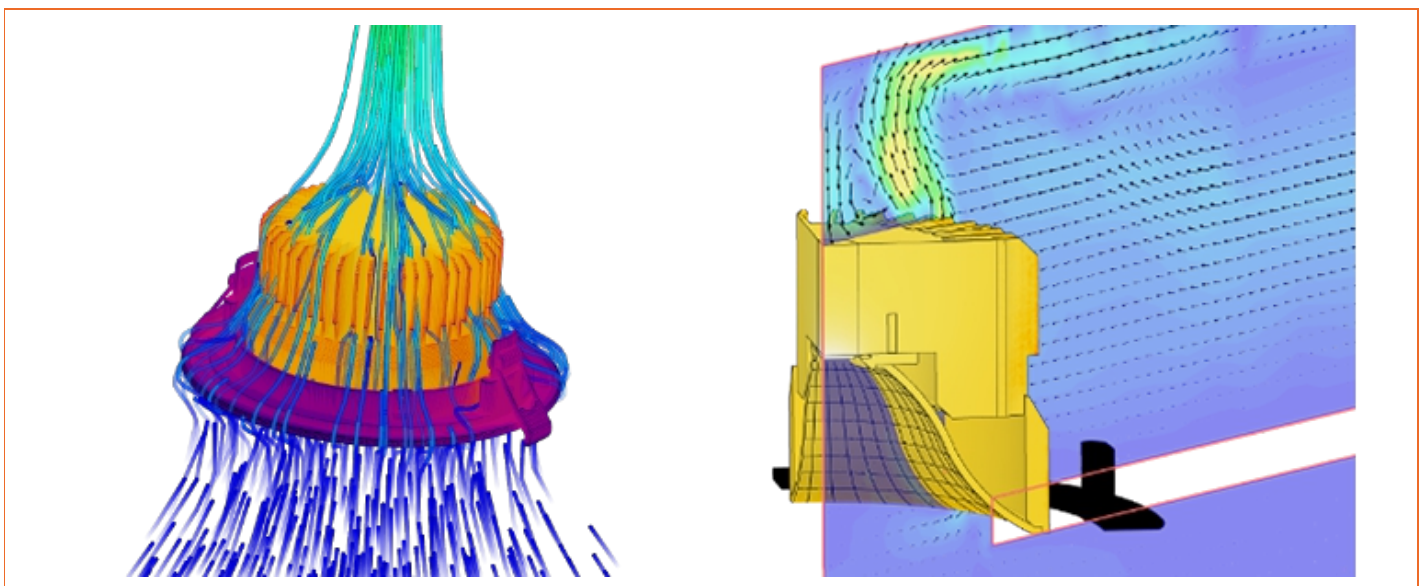


Figure 3: Free convection flow field around the LED fixture (left) and convection field around the ceiling-mounted LED fixture (right). The environment of the space above the LED is important to evaluate for cooling performance.

## AI-powered Digital Twin for Lighting Infrastructure in the Context of Front-End Industry 4.0

The scalability of the cloud, its public programmatic interfaces, and the robust simulation methods dedicated to allowing simulations on unsimplified CAD models or concept drafts thereof, enable entirely new workflows and integrations. SimScale is working on calibrating digital twin models for LED luminaires as part of the AI-TWILIGHT EU-funded project. Based on a fully scripted application, one can extract thermal resistance values for, e.g. SPICE-like reduced modeling without ever touching a graphical user interface, let alone simulation parameters or domain discretization (mesh). The AI-TWILIGHT project is bringing together the leading academic and industrial experts on solid-state lighting (SSL) and LED technology. “The main goal of AI-TWILIGHT is to merge the virtual and physical worlds to pave the way for innovations in fields where the European industry is likely to be competitive. Self-learning digital twins of lighting systems (LED source, driver of a lighting application) will be created and used as input for predicting the performance and lifetime of product and infrastructure design and management in an autonomous world. Tests will be carried out in selected application domains, e.g. automotive, horticulture, general and street-lighting.” (<https://ai-twilight.eu/>)



One of the key drivers of the project is to reduce the cost of developing and testing advanced SSL products. Typically, obtaining long-term lighting data at fixture and component level over a product lifetime is costly and complex, meaning that operational data needs to be adequately fed into the design loop representing a product development failure. Using simulation, statistical and artificial intelligence models will accelerate the predictive capabilities of LED performance models. Fast and accurate simulation capabilities offered by SimScale, for example, and other technology companies can create digital twins of the LED luminaires down to the chip level and analyze the thermal and structural performance of a single LED fixture model but also of a large number of designs of experiments

(DoE) variants of that same model, using the virtually unlimited computing power of the cloud. Hundreds of design candidates of a single LED fixture design can now be simulated in parallel in the cloud, helping to calibrate the thermal parameters of a reduced 1D model of a complete luminaire by using full 3D simulation<sup>1</sup>. ■



### About Alex FISCHER

With a background in computational mechanics and control technology, Alex Fischer has worked for ten years in a range of product and engineering roles, building a fully cloud and web-based simulation platform. He is a co-founder of SimScale and leads the company's thermal management and electronics solutions.

### About SimScale

SimScale GmbH has developed the world's first fully deployed cloud engineering simulation platform. SimScale allows engineers to test their designs against real-world physics using a powerful CFD engine accessed through a web browser. The SimScale Community Plan is accessible for engineers to begin simulating their projects for free.

<sup>1</sup>Adapted from <https://ai-twilight.eu/> with permission. This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 101007319. This dissemination of content reflects only the author's view. JU is not responsible for any use that may be made of the information it contains.)



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# Optics Simulation Based on Accurate Material Models

Dipl.-Ing. Gerhard FRIEDERICI, Editor and Dipl.-Ing. Matthias NOAK, Head of Optical Lab at CADFEM

**An optical simulation is only as adequate as the description of the material on which it is based. If a demanding development project requires high-precision data in order to achieve realistic results using simulation, these are ideally based on material models obtained through measurements. The new CADFEM Optical Lab provides such material models that are oriented towards the simulation requirements so that the calculation results correspond to reality.**

Many developers ask themselves how their planned product will affect potential customers and whether it can really fulfill the desired functions under extreme lighting conditions – for example, at night or in bright sunshine. This is why optical simulations are carried out in many areas, including medical technology, the consumer goods and automotive industries, as well as in the planning and design of lighting concepts.

## Continue to Invest in Expensive Prototypes?

Simulation solutions enable product developers to optimize the desired performance without investing in expensive physical prototypes. For example, the display quality of a dashboard or a rear light should not blind the following traffic but should also be clearly visible day and night even in adverse weather conditions. For developers of medical products, for example for the detection of skin cancer, the correct illumination of the body parts to be examined plays a decisive role.

For this purpose, software for the science-based simulation of light is necessary in order to reproduce human vision with the aid of physical models. Ansys is such a precise simulation tool for optical systems, which, integrated into virtual product development, simulates a realistic representation that corresponds to the individual user experience. In this way, the design of planned products can be designed and optimized even better.

## Proper Physics-based Representation of the Material

The accuracy of optical simulation, especially for complex macroscopic systems, is highly dependent on the quality of the material models used. Regarding surfaces, for example, the correct physics-based representation of the angle-dependent reflection is often important. Furthermore, properties regarding transmission and scattering are also of great importance.

In addition to powerful software such as Speos and a precise CAD model from the design department, a precise material model is required for successful optical simulations. A verification of the simulation results is of course also valuable, among other things by comparing the luminance image created by simulation with a real luminance camera image.

Although Ansys supplies a number of material models with the simulation software, it is not always certain whether the material model selected from the integrated library corresponds exactly to the material being used. The use of similar materials can produce useful results, but not necessarily.

An accurate optical material model can only be derived from specific measurements with corresponding material samples. For this purpose, CADFEM has set up a well-equipped optical laboratory at its new headquarters in Grafing-Schammach (Germany), headed by Dipl.-Ing. Matthias Noak. He studied information technology and has over 20 years of laboratory experience working at the lighting specialist OSRAM, including in the central laboratory for light measurements.

## Measurement of Spatial Light Distribution

“We conduct optical material measurements and modeling for our customers with samples they have supplied so they can perform correct optical simulations

with Ansys Speos and similar programs,” reports Matthias Noak. “In our measurement laboratory we have a spectral measurement system with which we determine the reflection or transmission spectrum of the material sample supplied. In addition, we have a so-called Ansys Optical Measurement Device, a goniometer, for measuring the spatial light distribution. This enables us to scan the spatial reflection or transmission and also to record how the light is scattered within the material. In this way, we provide our customers with the information necessary for an exact model of their material sample. The customer therefore receives simulation results that correspond to the real conditions.”

If, for example, the absorption or the scattering within a body cannot be represented correctly, the results of the optical simulation will be too light or too dark. Furthermore, if the characteristic values of the surface are inaccurate, reflections cannot be represented properly and, as a result, too much or too little light is reflected in a certain direction. Therefore, an accurate material model is required to perform sufficient simulations and to correct design imperfections already in the development phase.

## Time and Cost Advantages with Accurate Material Models

Many automobile manufacturers want to design unique rear lights for their vehicles that stand out. The challenging question is whether these lights actually work with the effects that developers have envisioned. And if not, what exactly needs to be changed so that the desired result can be achieved from every angle and in a wide range of lighting conditions? At the same time, legal requirements must be complied with at all times. Building various prototypes and testing them in detail is very time-consuming and costly.

Optics simulations using exact material models quickly provide the desired time



and cost advantages, and often enable design optimization. This is possible if it is known at an early stage how the light passes through the red plastic material and which wavelengths are more or less blocked. It must also be clear to what extent the metallized surfaces reflect light in the device. Very precise information about the applied materials is required, especially in the case of multiple reflections.

This not only applies to automobile rear lights, but also, for example, to dashboards. The focus is on how the material reflects the sun and might create blinding effects. In the case of household appliances, developers want to know how the surface of an espresso machine, for example, that shines like piano lacquer, matches the brushed aluminum of the cup tray. Another application example is the roughened glass pane of an office door. Here, not only is the visibility from inside to outside of interest, but also the opposite direction.

Finally, Matthias Noak emphasizes that “all generated material models are intensively validated for their suitability on an optical bench. The customer can therefore be certain that they are working with a material model that provides them with realistic simulations.” ■

**CADFEM**

CADFEM is a family-owned company based in Grafing near Munich, Germany, that has been providing decisive impulses for successfully continuing the Computer-aided Engineering (CAE) history ever since. From the CADFEM Germany GmbH, the organization has developed into one of the leading providers of simulation solutions worldwide. Strong engineering competence with high practical experience and far-sighted consulting with a good feel for the market and trends characterize CADFEM.



**Dipl.-Ing. Matthias NOAK**

Matthias NOAK worked as a Quality Manager at OSRAM in Munich from 1995 until 2008 and continued to work at OSRAM in the Central Laboratory for Light Measurement from 2018 to 2021. Since 2021 he has been Head of the Optical Lab at CADFEM.

**Portfolio of the CADFEM Optical Laboratory**

- Purely absorbing bodies Based on the transmission and reflection spectrum, we determine the wavelength-dependent absorption coefficients according to the Beer-Lambert law.
- Diffuse scattering bodies Here we scan the scattered light using our goniometer and determine the scattering parameters according to the Henyey-Greenstein and Gegenbauer models.
- Reflection behavior on surfaces of non-transparent bodies (BRDF) We scan the spatial light distribution at various angles of incidence with our goniometer and create a corresponding surface file.
- Reflection behavior on surfaces of transparent bodies (unpolished) For this, we need a metallized surface, or a CAD model of the surface, and we create a corresponding model based on a scan or simulation.
- Reflection and transmission on transparent bodies (BSDF, fixed thickness) We scan the reflectance and transmission and create a surface file that also represents the volume. This model may only be used with the thickness in which it was measured.

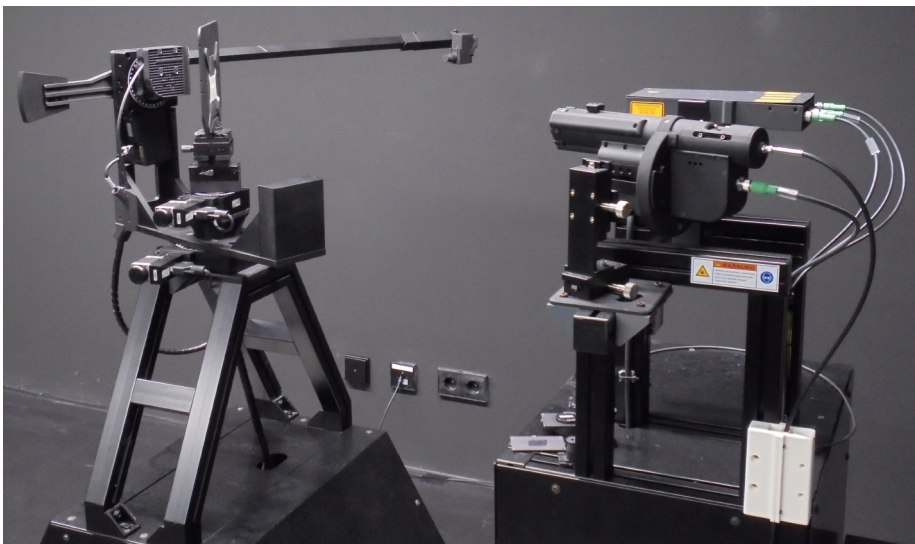


Figure 1: Optical Measurement Device (OMD): Goniometer for measuring the spatial light distribution (© CADFEM).

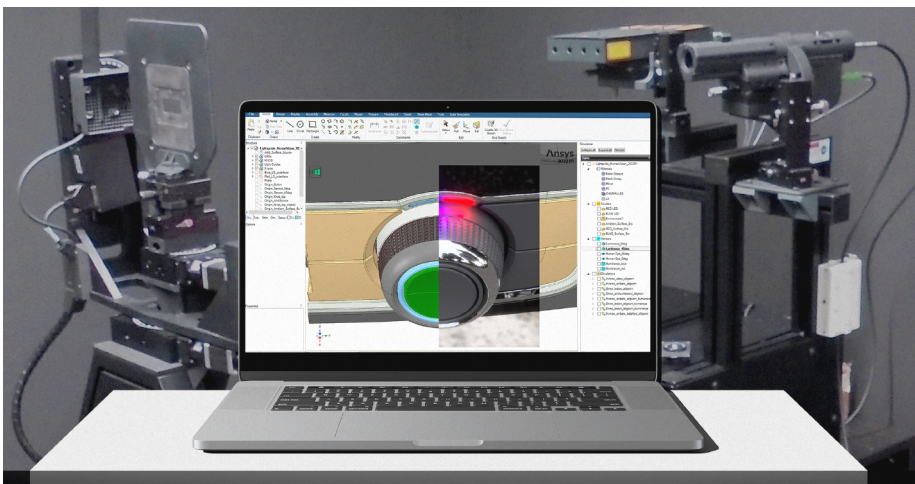


Figure 2: The spectral measuring station with control PC in the optics laboratory (© CADFEM).

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