ZXLD1320EV3 USER GUIDE

DESCRIPTION

The ZXLD1320EV3, Figure 1, is a PCB constructed using an FR4 base for evaluating the ZXLD1320 LED driver, which is connected to an external switch for high current LED applications. The evaluation board can be used to drive an external choice of LEDs with up to 2.8A LED current; the total forward voltage across the LEDs depending upon the number and type connected.

The suggested operating voltage for the evaluation board ranges from 5V to a maximum of 18V. Since the LED is working in step-down mode, a higher input voltage implies that the driver can be connected to a greater number of LEDs in series.

The nominal current for the evaluation board is set at 2.8A with a sense resistor of 35mR consisting of R3,R3A and R3B in parallel.

Test point ADJ provides a connection point for DC or PWM dimming and shutdown. Test Point TADJ provides a connection point for thermal compensation.

Note: The evaluation board does not have reverse polarity protection.

Warning: with 2.8A LED current, the connected LED will be hot and very bright

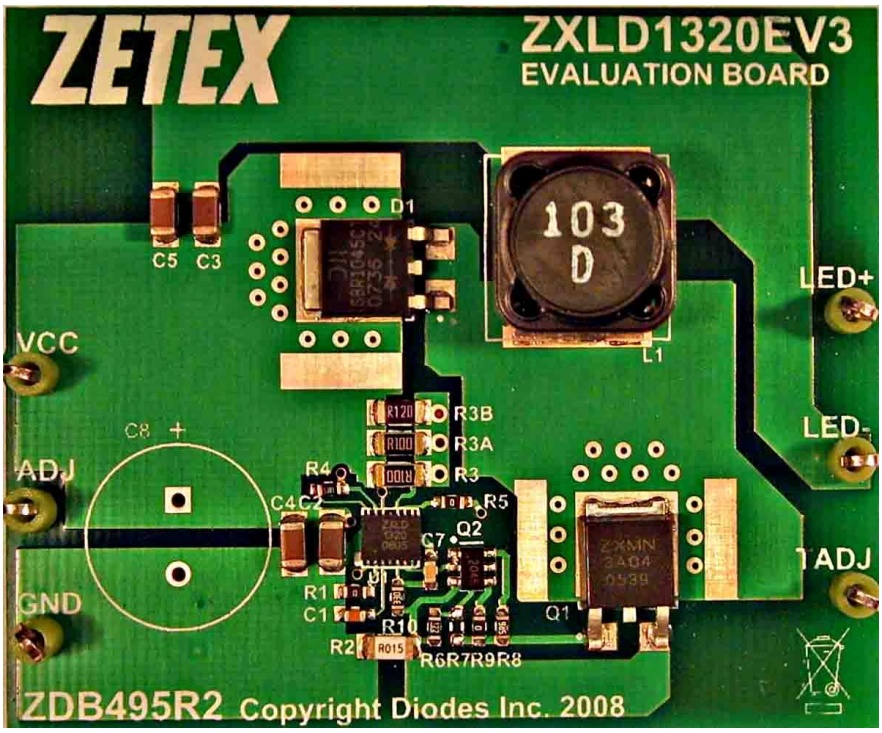


Figure 1: ZXLD1320EV3 evaluation board

ZXLD1320 DEVICE DESCRIPTION

The ZXLD1320 is an inductive DC-DC converter with an internal switch, designed for driving single or multiple LEDs in series up to a total of 1.5A output current. Applications cover both commercial and automotive environments with input voltages ranging from 4V to 18V. Depending upon the supply voltage and external components, it can provide up to 24W of output power. The device employs a variable 'on' and 'off' time control scheme with adjustable peak switch current limiting and operates in the step-down (Buck) mode, offering higher power efficiency and lower system cost than conventional PFM circuitry. The device includes the DC-DC converter, a high-side current monitor and an NPN switching transistor to provide an integrated solution offering small PCB size, competitive cost/performance, high power efficiency of DC-DC conversion and maximum LED brightness and reliability. More importantly, it retains design flexibility to add customer specific features.

The feedback control circuitry inside the ZXLD1320 provides excellent load and current regulation, resulting in very stable LED current over the full operating voltage and temperature range. The LED current can be adjusted from 100% down to 10% of the set value by applying a DC voltage to the ADJ pin and down to 1% by applying a PWM signal. An on-chip LED protection circuit also allows the output current to be reduced linearly above a predetermined threshold temperature using an external thermistor at the TADJ pin. External resistors set the nominal average LED current and coil peak current independently. The 'Power-OK' (POK) output flag remains high during normal operation, but switches low if the switch transistor remains on for more than 500µs. This provides indication of a low battery, or fault condition. The POK output may be used to drive an LED or the input of an MCU. The device can be shut down by applying a continuous low level DC voltage to the ADJ pin.

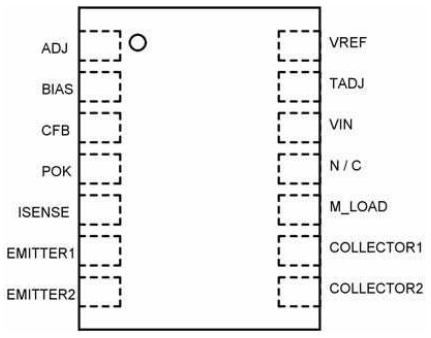
ZXLD1320 DEVICE FEATURES

- Step Down LED Driver
- 4V to 18V Input Voltage Range
- Up to 1.5A output current
- Typical efficiency *> 85%
- User-defined thermal control of LED output current using external thermistor
- 12µA typical standby current
- Adjustable Soft-Start
- Power ‘OK’ flag output
- Capable of driving 4 LEDs in series

DEVICE APPLICATIONS

- Low voltage halogen lamp replacement with LEDs
- LED projector
- High Power LED flashlights
- LED back-up lighting
- General LED lighting

ZXLD1320DCATC package and pin definitions



Pin Description

Name	Pin #	Description
ADJ	1	Adjust input • Leave floating, or connect to VREF to set 100% output current. • Drive with dc voltage. (50mV<VADJ< VREF) to adjust output current from 10% to 100% of set value. (DC brightness control mode) • Drive with low frequency (200Hz) PWM control signal to gate output 'on' and 'off' at the PWM frequency. (PWM brightness control mode) • Drive with low level dc voltage (VADJ<28mV) to turn off device • (Standby mode)
BIAS	2	Bias pin for setting base current of internal switch transistor • Short pin to ground to define maximum base drive current for output switch (Maximum output current condition) • Connect resistor (RBIAS) from this pin to ground to reduce base drive current (Reduced output current condition)
CFB	3	Control input/output for feedback control loop • Connect 10nF capacitor from this pin to ground to provide loop compensation
POK	4	Power OK flag output • Pin is high during normal operation. • Pin switches low if the switch remains on for more than 500µs (nom)
ISENSE	5	Switch peak current sense pin • Connect resistor (Rsense) from this pin to ground to define peak switch current (ISWPEAK)=0.05/RS
EMITTER1	6	Switch emitters (Connect both pins to top of RSENSE to sense emitter current)
EMITTER2	7	
COLLECTOR 2	8	Switch Collectors (Connect both pins to lower side of coil)
COLLECTOR 1	9	
M_LOAD	10	Load side input of high side current monitor. Connect to sensing resistor RM.
N/C	11	Not connected
VIN	12	Positive supply to device (4-18V) and sensing resistor RM • Decouple to ground with capacitor close to device • Nominal average output (LED) current = 0.1/RM
TADJ	13	Temperature Adjust input for LED thermal compensation • Connect thermistor/resistor network to this pin to reduce output current above a preset temperature threshold. • Connect to VREF to disable thermal compensation function (see section on temperature control for details)
VREF	14	Internal 0.5V reference voltage output
Exposed Pad	15	Connect to Ground (0V)

ORDERING INFORMATION

EVALBOARD ORDER NUMBER	DEVICE ORDER NUMBER
ZXLD1320EV3	ZXLD1320DCATC

Please note: Evaluation boards are subject to availability and qualified leads.

ZXLD1320EV3 EVALUATION BOARD REFERENCE DESIGN

The ZXLD1320EV3 is an evaluation board configured to be used with the ZXLD1320 in a DFN14 4X3 package and incorporates an external Mosfet switch to extend the LED current driving capability. The target application is LED driving, for one or more series-connected LEDs at up to 2.8A LED current.

The suggested maximum operating voltage for the evaluation board is 18V, and the nominal current is set at 2.8A with the sense resistor combination R3, R3A and R3B, set to 35mR.

An accurate way of determining the current, avoiding the need to insert an ammeter in the current path, is to measure the voltage on the sense resistor. A 10k resistor and a 1uF capacitor can be used to form a low pass filter, allowing the voltage measured across the capacitor to give a more stable representation of the current. Using this method, 100mV represents 2.8 Amps when using a 35mR sense resistor.

Both DC and PWM dimming can be achieved by driving the ADJ pin. For DC dimming, the ADJ pin may be driven between 50mV and 500mV to provide LED currents between 10% and 100%. Driving the ADJ pin below 28mV will shut down the output current. For PWM dimming, an external open-collector NPN transistor or open-drain N-channel MOSFET can be used to drive the CTRL pin. The PWM frequency should be around 100Hz to 1 kHz.

For further applications information, please refer to the ZXLD1320 datasheet.

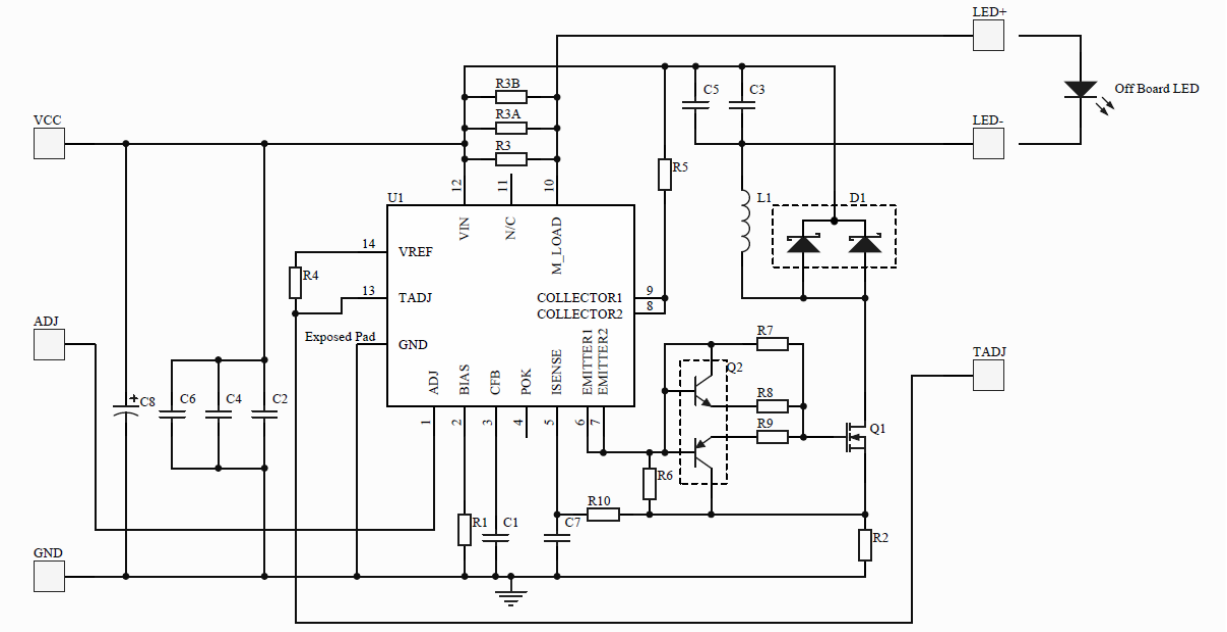


Figure 2: Schematic for the evaluation board ZXLD1320EV3

ZXLD1320EV3 Circuit Description

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

The output switch of the 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 the 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 the passive pull down effect of R6. 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 used as the free-wheeling rectifier D1. The ultra-low forward voltage characteristic of the Super Barrier Rectifier helps to improve the overall system conversion efficiency.

Since the voltage spike caused by the high switching current and stray inductance of the PCB's copper track would be high compared to the low I_{SENSE} voltage threshold of ZXLD1320, which is below 55mV, the RC filter formed by C7 and R10 is used to prevent false triggering of the ISENSE pin. i.e. C7 should be placed as close as possible between the ISENSE pin and the exposed GND pad of the ZXLD1320.

ZXLD1320EV3 Evaluation Board - BOM

Ref	Value	Package	Part Number	Manufacturer	Notes
U1	ZXLD1320	DFN14 4X3	ZXLD1320DCATC	DIODES INC	-
Q1	ZXMN3A04KTC	DPAK	ZXMN3A04KTC	DIODES INC	-
Q2	ZXTC2045	SOT23-6	ZXTC2045	DIODES INC	-
D1	SBR1045CT	DPAK	SBR1045CT	DIODES INC	-
L1	10uH 4.1A	-	NIC NPIS25H100MTRF Coilcraft MSS1260-103ML Wurth 744-77110	NIC Comps Coilcraft Wurth Elektronik	-
C1	10nF 10V X7R	0603	Generic	Generic	-
C2 C3 C4 C5	4.7uF 50V X7R	1206	GRM31CR71H475K	Murata	-
C6	1uF 50V X7R	1206	GRM31MR71H105K	Murata	-
C7	47nF 10V X7R	0603	Generic	Generic	-
C8	NOT FITTED	-	-	-	-
R1 R5 R9	0R	0603	Generic	Generic	-
R2	15mR	1206	Generic	Generic	5%
R3 R3A	100mR	1206	Generic	Generic	1%
R3B	120mR	1206	Generic	Generic	1%
R4	5K1R	0603	Generic	Generic	5%
R6	1K2R	0603	Generic	Generic	5%
R7	NOT FITTED	-	-	-	-
R8	5R6	0603	Generic	Generic	5%
R10	33R	0603	Generic	Generic	5%

The FR4 PCB design, with copious copper on the top and bottom and plated through vias for thermal coupling, guarantees a good thermal dissipation for the ZXMN3A04 and SBR1045 devices. Other sources of heat are the inductor, the capacitor and the sense resistor. Care must be taken in their placement.

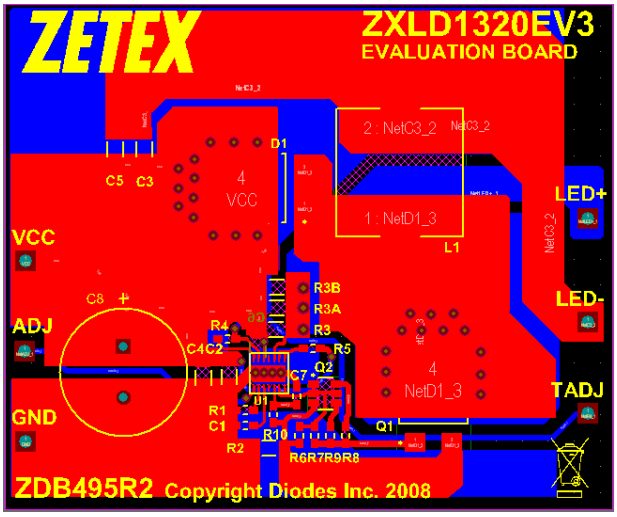


Figure 3: Component layout and circuit board view

ZXLD1320EV3 Connection Point Definition	
Name	**Description**
VCC	Positive supply voltage.
GND	Supply Ground (0V).
ADJ	Internal voltage ref. pin (500mV). This pin can be used to achieve dimming and for shutdown of the output current. • Leave floating for normal operation. Please refer to ZXLD1320 data for detailed descriptions.
TADJ	Thermal compensation pin. This pin can be used to achieve temperature compensation by connecting a 10k NTC thermistor to ground. • Leave floating for normal operation. Please refer to ZXLD1320 data for detailed descriptions.
LED+	LED+ connects to the external LED anode
LED-	LED- connects to the external LED cathode

ZXLD1320EV3 Basic operation at full voltage

1. Connect external LEDs across test pins 'LED+' (anode) and 'LED-' (cathode). The number of external LEDs that can be connected depends on their operating power and forward voltage drop, but typically 4 x 3.4V LEDs can be connected using an 18V rail. For an external load other than LEDs, the positive terminal of the load should be connected to the LED+ and the negative to the LED-.

2. Set the PSU to the desired input voltage (usually between 5V and 18V) with a current limit of 3A.

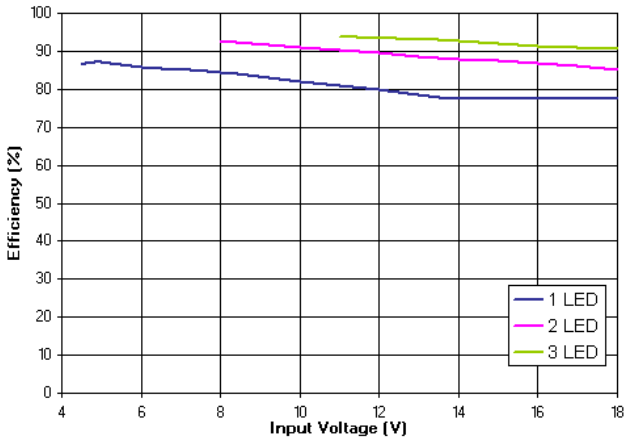
3. Connect VCC and GND.
   Warning: The board does not have reverse battery/supply protection.

4. Turn on the PSU. The external LEDs will illuminate and the LED current should be approximately 2.8A

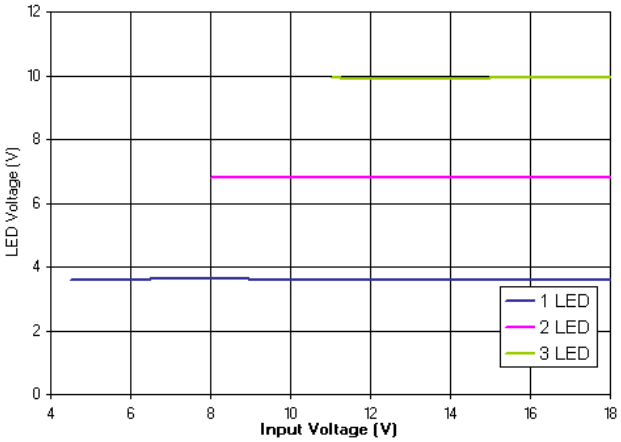
   Warning: Do not stare at the LEDs directly.

PERFORMANCE

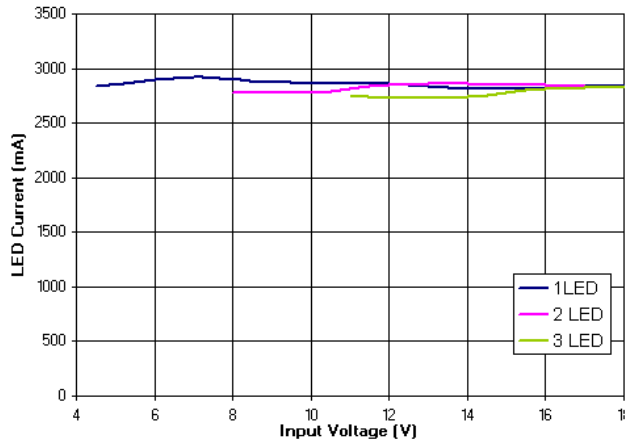
The system efficiency depends on the supply voltage, the inductor, and the number of LEDs.
The following graphs show the performance of the evaluation board using the recommended component values.



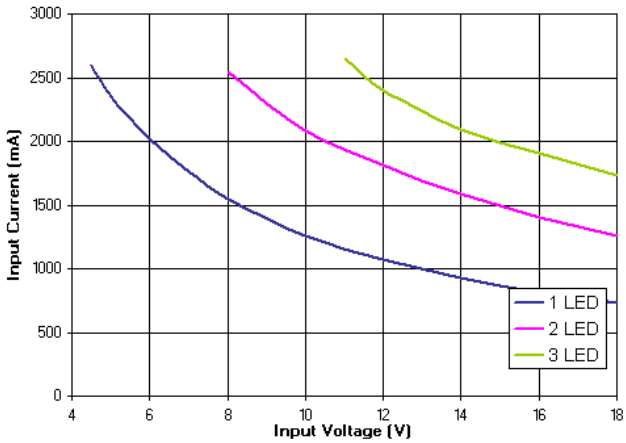
Efficiency vs Input Voltage



LED Voltage vs Input Voltage



LED Current vs Input Voltage



Input Current vs Input Voltage

Please visit our website www.diodes.com to find useful tools for circuit design and simulation.

REFERENCE

[1] ZXLD1320 Datasheet – www.diodes.com

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