

OSRAM

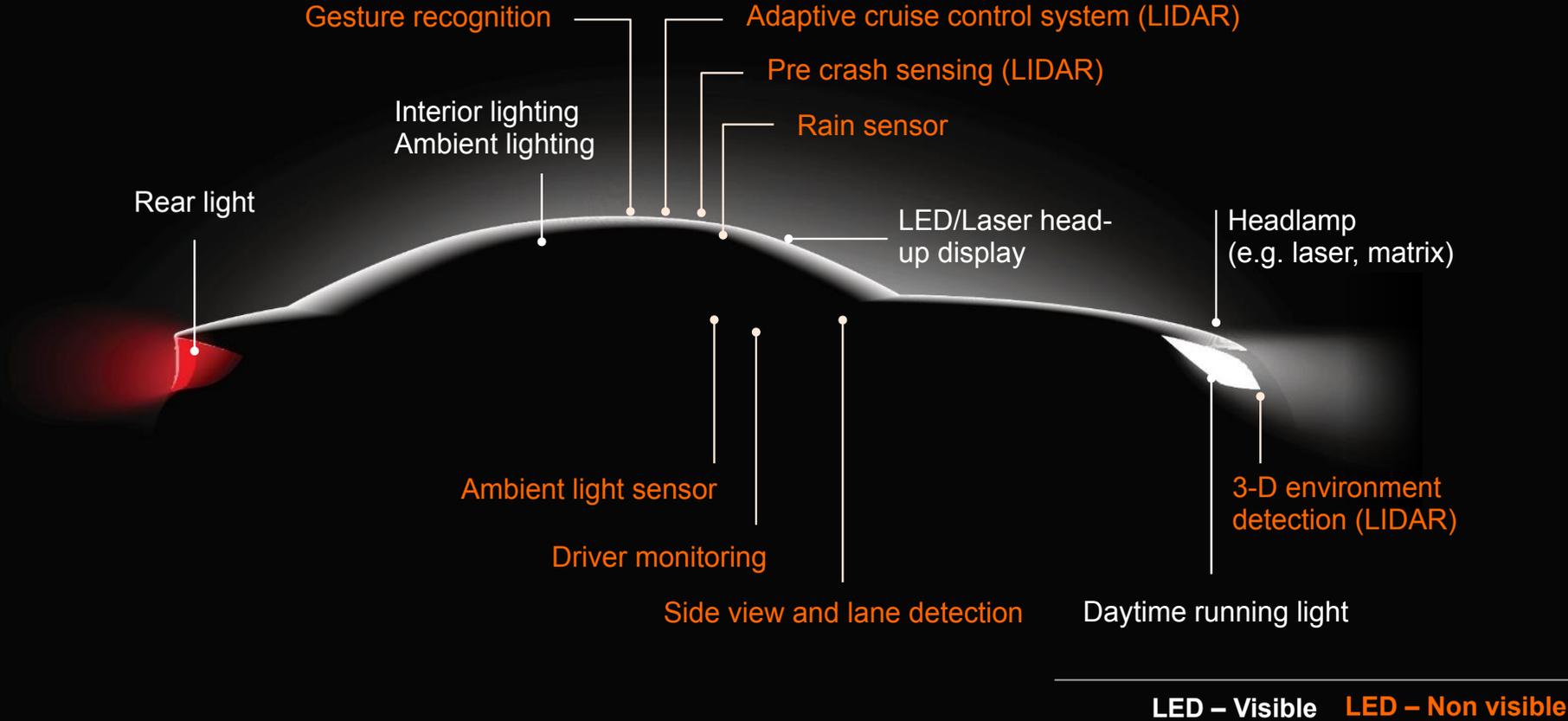
Osram Laser brings Autonomous Driving one step closer

Dr. Andreas Bauer, Stefan Mergl | DVN LIDAR CONFERENCE November 20, 2018 | Frankfurt
Light is OSRAM

Agenda

- **Introduction**
- LIDAR market and technology overview
- LiDAR@OS: Emitter technologies
- Outlook

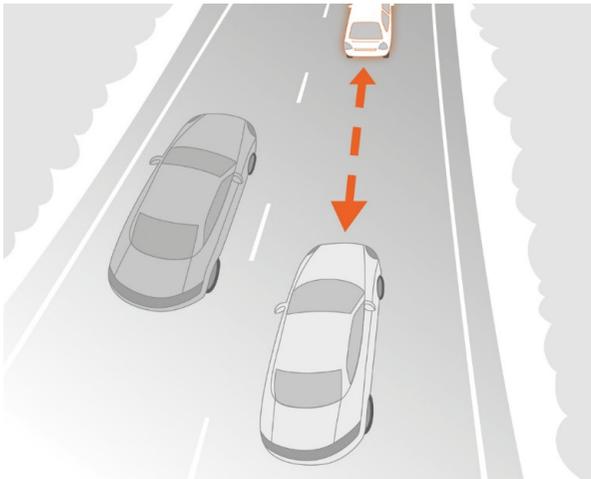
OSRAM has extensive autonomous driving expertise



OS is a long-time partner for lasers in the automotive industry

First use of LiDAR since early 2000s

Short-range-LiDAR – Cam System



905 nm pulse Laser,
75 W, 20 ns

**More than 10 car OEMs
use laser based AEB¹
systems with OSRAM
's 905nm laser already
today**

OS with pioneer role and a proven track record

- LiDAR Laser supplier to automotive industry for over 10 years
- over 10 million LiDAR lasers in the field (~ 200 billion km) without *chip failures*
- zero field failures for 7 million bare dies
- more than 20 LiDAR design-ins and -wins with OS lasers

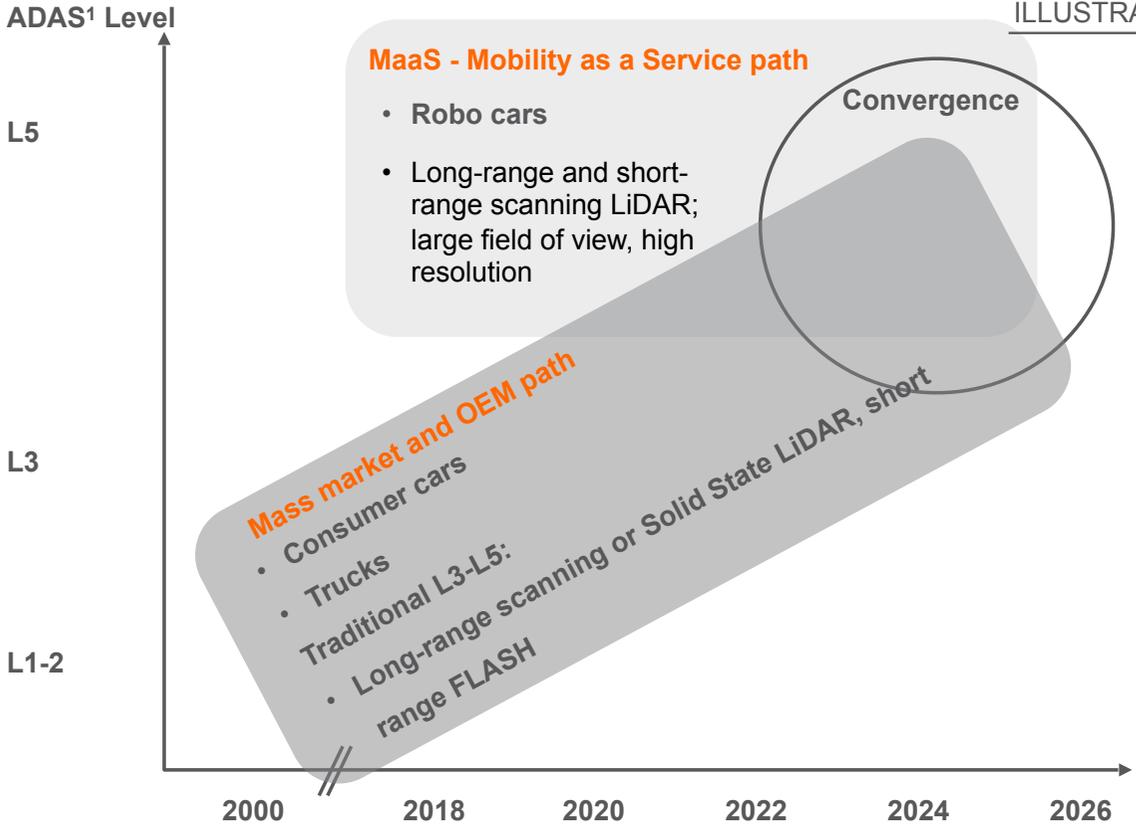
Technology USP

- Highest Efficiency (30%)
- Best thermal resistance
- First automotive grade pulse laser on the market

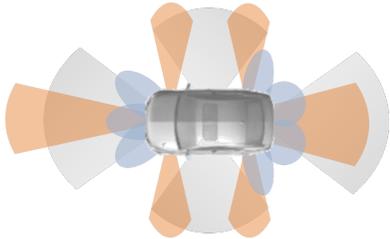
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Two different approaches to autonomous driving: Mobility providers starting with L5 short term, traditional OEMs evolve from L1 to L5



ILLUSTRATIVE



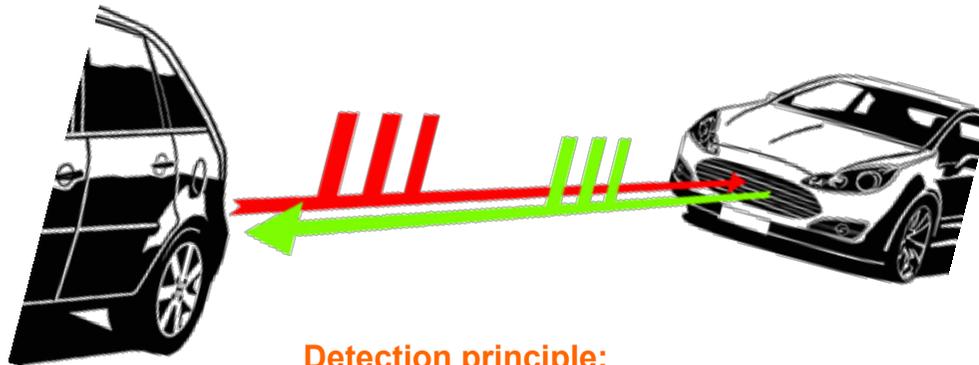
- Co-existence of LIDAR, RADAR and camera sensors in Autonomous Driving (L3 upwards)



- Two completely **different approaches to autonomous driving** with different dynamics driven **by two distinct groups of players** – mobility-as-a-Service providers (MaaS) and traditional car manufacturers
- However, in the long run there will likely be a **convergence of the two approaches**

LiDAR uses reflected light to measure distance to objects; it can be used for short-range up to a distance of ~300m

LiDAR (Light Detection and Ranging) – a Time of Flight measurement

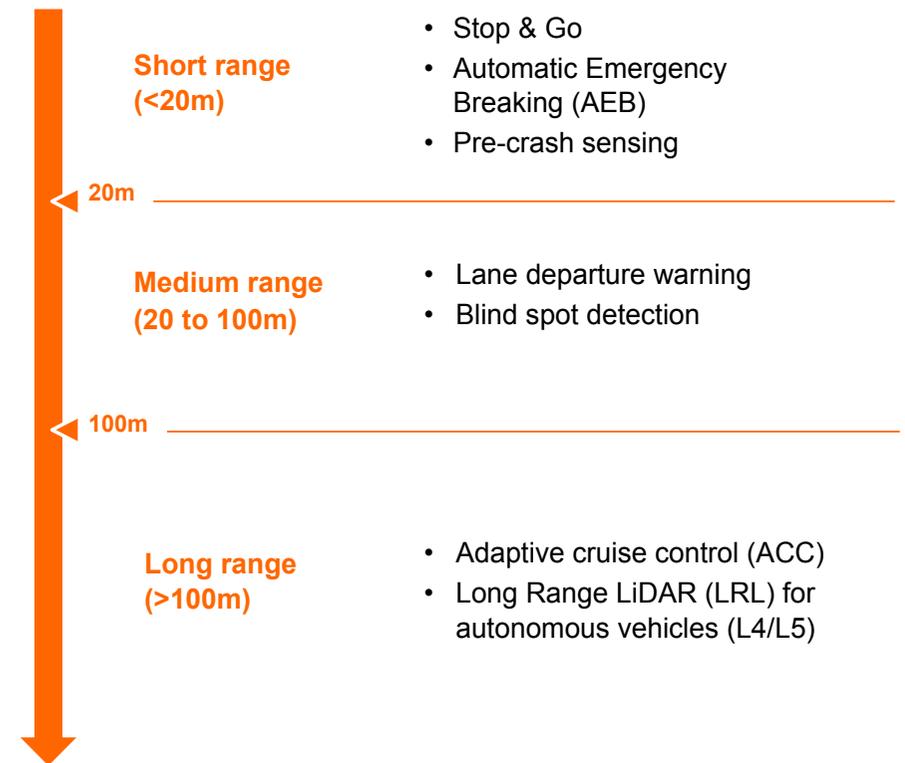


Detection principle:

A very short laser pulse travels from the LiDAR sensor to an object and back. The sensor measures the travelling time of the laser pulse and determines the distance and relative velocity of the object.

100 m distance \Leftrightarrow 0,6 μ s

Lidars can be used for different distances and use cases



Short range (<20m)

- Stop & Go
- Automatic Emergency Breaking (AEB)
- Pre-crash sensing

20m

Medium range (20 to 100m)

- Lane departure warning
- Blind spot detection

100m

Long range (>100m)

- Adaptive cruise control (ACC)
- Long Range LiDAR (LRL) for autonomous vehicles (L4/L5)

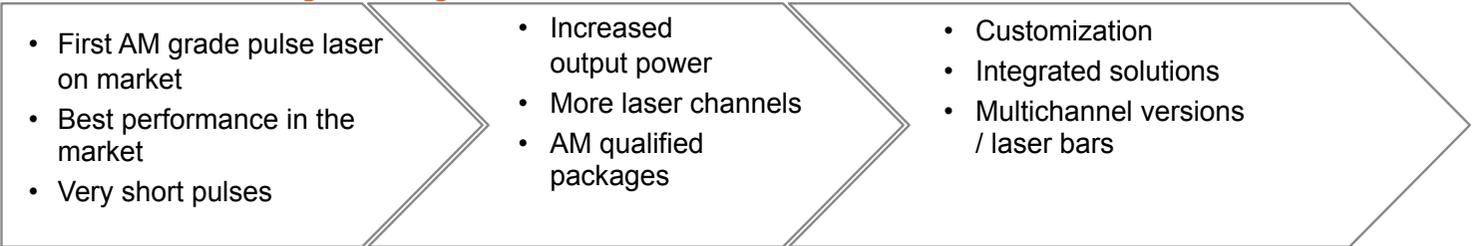
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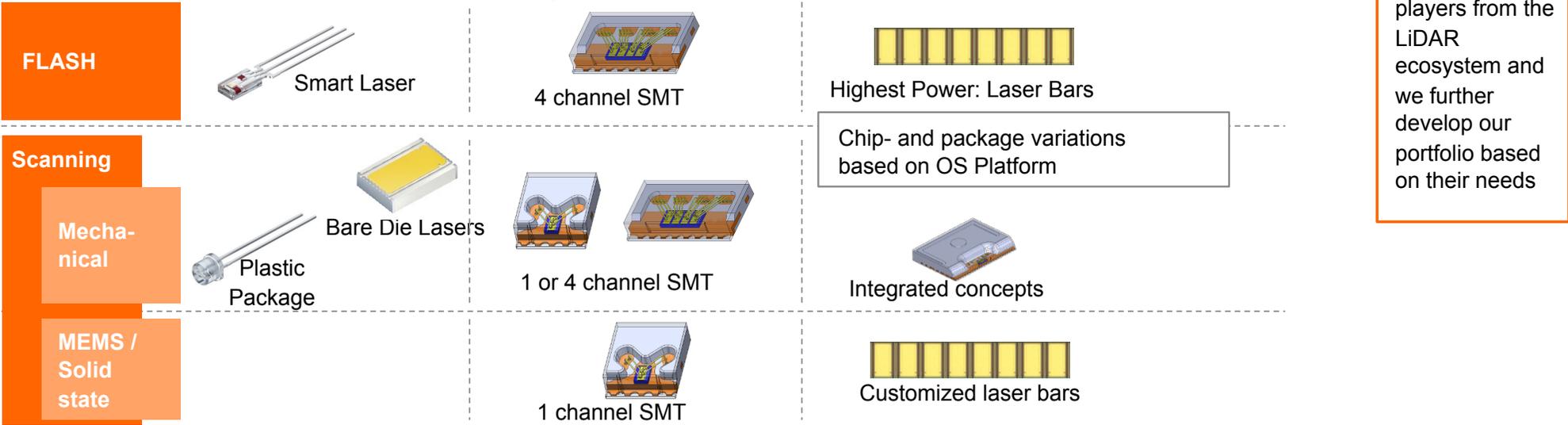
Osram: we offer solutions for all relevant LiDAR technologies based on 905 nm Lasers

SELECTIVE

Evolution of 905nm edge emitting laser



OS product roadmap for different LiDAR technologies



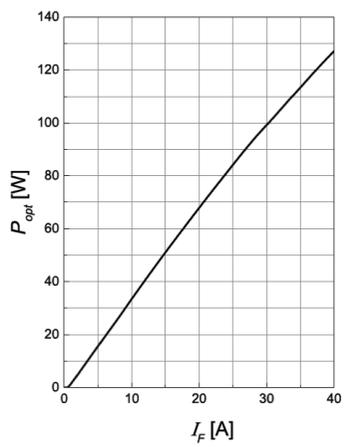
Bare Die 120W Infrared Laser Diode SPL DS90A_3



Technical details & Target performance

Optical Output Power

$$P_{opt} = f(I_F)$$



- Edge emitting pulse laser 3 vertically stacked emitters
- Dimensions 0.4 mm x 0.6 mm x 0.115 mm
- Efficiency @ working point ~30%
- DC max 0.1% (0,2% targeted)
- The product qualification test plan is referencing the guidelines of AEC-Q102(*)

Product Status

- Pre- Series production
- PPAP planned for Dec 2018

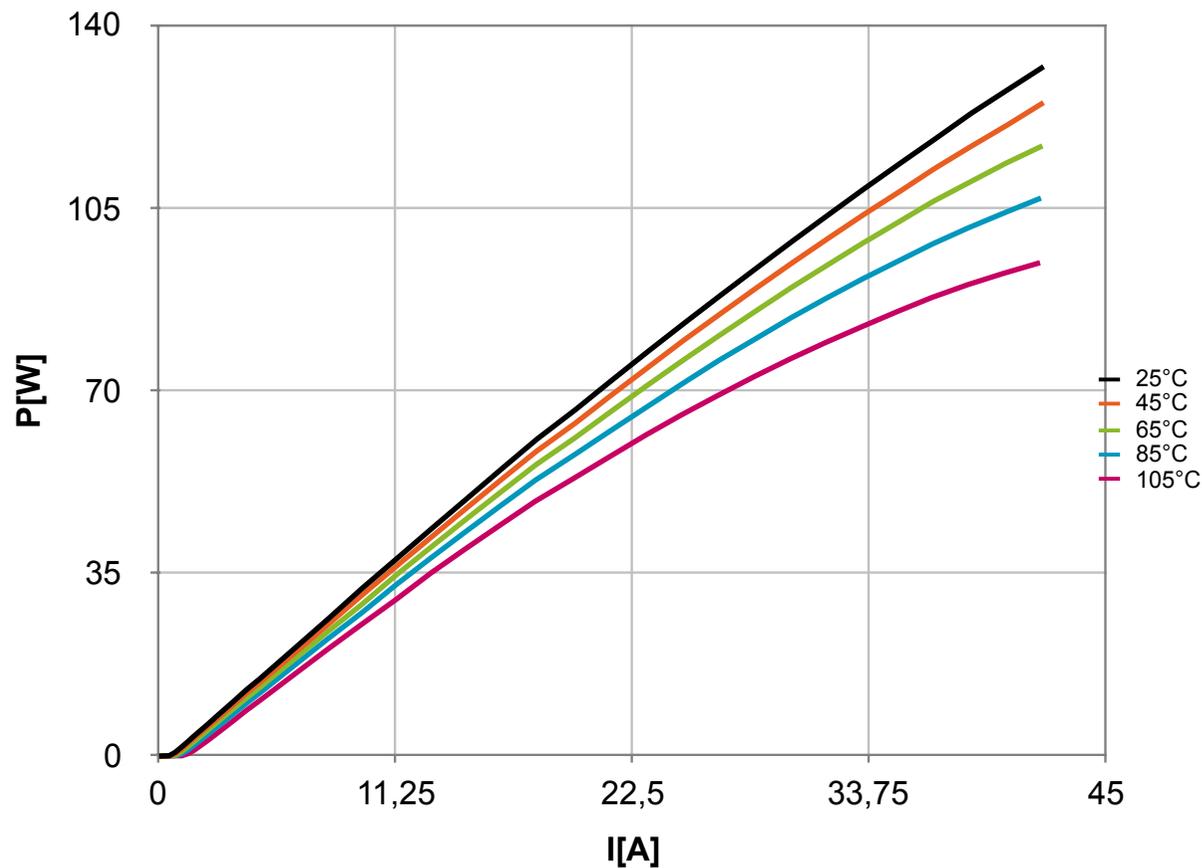
Highlights & Benefits

- Optical Power typ 125W @ 40A
- Pulsed Laser LiDAR Applications
- Wavelength: 905 nm

Data is subject to change due to status of development.

10 (*)The complete qualification test plan in AEC-Q102 is not applicable for bare IR laser die. Only selected tests from AEC-Q102 which are deemed relevant for bare die-related failure mechanism are performed.

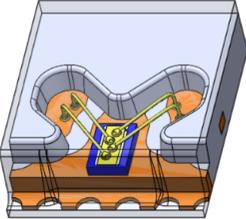
Technical discussion : LIV Curve for different temperatures



Measurement conditions

- Pulse Width 100ns
- Masured in TO can as test vehicle
- Variable T is Tambient as indicated in Diagram
- Pulse Repetition Frequency 10kHz
- Average approx $\sim -0.4\%/K$

SMD 1 Channel Device



Technical details & Target performance	Product Status
<div> <p>Opt. Power / Forward Voltage</p> <p>$P_{opt}, V_F = f(I_F)$</p> </div> <ul style="list-style-type: none"> • Optical Power: 120W@40A • Pulse length 2ns demonstrated • DC max 0.1% (0,2% target) • Dimensions 1.8mm x 2.3mm x 1mm • The product qualification test plan is based on the guidelines of AEC-Q102 	<ul style="list-style-type: none"> • In development • SOP 2019 <div style="background-color: #f4a460; padding: 5px;"> <p>Highlights & Benefits</p> <ul style="list-style-type: none"> • 1 channel SMD pulse laser • Wavelength: 905 nm </div>

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Short pulse Demonstrator

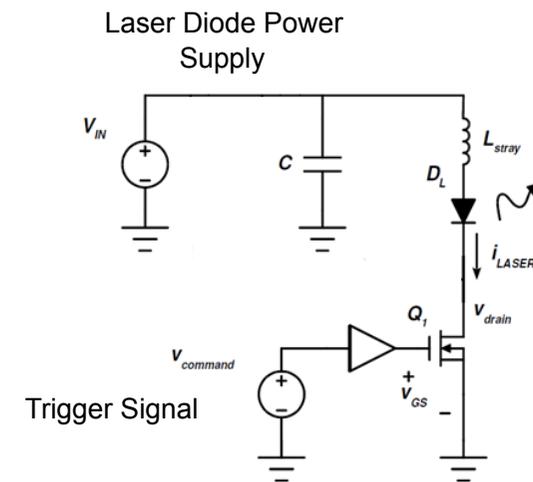
1 channel Pulse Laser and LiDAR Pulse Laser Demo

Pulse width, current slope rise time, duty cycle, eye safety and total reachable Popt are strongly linked.

We built up a reference design to demonstrate 2ns short pulse behavior of our laser source.

PCB routing strongly affects optical rise time and optical peak power

- 1 channel pulsed laser
- pulse width ~2ns
- Laser wavelength 905 nm
- Peak output power 120W @ 40A
- Option to measure the laser current

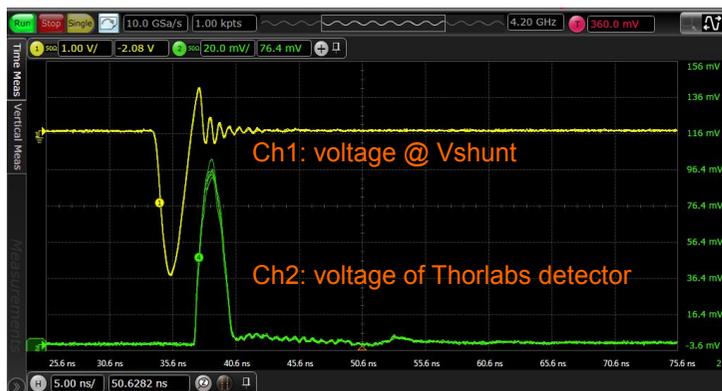


Driver principle

Measured optical Pulse width (50%) : ~2ns

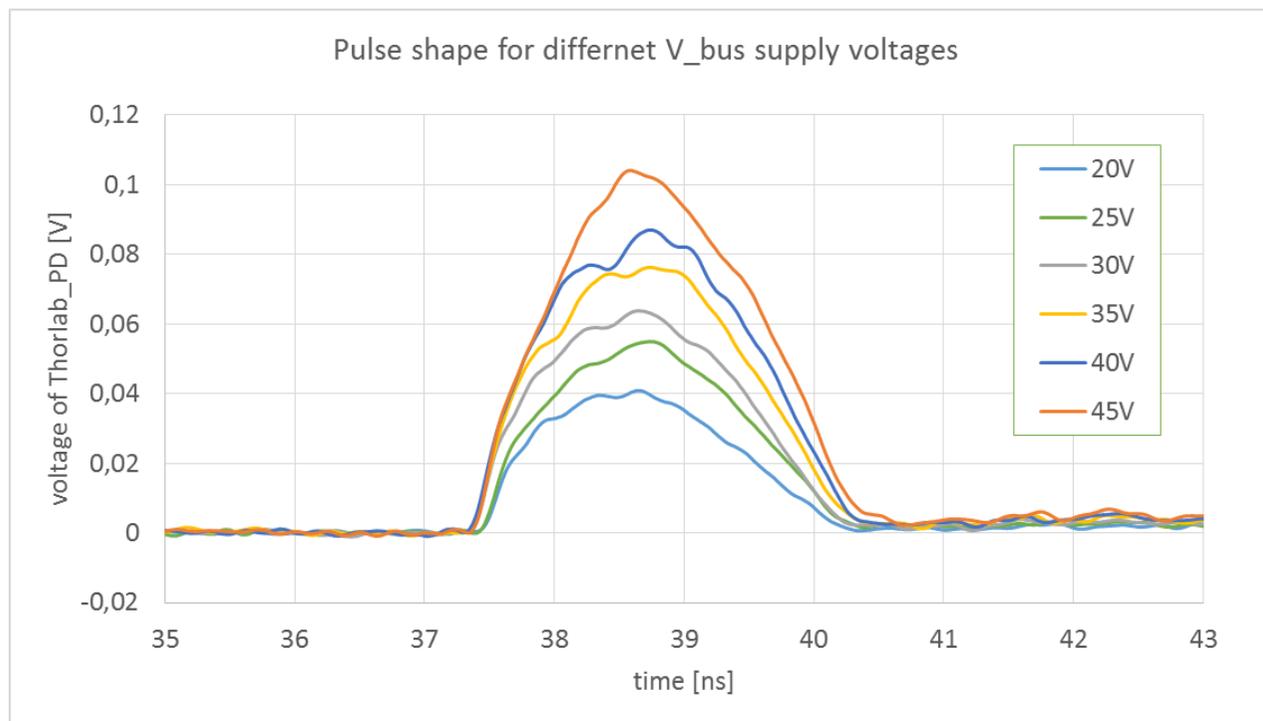
Actual shape of electrical and optical pulse

Example Pulse shape for Vbus = 45V



Vbus	Peak Optical Power	Optical pulse width @ PD
V	W	ns
20	41	2
25	53	2
30	66	2
35	81	2
40	93	2
45	107	2

Pulse shape of optical Signal for different Vbus levels



Measured optical Pulse width (50%) : ~2ns

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OSRAM is well positioned to participate in the LiDAR market

- OSRAM has a long track record in automotive LiDAR applications
- Successful 905 nm edge emitting laser platform will be further developed to higher power and packaged versions
- 2ns pulse operation demonstrated
- OSRAM LiDAR Lasers will be qualified referencing the guidelines of AEC-Q102

Many Thanks.

