

KSLD DVN LIDAR LASERLIGHT

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Company intro & Portfolio





Historv

- SLD spun out of Soraa (LED) in 2013
- ~200 employees with DNA from Auto, SSL, laser industries
- GaN pioneers UCSB Prof's Nakamura and DenBaars
- Acquisition in January 2021 by Kyocera Group

Operations

- HQ and Epi in Santa Barbara, CA
- Device engineering & Production fab in Si Valley, CA
 Module product design in AZ and assembly offshore

Technology

- Next gen LDs based on Semipolar GaN
- LaserLight Fiber & SMDs with 100x brightness of LEDs
- >500 patents covering materials to applications

Commercialization

- In series production for Auto since 2019
- Beyond Lighting Sensing and LiFi commercialization 2021
 IATF 16949 and ISO certified; UL and IEC safety certified



LaserLight Summary

Brighter

1100cd/mm² vs 200cd/mm² from LED, creates much greater light & luminous intensity

Smaller

350 µm LES vs 1mm from LED, enables unconventional shapes and ultracompact packaging

Farther

1km from 35mm reflector vs 100m from LED, up to 300m for ADAS & LiDAR

Faster

>2 Gbps data transfer vs 100 Mbps from LED, which is a multiple of 5G







Product Portfolio





KSLD Wins 2021 Prism Award





KYOCERA SLD Laser wins the 2021 Prism Award for Transportation Category (Auto) The World's First Dual Emission White/Infrared LaserLight Source!

Switchable, safe, dual-channel SMD: Systems that implement white light and infrared require separate optical assemblies that increase the size and weight of pure laser-based systems, in turn leading to speckle in the imaging sensors. The LaserLight W-IR SMD generates diffused incoherent light, with 10× higher luminance compared to other LEDs and/or light sources from the same optical point.



SMD Technology

11/19/21



World's only LaserClass 2 Reflective System in one unique 7x7 mm Package







ADAS & Sensing



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LaserLight Sensing for Range Finding

KYOCERa



Configuration

- High beam fitted with IR illuminator
- · Sensor module located behind rearview mirror

Operation

- Daytime: IR is sensing, white is off
- Nighttime: IR and white are on
- > 250 meter

Supplements / eliminates radars in bumper and grill

- Reduces vehicle expense of bumper/grill installation
- Address radar failures related to poor weather conditions
- Efficient and compact solution utilizing headlight for ranging

High Beam ranging module in headlight addresses challenges of forward radars



LaserLight ADAS Sensing Demos



SLDLASER

Sensing using Dual White-IR LaserLight SMD

- 3D flash Lidar demonstrated at video speed and VGA resolution
- Night vision image captured with 3D depth data
- Up to 10 m range with no collimation, extendable to > 100 meters with HB optic
- Road test conducted with a Laser HB + Flash LiDAR prototype



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LaserLight: W-IR SMD Parking & Ranging

🔇 КУОСЕRа

W-IR LaserLight SMD for NightVision/3D rear camera

Assisting Cameras for Parking & Ranging

From legal point of view the Reverse Lights have to be used. Licence plate beam pattern is legally limited to licence plate illumination only.



LaserLight Sensing Applications



Sensing using Dual White/IR LaserLight SMD



Low-speed city traffic



AEB





Park assist (stereo garage)



Pedestrian and cyclist warning



Height and width limitation warning



Cut-in warning

A promising solution to solve:

- Radar/LiDAR & Camera Vision mismatch
- CIPV cut in •
- CIPV has high lateral velocity •
- Motorcycle on the highway during night
- Driver breaks sharply on the highway •
- Radar stack "track break" at harsh break
- False slow down under bridge
- High speed stationary approach
- Rarely sloping or sharp turning road surface
- Stereo parking garage 0
- ADAS camera appears blinded 0
- Height and width limitation warning
- Objects on the vehicle roof
- Pedestrian detection in city traffic 0



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LaserLight: SMD W-IR Application Roadmap

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| Generation | Gen 1 IR Illumination | Gen 2 Sensing | Gen 3 LIFI |
|------------|--|------------------------------|----------------------|
| Consumer | White/Night Vision | Range Finding | LIFI, Range Finding |
| | Flashlight | Flashlight | Flashlight |
| Auto | White/Night Vision for | ADAS (Rangefinding, | Headlights with Comm |
| | Camera Module | Lidar) | to Smart City |
| 11/19/21 | KYOCERA SLD L C O N F I D E N T I A L A N | .ASER, INC. D proprietary | SLDLAS |

DataLight®















LiFi today can be 20x faster then 5G & WiFi



Large range: ≥ 50 m < 1000m 1-10Gbit/sec

Medium range: \geq 10 m and < 50m: 20Gbit/sec

Short range: <10m up to 100Gbit/sec

Cable operators in the U.S., whose networks currently pass 85 percent of U.S. homes, are implementing the new 10G initiative, with lab trials and field trials beginning in 2020.





LiFi Communication @ 20 Gbps, shown at CES 2020







... and it works in strong sunlight

| | | Dark Room | Sunlight Irradiance | Sunlight + Blue Filter |
|----------------------------|--|-----------|------------------------|---------------------------|
| | Average SNR [dB] | 18.58 | 16.42 | 17.36 |
| 4-05K mm ²] | SNR degradation compared to Dark Room | 0% | 11.6% | 1.7% |
| 366⁄ | Data rate @ BER< 3.8e-3 [Mbps] | 1139.26 | 1015 | 1080 |
| S: 0 | Degradation of data rates compared to Dark Room. | 0% | 10.9% | 5.18% |

M. S. Islim *et al.*, "The Impact of Solar Irradiance on Visible Light Communications," in *Journal of Lightwave Technology*, vol. 36, no. 12, pp. 2376-2386, 15 June, 2018.

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LiFi Center results proof KSLD solution is Best in Class

| Device | Bandwidth | Optical Power | Eye Safe |
|--------------|-----------|----------------------|----------|
| Micro LED | Medium | Very Low | Yes |
| COTS LED | Low | Very Low – High | Yes |
| LASER | High | High | No |
| SLDLaser SMD | High | High | Yes |

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DataLight[®] - LiFi Innovation



Bi-directional data transfer using only one LaserLight SMD State of the art data rates up to 2 Gbps

