



Improving vehicle visibility with dynamic projections

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Agenda

- Industry pull for dynamic ground projections (DGPs)
- Can ground projections help road users?
- How much brightness is needed for useful ground projections?
- Where can projectors be installed around the vehicle?
- How can Texas Instruments DLP® Technology improve ground projections?

Industry pull for ground projections



Audi showing extended turn signaling on the A6 eTron concept ([LINK](#))



OsramContinental showing many use cases for ground projection on their website ([LINK](#))

Ground projections can help users

Recent Study

“Impact of Advanced Lighting Function based on Road Projection for Departing Indication in Parking Lots” from ISAL 2019

Participants were tested to see if projections indicating a reversing car in a parking garage improved detection.



Conclusions

“First, it is shown that the projected signal is better detected than reverse lights, also combined with a longer detection range for pedestrians and cyclists.”

“Furthermore, evaluations of the test participants during the questionnaire show that the projected signal is well accepted (good intention to use) and that it is linked to a favourable attitude and perceived safety, itself related to a perceived utility.”

S. Azouigui, B. Barbedette, S. Saudrais und Y. Sortais, “Impact of Advanced Lighting Function based on Road Projection for Departing Indication in Parking Lots” in *13th International Symposium on Automotive Lighting*, Darmstadt, 2019.

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How much brightness is needed?

External factors impacting brightness

Ambient Lighting Conditions

Twilight	10.8 lux
Full Moon	0.108 lux
Starlight	0.0011 lux

Projection Surface Reflectivity

Cement	0.47
Asphalt	0.15
Grass	0.20
Gravel	0.29
Dirt	0.15

Luminance Contrast Ratio (LCR)

$$LCR = \frac{Image\ Brightness + Ambient\ Brightness}{Ambient\ Brightness}$$

$$Image\ Brightness \left[\frac{cd}{m^2} \right] = \frac{Projector\ Flux\ [lm] * Reflectivity}{Image\ Size\ [m^2] * \pi}$$

$$Luminance \left[\frac{cd}{m^2} \right] = \frac{Illuminance\ [lux]}{\pi} * Reflectivity$$

Brightness requirements – Example calculation

External factors impacting brightness

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Luminance Contrast Ratio (LCR)

$$\text{Ambient Brightness} \left[\frac{cd}{m^2} \right] = \frac{10.8 [lux]}{\pi} * 0.47 = 1.62$$

$$LCR = \frac{\text{Image Brightness} + 1.62}{1.62} = 6 \quad \begin{array}{l} \text{Minimum LCR} \\ \text{is 2-4} \end{array}$$

$$\text{Image Brightness} = 14.58 \left[\frac{cd}{m^2} \right]$$

$$\text{Image Size} = 1.33m * 1m = 1m^2$$

$$14.58 \left[\frac{cd}{m^2} \right] = \frac{\text{Projector Flux} [lm] * 0.47}{1 [m^2] * \pi}$$

$$\text{Projector Flux} [lm] = 54.14$$

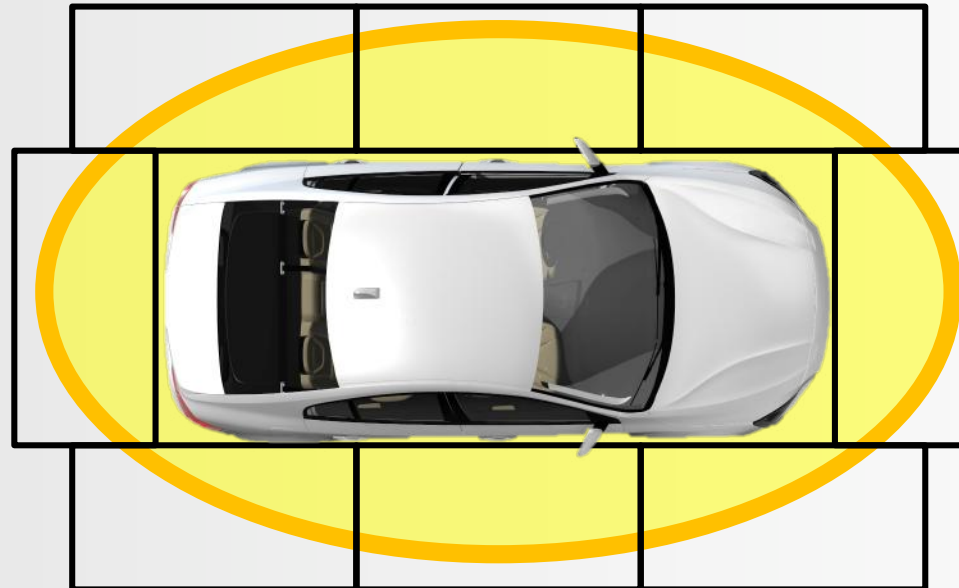
Projector mounting locations & 360° orchestration

Rocker Panel

- Walk-up animations
- Light carpet for styling
- Vehicle personalization

Rear Lights

- Extended reverse lighting
- Automatic trunk communication
- Vehicle communication



Side Mirror

- Extended turn signaling
- Animated logo projection
- Vehicle customization
- Warning communication

Headlights

- Extended turn signaling
- Symbol projection
- Walk-up animations
- Welcome lighting

Demo video for DGP use cases

<https://training.ti.com/dynamic-ground-projection-dlp-auto-technology>



Key Use Cases

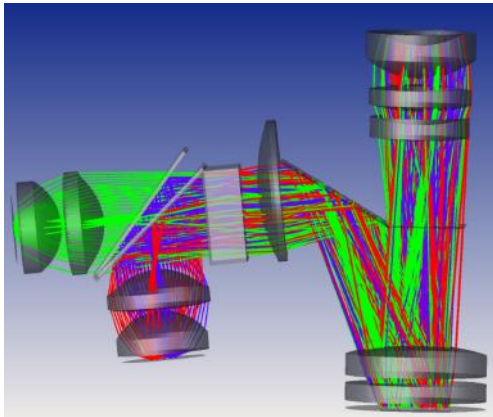
Animated logos

Safety features

Vehicle visibility

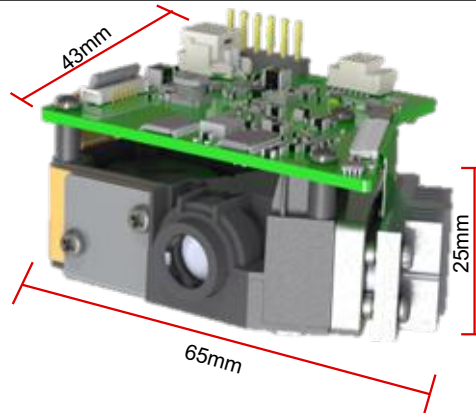
How DLP technology enables ground projection all around the vehicle

High optical efficiency



- ❑ Optical reference designs achieving >23 lm/W (RGB) & >30 lm/W (B/W)
- ❑ Additional brightness enables larger images and more visible time

Compact size & easy integration



- ❑ <70cm³ total module volume
- ❑ Only requires power and ground
- ❑ Chipsets support 100+ lumens
- ❑ GPU-free content generation

Automotive reliability



- ❑ Automotive qualified, operating temp. range -40°C to 105°C
- ❑ DLP technology on the road today with multiple OEMs & Tier 1s