Automotive Exterior LED Lighting Products

Texas Instruments

www.ti.com/autoled

2015

Build Innovative, Reliable and Cost-Effective Automotive Lighting Systems

Introduction

Automotive exterior LED lighting products from Texas Instruments (TI) help you build innovative, reliable, cost-effective exterior automotive lighting systems that exceed today's stringent requirements. Our highly efficient LED solutions extend the life of your lighting system, enable greater driver and pedestrian safety, and enhance the driver experience.

From headlights to taillights and everything in between, TI delivers reliable, scalable and power-efficient linear and switching solutions for simple and complex systems.

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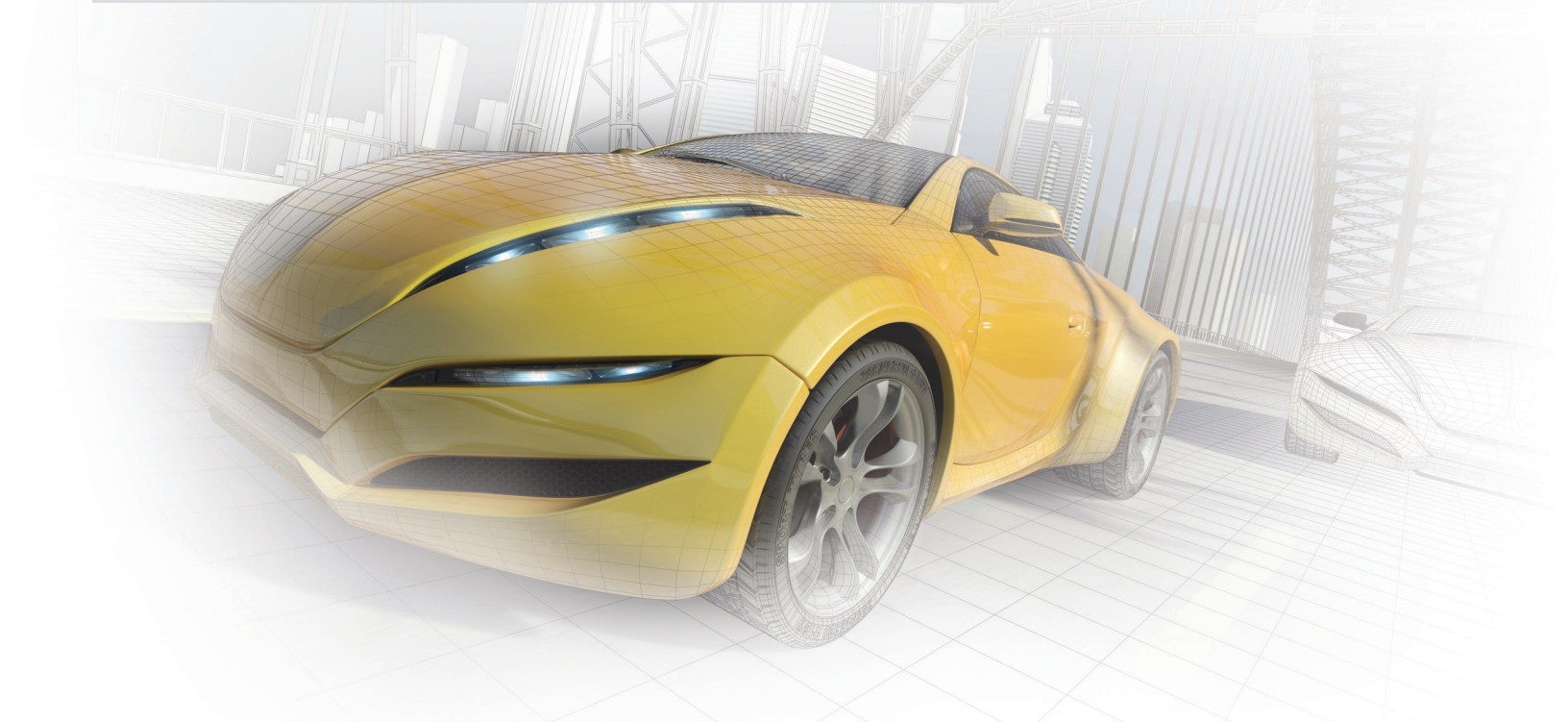
Design Support from TI

TI offers comprehensive design tools, technical resources and direct customer support to help you get your automotive lighting products to market faster.

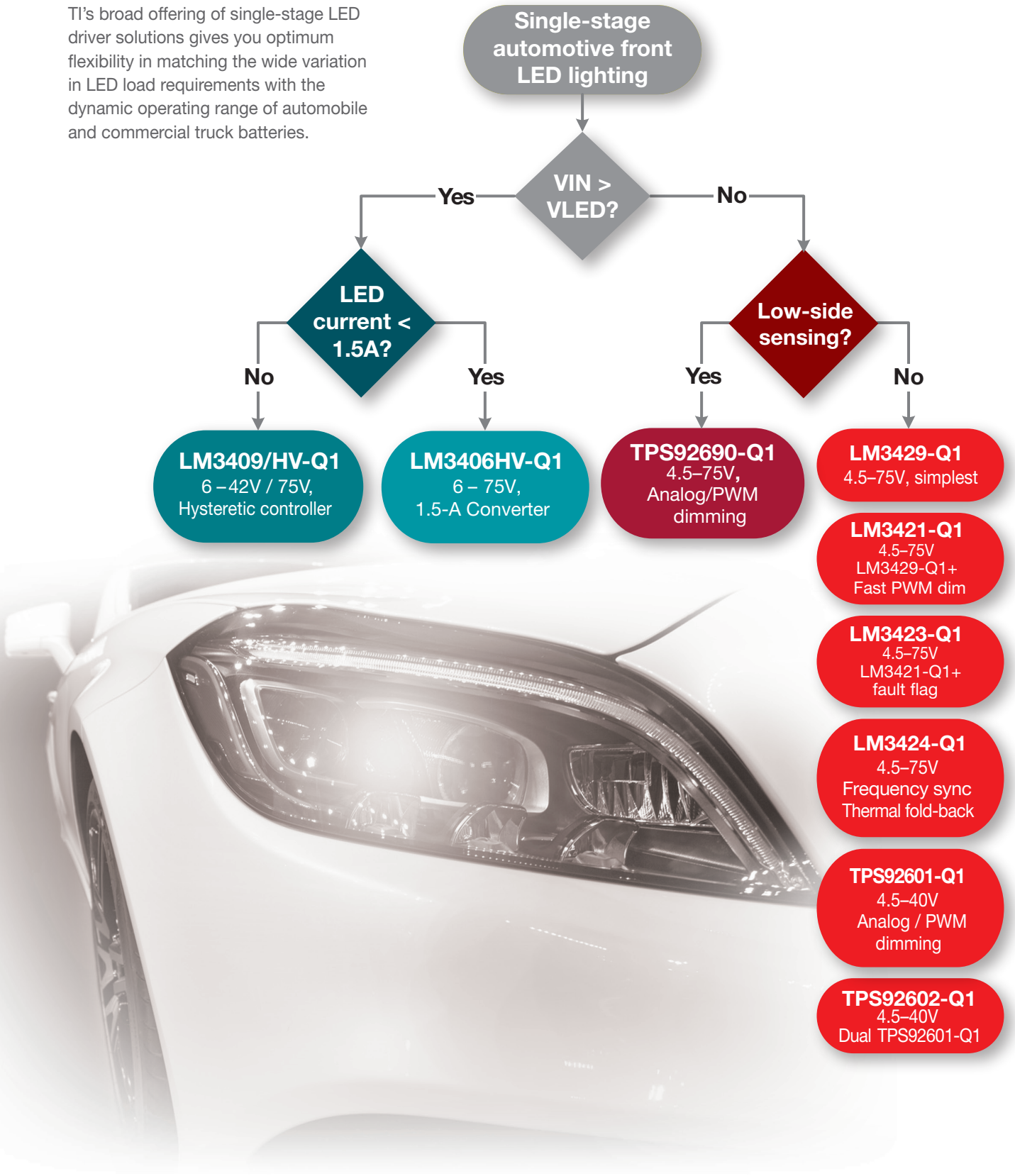
- TI Designs – Lab-tested automotive lighting reference designs
- LED driver evaluation modules (EVMs)
- Automotive system block diagrams
- Application notes
- WEBENCH® LED design tool
- Search for solutions and get help in the LED driver forum in TI's E2E™ Community



Single-Stage Front Lighting Selection

Choose Many Single-Stage LED Driver Solutions

TI's broad offering of single-stage LED driver solutions gives you optimum flexibility in matching the wide variation in LED load requirements with the dynamic operating range of automobile and commercial truck batteries.



Single-Stage Front Lighting Selection

Featured Products

Type	Device	No. of Channels	VIN Min (V)	VIN Max (V)	Topology						Dim Method		Current Sense		Freq. Sync.	Comments
					Buck	Boost	Buck-Boost	Flyback	SEPIC	Cuk	Analog	PWM	HS	LS		
Switching	LM3406HV-Q1	1	6	75	•							•		•		Integrated NFET converter 1.5 A max LED current
	LM3409HV-Q1	1	6	75	•						•	•	•			PFET controller
	LM3409-Q1	1	6	42	•						•	•	•			PFET controller
	LM3421-Q1	1	4.5	75	•	•	•	•	•		•	•	•			50–500 mV sense voltage Fast PWM dimming
	LM3423-Q1	1	4.5	75	•	•	•	•	•		•	•	•			50–500 mV sense voltage Fast PWM dimming Fault flag
	LM3424-Q1	1	4.5	75	•	•	•	•	•		•	•	•		•	50–500 mV sense voltage Thermal fold-back
	LM3429-Q1	1	4.5	75	•	•	•	•	•		•	•	•			50–500 mV sense voltge
	TPS92601-Q1	1	4.5	40	•	•	•	•	•		•	•	•		•	15–150 mV sense voltage Fast PFET PWM dimming Fault diagnostics
	TPS92602-Q1	2	4.5	40	•	•	•	•	•		•	•	•		•	15–150 mV sense voltage Fast PFET PWM dimming Fault diagnostics
	TPS92690-Q1	1	4.5	75		•		•	•	•	•	•		•	•	50–500 mV sense voltge

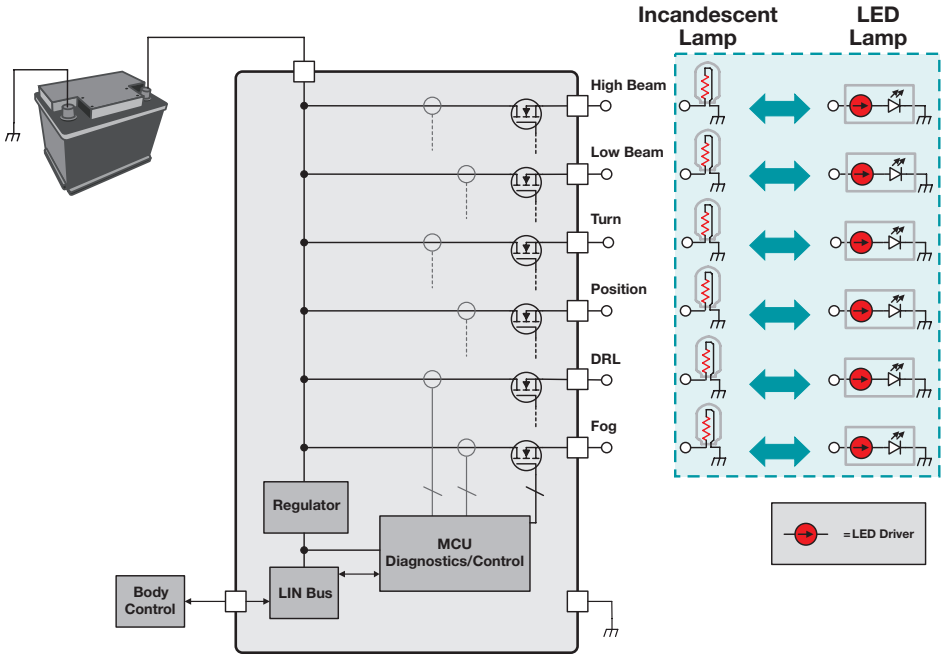
Single-Stage Front Lighting Overview

Design Long Lasting LED Lights Without Modifying the BCM

Automotive front lights are evolving from incandescent high-intensity discharge (HID) based lamps into highly intelligent and adaptive luminaires that automatically adjust to dynamic environmental, roadway and traffic conditions.

Common implementations today are a mixture of both traditional filament-based lamps and LED light sources with LEDs typically being utilized on mid- and high-end models or trim levels.

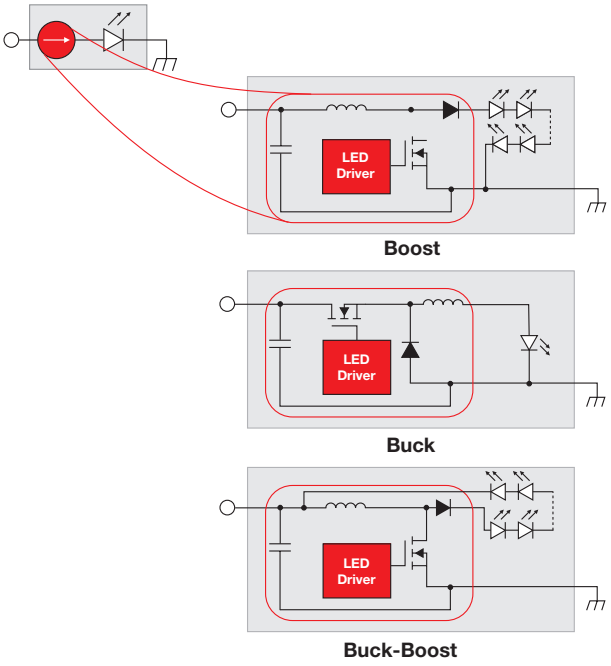
TI's flexible portfolio of single/dual channel LED drivers and development tools help you in the design of long lasting LED light sources for replacement of incandescent lamps without expensive modification to existing Body Control Modules (BCMs).



Flexible, Module Single Power Conversion Stage Architecture

LEDs are not only a long-lasting, energy efficient sources of light, they also provide OEMs with creative new ways to combine lighting function with innovative styling. TI's flexible, single-stage LED driver products are highly configurable and modular point-of-load solutions. They simplify matching the dynamic voltage range of modern automotive batteries to strings ranging from 1 to "n" LEDs in length.

Available in single and dual-channel options, TI's single-stage LED drivers also can be configured to support all common topologies. Diagnostic and protection features ensure reliable operation under fault conditions.



TI Advantages

- Easy to mix LED and conventional light sources without ECU modification
- Flexible driver solutions for strings of 1 to "n" LEDs
- Low BOM cost

Flexible Portfolio Meets Your Needs

Condition	Topology
VLED > VBATT	Boost
VLED < VBATT	Buck
VLED > or < VBATT	Buck-Boost SEPIC Flyback Cuk

Dual-Stage Front Lighting Overview

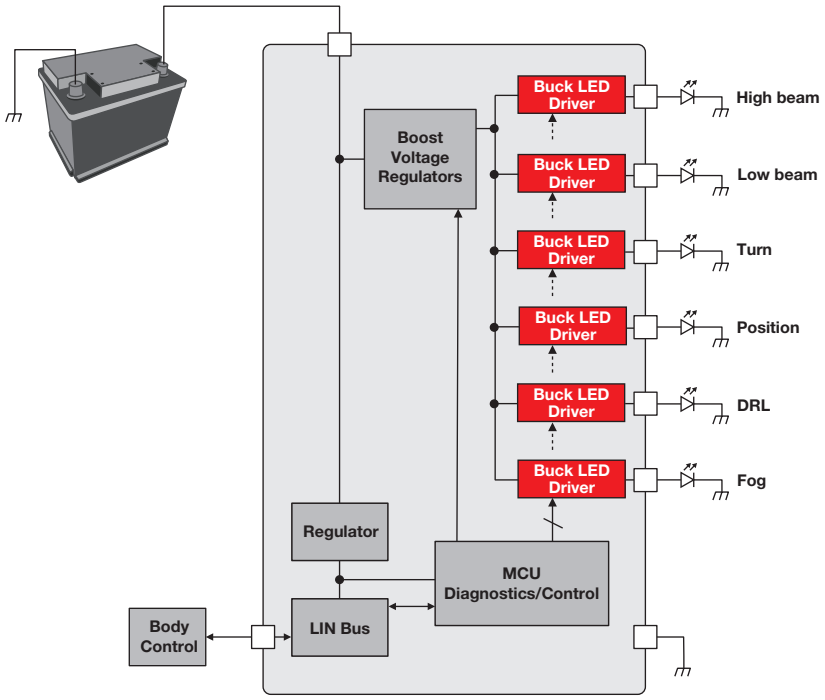
Benefit From a Full LED Electronics Control Unit Approach

Vehicles adopting LEDs for all exterior lighting functions can benefit from a full LED ECU platform approach based upon a dual power conversion stage architecture consisting of a boost voltage source and buck current regulators for each lighting function.

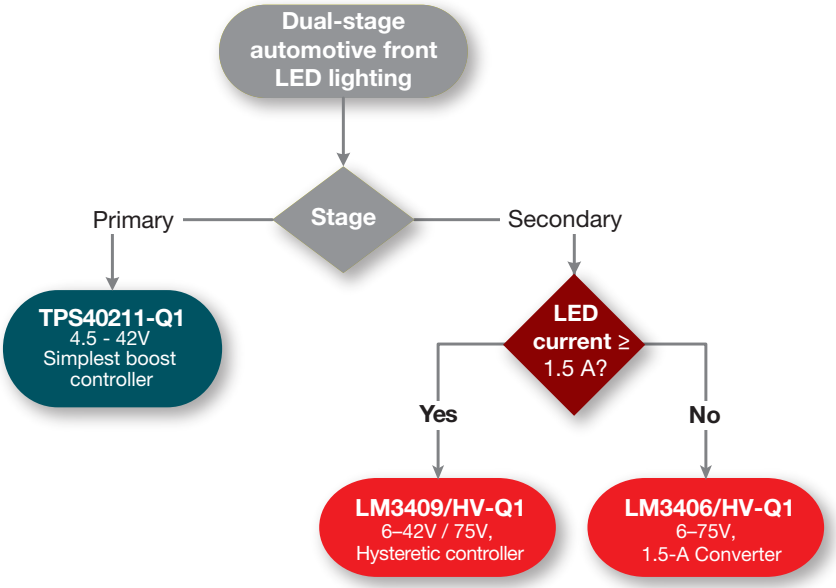
Buck LED drivers from Texas Instruments are ideal current sources and offer the best immunity to common fault conditions such as short circuits to chassis and battery. TI's boost regulators produce stable DC input supplies for buck current source operation.

TI Advantages

- Boost removes VBATT fluctuations
- Buck LED drivers have best immunity to LED open or short faults
- Scalable ECU platform for static or adaptive front lighting



Dual-Stage Front Lighting Product Selection Flow



Adaptive Front Lighting Overview

Featured Products

Type	Device	No. of Channels	VIN Min (V)	VIN Max (V)	Topology				Dim Method		Current Sense		Comments
					Buck	Boost	Flyback	SEPIC	Analog	PWM	HS	LS	
Switching	LM3406HV-Q1	1	6	75	•					•		•	Integrated NFET converter 1.5 A max LED current
	LM3409HV-Q1	1	6	75	•				•	•	•		PFET controller
	LM3409-Q1	1	6	42	•				•	•	•		PFET controller
	TPS40211-Q1	1	4.5	52		•	•	•				•	260 mV fixed FB voltage

Adaptive Front Lighting (AFL) Gives You Optimal Illumination

Traditional high-/low beam High-Intensity Discharge (HID) lamps consist of a bulb and reflector to create a predefined distribution of light. In most vehicles, the only control for these headlamps is ON or OFF. A relative few can alter the beam direction by rudimentary mechanical means based on steering wheel position. These systems are subject to wear out mechanisms and long-term reliability concerns as they rely on motors, actuators and baffles to physically steer the headlamps.

Unlike incandescent bulbs, LEDs are point sources of light. If they are creatively arranged and paired with a suitable control method light is easily steered without moving parts.

TI's solid-state approach is a more reliable, dynamic and scalable means of solving designers AFL challenges. Using speed, steering wheel position, navigation system inputs, and front-facing cameras for vehicle and object detection, TI's LED Matrix Manager for AFL enables vehicles to automatically adjust the distribution and intensity of light emitted from the high/low beams without physical movement of the headlamps.

This capability provides always optimal roadway, shoulder and median illumination free of common high-beam glare. The result is greater long distance visibility at highway speeds, enhanced side visibility when cornering, and providing the driver with an obvious over-illuminated visual warning of roadway debris and potential animal or pedestrian hazards.

Traditional Front Lighting

Adaptive Front Lighting

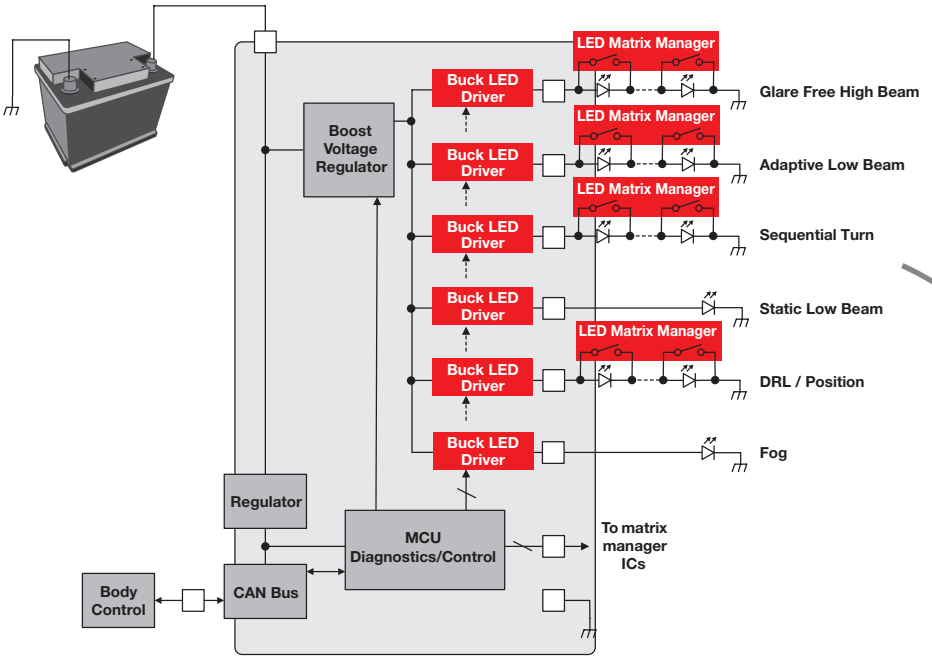
LED Matrix Manager
for Adaptive Front Lighting

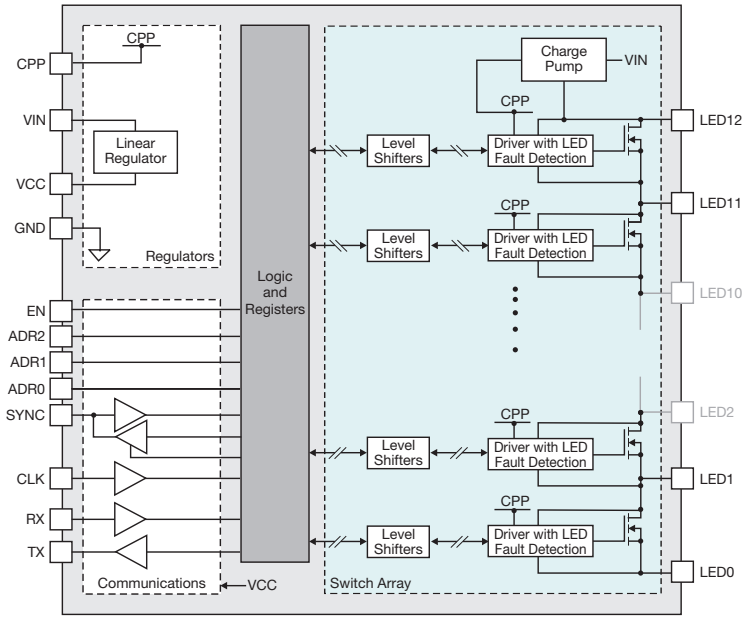
Simplify Your Automotive Exterior Lighting Design with the TPS92661-Q1

LED drivers from TI provide the ultimate flexibility for enhancing automobile styling and safety. The TPS92661-Q1, LED Matrix Manager IC, is a compact solution with LED pixel-level brightness control and diagnostics ideally suited for adaptive high/low beams, sequential turn indicators and daytime running lights. This solid-state approach requires no moving parts, increasing system reliability.

TI Advantages

- Solid state – no moving parts required
- Controls up to 96 LEDs for headlamp beam forming and directional control
- 10-bit pulse-width modulated (PWM) LED brightness control for pixel-level light intensity adjustment
- LED open/short fault diagnostics
- Easy integration into dual-stage ECU





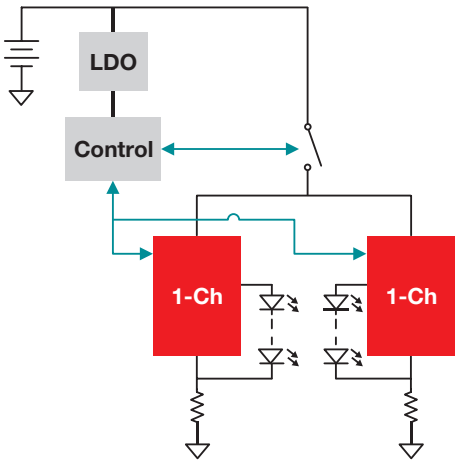
LED Matrix Controller

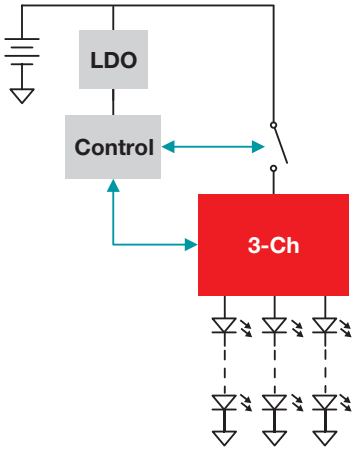
Device	V_{IN}	F_{CLK} (MHz)	Package	Features
TPS92661-Q1	4.5–5.5V	0.1–16	TQFP Exp-Pad 48 pins	AEC-Q100 Grade 1 qualified Automotive grade production flow

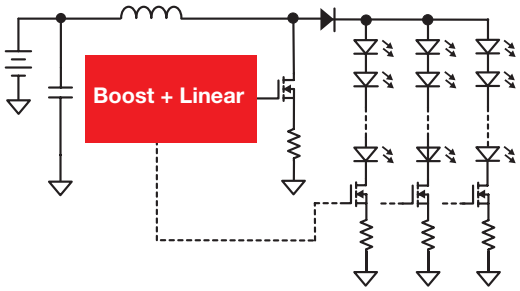
Rear Lighting: Reliable, Low EMI Solutions

Get Integrated Solutions with Full Diagnostic and Thermal Management Features

TI's Linear LED driver portfolio consists of reliable, low-EMI solutions for rear stop, turn and backup lighting. Integrated DC/DC with linear LED drive is suitable for long LED strings where the LED forward voltage is greater than the minimum battery voltage. TI's Linear solutions offer the leading features of full diagnostic (e.g., LED open, short and single LED short) and thermal management.







Single-Channel Linear

- Ideal for few LED pixels, high-current designs
- Simple building block, repeat circuit for additional channels

Multi-Channel Linear

- Best for designs using many parallel, low-current LEDs
- Simplified fault reporting as single IC controls multiple channels

Boost + Linear

- DC/DC (boost, SEPIC) buffers LED strings from battery voltage variation under cold/warm crank
- Suitable for longer series-connected LEDs

Rear Lighting Product Selection Flow

DC/DC	Low Side	**LM3492HC-Q1** 4.5–65V, 0.25A/Ch × 2-Ch	**LM3431/A-Q1** 5–36V, >0.2A/Ch × 3-Ch		
Linear	High Side	**TPS92630-Q1** 5–45V, 0.15A/Ch × 3-Ch			
		TPS92638-Q1 5–45V, 0.07A/Ch × 8-Ch			
	Low Side	**TL4242-Q1** 4.5–42V, 0.5A/Ch × 1-Ch			
Typology	Current Sense	1 × Channel	2 × Channels	3 × Channels	8 × Channels

Rear Lighting: Reliable, Low EMI Solutions

Featured Products

Type	Device	No. of Channels	VIN Min (V)	VIN Max (V)	Dim Method		Current Sense		Comments
					Analog	PWM	HS	LS	
Linear	**TL4242-Q1**	1	4.5	42	●	●		●	500 mA max current
	TPS92630-Q1	3	5	40	●	●	●		150 mA / channel Single LED short detection Fault detection and protection Thermal foldback
	TPS92638-Q1	8	5	40	●	●	●		70 mA / channel 4-bank PWM control Stop / tail function Fault detetion and protection Thermal current foldback
Boost + Linear	**LM3431/A-Q1**	3	4.5	36	●	●		●	3-channel boost and linear controller “A” – lower offset
	LM3492-Q1	2	4.5	65	●	●		●	2-channel integrated boost and linear converter 50–200 mA max / ch
	LM3492HC-Q1	2	4.5	65	●	●		●	2-channel integrated boost and linear converter 50–250 mA max / ch High contrast ratio up to 10,000:1

Design Resources, References and Support

TI provides many resources for your external lighting needs to help you design systems faster, including TI Designs and guides. We also offer worldwide support to ensure your questions are answered fast.

WEBENCH® Automotive

TI's automotive WEBENCH designs are another way to get your applications to market faster. The design tool helps you:

- **SELECT** the right automotive-grade parts for your system requirements
- **CREATE** a design in seconds and visually optimize results for efficiency, size and cost
- **ANALYZE** your design by running electrical and thermal analysis right in the tool
- **EXPORT** your optimized design directly into your CAD program

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TI Designs

Jump start your design process

- Comprehensive reference designs
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