DN95

2.8A high current LED driving using ZXLD1320 with external power switch

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Introduction

In the past decade, solid state lighting devices have gained popularity. High brightness LEDs are finding their way into a wide range of applications. High power capacity multi-chip LED devices now often require higher LED driving current than peviously.

The ZXLD1320 is a buck LED driver IC with built in 2A bipolar power switch which is capable of driving high power LED with constant LED current up to 1.5A. Higher LED driving current can be achieved with additional external power switch.

The following are design examples of two 2.8A constant current LED driver circuits which are capable to drive multi-chip LED devices likes the Cree XLamp MC-E or the Seoul Semiconductor Z-Power P7 .

2.8A LED driver with external MOSFET switch

Figure 1 and Table 1 show the schematic and bill of materials of 2.8A step down LED driver circuit for input voltage ranged from 4V up to 18V.

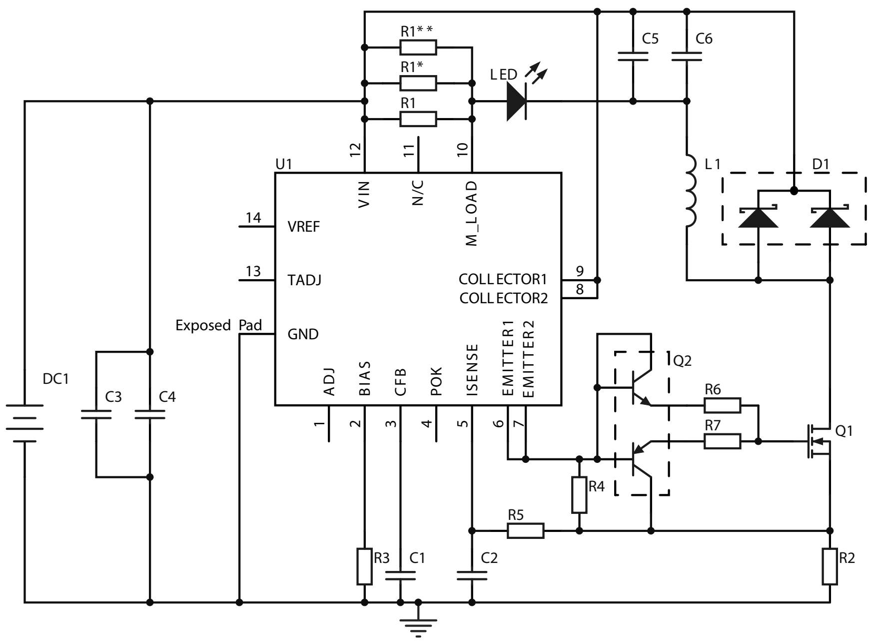


Figure 1 - Schematic

Ref No.	Value	Part No.	Manufacturer	Website
U1	LED Driver	ZXLD1320	Diodes Zetex	www.diodes.com www.zetex.com
Q1	MOSFET	ZXMN3A04KTC	Diodes Zetex	www.diodes.com www.zetex.com
Q2	Gate Driver BJT Pairs	ZXTC2045	Diodes Zetex	www.diodes.com www.zetex.com
D1	Super Barrier Rectifier	SBR1045CT	Diodes Zetex	www.diodes.com www.zetex.com
L1	10uH 4.1A	74477110 NPIS24H100MTRF MSS1246-103ML	Wurth Electronik NIC Coilcraft	www.we-online.com www.niccomp.com www.coilcraft.com
C1	10nF 25V X7R SMD 0603	NMC0603X7R103K25TRPF GRM188R71E103KA01	NIC Murata	www.niccomp.com www.murata.com
C2	47nF 25V X7R SMD 0603	NMC0603X7R473K25TRPF GRM188R71E473KA01	NIC Murata	www.niccomp.com www.murata.com
C3 C4 C5 C6	4.7uF 50V X7R SMD 1206	GRM31CR71H475KA12	Murata	www.murata.com
R1 R1*	100mΩ	NCST12FR100FTRF	NIC	www.niccomp.com
R1**	120mΩ	NCST12FR100FTRF	NIC	www.niccomp.com
R2	15mΩ	SMD 1206	generic	
R3 R7	0Ω	SMD 0805 / 0603	generic	
R4	1.2KΩ	SMD 0805 / 0603	generic	
R5	33Ω	SMD 0805 / 0603	generic	
R6	5.6Ω	SMD 0805 / 0603	generic	

Table 1 - Bill of materials

Circuit description

In this design, the ZXLD1320 is used as current feedback controller to control the MOSFET power switch through a ZXTC2045 gate drive transistor pair.

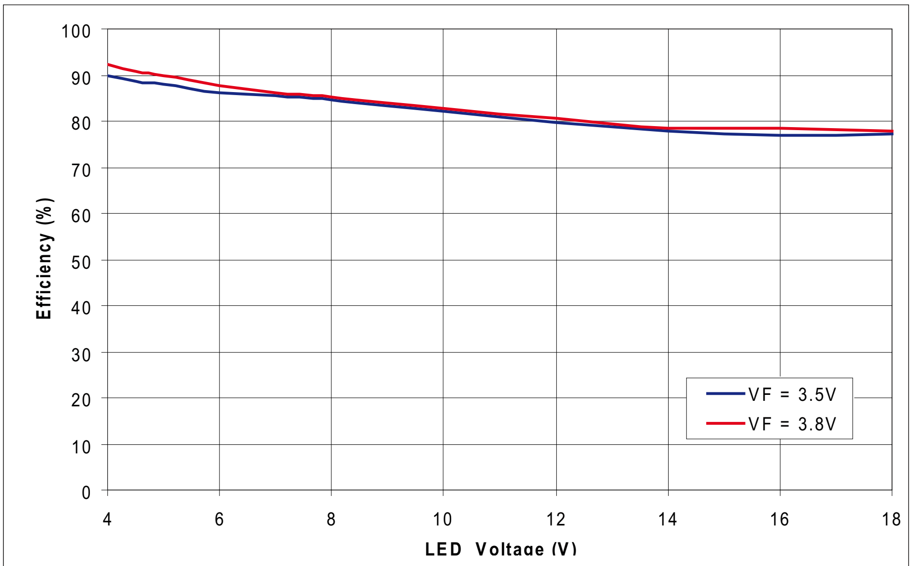
The output switch of ZXLD1320 is configured as an emitter-follower which becomes part of the gate drive circuitry. Q2 is a complementary BJT pair with the NPN transistor connected as a blocking diode.

During the on-state, the NPN transistor is bypassed and the driving current from ZXLD1320 Emitter pin charges up the gate of the MOSFET, causing the MOSFET to turn on. During the off-state, the PNP transistor turns on due to passive pull down of R4. This acts as an active pull down to discharge the gate of the MOSFET, causing the MOSFET to turn off.

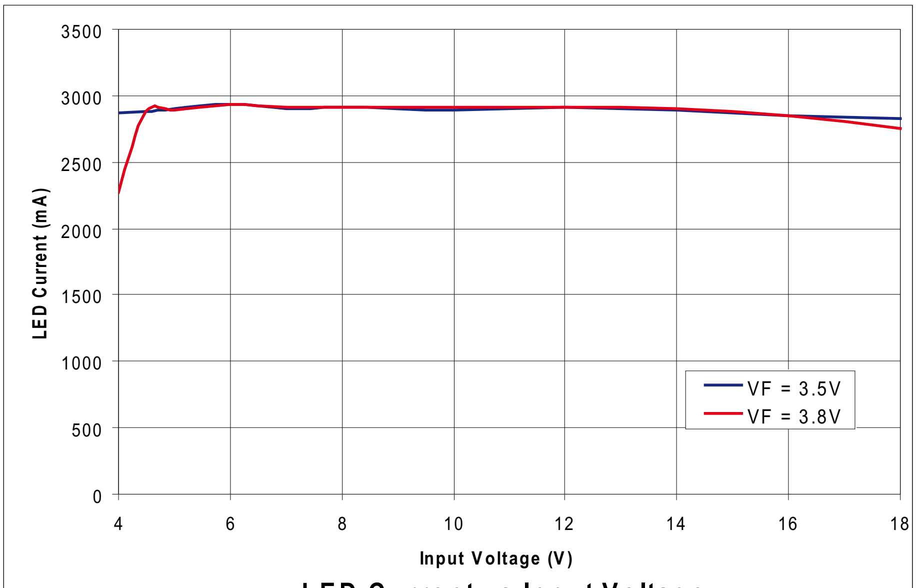
The super barrier rectifier SBR1045CT is selected as the free wheeling rectifier D1 due to its ultra-low forward voltage characteristic and its much better reverse leakage current. This helps to improve the overall system conversion efficiency.

A voltage spike is generated by high switching current and stray inductance of PCB's copper track. This would be high compared to the low ISENSE voltage threshold of ZXLD1320 which is below 55mV. An RC filter formed by C2 and R5 is used to prevent false triggering of ISENSE pin. C2 should be placed as close as possible to the ISENSE pin and the exposed GND pad of the IC.

Typical performance (MOSFET power switch)



Efficiency vs LED Voltage



LED Current vs Input Voltage

A high performance BJT could also be used as power switch with good performance at lower working voltage range

2.8A LED driver with external BJT switch

Figure 2 and Table 2 show the schematic and bill of material of 2.8A step down LED driver for input voltage ranged from 4.5V up to 7.5V.

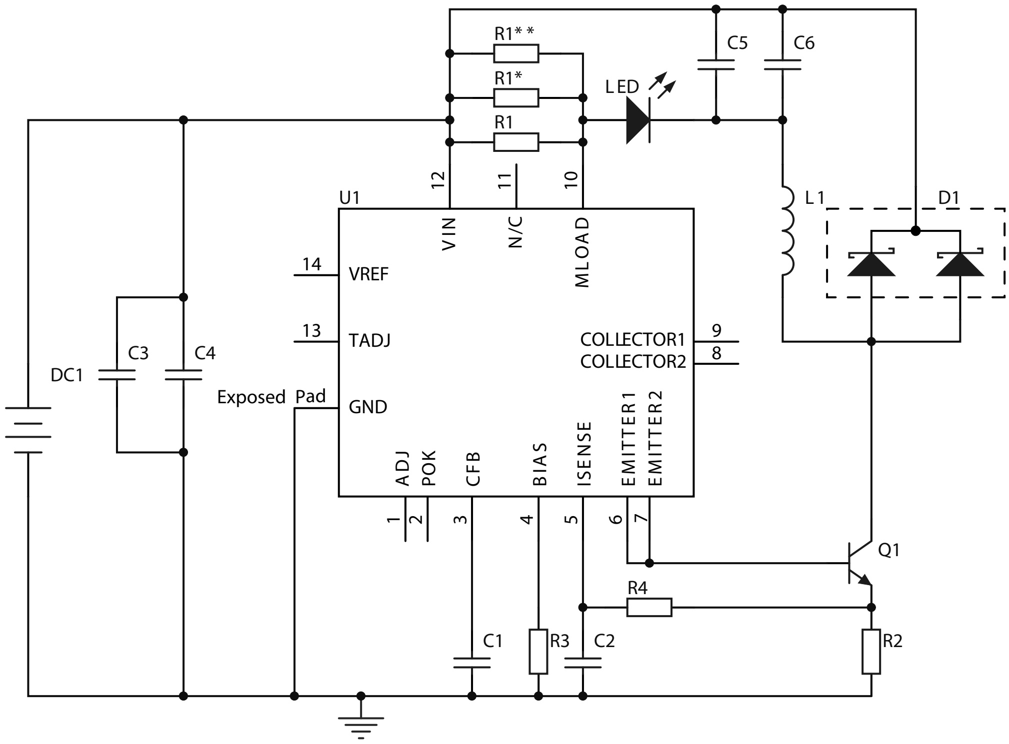


Figure 2 - Schematic

Ref No.	Value	Part No.	Manufacturer	Note
U1	LED Driver	ZXLD1320	Diodes Zetex	www.diodes.com www.zetex.com
Q1	Super Transistor	ZXTN25012EZ	Diodes Zetex	www.diodes.com www.zetex.com
D1	Super Barrier Rectifier	SBR1045CT	Diodes Zetex	www.diodes.com www.zetex.com
L1	10uH 4.1A	74477110	Wurth Electronik	www.we-online.com
C1	10nF 25V X7R	SMD 0805 / 0603		
C2	47nF 25V X7R	SMD 0805 / 0603		
C3 C4 C5 C6	4.7uF 25V X7R	SMD 1206		
R1 R1*	100mΩ	SMD 1206		
R1**	120mΩ	SMD 1206		
R2	15mΩ	SMD 1206		
R3	220Ω	SMD 0805 / 0603		
R4	33Ω	SMD 0805 / 0603		

Table 2 - Bill of materials

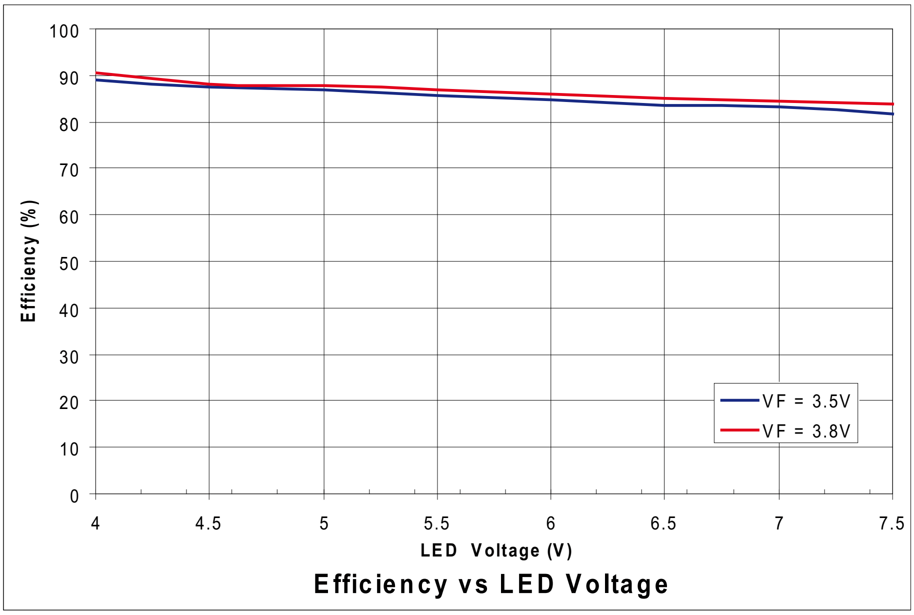
Circuit description

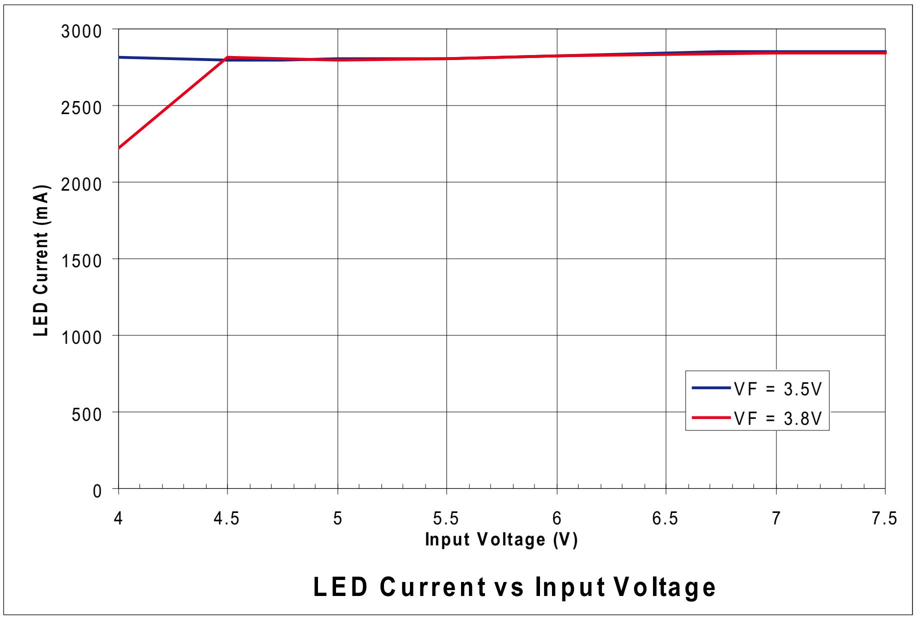
This circuit is similar to the MOSFET switch circuit. The gate driver transistor and MOSFET is replaced by single ZXTN25012EZ bipolar transistor. In this case, the COLLECTOR pins of ZXLD1320 are not connected to VCC. i.e. the ZXTN25012EZ is driven by the ZXLD1320's internal driver through the BE junction of internal bipolar switch.

R3 is set to 220 Ohm to supply 25mA of drive current. Adequate base driving current is essential to prevent excess minority charge accumulating in the base region of the ZXTN25012EZ. This causes the transistor to go into deep saturation which stores charge. The removal of this excess charge will actually increase the rise time during turn off state.

A BJT exhibits higher rise/fall time compared to MOSFET. The switching losses become significant as switching voltage and frequency increase. i.e. Input voltages of greater than 9V are not recommended for this design.

Typical performance graphs (BJT Power Switch)





Conclusion

Bipolar and Mosfet power switches could be connected to ZXLD1320 to produce a high current buck type LED drivers with scalable output current capability at an efficiency of around 85%. If power supply voltage is below 8V, bipolar power switch is recommended with less component count. For application with higher input voltage, efficiency of bipolar switch drop quickly as input voltage increase. Mosfet switch shows better efficiency performance over the whole input voltage range.

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