Designing Cooler Running, Multi-Channel Dynamic Automotive Lights

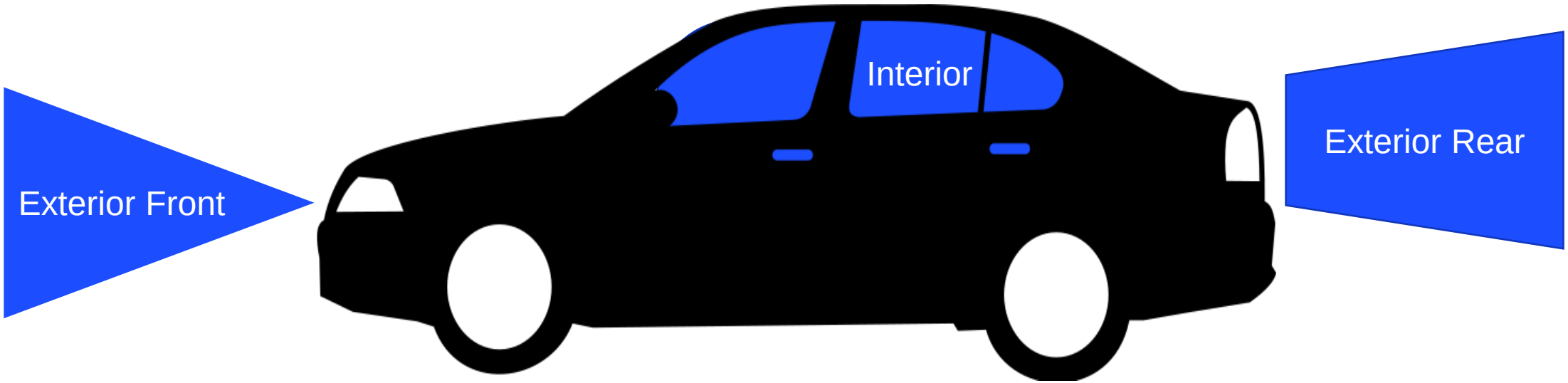
Key points to help you choose the best LED Driver

January 2023

Agenda

- Introduction
- Understanding the Matrix LED System
- Selecting the Right Topology
- Challenges for Rear Light Designs
- Selecting the LED Driver
- Thermal issues
- EMC issues
- Our Tail Lamp Design
- Conclusions

Introduction

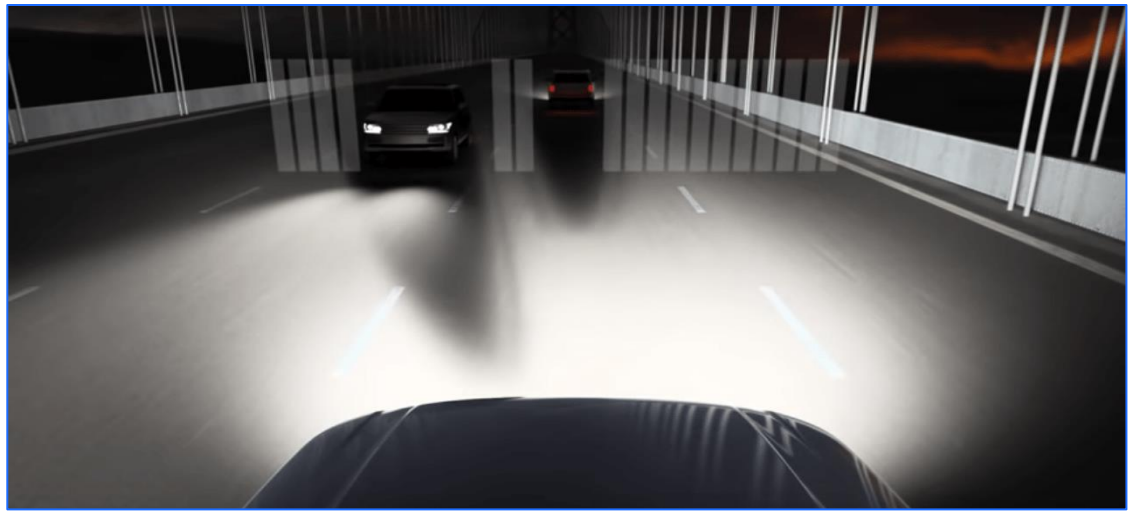


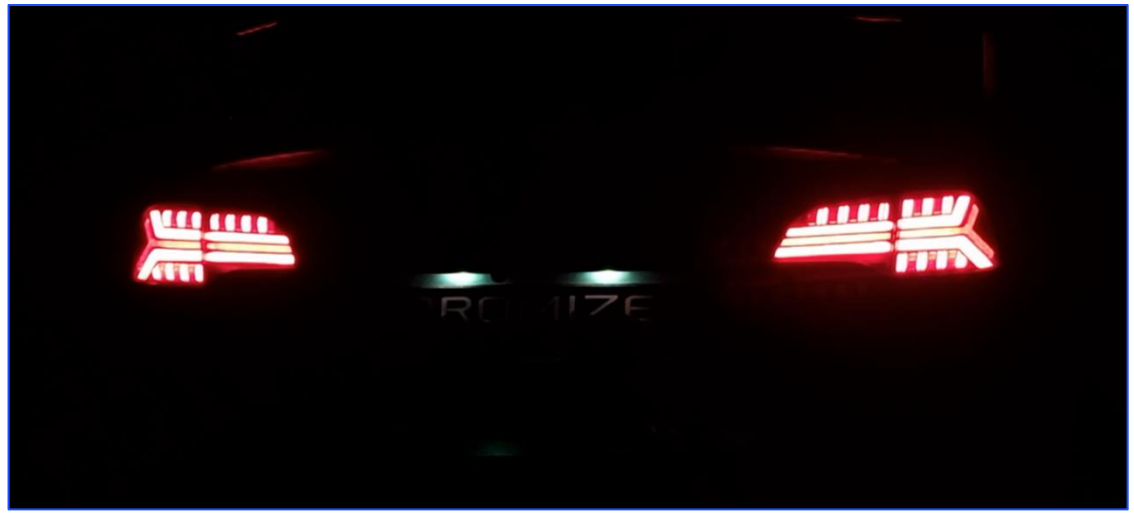
Halogen Lamp → HID Systems → **LED Systems**

Halogen Lamp	HID Systems	**LED Systems**
• Cost efficiency • Ease of service	• Better lighting performance • Less energy consumption	• **Longer life span** • **More efficient**

Understanding the Matrix LED System

- Each LED of the matrix is controlled independently to create innovative and fascinating light designs:
  - Improve driver’s visibility
  - Adjust light beam to the environment
  - Opens new communication channel with other road users

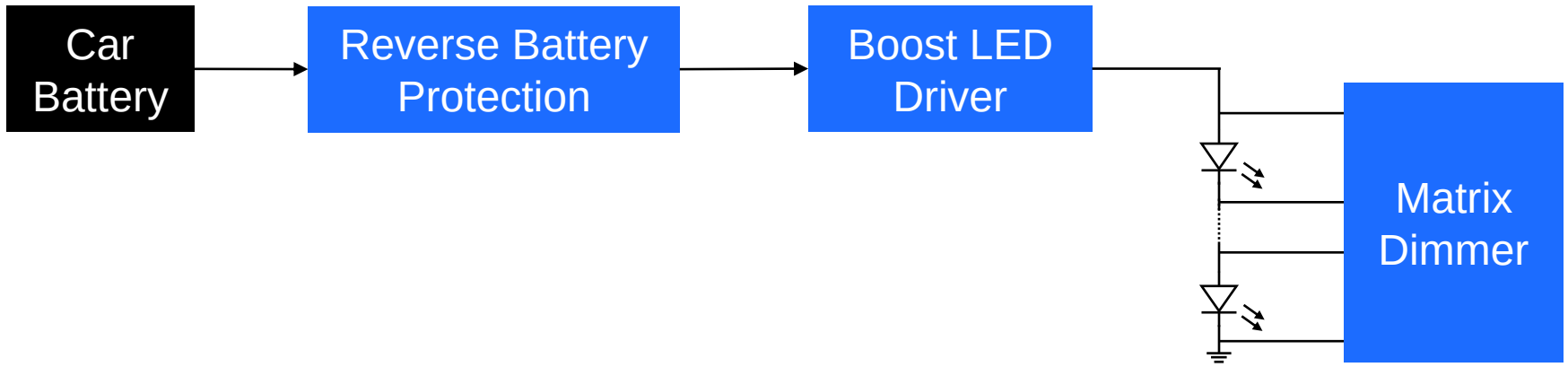




Selecting the Right Topology

Headlight with Matrix Dimming

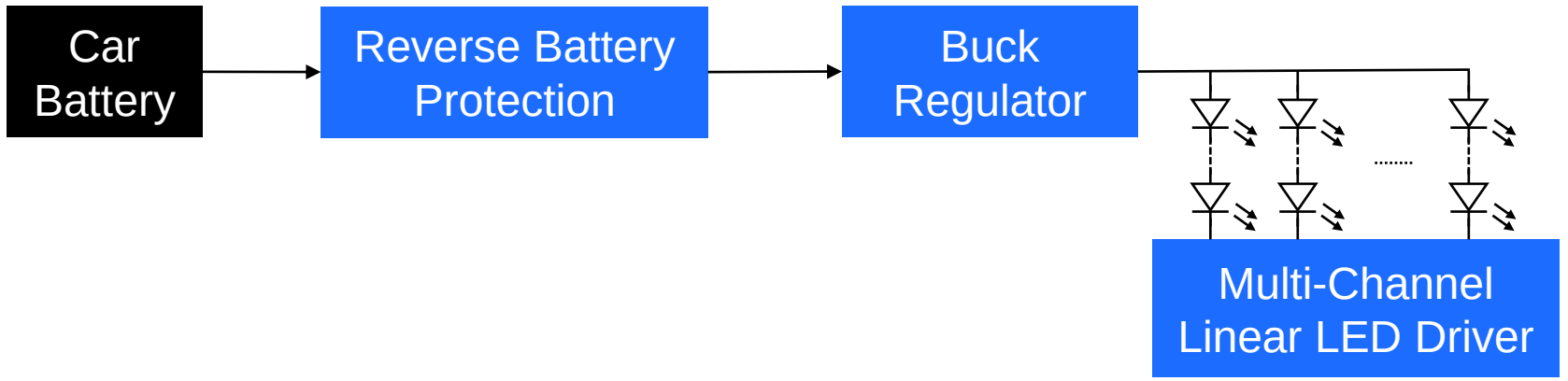
- High Voltage
- Low Current



Selecting the Right Topology

Rear Light with Dynamic Effect

- Low Voltage
- High Current



Challenges for Rear Lights Design

1. PCB size

- Lighting systems must be integrated inside car
  => PCB size is limited
- Reduce number of components without losing LED controllability

2. Scalability

- Long rear light designs are commonly built joining smaller modules
- Easy connection between modules

3. Brightness

- To get uniform and brighten designs it is required to have systems that allows high currents and well compensated channels

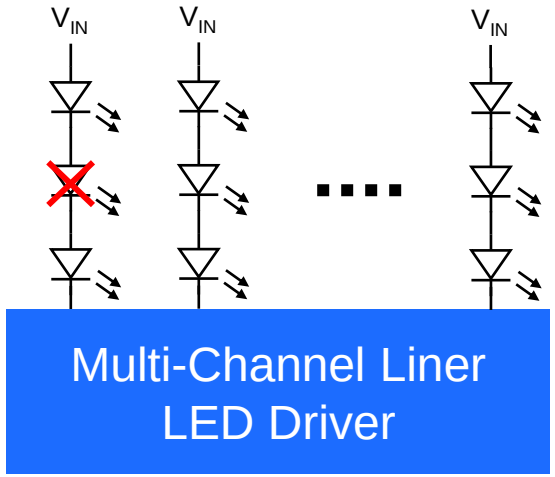
Challenges for Rear Lights Design

4. Protection

- When working with LED matrices it is important to sense malfunctions inside the system
- Detecting over-temperatures, SC or OC is vital to extend lifetime of the system

5. Communication

- LED Driver configuration must be easily accessible by the user
- Noisy environment of lighting systems
- The communication interface must be immune to noise



Selecting the LED Driver

Challenge	Solutions
PCB Size	✓
Scalability	✓
Brightness	✓
Protection	
Communication	

Ease of Scalability

- High number of Channels per LED Driver
- High number of programmable device addresses
- Pin-programmable device address
- Single I/O Pin for Daisy Chaining

Class Leading Brightness

- Capable of individually driving all channels at high current simultaneously
- High accuracy across the full temperature range
- High resolution Analog and PWM dimming

Selecting the LED Driver

Challenge	MPQ7225
PCB Size	✓
Scalability	✓
Brightness	✓
Protection	✓
Communication	✓

Safety Oriented

- Assist system design to achieve a functional safety grade of ASIL-B
- Protection suite includes thermal warning, LED open/short, PIN open/short
- Fail safe pin and fault registers for system protection and diagnostics

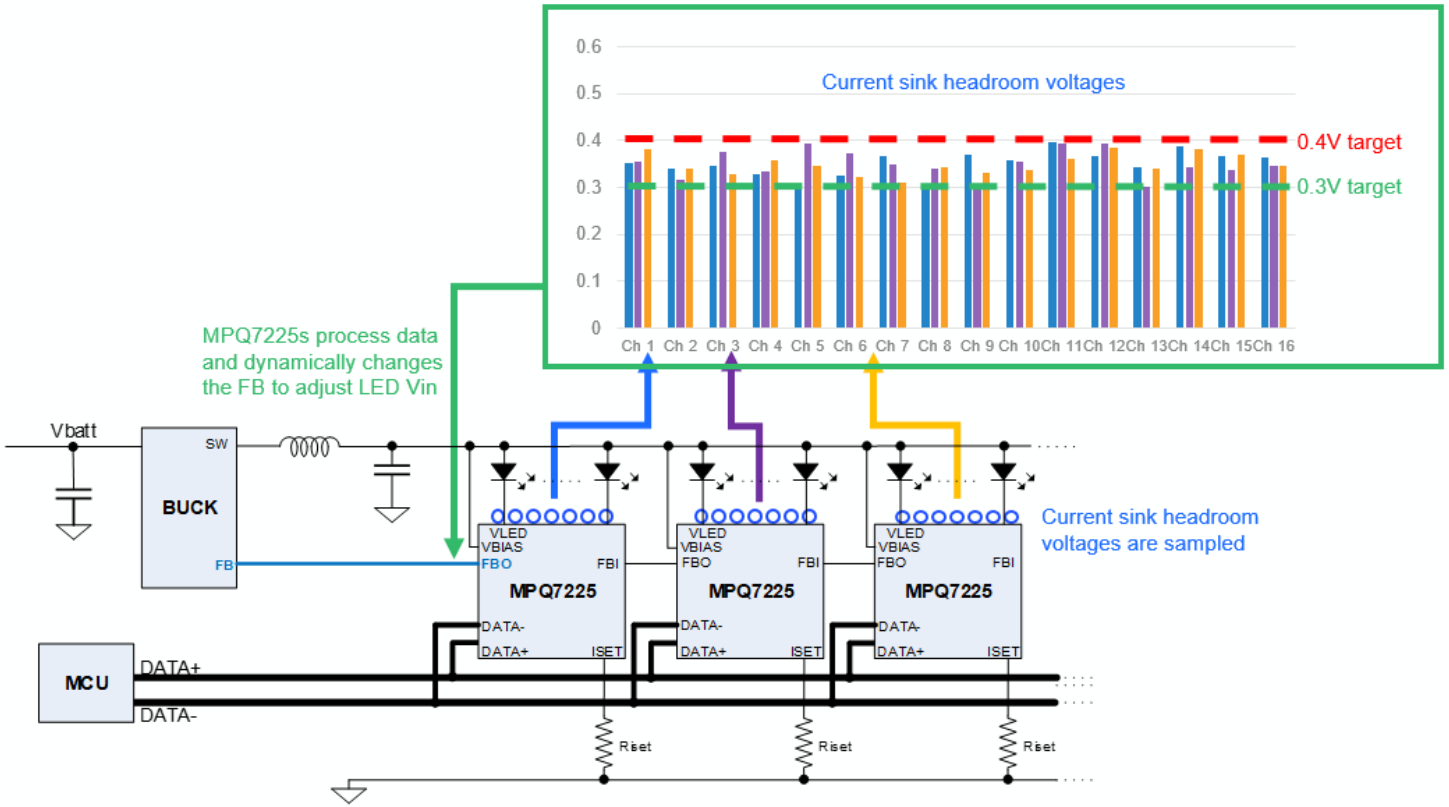
Robust Communication

- Differential Interface (for example CAN)
- Other possible interfaces:
  - LED Driver with UART
  - LED Driver without communication interface

Thermal Issues

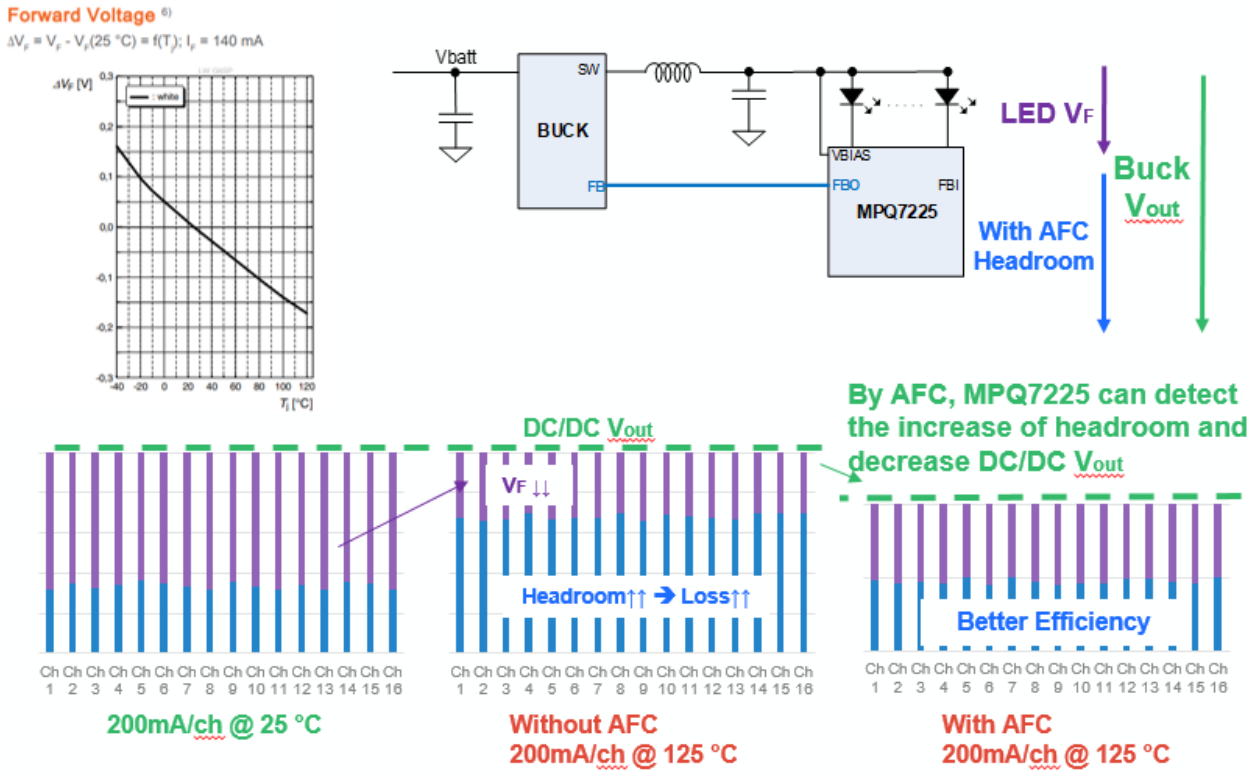
Adaptive Feedback Control (AFC)

- Optimization of system efficiency
- Dynamically adjust the output voltage of DC/DC converters in respect to the characteristics of the LEDs



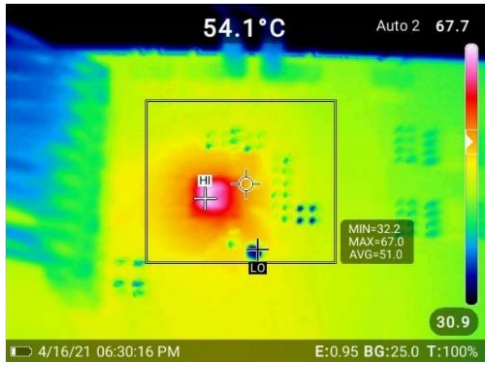
Thermal Issues

Adaptive Feedback Control (AFC)



No AFC

AFC



Test Condition: 2LEDs, ILED=200mA/CH, All 16 CH on, 4 layers, 2oz

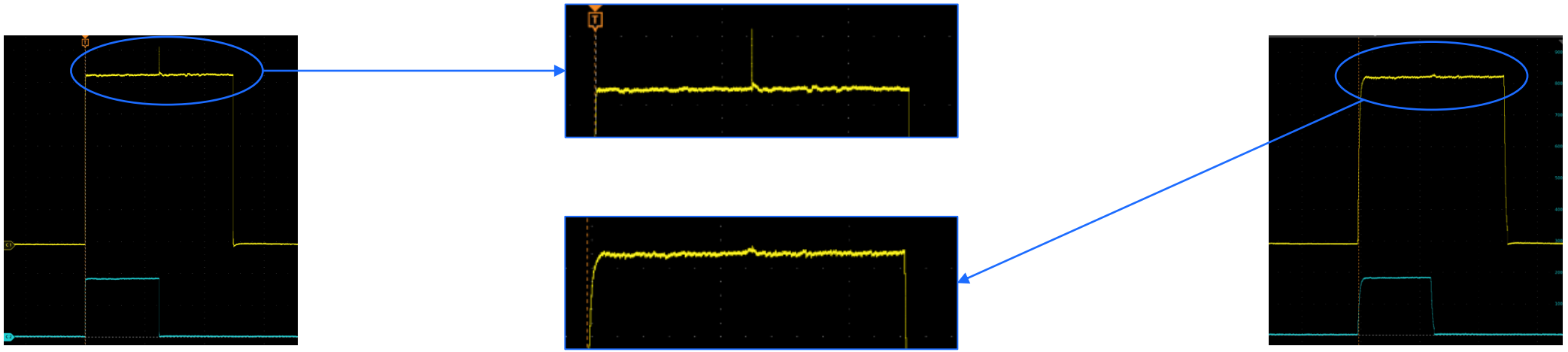
AFC adjust the VBIAS, VLEDX Boundary [0.3V, 0.4V]
Fix VBIAS=7V, VLEDx=1.07V

EMC Issues

- When designing system for automotive sector, it is a must to follow the EMC constraints

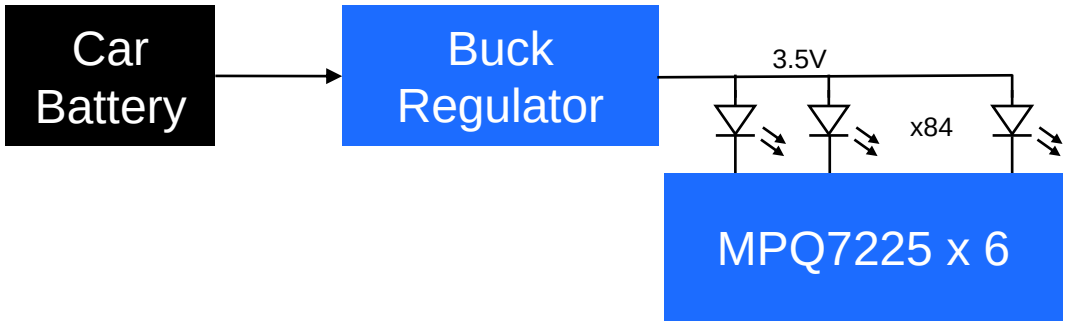
Possible Solutions

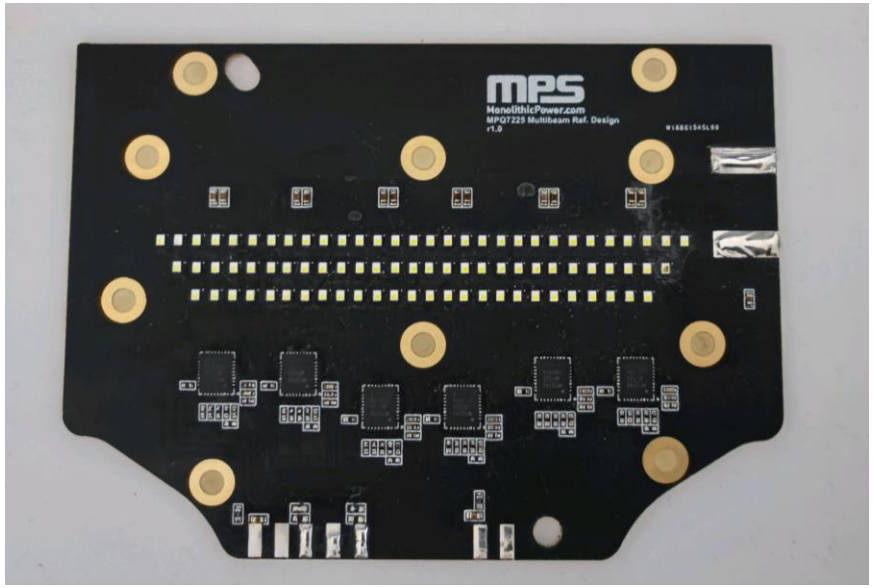
1. Programmable Slew Rate and Phase Shift
2. Frequency spread spectrum (internal clock)
3. Selectable Frequency in PWM Dimming



Our Tail Lamp Design

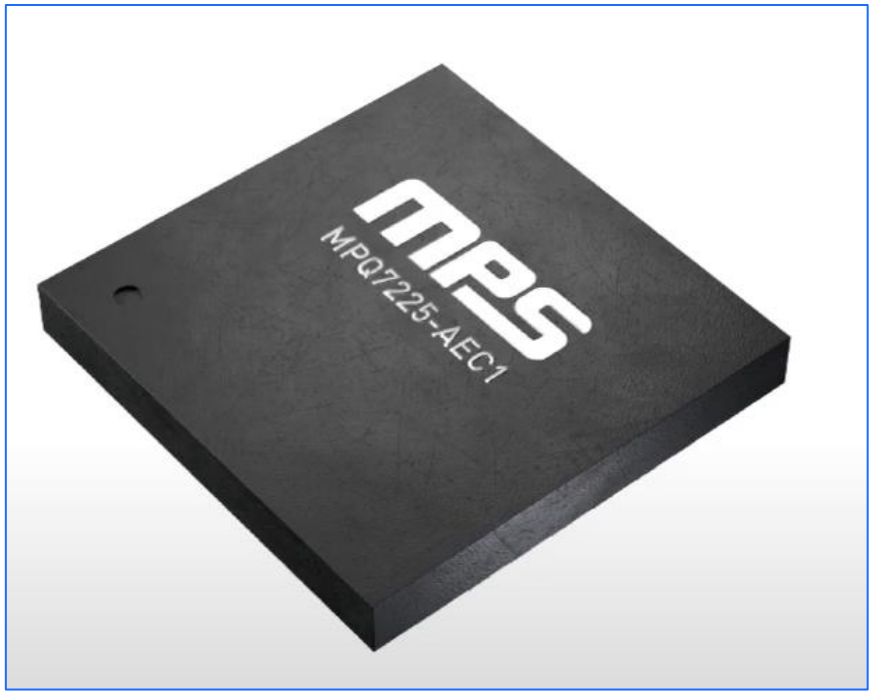
- 84 LEDs
  - 30 columns
  - 3 rows
- 6 LED Drivers: MPQ7225
- Each LED is controlled independently
- LED PCB:
  - 80mm x 110mm
  - 2 layers
- The system includes a 36V, 20A buck converter to power LEDs and LED Drivers





Conclusions

- Great Scalability
- Class Leading Brightness
- Safety Oriented Design
- Robust Communication
- EMIs reduction techniques
- Excellent Thermal Performance



- MPQ7225 is one of the best options to design Multi-Channel Dynamic Automotive Lights

Q&A

Let us know your questions