

Communication with High-Resolution Light 高分辨率照明通讯

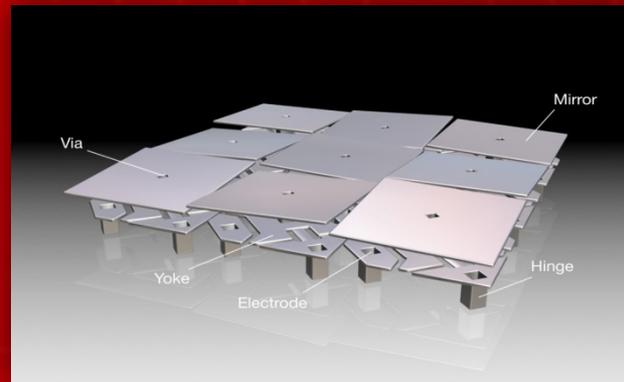
25th April, 2019

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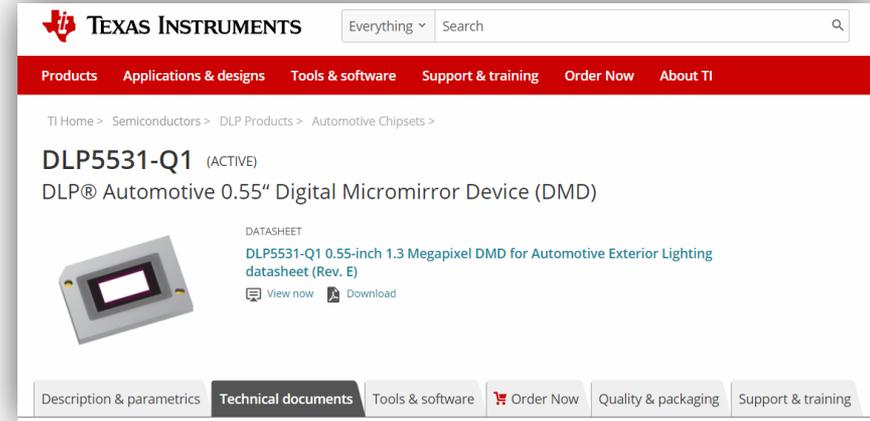
德州仪器 DLP[®] 技术中国区市场经理



Topics for today

今日主题

- Benefits of a digital micromirror device (DMD) for automotive lighting applications
- A case for high resolution
- Efficiency and throughput analysis
- Future improvements
- Additional applications for communicating with light



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DLP5531-Q1 (ACTIVE)

DLP® Automotive 0.55" Digital Micromirror Device (DMD)

DATASHEET
DLP5531-Q1 0.55-inch 1.3 Megapixel DMD for Automotive Exterior Lighting datasheet (Rev. E)

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ti.com/dlpautomotive

Highest resolution exterior automotive lighting solution available

提供最高分辨率的汽车外部照明方案

More than
1 MILLION
addressable pixels
per headlight

Extends the resolution by
more than **10,000** times
compared to existing adaptive
driving beam technologies

Final lens less than **40mm**
in height, giving automakers
the ability to increase technical
performance without
sacrificing style

Ability to support any light
sources, including **LED**
and **laser** illumination

Developed from proven
DLP technology
used in cinemas, displays
and in automotive

ENHANCES DRIVER VISIBILITY, MINIMIZE GLARE, AND COMMUNICATE WITH LIGHT
增强驾驶员的可视性，减少眩光，利用照明交流

Only automotive technology on the market that is both fully programmable and highest resolution available
汽车市场上唯一可完全编程和最高分辨率

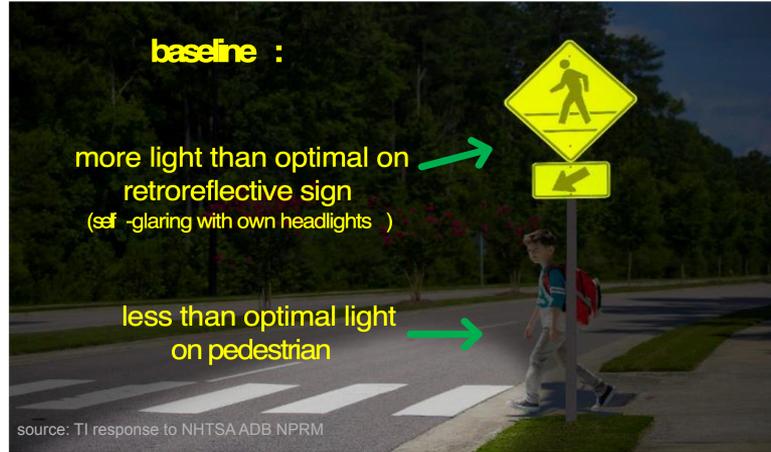


**Programmable
lighting
technology**

Transforms headlight systems into communication channels by projecting relevant information on the road that can enhance communication between drivers, pedestrians and other vehicles

Flexibility to create custom, fully programmable headlight systems that reinvent how vehicles and drivers interact

灵活地创建定制、完全可编程的前照灯系统，重塑车辆和驾驶员的互动方式



Adaptive driving beam (ADB) solution

Allows automakers and Tier-1 suppliers to control every one of the more than one million pixels in each headlight to maximize brightness and minimize glaring for oncoming traffic or reflection from retroreflective traffic signs

On-road Symbol Resolution Requirements

路面符号分辨率要求

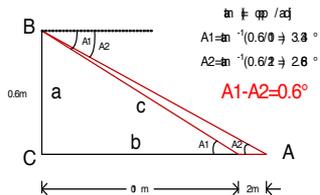


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<https://www.mercedes-benz.com/en/mercedes-benz/innovation/digital-light-headlamps-in-hd-quality>

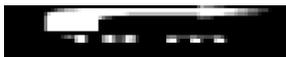
On-road Symbol Requirements

路面符号分辨率要求

Assuming a 14x7 degree system...



Resolution Examples:



0.05 degree / pixel

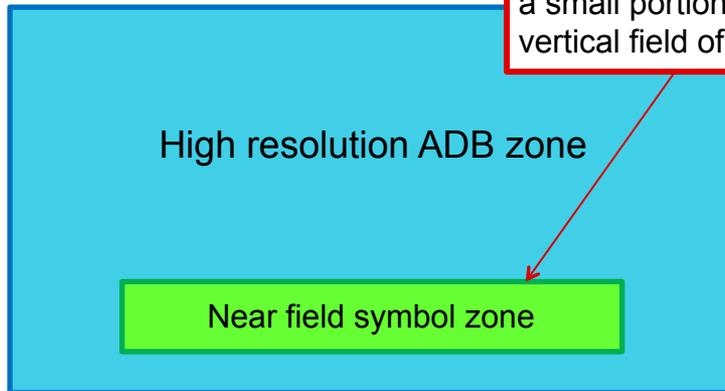


0.013 degree / pixel

for a 2m symbol at 10m \rightarrow symbol is a mere 0.6° tall

Very high resolution is required for on-road symbols
路面符号投影要求非常高的分辨率

The symbol region is a small portion of the vertical field of view



On-road symbol zone is ~8-10% of imager vertical lines

$(0.6^\circ / 7^\circ) * 576 \text{ lines} = 49 \text{ lines (good)}$

for a 100 line system $\rightarrow 8 \text{ lines (bad)}$

(a 40,000 pixel system is generally ~100 lines)

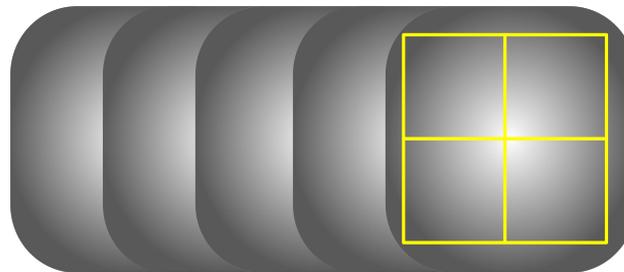
Displacement Resolution vs. Display Resolution

位移分辨率 VS. 显示分辨率

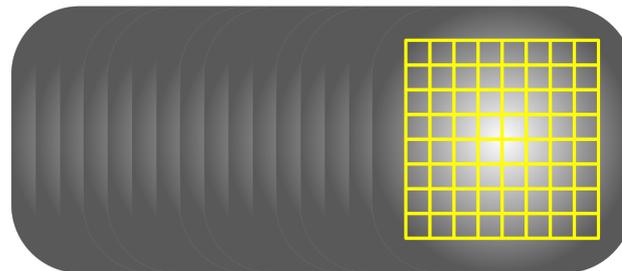
One benefit of high resolution for ADB is smooth mask opening motion

Higher resolution = smoother

Even with optics resolution lower than the imager resolution, the high resolution of the imager produces useful benefits – smooth motion, smoother object edges, pixel-free appearance



imager resolution ~ optics resolution : large steps



imager resolution \gg optics resolution : small steps

High resolution enables smooth object motion
高分辨率提供平滑物体运动

Long Range High Resolution Applications

远程高分辨率应用

number of stripes on 1mtall object		degree / pixel			
		0.2	0.1	0.05	0.02
distance (m)	25	5	11	22	57
	50	2	5	11	28
	100	1	2	5	14
	150	0	1	3	9



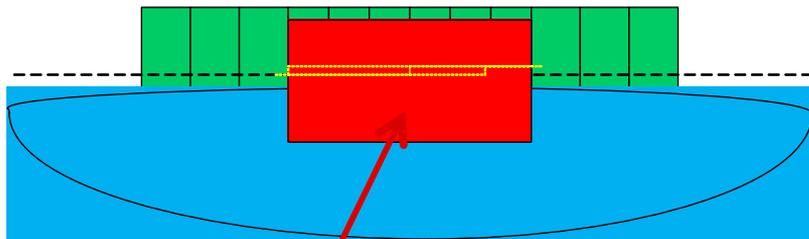
DMD case: $10^\circ/576$ lines = 0.017 degree / pixel in vertical, better than $0.02^\circ/\text{pixel}$

0.1° per pixel supports useful patterns out to only about 50m

Better than 0.1° per pixel resolution is required to pattern at long range
远程图案投影需要高于 $0.1^\circ/\text{pixel}$ 分辨率

High resolution DMD module + low resolution LED matrix 高分辨率 DMD模块 + 低分辨率LED矩阵

This combination makes a lot of sense – headlight efficacy is a mix of matrix and DMD module

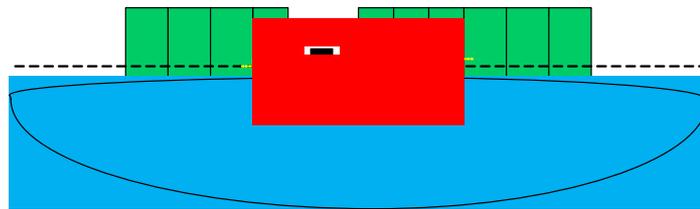


Total high beam is a very effective combination of DLP technology and LED matrix base light:
DLP技术和LED矩阵基础灯组合成非常有效的整体远光照明。

$$0.4 * 24 \text{lm/W} + 0.6 * 45 \text{lm/W}^{(1)} = \underline{\underline{36.6 \text{lm/W}}}$$

[1] E.-O. Rosenhahn, "New Systems for Safety and Comfort, Improvement by High Resolution Flexibility," SIA Vision, Paris, 2018.

system **performance** is set by DMD module



system **efficiency** enhanced by low cost matrix base light

“All pixels on” efficacy comparison

“所有像素打开”的效率比较

DLP technology + Osram Oslon Boost HX



KW CULPM1.TG Version 1.6 | 2018-10-10

Key characteristics:

- Color: Cx=0.32, Cy=0.33, acc. to CIE 1931 (white)
- Inom: 6 A
- Imax: 6.6 A
- Phiv @ Inom pmin: 1400 lm
- Luminance: >200 cd/mm²
- Rth JS real typ.: 1.8 K/W
- Rth JS el typ.: 1.3 K/W
- Vf typ.: 3.35 V
- Dimensions: 4 x 4 x 0,73

Source:
https://www.osram.com/os/ecat/OSLON%C2%AE%20Boost%20HX%20KW%20CULPM1.TG/com/en/class_pim_web_catalog_103489/global/prd_pim_device_2190861/

Collimator	96%
Collection eff.	75%
DMD	66%
Projection Lens	92%
Cover Glas	90%
Total	39%

Table 2: Optical on axis efficiency transmissions and contributors for efficiency.

6 A	If
3.35 V	Vf
20.1 W	power
1400 lm	lumens
69.7 lm/W	device efficacy
0.9 W/W	e/e conversion eff.
62.7 lm/W	Oslon+PS efficacy
0.39	optical efficiency
24.4 lm/W	DLP efficacy, baseline

Osram EVIYOS Gen2:

Optics Eff:	33%
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Punch

Field o View	H	19,0°	V	5,0°
	H/pix:	0,1°	V/pix:	0,1°
Pixels:	H	190	V	50
Hot Spot Target:	168 lx @25m	Pixel Number:	9500	
Pixel Size in 25m:	H	0,04 m	0,04 m	
Pixel Flux in 25m:	0,320 lm			

Table 6: Calculation of the performance values for the EVIYOS idea for the base and punch area

With the hybrid integration of the driver and latest UX:3 LED technology efficacies of 65 lm/W including current regulating drivers can be expected. This promises to place the power consumption of a full beam of 1200 lm on the road (3600lm at the source) at just 56 electrical Watts.

65 lm/W	device efficacy
0.33	optical efficiency
21.5 lm/W	system efficacy

Information sourced from Oslon Boost HX datasheet and 2018 SIA Vision paper:

Illumination vs. Visualization in Headlamps: Way towards HD light source requirements

S. Groetsch¹, J. Reill¹, M. Schwind¹, S. Haneder¹, U. Hiller¹

¹: Osram Opto Semiconductors GmbH, Leibnizstr. 4, D-930555 Regensburg, Germany

Impact of ADB masking on efficacy

ADB遮蔽对光效的影响

93% of zones are "on"

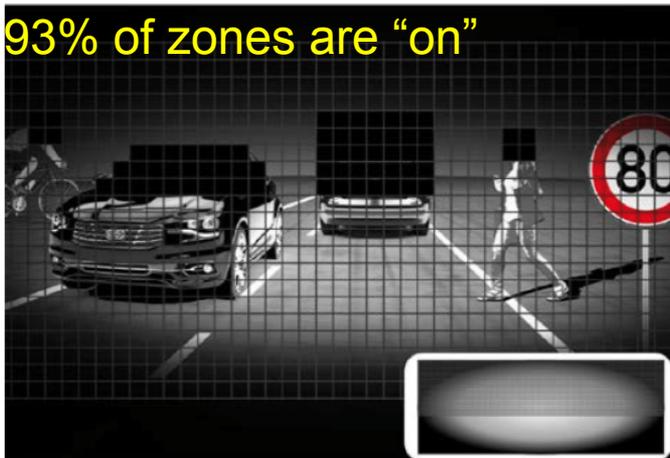


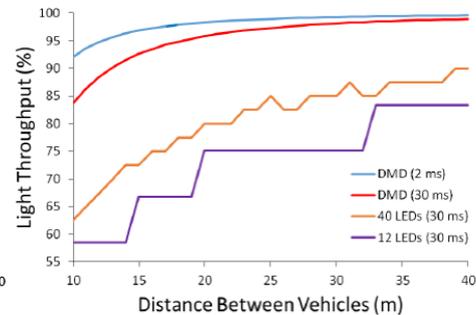
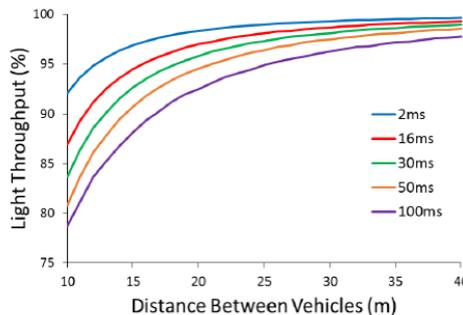
Figure 6: Elements from Figure 2 illuminated with a two dimensional pixel matrix

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This ~90% "throughput" case (or ratio of on pixels to total over time) is expected for a *DMD* ADB system:
对于DMD ADB系统, 90% "throughput"是一个可预见值。



see: Programmable Automotive Headlights

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Impact of ADB masking on efficacy

ADB遮蔽对光效的影响

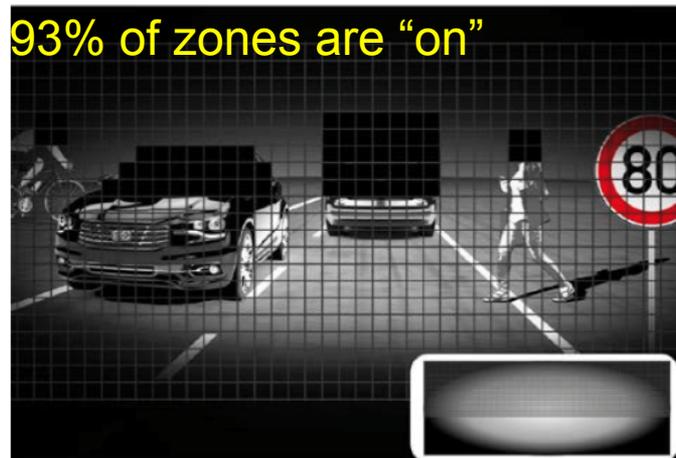


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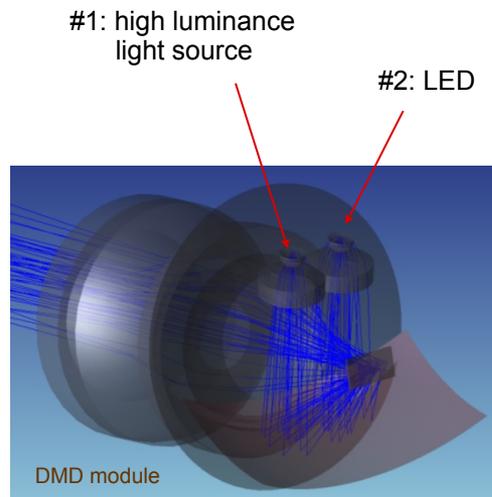
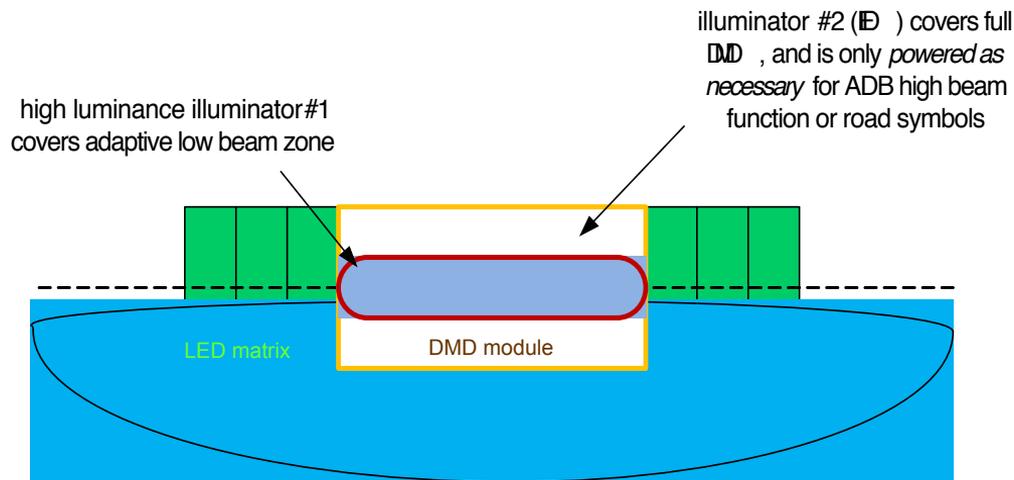
¹: Osram Opto Semiconductors GmbH, Leibnizstr. 4, D-93055 Regensburg, Germany

880	zones	total (~40x22)
65	zones	are off...
815	zones	are on...
0.93		subtractive loss factor
24.4	lm/W	DLP efficacy, baseline
22.6	lm/W	DLP efficacy, adjusted
21.5	lm/W	micro LED efficacy

The net impact on total efficacy from “subtractive” ADB has been greatly exaggerated – with *high resolution*, very little *subtracting* actually happens in real-world situations

“减去损失”ADB对总光效的影响被大大夸大了—基于高分辨率，实际情况下只会有非常少的光效损失。

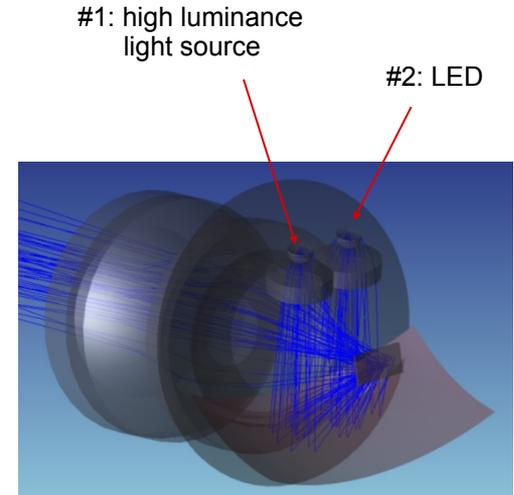
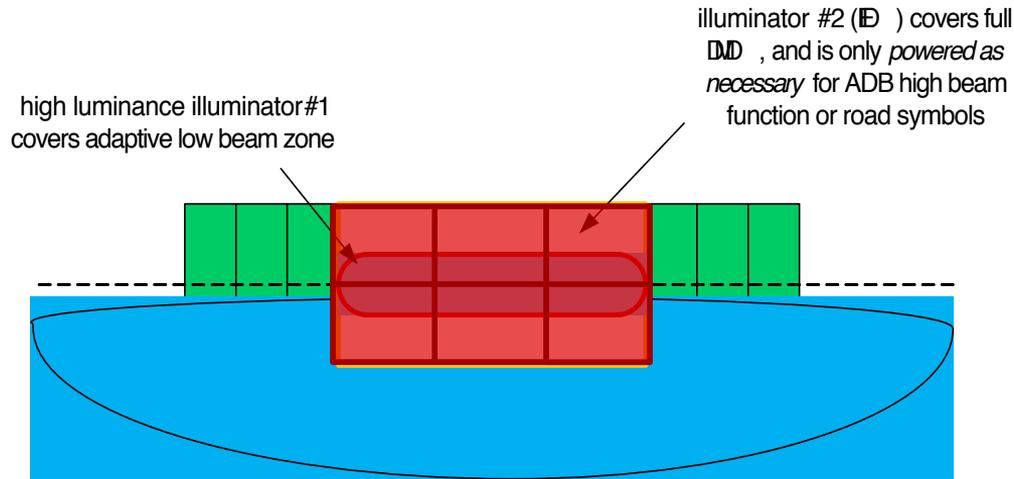
Future improvements – mix of high luminance source and LED improves low beam-only efficiency 未来的改进



During low beam only operation - majority of illuminator power directed to cut line region where most of the light is needed, the broader coverage LED operated at reduced current

只有近光的时候-大多数照明器功率被引导至需要大部分光线的切割线区域，更广的覆盖范围LED低电流工作。

Future improvements – mild segmentation of LED 未来的改进



Modest segmentation of LED source further enhances situational power consumption, allowing for up/down left/right source power optimization – high density micro-LED technology is not required, a few dimming zones is enough
适度分割LED光源的进一步提高了情景功耗，允许上/下左/右光源功率优化-不需要高密度微型LED技术，几个调光区域就足够了

Surprise and delight with DLP Technology

DLP技术带来的惊喜和愉悦

- Dynamic ground projection capable of animation and full color
- Develop unique welcome sequences or messaging
- Reinforce branding or ease communication
- Many install locations:
 - Side-mirror, vehicle corners, rocker panel, etc.



Surprise and delight with DLP Technology

DLP技术带来的惊喜和愉悦



Photos from TI Exhibition Booth at CES 2019



DLP Technology offers compelling solutions in automotive lighting DLP技术为汽车照明提供了引人注目的解决方案

- **Highest resolution** with 1.3 million pixels for precise light control
- Uniquely enables true **on-road symbol projections** with sufficient vertical resolution
- **Smooth** ADB masking
- Programmable and customizable = **future-proof** in changing regulatory landscape
- Suitable for **additional innovation** in long range projection applications
- **Good efficiency** and a path towards even higher efficiency
- Automotive qualified and **available today**

ENHANCES DRIVER VISIBILITY, MINIMIZE GLARE, AND COMMUNICATE WITH LIGHT
增强驾驶员的可视性，减少眩光，利用照明交流

Thanks You

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