

FACILITATING THE FUTURE OF AUTOMOTIVE 3D SENSING




Vertical-Cavity Surface-Emitting Lasers (VCSELs) in Vehicles:

Why VCSELs are the laser technology of choice for automotive

EXPANDING DEMAND

Between the increasing pervasiveness of advanced driver assistance systems (ADAS) and the continued push towards fully autonomous vehicles, the applications and demand for automotive 3D sensing are growing rapidly.

IN-CABIN APPLICATIONS:

-  **Driver Monitoring Systems (DMS)**
- Drowsiness, recognition, distraction
-  **Occupancy Monitoring Systems (OMS)**
- Car status and settings as result of occupancy
- Fail-safe occupancy monitoring
-  **Gesture recognition**
- Controls, functions



■ Long range
■ Short range

Long-Range LiDAR (200 m)

- Used for pedestrian detection, collision avoidance, and emergency braking.

Short-Range LiDAR (10-50 m)

- Used to scan the area around the bumpers—not to just detect objects, but to also identify what they are.

OUR EVER-EXPANDING CAPABILITIES

As automotive LiDAR evolves and demands higher power, lower divergence, lower pulse widths, and better detection, Lumentum VCSEL advancements are able to solve key LiDAR illuminator challenges.

LIDAR REQUIREMENTS

NEEDS FROM LIDAR ILLUMINATOR

LUMENTUM SOLUTION

- Resolution, brightness, and range
- High object detection accuracy
- Best field of view (FoV)

- Highest possible power
 - Pulse power >100 W at <30 A (10 ns, 0.1% DC)
 - Slope efficiency >3 W/A over temp range
 - Power density of up to 800 W/mm²
- Low divergence angle

- Multi-junction VCSELs address time-of-flight (ToF)
 - Outstanding, scalable power
 - Significantly improved efficiency >6 W/A
 - Ideal for d-ToF applications

- Stay within eye safety limits

- Nanosecond pulse capability (<10 ns)
- Low wavelength shift over temp (<0.07 nm/°C)
- Small emitter size/optical area

- Addressable arrays enable small emitter size/optical area and no need to illuminate entire scene
- Pulse capability of just a few nanoseconds!

- No moving parts
- Compact, easy to integrate

- Ability to integrate with sensor processing speed and field-of-view requirements

- Addressable VCSEL sections allow for easy integration and elegant solutions with no moving parts
- Small die, illumination matched to SPAD read-out

- Automotive quality and reliability

- AEC-Q qualification
- IATF16949 certified fab
- RoHS compliant

- Proven Kaizen history and quality culture
- VCSEL chips and modules undergo AEC-Q102 qualification
- IATF16949 certified fab

- Cost-effective solution

- Ability to drive scale and process expertise

- High-volume fab shipping millions of VCSELs every week
- Proven manufacturing and test processes

PREMIUM AUTOMOTIVE-QUALITY SOLUTIONS

Lumentum's industry leadership and quality culture mean cost-effective, reliable manufacturing for demanding automotive applications.



AEC-Q102 QUALIFIED VCSEL CHIPS AND MODULES

Stress-test qualified for automotive applications



IATF16949 CERTIFIED FAB

Automotive-approved, process oriented quality management system



MILLIONS OF VCSELS SHIPPED PER WEEK, ZERO FAILURES

Able to drive scale without sacrificing quality

