APPLICATION NOTE

Diotec Semiconductor

Automotive Lighting Solutions

Lighting in the automotive industry is heading towards a transition stage with several technological advancements emerging in the market, enabling enhanced performance, safety, security and aesthetics. Based on the current trend, investments in R&D by major OEMs make it evident that there will be a significant growth in the lighting sector.

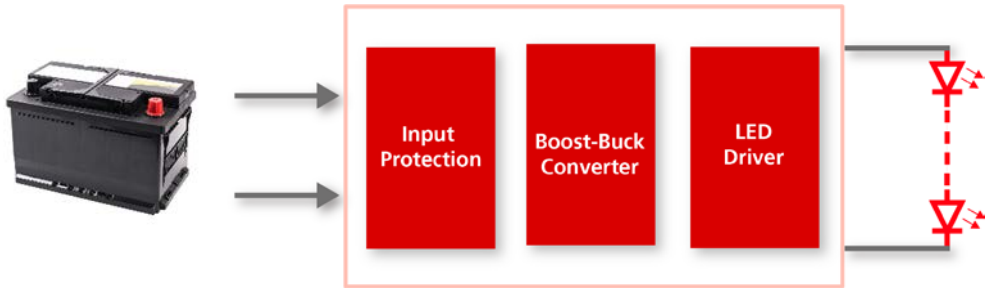
In Automotive industry particularly in lighting segment a new era came with the light emitting diodes (LED). Due to their advantages like smaller size, high efficiency, lower energy consumption and thus fuel efficiency, long service life and design freedom, LEDs are becoming a more popular choice to replace traditional lamps.

Their small size and design flexibility let them fit very well in the interior lighting, creating comfortable ambience and good mood, which improves the concentration of the driver. While in the exterior lighting, the laser headlight, LED/OLED matrix are added to the high beam, promoting higher luminance and greater visibility, to enhance safety driving.

Discrete components always provide flexibility in choosing the perfect match based on the circuit requirements. By choosing the best suited semiconductor components in the design, power losses decrease and energy savings can be pushed even further. Hence, the selection of the right components can also boost-up the overall performance.

Diotec offers a wide range of silicon based, power discrete components such as small signal, high voltage, transient protection, current limiting, Schottky, Zener diodes and transistors.

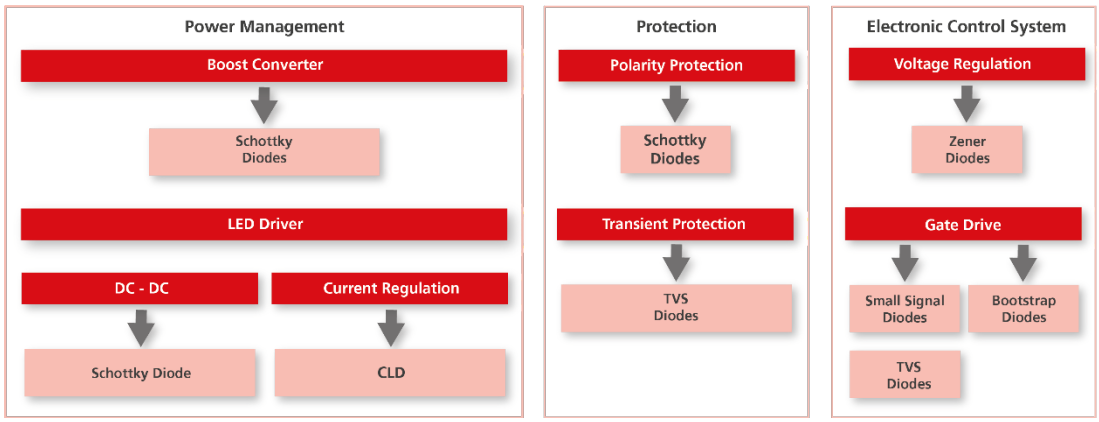
The following block diagram shows the typical energy regulation procedure from a Battery, DC voltage to a Constant output current:



Block diagram for typical automotive lighting applications

The overall function of the automotive lighting can be classified into three groups:

1) Power management system, which has different stages such as AC-DC rectification, power factor correction, DC-DC conversion for Alternator driven power supply. While Battery power supply is as an alternative/additional external source in parallel to the power supply from alternator.
2) Protection Circuit: One of the major technical challenges faced in automotive electronics is the protection against variety of electrical transient voltages. It includes load-dump protection from regular happening events due to disconnection of vehicle battery from the alternator while the battery being charged, ESD protection from the humans and most unlikely event like lightning. By adding extra protection components, it is possible to protect the automotive electronics from such higher voltage disturbances.
3) Electronic control and gate drive units: In the modern automobiles, the entire lighting systems are being controlled by intelligent lighting control systems to distribute power, sense the inputs, control and actuation function. It would facilitate to improve the energy savings, efficiency and helps to optimize the usage.



Protection Circuit

Reverse Polarity Protection

Schottky Diodes

Part no	Package	I_{FAV}	V_{RRM}
PPS1040 ... 60 (-3G)	Power SMD	10 A	40 ... 60 V
PPS1540 ... 60 (-3G)	Power SMD	15 A	40 ... 60 V
SK1040...100D1)-3G)	D-PAK	10A	40...100 V
SK1040...100D2 (-3G)	D2-PAK single	10A	40...100 V
SK2040...100CD2 (-3G)	D2-PAK dual	2x 10A	40...100 V
SK3040...100CD2 (-3G)	D2-PAK dual	2x 15A	40...100 V
SK4040...45CD2 (-3G)	D2-PAK dual	2x 20A	40...45 V
SBT1040...100 (-3G)	TO-220AC	10A	40 ... 100 V
SBCT1040...100 (-3G)	TO-220AB dual	2x 5A	40 ... 100 V
SBCT2040...100 (-3G)	TO-220AB dual	2x 10A	40 ... 100 V
SBCT30100...150	TO-220AB dual	2x 15A	100 ... 150 V

-3G: Available in 3rd Generation Schottky Technology with low V_F and low I_R

Transient Protection

TVS Diodes (Load dump, Transient protection)

Part no	Package	P_{PPM} / IFav*	V_{WM}	V_{BR}
6.6SM8Z...	DO-218AB	6600 W	10 ... 43 V	11.1 ... 52.8 V
4.6SM8Z...	DO-218AB	4600 W	10 ... 43V	11.1 ... 52.8 V
5KP...	D8 x 7.5	5000 W	6.5 ... 120 V	7.2 ... 133 V
BYZ35...	D12.75 x 4.2 / Press-fit	35 A*	17.8 ... 38.1 V	22 ... 47 V
BYZ50...	D12.75 x 4.2 / Press-fit	50 A*	17.8 ... 38.1 V	22 ... 47 V

Diotec offers product families for load dump protection according to ISO 16750-2: 2012 (E), both for the application without central load dump limit (according to standard Table 5, test A) and for those with central limitation (Table 6, Test B).

The new 6.6SM8Z series with 6.6kW peak pulse power in DO-218AB is already available, it will soon be supplemented by the 4.6SM6Z with 4.6kW. Both variants conform to AEC-Q101. The 5KP series represents an alternative in the axial housing, it allows up to 5kW in the usual design with 10 / 1000µs pulses.

Classic alternator rectifier diodes in the Pressfit package are the BYZ35 and BYZ50, which we offer especially for the After Sales market. They have a delimiter feature and thus provide the central load dump protection.

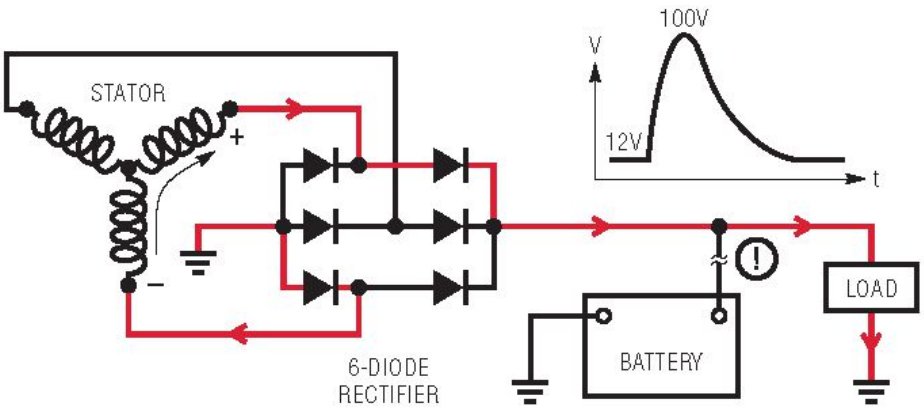


Figure: Typical load dump surge, during disconnection of the battery when alternator is in operation [i])

Boost Converter

Schottky Diode

Part no	Package	I_{FAV}	V_{RRM}
SKL34 ... 36	SOD-123F	3 A	40 ... 60 V
SK34SMA-3G ... 315SMA (-3G)	DO-214AC/SMA	3 A	40 ... 150 V
SK420	DO-214AB/SMC	4 A	200 V
SK54 ... 515 (-3G)	DO-214AA/SMB	5 A	40 ... 150 V
SK84 ... 815 (-3G)	DO-214AB/SMC	8 A	40 ... 150 V

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LED Driver

DC – DC Converter

Schottky Output Rectifiers

Part no	Package	I_{FAV}	V_{RRM}
PPS1040 ... 60 (-3G)	Power SMD	10 A	40 ... 60 V
PPS1540 ... 60 (-3G)	Power SMD	15 A	40 ... 60 V
SK1040...100D1)-3G)	D-PAK	10A	40...100 V
SK1040...100D2 (-3G)	D2-PAK single	10A	40...100 V
SK2040...100CD2 (-3G)	D2-PAK dual	2x 10A	40...100 V
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SK4040...45CD2 (-3G)	D2-PAK dual	2x 20A	40...45 V
SBT1040...100 (-3G)	TO-220AC	10A	40 ... 100 V
SBCT1040...100 (-3G)	TO-220AB dual	2x 5A	40 ... 100 V
SBCT2040...100 (-3G)	TO-220AB dual	2x 10A	40 ... 100 V
SBCT30100...150	TO-220AB dual	2x 15A	100 ... 150 V

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Zener Diodes

Part no	Package	P_{tot}	V_Z
MM3Z	SOD-323	300 mW	2.4 ... 47 V
BZT52	SOD-123	500 mW	2.4 ... 75 V
ZMC	Micro Melf	500 mW	2.4 ... 75 V

Current Regulation

CLD (Constant Current Regulator)

Part no	Package	I_{Pnom}	V_{AK}
CL10MD ... 30MD	DO-213AA/MiniMelf	20 ... 40 mA	90 V
CL15M35 ... 40M35	DO-214AC/SMA	15 ... 40 mA	90 V
CL15M45 ... 40M45	DO-214AA/SMB	15 ... 40 mA	90 V

Electronic Control and Gate Drive

Zener Diodes

Part no	Package	P_{tot}	V_Z
MM3Z	SOD-323	300 mW	2.4 ... 47 V
BZT52	SOD-123	500 mW	2.4 ... 75 V
ZMC	Micro Melf	500 mW	2.4 ... 75 V

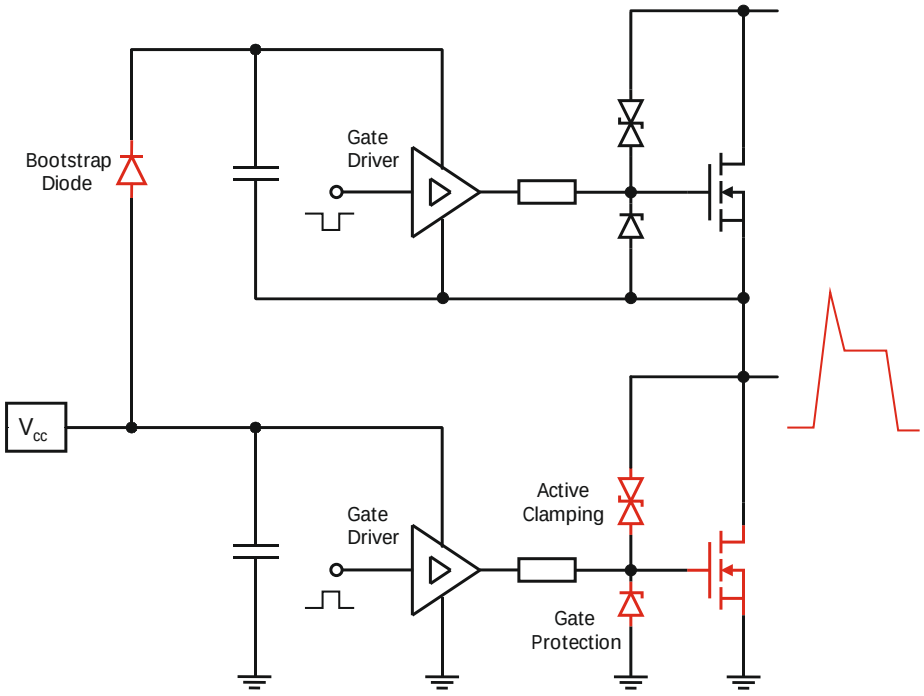
Small Signal Diodes

Part no	Package	I_{FAV}	V_{RRM}
1N4148WS	SOD-323	150 mA	100 V
BAT54A	SOT-23	200 mA	30 V
BAV99	SOT-23	215 mA	85 V

Schottky Diodes

Part no	Package	I_{FAV}	V_{RRM}
BAT54A	SOT-23	200 mA	30 V
BAS40-05	SOT-23	200 mA	40 V

Bootstrap Diodes



Part no	Package	I_{FAV}	V_{RRM}
FR2TSMA...FR2YSMA (Fast)	DO-214AC/SMA	1 A	1300 ... 2000 V
BYG23T (Superfast / Avalanche)	DO-214AC/SMA	1A	1300V

TVS Diodes (Gate Protection/Active Clamping)

Part no	Package	P_{PPM}	V_{WM}	V_{BR}
TGL34-...	DO-213AA/MiniMelf	150 W	5.5 ... 171 V	6.8 ... 200 V
SMF...	SOD-123F	200 W	5.0 ... 220 V	6.8 ... 260 V
TGL41-...	DO-213AB/Melf	400 W	5.5 ... 423 V	6.8 ... 520 V
P4SMA...	DO-214AC/SMA	400 W	5.0 ... 495 V	6.8 ... 550 V
P6SMB...	DO-214AA/SMB	600 W	5.0 ... 495 V	6.8 ... 550 V
1.5SMC...	DO-214AB/SMC	1500 W	5.0 ... 495 V	6.8 ... 550 V

[i]) Source: Low Quiescent Current Surge Stopper: Robust Automotive Supply Protection for ISO 7637-2 and ISO 16750-2 Compliance, Dan Eddleman, LT Journal of a Analog Innovation, January 2017