

Marelli Automotive Lighting

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About the author and Driving Vision News

Hector Fratty's entire career has been in automotive lighting. From 1995 to 2006, he was Valeo Lighting Systems' chief of R&D, managing a staff of 650 engineers and technicians and a budget of over €70m. His level of expertise in lighting gained him recognition as one of Valeo's 5 Master Experts. He headed the Valeo Lighting Expert Committee through March 2008.

Hector Fratty presides over the biennial VISION Congress international automotive lighting and driver assistance symposium. The next VISION Congress will be held on the 7th and 8th of October, 2020 in France; more than 600 experts from around the world will attend the congress, and 20 technology demonstration vehicles will be presented. He is also a member of the ISAL steering committee, which guides and administers the ISAL international symposium on automotive lighting organized by TU Darmstadt. He founded and is now president of Driving Vision News, the automotive lighting and ADAS industry's journal of record, dedicated to keeping the involved community informed and communicating about the latest progress and developments.

The three targets of DVN are:

Technological watch on new emerging technologies, with weekly electronic newsletters (available in English and in Chinese) bringing news, analysis, and crucial information on innovation in lighting, ADAS, and smart car interiors; there are also monthly technical reports with sharp focus on cutting edge technologies, company profiles, motor shows, regulatory matters, and other relevant content available only from DVN.

Networking of high-level decisionmakers, researchers, innovators, practitioners, academics, and regulators to make new business connections with two workshops per year in rotating locations throughout America, Europe, China, Japan, India, and Korea. DVN Workshops gather over 300 participants, and include two days of conference, lunch and coffee breaks, sponsored expo booths, and a gala dinner preceded by a cocktail party. These events really bring together the DVN lighting, ADAS, and car interior communities.

Promotion of innovations from DVN's 150 (and counting!) member companies—we facilitate the promulgation of knowledge of innovation, which in turn paves the way for commercialisation, enabling to build new relationships through DVN Community to forge new business worldwide.

The DVN Gold membership roster includes 30 car makers, 30 lighting & ADAS tier-1 suppliers, 15 light source suppliers, 50 tier-2 & -3, suppliers and 25 universities. DVN Gold members—a thousand of them at last count—receive all publications and attendance privileges at all DVN Workshops. Basic members (2,500 and counting) receive Newsletters and can obtain access to other DVN publications and functions.

Introduction

Marelli Automotive Lighting was established in 1999 as a 50:50 joint venture between the automotive lighting operations of Magneti Marelli and Robert Bosch. In 2001, Magneti Marelli increased their stake from 50% to 75%, and in 2004 bought out Bosch in the joint venture.

In 2019, Magneti Marelli was acquired by CK Holdings, a holding company of Calsonic Kansei Corporation and in May 2019, the two companies united to create one of the world's largest independent automotive suppliers, under one worldwide brand, Marelli led by Beda Bolzenius.

Marelli is headquartered in Saitama, Japan, with an operational headquarter also in Corbetta (Milan) Italy.

In 2018, total revenues for Calsonic Kansei were €7.1 billion and total revenues for Magneti Marelli were €7.5 billion.

MARELLI becomes one of the world's leading global independent suppliers to the automotive sector. With a strong and established track record in innovation and manufacturing excellence, its mission is to transform the future of mobility through working with customers and partners to create a safer, greener and better-connected world.

With around 60,000 employees worldwide, the MARELLI footprint includes 170 facilities and R&D centers across Asia, the Americas, Europe, and Africa, generating revenues of € 13.4 Billion in 2019 Marelli Automotive Lighting- has headquarters in Reutlingen, Germany and organizes its business into three units — headlamps, rear lamps and ECU — with dedicated production units reflecting the difference in technology used. Marelli Automotive Lighting supplies all major vehicle manufacturers including Volkswagen, Daimler, BMW, Fiat Group, Ford, GM, PSA and Renault. The company also supplies Honda and Mazda in Japan and their transplants worldwide.



Executive Summary



Marelli Automotive Lighting is now a global player in automotive lighting, one of the three worldwide largest suppliers in front and rear, with Koito and Valeo.

In 2019, Magneti Marelli owner of Automotive Lighting was acquired by CK Holdings, a holding company of Calsonic Kansei Corporation which creates one of the world's largest independent automotive suppliers, under one worldwide brand, Marelli led by Beda Bolzenius.

At the former report on Automotive Lighting company in 2008, its sales, mainly focussed to Europe, were at 1.6 billion with 11,700 employees to be compared with €3.9 billion and 20,500 employees. It means a huge growth better than 11%/year.

Like Sylvain Dubois, its CEO said, Marelli Automotive Lighting is a well-established lighting supplier, with the critical size, a global footprint, and a well-balanced customer portfolio.

Its challenges are to adapt continuously to the new technologies such as mass-market full LED solutions, democratization of ADB and development of DLP and Laser for high end.

For that, the company built a clear strategy of standardization mainly with modules e-Light, s-Light, k-Light, m-Light, d-Light which allow the achievement of most of the OEM specifications, volume, weight, functions, and cost.

For high end, all technologies, laser, sensors, OLED, new lighting functions, matrix, ADB with all technologies of digitalization for front and rear lights.

Marelli Automotive Lighting won three greatest awards these last years: In 2015 the Red Dot Design Award for Matrix headlamp of Audi TT3, in 2019 the CES innovation award for Smart Corner, and in 2020, the Pace Award for its h-Digi[®] lighting module. The company was first to market ADB with DMD with Mercedes-Benz, and then with Audi E-Tron.

Marelli General Information

History

Great dates for Magneti-Marelli

- 1910s: Magnets, coils, electrical devices in the Motorsport for the beginning
- 1940s: Communication
- 1970s: A global component manufacturer
- 1980s: Development of electronics
- 2000: Full control of Automotive Lighting
- 2007: First Full LED
- 2019: Calsonic Kansei and Magneti Marelli officially unite in the new Marelli from May 2nd

Great dates for Calsonic

- 1938: 1938 Nihon Radiator manufacturing established
- 1955: Start production car heaters
- 1987: Start production of compressors
- 2000: Calsonic Kansei Corporation established
- 2008: R&D center and headquarters moved to Saitama
- 2019: Calsonic Kansei and Magneti Marelli officially unite in the new Marelli from May 2nd

Great dates for Kansei

- 1956: Kanto Seiki established, motor production starts
- 1972: Start production of instrument panel
- 1991: Company renamed Kansei Corporation
- 2000: Calsonic Kansei Corporation established

2005: Calsonic Kansei became a subsidiary of Nissan

2010: Start production of inverter to EV

- 2017: KKR acquires Calsonic Kansei from Nissan
- 2019: Calsonic Kansei and Magneti Marelli officially unite in the new Marelli from May 2nd

Marelli Key data

Marelli sits among the top 10 largest global automotive suppliers

- Total sales 2019 - €13.4 billion
- Global employees – 60,000
- Worldwide locations – 170

The technology domains of Marelli are:

- ELECTRIFICATION
- CONNECTED SYSTEMS
- AUTONOMOUS DRIVING
- ON-BOARD EXPERIENCE
- I.C.E. (Internal Combustion Engine) AND CHASSIS EFFICIENCY

Marelli Automotive Lighting contributes with its technology mainly to three domains: Connected System, Autonomous Driving and On-Board Experience.

The 10 Business Units of Marelli

- Automotive Lighting
- Electric Powertrain
- Cabin Comfort
- Thermal Solutions
- Interior experience
- Green technology Systems
- Powertrain
- Electronics
- Ride Dynamics
- Motorsport

Marelli Global Footprint

	Marelli
R&D centers	29
Production units	150

Marelli Organisation

The President and CEO is Beda Bolzenius



Dr. Bolzenius spent nearly two decades at Robert Bosch, rising to the position of Division President of the company's Body Electronics unit in Germany. Then he had a distinguished career at Johnson Controls, where he was Vice Chairman of the company's Asia Pacific operations, in addition to holding the role of President of Automotive Experience. He additionally held various senior roles in the company's automotive division in global markets such as China, Germany and US.

He joined Calsonic Kansei as President and CEO on April 1, 2018 and was appointed President and CEO of Marelli in May 2019.

Over the last year, Mr. Bolzenius has led the integration of Magneti Marelli and Calsonic Kansei, and in May 2019, the two companies united to create one of the world's largest independent automotive suppliers, under one worldwide brand, Marelli.

Beda Bolzenius has been named an "Automotive News All-Stars" for 2019 in the "CEO, Global Supplier" category.

The COO is Ermanno Ferrari



Ermanno Ferrari was named CEO of Magneti Marelli in October 2018. Prior to his new position, Ferrari was the Head of AL, largest business unit of Magneti Marelli. He has held a variety of roles of increasing responsibility at the systems and components leader. Before joining the Group in 2002, he held leadership positions at AlliedSignal Inc. and Gilardini Group.

He is a graduate of the Università La Sapienza master's degree mechanical engineering program. He was born in Colleferro, Italy.

Bolzenius envisions being able to deliver vehicle systems on a flexibly massive scale. He uses the industry term "tier 0.5" for a supplier that's big and diverse enough to produce most of a vehicle if an automaker requests it. "They are now talking more about the Tier 0.5 supplier, sitting on the systems side and the component side, and we are targeting to get there," he said.

The plan is to move further into automated driving, with the Italian part of the company poised to grow in the critical area of object detection through its headlamp business. KKR, who control nearly \$200bn in assets of 107 companies, see electrification as a logical play. The combined suppliers' electronics businesses will evolve deeper into areas of human-machine interface.

"Further acquisitions are in discussion," he said. "At this point, we are finalising our five-year business plan and cannot disclose any more precise investment numbers."

Calsonic Kansei and Magneti Marelli join to form Marelli, with combined annual sales of \$16.4 billion, 170 worldwide locations and 62,000 worldwide employees.

Bolzenius says the company will remain headquartered in Japan. Management of the operating units will reside where their strengths are: the electronics business in Italy, the exhaust system unit in Saitama, Japan, and the powertrain business in Japan, led by another German, Executive VP Joachim Fetzer.

Marelli AL History

Great dates for Automotive Lighting

- 1912: Carello present the first European electric headlight
- 1930: Bosch design and produce automotive bulbs
- 1957: Bosch produce a headlamp with low and high beam and inbuilt turn indicator.
- 1958: Carello present first asymmetric headlamps conforming to the new European code
- 1962: Carello present the first application of halogen bulbs
- 1964: Carello present the first halogen fog lamps
- 1967: Carello introduce first headlamp with 2 halogen bulbs in a common lens-reflector
- 1972: Bosch present a high/low beam headlamp with the new H4 bulb
- 1981: Bosch release the first projector low beams
- **1987: Magneti Marelli found Lighting Group,**
- 1988: Magneti Marelli repurchase their primary spinoff Carello SpA,
- 1991: Bosch commercialise the first Xenon headlamp system,
- 1997: Magneti Marelli present the first LED rear lamp system for Maserati,
- **1999: Automotive Lighting is created as a JV between Bosch and Magneti Marelli**
- 2000: AL complete the transfer of two production lines to Jihlava in the Czech Republic
- 2001: Seima group are taken over by MM. Brands include Seima, Axo, and Yorka.
- 2003: AL present the first dynamic bending light on BMW 3 Cabrio,
- 2003: AL present LED rear lights on the Peugeot 307 DC.
- **2003: MM repurchase all the JV shares from Bosch.**
- 2004: Automotive Lighting becomes a subsidiary company of Magneti Marelli
- 2005: MM acquire Mako, a Turkish manufacturer of lighting for cars.
- 2005: AL launch the construction of a new factory to China in Wuhu
- 2007: AL launch the first worldwide Full LED in the Audi R8
- 2008: The e-light module is launched with 11W for low beam
- 2015: Red Dot Design Award for Matrix headlamp of Audi TT3
- 2018: AL launches the "Digital light" using DMD technology for ADB.
- 2019: Calsonic Kansei and Magneti Marelli officially unite in the new Marelli from May 2nd
- 2020, Marelli-Automotive Lighting wins Pace Award for its h-Digi[®] lighting module

Marelli AL Key data

Marelli Automotive Lighting is a global player in automotive lighting, Front and Rear, one of the three worldwide largest suppliers:

- Total sales - €3.9 billion, more than 25% of the Marelli Group sales
- Global employees – 20,500
- Worldwide locations – 31

Production is dedicated to 3 product lines.

Marelli Automotive Lighting is set up as three business units, Headlamps, Rear lamps, and electronic control units and their plants are optimized and dedicated to one or the other product according to the different technologies used. In emerging markets like Brazil, China, Malaysia, and Turkey, production is shared between headlamps and rear lamps.

Marelli Automotive Lighting supply all major vehicle manufacturers including Volkswagen Group, Daimler, BMW, Fiat Group, Ford, GM, PSA and Renault. The company also supplies Honda, Mazda and Suzuki in Japan and their transplants worldwide.

Aftermarket sales are handled through both Bosch and Marelli's aftermarket distribution channels and include OE-replacement as well as auxiliary and accessory lighting components.

Customer portfolio 2018 in headlamp

The 4 greatest customers are VW Group, FCA Group, Daimler Group, and BMW Group.

VW Group	FCA Group	Daimler Group	BMW Group	GM Group	PSA Group	RNM*	Ford Group	Hyundai Group	Others
30%	24%	14%	11%	5%	4%	3%	2%	1%	4%

Based on IHS reports

* Renault-Nissan-Mitsubishi

Customer portfolio 2018 in rear lamp

The greatest customers are FCA Group, VW Group, PSA Group and Honda Group.

FCA Group	VW Group	PSA Group	Honda Group	Daimler Group	RNM*	GM Group	Ford Group	BMW Group	Others
25%	23%	12%	10%	7%	7%	3%	6%	2%	5%

Based on IHS reports

* Renault-Nissan-Mitsubishi

Marelli Automotive Lighting Global Footprint

Marelli Automotive Lighting has two R&D centers, one in Reutlingen, Germany for headlamps and the other one in Tolmezzo, Italy for rear lamps.

The company has 16 production units and application centers in France, Germany, Poland, Russia, Czech republic, China, India, Malaysia, Turkey, Italy, Spain, USA, Mexico, Brazil with 2 application centers in Japan and Romania, and one production unit in Morocco.

Main competitors in 2019

The 10 biggest suppliers represent 75% of the total market in Headlamps

The 10 biggest suppliers represent 69% of the total market in Rear Lamps

In Headlamps

In front lighting, the two main competitors are Koito, and Valeo.

Koito	Valeo	MAL	Hella	Stanley	SL Corp	Hasco	ZKW	Varroc	Mobis
14.6%	13.5%	11.8%	8.1%	7.9%	7.6%	3.9%	2.9%	2.5%	2%

Based on IHS reports

In Rear lamps

In rear lighting, the main competitor is Koito

Koito	MAL	Valeo	Hella	Stanley	SL Corp	Mobis	Hasco	Magna	Varroc
12.8%	10.6%	9.1%	6.2%	6.1%	6.1%	5.8%	4.9%	4.2%	4%

Based on IHS reports

Marelli Automotive Lighting Organisation

Sylvain Dubois is the CEO and EVP



Sylvain Dubois is graduated in 1991 in Mechanical Engineering from the University of Technology of Compiègne, France. He holds an MBA from Sorbonne Business School in Paris, and a Master of Science from Cranfield University, UK. He attended the Advanced Management program and International Directors Program (IDP-C) from INSEAD.

His international career spans across important roles in companies in the automotive industry, including Ferrari as Chief Purchasing Officer.

Since 2011, he has held Managing Director positions of growing importance. Last May, he became CEO of Marelli Automotive Lighting.

Andrea Stella is the R&D director

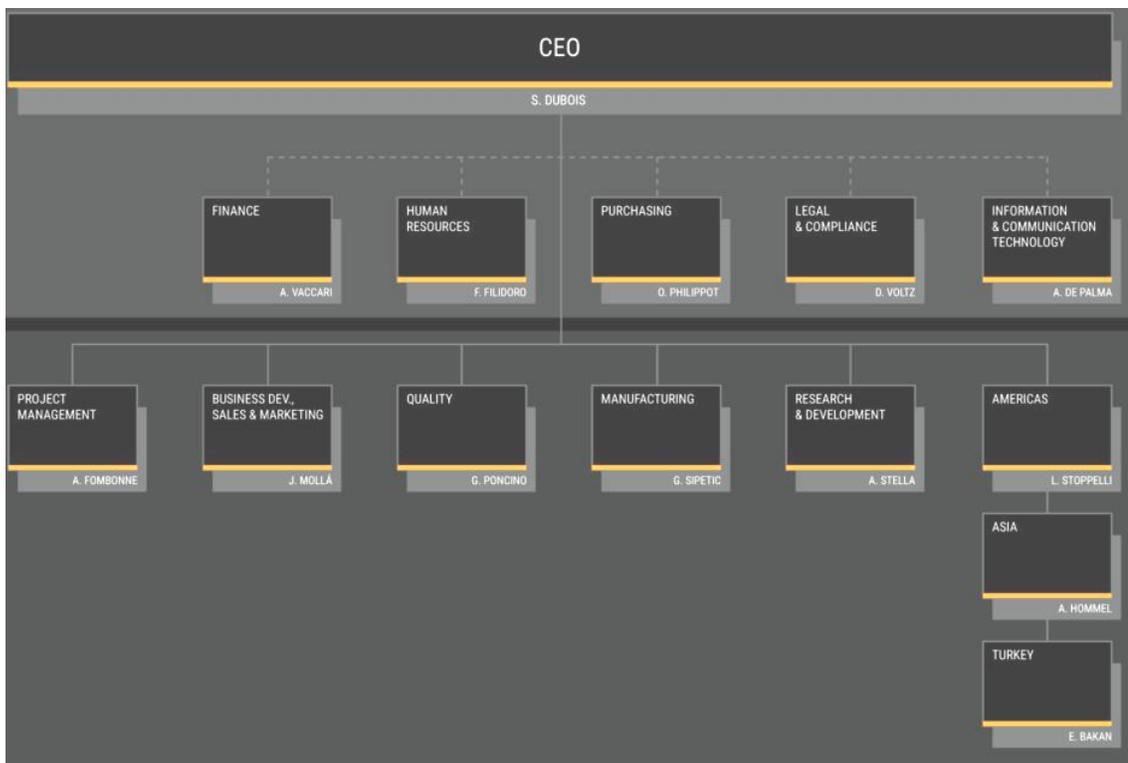


Andrea Stella has a degree in Industrial Engineering from the University of Udine, Italy. He's worked at AL since 2003 and has been Program Manager and then R&D manager for tail lamps at AL in Tolmezzo, Italy up to 2011. Then, he covered the position of R&D Director for AL in America. In 2015 he moved to the Automotive Lighting headquarters in Reutlingen, to cover the position of R&D Director Headlamps and since September last year, he became the R&D VP at Marelli Automotive Lighting.

Juan Manuel Mollá is VP of Business Development, Sales and Marketing



Juan Manuel Mollá got a degree in Business Administration in 2001 from Universidad Nacional de Córdoba and a degree of Leadership & Management Program from Florida Gulf Coast University in 2002. He was industrial director of a plant of Dynamit Nobel in Argentina, before joining Magneti Marelli in 2007, as general manager Argentina operations, then Head of Sales, Marketing & Business Development until 2017 and VP Business Development, Sales and Marketing at Marelli Automotive Lighting.



Andrea Stella is R&D VP of Marelli AL

Andrea Stella, arrived at the company in 2003, is the R&D Vice-President since September 2019.



Two R&D centres

- in Reutlingen, Germany
- in Tolmezzo, Italy, with J.P. Herlin in charge of rear lighting activity.

MAL aims to be the global leader in exterior automotive lighting. Their mission is to be an innovative and reliable partner with qualified and motivated employees

Marelli Automotive Lighting aim to be the global leader in exterior automotive lighting

MAL aim to be the global leader in exterior automotive lighting, and the preferred partner of automakers. Their unique corporate culture is based upon their multicultural identity and their sense for competitiveness. This is the foundation for their constant innovations and the high-quality solutions that they provide.

The mission of Marelli Automotive Lighting is to be an innovative and reliable partner

to their customers for external lighting of automobiles. Marelli Automotive Lighting also represent a dependable and safe value to their shareholders, to their employees and to their partners.

Marelli Automotive Lighting search qualified and motivated employees

Within MAL organization, employees are the most important link to customers, and to partners and within our organization. MAL will fulfil their mission and reach their vision with strong, able and motivated employees. Therefore, MAL will endeavor, within their economic possibilities, to get the best qualified people in their field.

New Turin Location for R&D

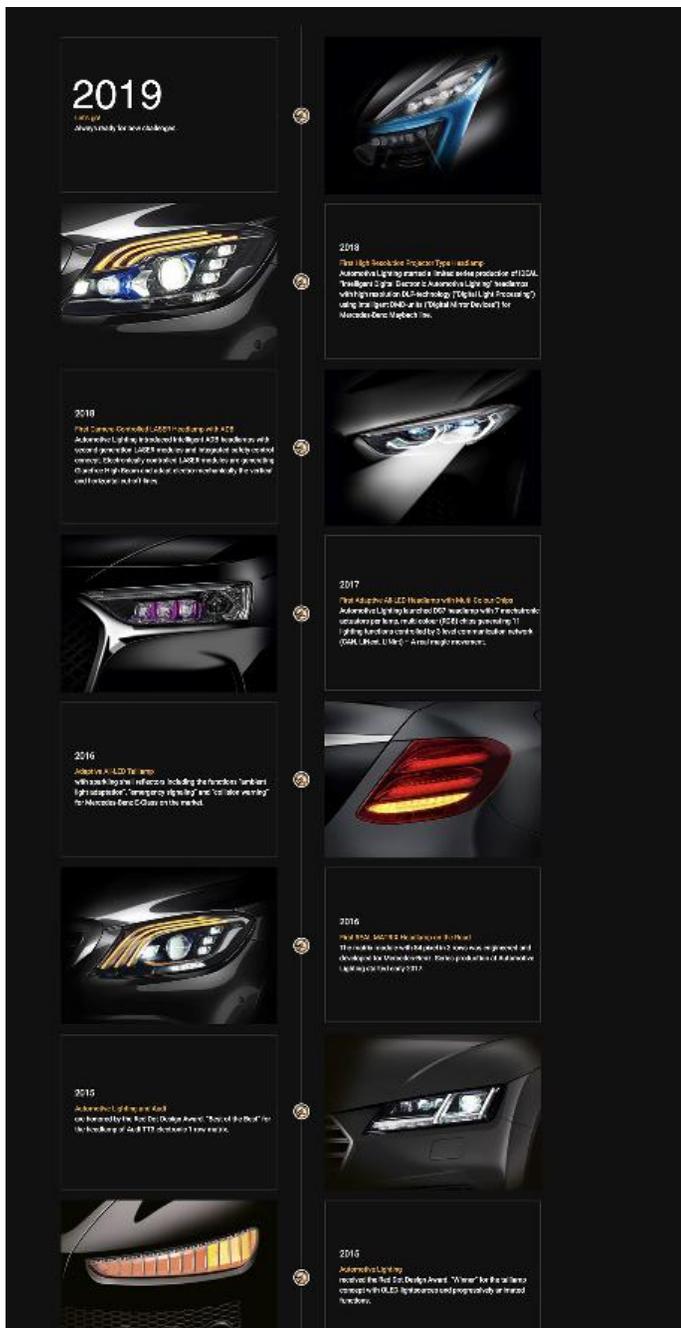
In Turin, Italy, Marelli AL have a new site. It's the R&D centre of Marelli Automotive Lighting devoted to lighting and body electronics (LBE), with an area devoted to ADAS sensor development. By combining different capabilities in one location, the hub will be central to supporting Marelli AL's activities across LBE, which are long-lasting core competences of the company.



***Official opening of the R&D centre in Turin
- Heinrich-Gerhard Schuering, CEO Electronics Business Unit
- Sylvain Dubois, CEO Automotive Lighting Business Unit***

There's also an area devoted to development of ECUs for management and control of lighting systems in the vehicle, which have become increasingly relevant in the last years following the evolution of lighting technologies.

Latest Product launches



- Audi** A4, A5, e-Tron
- BMW** 3 Series, 7 Series, 8 series; Z4, X7
- DS** DS7, DS3
- Ford** Fusion, Transit
- Honda** Accord
- Jeep** Cherokee, Renegade, Wrangler
- Land Rover** Evoque
- Mercedes** GLE, GLS, Maybach,
- Nio**, SUV, ES6
- Porsche** 911
- Renault** Captur, Clio V,
- Skoda** Superb, Octavia
- Toyota** Supra
- VW** Passat, Nivus

Main recent launches

FRONT LIGHTING



Renault Clio



Porsche 992



BMW 8 series



Audi e-tron

REAR LIGHTING



Porsche Cayenne



Audi e-tron

Range Rover



VW Passsat



Marelli AL Strategy

Automotive Lighting's project teams develop new technologies for headlamps and tail lamps. With innovative optic concepts, modular components and electronic modules AL develops and produces the full range from economic lamps up to LED matrix and laser light systems.



In front lighting

Innovative solutions are developed for the technological requirements of car makers. Attractive design visible and set standards is made with intelligent lighting technologies based on Halogen, LED and Laser systems as well as adaptive lighting systems in headlamps and rear lamps.

Light Hall is the name given to the new building in Reutlingen for a light tunnel of more than 60 × 12 meters for static headlamp investigations and demonstrations.



Light Hall

In rear lighting

Conception is done in close coordination with all carmakers, through product design, the planning process, based on incandescent bulbs, LED, and OLED light sources. The light pattern of a LED-chip, distributed in an angle of 180°, needs to be captured, focused, reoriented and distributed towards other traffic partners.

In CPU

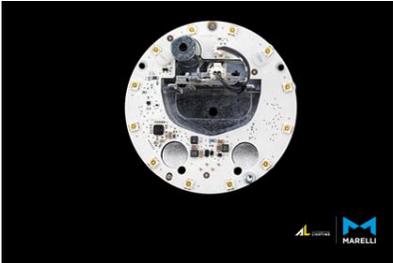
through the years, the development and production of their electronic systems have witnessed intense growth focused on the integration of the innovative technologies.

Highest precision in lighting control called "ALCC", Automotive Lighting Control Concept

- Modular: Electronic content of the boards according to the functional specification extend of car makers' concept.

- Scalable: According to the range and number of driven semiconductor light sources

- Adaptable: To the car makers' electronical philosophies and vehicle architecture.



LED driver



AFS control



Actuator driver



Front lighting electronics

Innovative controlling for upcoming lighting generations



Body electronics

Making life easier for you and your customers



Rear lighting electronics

Remarkably intelligent control technology

LED Technologies

LED headlamps will offer greater freedom in styling, to such a degree that they could make the traditional symmetric two-headlamp front-end design concept a thing of the past. All the LED emitters could be located in the fascia; the typical headlamp appearance would no longer be necessary, and this would allow the design of headlamps in entirely new shapes. The new LED headlamps offer other advantages, such as an expected lifetime exceeding that of the vehicle.

History

The first Full LED in the market: Audi R8

The Audi R8 is in 2008 the first vehicle in which all lighting functions of the headlamp are realized with LED technology, i.e. low beam, high beam, turn signal, daytime running light and position light.



With this development AL once again emphasise their innovative leadership in lighting technology and provide a preview of their central topics of the future: design, technology and energy consumption.

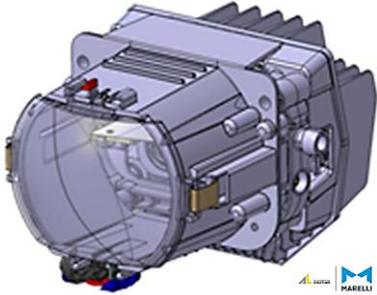
The basic light distribution is produced from two half-shell free-form reflectors, which are supplied by LED arrays (modules consisting of several light-emitting diodes) with four white LEDs each. The spot projection module is positioned centrally between them. The range of the low beam is generated with a high-performance lens system with three additional 2-chip-LED arrays. So, the low beam twelve years ago 14 LED chips (1 mm²) were needed. Directly next to these, the high beam with a pair of 4-chip-LED arrays shines out of the two shell-shaped high-beam chambers. The R8 headlamp is equipped with customized electronics and offers Xenon performance levels for the low beam and high beam from the very start.

LED Modules

AL uses several standard modules for headlamp applications and has the next generation under development.

AL's present module library includes:

- **e-Light and s-Light**



The s-Light provides low beam / high beam bi-function and also a version with ADB. A s-Light module with 12 segments in the high beam equips the Audi e-tron sportback together with digital light module h-Digi[®]. Another version of the s-Light module family is also applied in the Fiat 500 and the Škoda Fabia.

- **k-Light**

The company also develops the k-Light module using a lens of 35 mm height at better cost. The

k-Light module is built only out of 7 parts versus 11 parts of the s-Light module. The SOP is expected in 2022 from plants in China, Mexico and Czech Republic.

- **m-Light**

This is an ADB module with a lens height of 35 mm, delivering ADB with one or two rows, using 12 or up to 36 ADB-segments. Production started this year. This module can be combined e.g. with the low beam s-Light module. The luminous flux is between 650 lm and 800 lm with a 1.5° pitch resolution in the center region of the beam.

- **d-Light**

d-Light is an ADB module with a very small projection lens of 30 mm height and 100 mm width. The module delivers 950 lumens with a hot spot of 81,250 cd and configurable from 16 to 24 segments. With proper styling, the lens height can be reduced to 25 mm. The SOP is planned for 2021.

With these modules, AL has a portfolio allowing to achieve most of the OEM specifications, volume, weight, functions and cost.

With these modules, Marelli AL have a range allowing to achieve most automaker specifications for volume, weight, functions, and cost.

Marelli Automotive Lighting's DMD Module h-Digi®

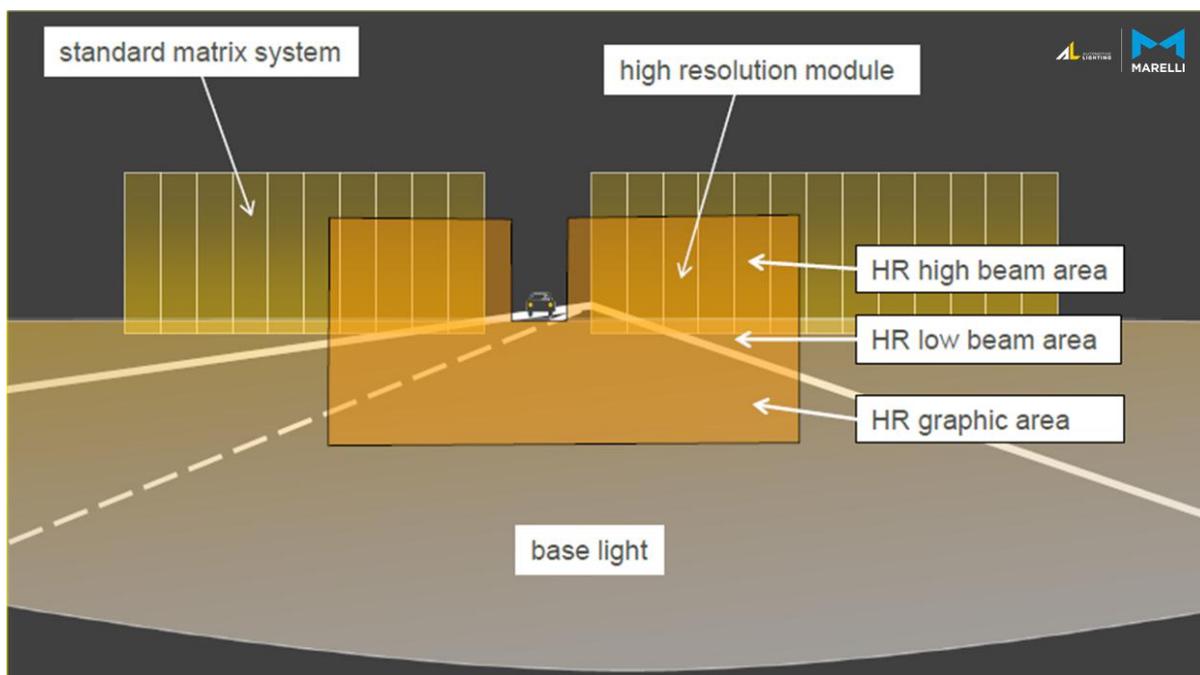
In spring 2020 the PACE Award for innovations was celebrated in an online session. AL as a finalist was finally awarded as PACE Award Winner 2020 for its DMD module called "h-Digi®".



Digital light module h-Digi®



For high resolution headlamp technology Marelli Automotive Lighting focus their development first on DMD technology. The high-resolution module is combined with a supporting conventional background matrix system with 12 segments to 84 pixels.



Very first ideas of a high-resolution technology based on DMD chip for dynamic light distributions started in Reutlingen more than 20 years ago. Several patents were written in 1997 & 1998 by Bosch's lighting development team on the basis of a DMD chip. Predevelopment activities investigated a lightguide solution with a gas discharge lamp to concentrate as much light as possible on the DMD chip to achieve a certain intensity in the light distribution for low and high beam.



19 BUNDESREPUBLIK
DEUTSCHLAND



DEUTSCHES
PATENT- UND
MARKENAMT

12 **Patentschrift**
10 **DE 198 22 142 C 2**

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G 05 D 25/00

21 Aktenzeichen: 198 22 142.8-31
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43 Offenlegungstag: 18. 11. 1999
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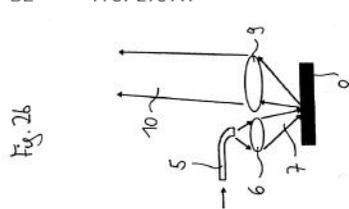
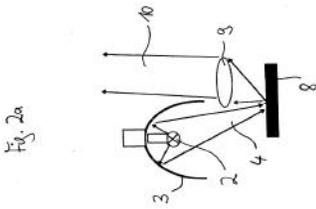
Innerhalb von 3 Monaten nach Veröffentlichung der Erteilung kann Einspruch erhoben werden

23 Patentinhaber:
Robert Bosch GmbH, 70469 Stuttgart, DE

24 Vertreter:
Dreiss, Fuhlendorf, Steimle & Becker, 70188
Stuttgart

22 Erfinder:
Hege, Guenter, Dr., 72810 Gomaringen, DE; Hamm,
Michael, Dr., 72793 Pfullingen, DE

55 Für die Beurteilung der Patentfähigkeit in Betracht
gezogene Druckschriften:
DE 1 95 30 008 A1
DE 44 37 270 A1



The concept development at this time didn't lead to a series solution out of several reasons:

1. Weak light performance with existing gas discharge light sources
2. At that time AFS lighting functions were in research status and high resolution didn't create enough advantage for conventional static low and high beam light distributions.
3. ADB lighting functions were completely unknown
4. Thermal issues on the DMD chip
5. The effort was quite huge and cost – value ratio was not attractive enough to continue the activities.

In consequence, the nice ideas were frozen for a long time. Several circumstances had to change for a new attempt for this technology about 20 years later:

1. LED as a light source became available, especially high current LEDs with a significantly increased luminance and flux.
2. Needs for more flexibility in the beam pattern like camera controlled and ADB lighting functions
3. Ideas about driver assistance by projections on the road increases the attractiveness for a high-resolution technology.

Automotive Lighting started in 2014 predevelopment activities to investigate in the DMD technology in headlamps for main lighting functions. In this time some alternative technologies were under investigation all over the world for high resolution headlamp systems, but the decision for DMD was taken together with the first predevelopment partner Daimler, because of the availability and the unbeatable number of pixels. During the development of this technology several new solutions in light source technology, optics and DMD chip technology, which was automotive qualified by the high motivated partner Texas Instrument, have been created.

As result, the PACE Award 2020 was given to Marelli Automotive Lighting for the DMD technology in headlamps, because of its fast series introduction of this technology and a fast spread in several end customer products. Both aspects were successfully achieved by Marelli Automotive Lighting. In the upcoming years more and more cars from different OEMs will offer this option for end customers.

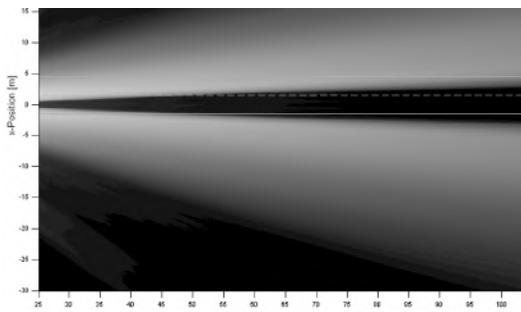
Several properties of the h-Digi[®] module provide increased safety during nighttime driving:

1. Increased overall intensity of the headlamp system
2. Creation of smaller and more accurate shadows during glare free high beam mode
3. Assistance projections onto the road for driver information and assistance.

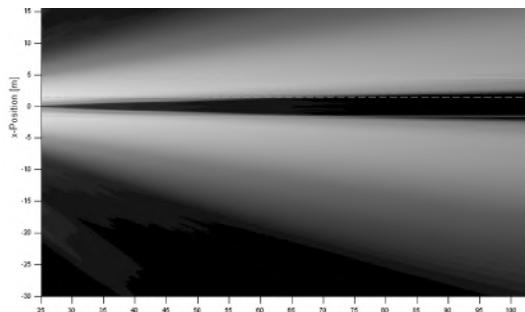
This improved and new lighting functions are enabled by three high current LEDs (each 2 mm²), which are illuminating the DMD chip via a concentrating reflector. The never before seen luminance of this type of light sources helps to achieve enough module luminous intensity and contrast to fulfill the above-mentioned lighting functions. The first car shown to the public was a special edition of Mercedes Maybach at Geneva Motor show in March 2018 and the first series application started in Audi e-tron in 2019. Several OEM projects will follow soon.

The main benefits of the DMD technology are:

- Improved resolution, which is providing more flexibility to shape the “cut-off” line (country-, motorway-light, ...) and to provide more accurate and smaller “blockout” areas for the glare free high beam.

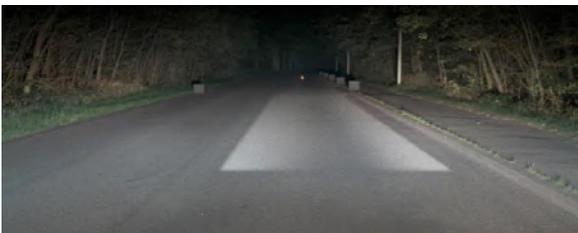


Bird's eye without high resolution



Bird's eye view: With high resolution

- New lighting functions enabled by high resolution such as road guidelines (construction lines), lane departure warning, distance warning, symbols (ice, speed), etc. A research study shows that nighttime traffic safety is significantly supported by guiding projections.



- Possibility of a dynamic bending light with precision based on this high resolution
- Flexible cutoff line shaping (country light, motorway light, town light, etc.)

Marelli Automotive Lighting is on the first line in this technology, launching their first generation of DMD module in the Mercedes S-class Maybach, then in the Audi e-tron sportback.



Mercedes Maybach S-Class 2018



Audi e-tron Sportback 2019

The second-generation DMD module design with a lower cost will equip several other cars currently under series development. Now, the two big challenges are about the definition of standardized symbols (warning & information) and about the regulations allowing driver assisting light patterns on the road with clear boundary conditions but minimum constraints.

Micro-LED Technology

In addition to the DMD technology a second path to high resolution headlamps was opened in the predevelopment based on micro-LED light sources. This are arrays out of ultra-small LEDs with about 20,000 pixels in an array with a rectangular shape, which is adapted to the beam pattern needs. This technology can be driven by less complex optics and system costs and therefore is offering the high-resolution advantages to additional car segments and make high resolution technology available for all OEMs beside the premium brands. This technology will go to market in 2023 and AL is leveraging its knowledge of high-resolution technology also in this field.

In the future both technologies will play an important role for further improvements in flexible and dynamic controlled headlamp lighting functions.

Laser

After the first generation launched in 2014, and the second-generation last year on multiple BMWs and the Audi A5, Marelli's AL unit are working with Nichia on a new generation of laser lighting.



2014 Audi R8 LMX - Special edition

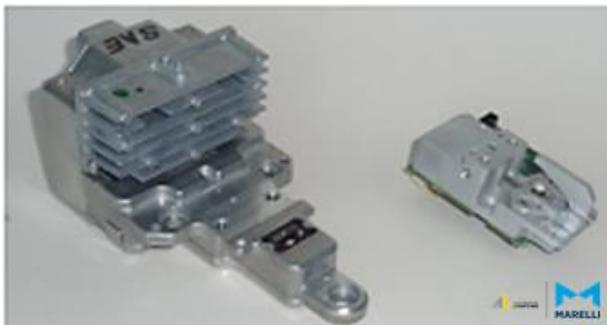


2015 Audi R8 Laser Headlamp



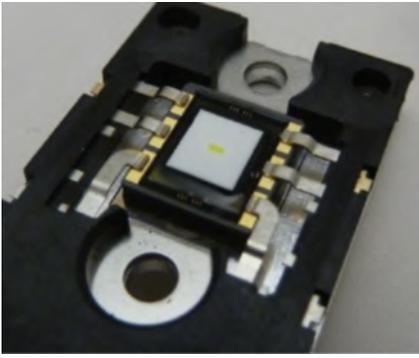
2018 BMW: Laser support for High Beam & ADB

Laser technology is not only used to increase the visibility distance in high beam, but also to make the ADB, with the laser spot being located at the vertical cutoff to increase the visibility close to cars ahead.

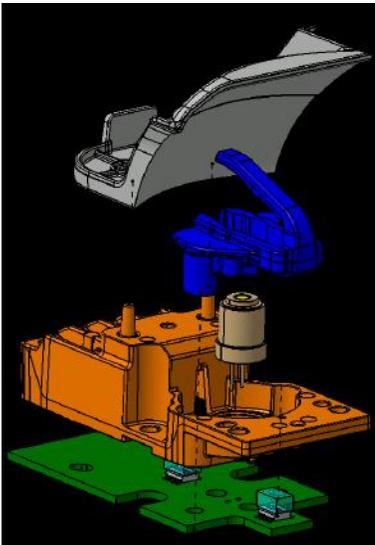


Two generations—impressive miniaturization!

In the next generation to be launched with Nichia, there are now two laser sources illuminating one converter and producing twice the luminous flux: now about 800 lumens (hot). This will boost the laser performance to a new level with larger volume.



Great progress has been made over about five years on laser technology. An onboard electrical safety system integrated on the laser converter is in the meanwhile standard. The main challenge is now to have a competitive cost vs. LED systems; this depends on the technology and production volume.



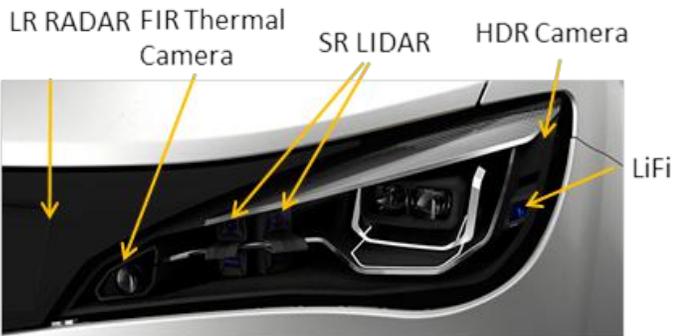
Laser source using a reflector 30 mm high × 40 mm wide

Sensors

In parallel to latest innovations on lighting side, Marelli AL also work on solutions to integrate sensors for ADAS in headlamps and rear lamps.

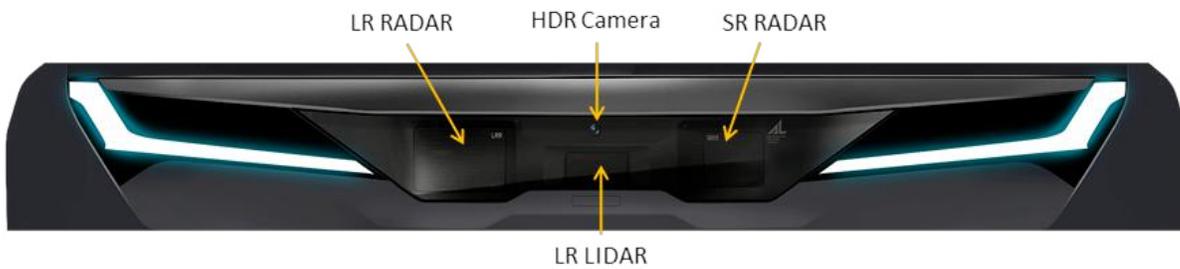
As the LiDAR will be in future one main sensor for highly automated vehicles Marelli Automotive Lighting also develop their own LiDAR sensors which is based on joint activities with Xenomatix: Using patented true solid-state LiDAR modules, this compact technology is especially robust to serve demanding Automotive environments. Marelli Automotive Lighting and Xenomatix will combine competencies and technologies to offer modular LiDAR sensing solutions to meet future global needs. These sensors will also have ability to perform object classification, leveraging the Artificial Intelligence (AI) capabilities derived from SmartMeUp, a French start-up acquired in 2018. *“Our objective is to support our customers in enabling a crucial set of functions in the ADAS and AD field thanks to the true solid-state LiDAR technology of Xenomatix.”* said Sylvain Dubois, CEO of Marelli Automotive Lighting division.

In front lighting



sample

Latest lidar



In rear lighting



Smart Corner for Autonomous Driving



Smart Corner was named a CES 2019 Innovation Awards Honoree in the Vehicle Intelligence & Self-Driving Technology category. It integrates autonomous sensors into headlamps and tail lamps to provide automakers with the required functionality for autonomous driving, while maintaining styling aesthetics and world-class lighting performance.

Smart Corner can accommodate any sensor an automaker may choose to deploy, including lidar, radar, cameras, and ultrasonics, as well as advanced, LED-based lighting features like ADB

and digital light processing. Smart Corner provides a 360-degree view around the vehicle with redundancy. Because the sensors are integrated into existing headlamps and tail lamps, an automaker benefits from a fully calibrated, plug-and-play solution, resulting in a simplified manufacturing process that's lower cost and lighter weight than alternatives.

As an extension of the Smart Corner concept, Marelli AL have developed connectivity features seamlessly integrated into a test vehicle. Technology includes AMOLED (active matrix organic light-emitting diode displays embedded in the front grille and rear appliqué areas to communicate intent to pedestrians, bicyclists, and other vehicles; autonomous signaling to communicate to others that the vehicle is in autonomous mode; an interactive exterior virtual assistant that can perform commands for the driver and passengers such as opening the trunk or unlocking the doors when approaching the vehicle; positional advertising using V2X that provides targeted advertising projected onto the windows to individuals based on micro-location; and high power projection and film technologies to support the exterior virtual assistant and positional advertising functionality to achieve a viewable, high quality image from outside and inside the vehicle.

New Lighting Functions

Evolution of signal functions Lighting Signals 360° Around the Car

Signal functions are evolving in three directions: with animations, with extension to the whole rear end width, and with extension to the whole front-end width. Light is also now used as chrome was used yesterday, to embellish cars.



A very important new direction is the digitalisation of signal functions, to give the vehicle status—for instance autonomous mode—or a virtual zero-emission vehicle placard for access to areas off limits to exhaust-emitting vehicles.



Another important developmental direction is animation, to give information by matrix and displays and to communicate via ground projection.

All these new technologies will need a complete change for electronics, with a huge increase of data transfer rate from LIN with 20 kbit/s to network backbone at 1000 Mbit/s. A possible architecture to save money could be with a central control unit.



However, it will be important to avoid having cars decorated like Christmas trees and to keep elegance with signal lighting.

Evolution of signal functions



Animation



Porsche Panamera
Extension to whole rear end width



Toyota Supra
Extension whole front end width



Audi e-Tron
Sequential turn and animated DRL/Position



Audi e-Tron
Animated Tail Light

Lighting decoration extended on car body



The border between lighting surfaces and body surfaces is becoming less defined

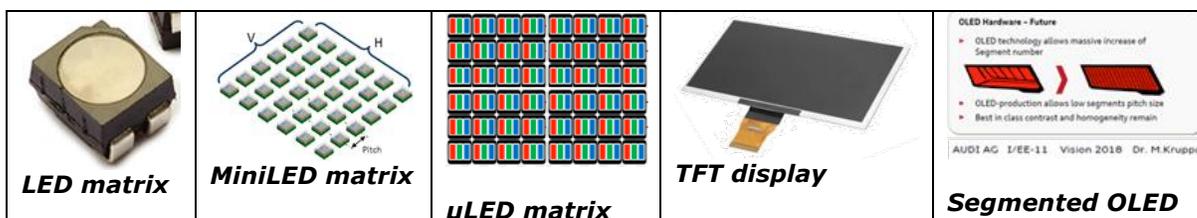
Similar to chrome trims, light trims are used to highlight the styling lines—**light is the new chrome.**

With EVs and ADs knowing in which status the vehicle is running is important and light is a perfect mean to transfer this information, for example with a green signal for zero emission is under discussion in GTB.

Digitalisation of signal functions



New technologies allow customisation and pictograms in front and rear lights (shown at left). Luminance level should be in line with tail function: 1,500 cd/m². On top of all these new style trends, the digitalisation of signal lighting is enabled through new light sources as shown below.



Information by Matrix & Display



Light Matrix



Lighting Signals 360° around the car

Additional tasks & functions appear at the horizon for exterior signal lighting. The first priority of Marelli AL is signaling for information and safety, while avoiding light pollution or confusion.

Ground Projections for Communication



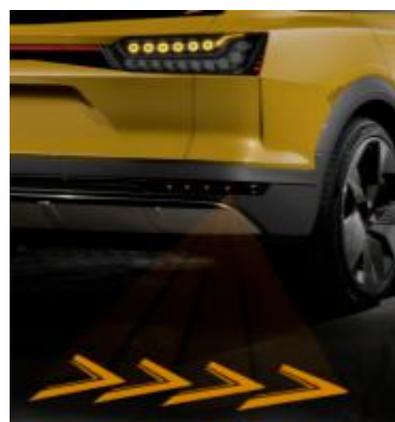
Signs in front of the vehicle



Signs in rear of the vehicle



Signs in bad weather (laser rear fog lamp shown)



Signs to the side of the car

SWOT

Strengths

Lighting technology leadership

The well-established collaborative link with high-level German car makers facilitates development, production and commercialisation of new technologies.

Engineers, greatly involved, have a long experience in R&D with a strong know-how in Reutlingen.

Good portfolio with innovative projects and high volume projects

The portfolio is obtained from a flexible management that responds quickly to customer' needs. Marelli AL expect an increase of market share from 11.4% in 2019 to 13.7% in 2023 in front lighting and from 10.3% in 2019 to 12.1% in 2023, both close to Koito.

Good structure in terms of production and location

Most of project development for car makers is done in low cost countries with strategic part in Reutlingen/Tolmezzo and other parts in Czechia or China.

Good image in technology

Many awards recently, with the latest being a CES innovation award for Smart Corner and concept Pace award for the h-Digi lighting module.

Weaknesses

Big risks on SOP with the COVID-19 crisis

Marelli AL have taken many orders for projects now at risk, and will have some difficulty to manage the development and the production in this uncertain situation.

Low skills on Driver Assistance systems.

Lighting is more and more dependent on cameras and other sensors and becomes part of an integrated software-firmware-hardware electronic system. Night Vision, AFS and now ADB high definition, need know-how in sensors and appropriate software.

Portfolio focussed to 4 OEMs

VW, FCA, Daimler, and BMW represent almost 80% of Marelli AL customers' portfolio in front lighting.

In rear lighting VW and FCA represent almost 50%.

Opportunities

Weakness of some competitors with the COVID-19 crisis.

Also predicted is a decreased market, expanding Marelli AL 's opportunities as the market leader in LED systems, ADB with and without high definition.

New lighting functions coming

New lighting functions as constructions, danger signs, and decorations are coming and expected to greatly grow.

Door open to get new markets

The weakness of marketshare concentration opens the door to get new markets from generalists Ford, GM, Renault-Nissan, Toyota.

Threats

Big risks with the COVID-19 crisis

Marelli AL operate in a strongly competitive environment, particularly with the arrival of low-cost countries. Adding to cost pressure is the difficulty to cut strongly-established, high-cost German development and production resources.

Intensifying competition lighting, front and rear

Too many actors are in the business driving reduced prices. The endless new technologies and the increasing number of models lead to high level R&D costs not paid by the car makers.

Order book too large in the uncertain post-crisis situation

The strong expected growth of market share is done with the recent orders. Marelli AL obtained in 2018-19 a lot of orders for LED, simple LED, and ADB with and without high definition. The corresponding projects need resources and investment difficult to find in this crisis period.

Sylvain Dubois, CEO



Sylvain Dubois, Marelli Automotive Lighting CEO

DVN: Could you present the new company Marelli

Sylvain Dubois: Marelli is born from the merger between Calsonic Kansei and Magneti Marelli, creating one of the world's top ten independent Automotive Tier one suppliers. Marelli has a well-balanced global footprint and products portfolio spanning from Thermal solutions, Cabin comfort and Interior experience, Electrical and conventional powertrain, Green technology and Ride dynamics, Electronics and Lighting and finally Motorsport. Marelli represents a Sales revenue of €13,4 billion with around 60 000 employees in 170 locations over the world.

DVN: Will you see big changes in the next 12 months inside the new Group and inside Marelli Automotive Lighting?

S.D.: Change is already underway, with a new leadership team in place from day one (May 2019), moving forward with the integration of the new Marelli. Defining strategic direction for the Group and managing the synergies that you can expect from such a merger as just two major objectives. At Automotive Lighting, we are already working on how to be more present with Japanese OEMs - an example of the numerous initiatives that we have launched since the merger.

DVN: What are for you the strengths of Marelli Automotive Lighting and the challenges in front of you?

S.D.: Marelli Automotive Lighting is a well-established lighting supplier, with the critical size, a global footprint, a well-balanced customer portfolio, a diverse leadership team and we are at the vanguard of lighting technology. These are all qualities that make up our strength. Our challenges are to adapt continuously to changing environments, increasing competition and strategic positioning on the new technologies such as mass-market full LED solutions, democratization of ADB and development of DLP and Laser for high end. In addition, we are positioning ourselves on the sensing area, investing in LiDAR, and not only that, to contribute to ADAS development. Our primary target is ADAS Level 2+/3, where I believe the market is going to grow significantly in the next years.

DVN: 2019 was difficult for Tier 1 partly because the decreasing of volume of the cars mainly in China. How do you see the next 12 months for the automotive suppliers?

S.D.: As you mentioned, the downturn in the automotive industry does not spare any Tier 1. We expect 2020 to be equally tough across the global industry, where not only China, but also the rest of the world, continues to be impacted by the external

environment. In this situation, we will continue to focus on what we can control, which includes working on our cost base and investing in key growth areas to make sure we are well prepared for the future. This is what we are doing at Marelli Automotive Lighting.

DVN: ADB is a wonderful technology able to greatly improve the safety at night. What could the lighting suppliers do to convince the drivers to buy this technology?

S.D.: Most of deadly casualties involving car accidents happen at night and OEMs and Lighting suppliers know how crucial light is in helping to avoid accidents. In this regard ADB is a new step in improving safety thanks to better distribution of light towards where it is needed, hence securing a no-glaring system. As a Tier 1, our interlocutor is the OEM and we have few occasions to have direct access to the final users. Nevertheless, every time we have access to the public like during Motor shows we take the opportunity to promote ADB. In addition, we realize that car dealers do not always know about Lighting technology and ADB. Therefore, we offer our customers support, providing lighting training for their Salespeople. However, it is in the OEMs' hands to convince the end customers and it is noticeable that lighting technology is getting increasing attention in OEMs' ads and events.

DVN: Congratulation for the award. After the Mercedes-Benz S-Class Maybach, did you receive other orders from Premium brands?

S.D.: I would like to mention that we were first to market using this technology with Mercedes-Benz. And we are also producing it for Audi on the E-Tron. We have also received other orders which are currently under development.

DVN: How do you see road communication to help the driver as construction, warnings, in the future?

S.D.: Every time we talk about lighting, we talk about a system that is a key contributor to driver's safety. This new lighting technology, which allows the driver to receive information projected on the road, in his or her field of view, is clearly a step forward towards driver's safety. I am convinced that this and other high-resolution technologies will develop broadly in the coming years.

DVN: How do you assess the DMD technology with the thousands μ LEDs technology?

S.D.: DMD technology is the high end of light digitalization with 1.3 Megapixel. It has a cost that cannot be afforded by the mainstream OEMs. However, we are currently developing a more affordable solution in the range of 30.000 pixel for generalists, so called Micro-LEDs (μ LEDs). We are convinced that our new development will allow the democratization of this safety feature.

DVN: Automotive lighting field was going in a wonderful future before the crisis. How do you see the effect of the crisis on lighting innovations?

S.D.: Before the crisis, megatrends such as electrification, autonomous driving or car connectivity were pushing carmakers to invest a lot in innovation, sometimes making choices not to spend in other areas like lighting. The COVID crisis, whose magnitude is still difficult to evaluate, is already having some impact on innovation where in some cases, OEMs have decided to delay or stop some programs. So, for sure, innovation will be affected, and a slowdown is expected, not specifically for lighting, but in general.

Andrea Stella, R&D Vice President



Andrea Stella, R&D Vice President at Marelli Automotive Lighting.

DVN: ADB has now made it from premium cars to middle range cars. How could the lighting suppliers convince generalist car makers to accelerate this shift?

Andrea Stella: We are convinced that driving down the cost of ADB will be the best way to make this technology popular, allowing generalist OEMs to use it, and it is already happening. In order to make them accelerate the shift to ADB, we offer cost convenient and scalable ADB systems for example with our standard LED modules. ADB requires a more complex architecture referring to camera or electronic control unit. So, to speed up the process of « ADB-zation » we additionally offer to the OEMs entire system integration to fill some technological gaps.

DVN: With the arrival of communication functions (V2drivers, V2pedestrians) and the need of styling differentiations, all lighting players, are working on them. Could you present your works on them?

A.S: We have taken a lead at introducing first on the market communication with light: our digital light is able to project assisting and warning symbols on the road. With this high-resolution system, we go into the next generation for a new market launch. Our animated signal functions are available in front and rear lights. Another promising communication opportunity for V2V is the LiFi technology, currently integrated into our SMART CORNER concept.

We are also working on displays to enable the communication vehicle-to-pedestrians or to other drivers in future.

Speaking of styling differentiation, we have to mention our FOLIA LED, a cost optimized OLED alternative. Very robust, very long lasting, efficient and, in combination with a dedicated software, extremely flexible in terms of design. Here we can use software features to realize different possible animations and signatures.

In all these fields, software is the key.

DVN: Laser technology is used for long visibility distance and now for ADB scanning and communication. Do you see a future of this laser technology in comparison with DMD, LCD, LCoS?

A.S: Laser technology is one of our forte. Starting with the first laser headlamp in 2014 we now have volume projects with our 3rd generation laser, capable of ADB. We will continue to work on this technology, though we need to develop more cost-optimized solutions. Regarding the use of laser for ADB scanning, we must keep in mind that all systems dealing with laser light sources require multiple and redundant safety features.

DVN: OLED is not perceived as an established light source because of cost, durability, and reliability. Do you see a future for this technology?

A.S: OLED is still a remarkable technology allowing for light surface segmentation – which provides a unique aspect for styling possibilities. Therefore, we are still working on it for interested carmakers and have good projects in development. However, since the

reliability of OLED in general is still not comparable with LED, we have also developed a very attractive alternative solution called FOLIA LED. With an appearance very similar to OLED, it offers plenty of benefits in terms of reliability, lifetime and finally, cost as mentioned previously.

Conclusion



MARELLI is one of the world's leading global independent suppliers to the automotive sector. With a strong and established track record in innovation and manufacturing excellence, its mission is to transform the future of mobility through working with customers and partners to create a safer, greener and better-connected world. With around 60,000 employees worldwide, the MARELLI footprint includes 170 facilities and R&D centers across Asia, the Americas, Europe, and Africa, generating revenues of 13,4 Billion Euro in 2019.

Marelli-Automotive Lighting, a new division of Marelli, was born in 1999, from long-established car lighting parent operations of Bosch and Magneti Marelli.

In 2019, Magneti Marelli was acquired by CK Holdings, a holding company of Calsonic Kansei Corporation. The two companies united to create Marelli led by Beda Bolzenius. Marelli Automotive Lighting is a global supplier of front and rear lighting products and considered one of the top 3 exterior lighting suppliers worldwide. It has now a worldwide strong position.



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