ZXSC310EV6 EVALUATION BOARD USER GUIDE

ZXSC310 DESCRIPTION

The ZXSC310 is a single or multi-cell LED driver designed for LCD backlighting applications. The input voltage range of the device is between 0.8V and 8V. This means that the ZXSC310 is compatible with single NiMH, NiCd or Alkaline cells, as well as multi-cell or Li-Ion batteries.

The device features a shutdown control, resulting in a standby current less than 5µA, and an output capable of driving serial or parallel LEDs. The circuit generates a constant power output, which is ideal for driving single or multiple LEDs over a wide range of operating voltages. These features make the device ideal for driving LEDs in LCD backlight applications, for example, in Digital Still cameras and PDAs.

The ZXSC310 is a PFM DC-DC controller IC that drives an external Zetex switching transistor with a very low saturation resistance. Such transistors are excellent for this type of conversion, enabling high efficiency conversion with low input voltages. The drive output of the ZXSC310 LED driver generates a dynamic drive signal for the switching transistor.

The ZXSC310 is offered in the SOT23-5 package, which, when combined with a SOT23 switching transistor, generates a high efficiency, small size circuit solution. The IC-and-discrete combination offers the ultimate cost-versus-performance solution for LED backlight applications.

FEATURES

- 94% efficiency
- Minimum operating input voltage 0.8V
- Maximum operating input voltage 8V
- Standby current less than 5µA
- Programmable output current
- Series or parallel LED configuration
- Low saturation voltage switching transistor
- SOT23-5 package

TYPICAL APPLICATIONS

- LCD backlights:
- Digital still camera
- PDA
- Mobile phone
- LED flashlights and torches
- White LED driving
- Multiple LED driving

ORDERING INFORMATION

EVALBOARD ORDER NUMBER
ZXSC310EV6

DEVICE ORDER NUMBER
ZXSC310E5TA

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

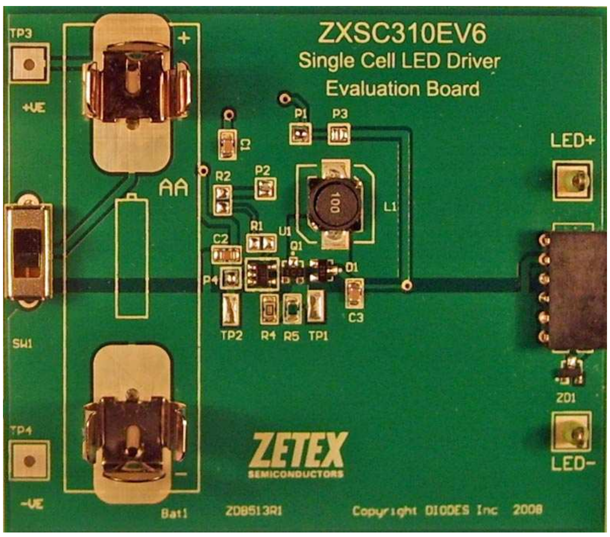


Figure 1: ZXSC310EV6 evaluation board

REFERENCE DESIGN

Schematic Diagram

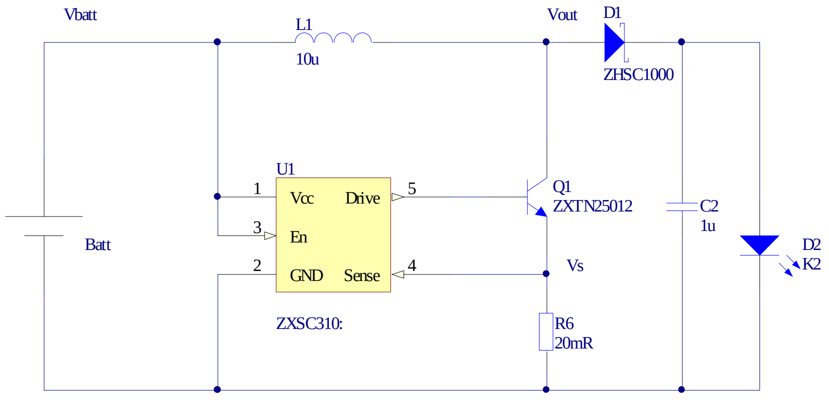


Figure 2: Conceptual Schematic for the evaluation board ZXSC310EV6
(The LED is not fitted on the board)

The ZXSC310EV6, Figure 1, is an evaluation board for the ZXSC310 boost LED driver. It is configured as in
Fig. 2, to drive approximately 200mA into either a single LED, or an external choice of LEDs, from a single 1.5V battery.

The operating voltage is nominally 1.5 volts, but the circuit will operate from 0.8volts up to 8 volts. The 10uH inductor used in the circuit has been chosen as being the optimum value for this voltage range. Power should be applied across the +VE and -VE pins, or, alternatively, a 1.5v ‘AA’ size battery can be inserted in the clips provided. The nominal input current for the evaluation board is 600mA, and the operating frequency will be about 250kHz

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

WARNING: Exposed battery connections exist on the front and back of the board. Do not cause the batteries to short-circuit by placing it on a conductive surface or allowing other conductive materials to come into contact with it.

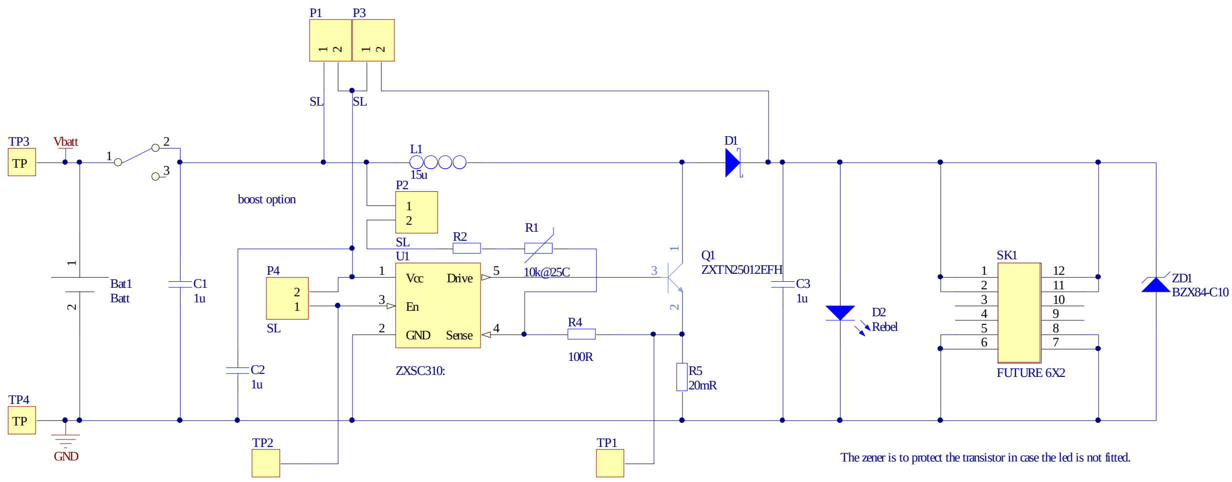


Figure 3: Actual schematic for ZXSC310 EV6
(The LED is not fitted on the board)

Differences between the Actual and Conceptual Schematics

The actual board has several different configurations, as in the schematic Fig. 3. Some of these are not appropriate for this application.

R4 is not needed in this application, so a low (or zero) value resistor fitted.
For operation as described, solder links P1 and P4 should be shorted and P1 and P2 left open.

The LED is not fitted. A LED suitable for the actual application can be fitted on an external PCB via SK1. The zener diode is fitted to protect Q1 against high voltages that would be produced by the circuit of there was an open circuit load. It is not needed for applications where the LED is permanently connected.

Design Procedure

The objective of this evaluation board is to drive the LED with the maximum current, subject to a reasonable efficiency and component cost.

Fundamentally for this type of circuit the limiting factor is the peak current through the inductor. Using the ZXTN25012 with the ZXSC310 at 1.0V to 1.5V the highest design current is about 1A. The threshold Voltage on the Isense pin is given as 19mV so a 19mR resistor could be used. The next highest preferred value is 20mR and the dissipation is only 20mW, so an 0805 package is adequate.
The ZXTN25012 is optimized for this type of application as it has an excellent combination of Vcesat and gain at 1A. If a different type of transistor is used, the value of the sense resistor may have to be increased, causing a reduction in output current.

The choice of inductor is a compromise between size and price. The small 10uH is a good compromise here: a larger inductor value in the same case would have a higher series resistance and hence higher losses. The value is not critical: a higher value could be used with little change in performance. If the inductor is too small, not only is the power output reduced, but the circuit could enter discontinuous mode, which is undesirable for e.m.c. and efficiency reasons.

The Schottky diode should have low forward voltage at 1A: the ZHSC1000 comes in a SOT23 package and has a Vf of about 400mV at 1A.

The output capacitor could be regarded as unnecessary, as the flicker that results from it's omission is not visible, but it helps with respect to e.m.c.

In this design the 'Enable' pin is tied to the Vcc pin (via solder link P4), as it's functionality is not used.

If no load is placed on the circuit, the output voltage continues to rise to an unacceptable level, so ZD1 is included to limit the voltage to approximately 10volts.

For other reference designs or further applications information, please refer to the ZXSC310 datasheet, Application Notes and Design Notes at www.zetex.com.

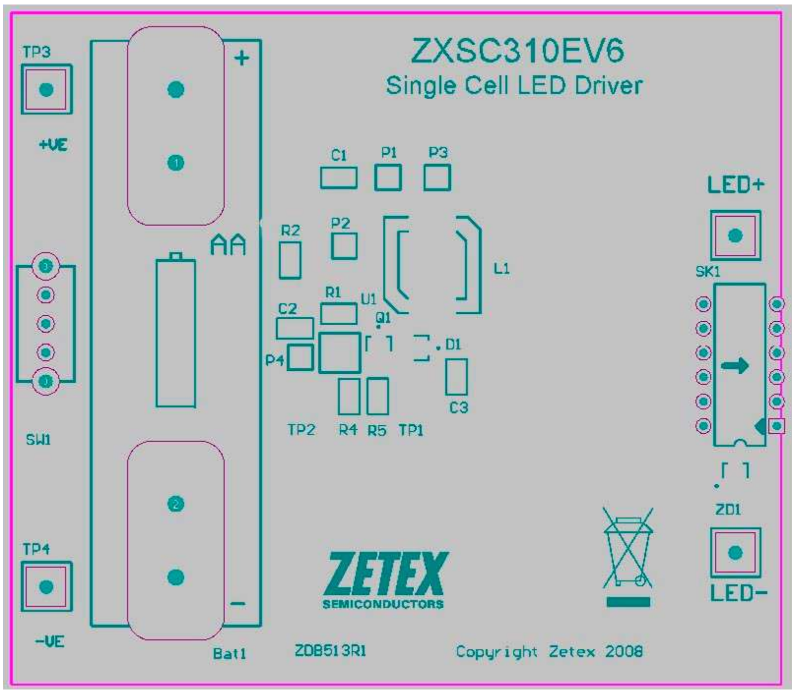


Figure 4: Component layout

ZXLD1360EV6 Component list

Designator	Value	Footprint	Part No	Manufacturer	Quantity
U1	ZXSC310E5	SOT23-5	ZXSC310E5	DIODES / ZETEX	1
ZD1	BZX84C10 350mW	SOT23A		DIODES / ZETEX	1
Q1	ZXTN25012EFH	SOT23	ZXTN25012EFH	DIODES / ZETEX	1
D1	ZHCS1000	SOT23	ZHCS1000	DIODES / ZETEX	1
C1, C2	1uF, 10V	0805	C0805C105K8RAC GRM21BR71A105KA01L NMC0805X7R105K10	Kemet Murata NIC	2
C3	1uF, 16V	0805	C0805C105K4RAC GRM21BR71C105KA01L NMC0805X7R105K16	Kemet Murata NIC	1
L1	10uH 1.5A	NPIS73100	NPIS73T100MTRF	NIC	1
R1	10k	0805	SMD 10k@25C 0805 NTC Thermistor	generic	0
R2	10k	0805	Resistor +/- 1%	generic	0
R4	100R	0805	Resistor +/- 1%	generic	1
R5	20mR	0805	Resistor +/- 1%	generic	1
SK1	N/A	DIL		generic	1
SW1	Slide switch, SPDT			generic	1
Bat1	Batt holder		Rapid 18-3505	Keystone	1

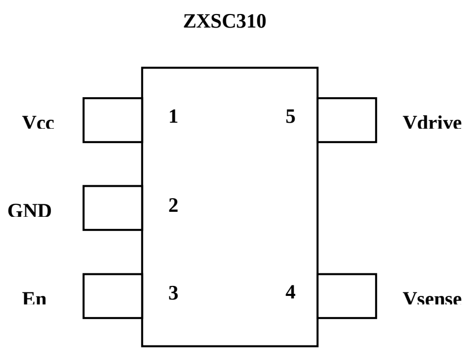
ZXLD1360EV6 Connection Point Definition	
Name	**Description**
+Ve	Positive supply voltage.
-Ve	Supply Ground (0V).
TP1	To monitor the voltage across the current sense resistor R6
TP2	Can be used to supply an Enable voltage if solder link P4 is opened.
LED+	External LED +ve
LED-	External LED -ve
SK1	The socket is designed to accept an LED Module Board. The pins are: 5 ,6, 7, 8 = LED cathode (-ve) and 1, 2, 11, 12 = LED anode (+ve). Pins 3, 4, 9, and 10 are not used.

ZXLD1360EV6 Basic operation at 1.5V

WARNING: Exposed battery connections exist on the front and back of the board. Do not cause the batteries to short-circuit by placing it on a conductive surface or allowing other conductive materials to come into contact with it.

1. Connect a power supply to TP3 (+ve) and TP4 (-ve) or insert an 'AA' size battery as depicted on the top of the board .
   Warning: The board does not have reverse battery/supply protection.
2. Set the PSU (if used), to 1.5V
3. Connect a suitable LED board to connector SK1, or an extyernal LED to LED+ and LED-. . (The LED must be capable of handling 600mA)
4. Turn on the PSU (if used), and the switch SW1. The LED will illuminate and the current should be approximately 600mA.
   Warning: Do not look at the LED directly.

ZXSC310 Device Packages, Pin and Definitions



SOT23-5 package

ZXLD1360 Device Pin Definition

Name	Pin No	Description
VCC	1	Input Voltage
GND	2	Ground (0V).
Enable	3	Tie high for normal operation, low to shutdown
Vsense	4	From the sense resistor
Vdrive	5	Drive current output to transistor

ZXSC310 Operation

The ZXSC310 is a constant off-time converter (also known as PFM). It operates as follows:-
On switch on, Q1 is switched on and the current through the inductor rises until the voltage across the sense resistor R6 reaches the threshold (set by the device to about 20mV). Q1 is then switched off for a constant time (determined by the internal device characteristics) of about 1.5us. During this time the inductor partially discharges into the load.
After the off-time, the cycle repeats.

It is worth noting that the frequency is determined by the ratio of the input voltage to the load voltage (and the fixed off-time) and does not depend on the inductor value.

Test and Diagnostics

With this type of circuit the performance is best evaluated by watching the waveform on the current sensing resistor. A test pad (TP1) has been provided for this purpose.
The voltage is normally 0-20mV so a sensitive oscilloscope with fairly narrow bandwidth is ideal.
This waveform with a corresponding inductor current waveform is shown schematically in Fig 5

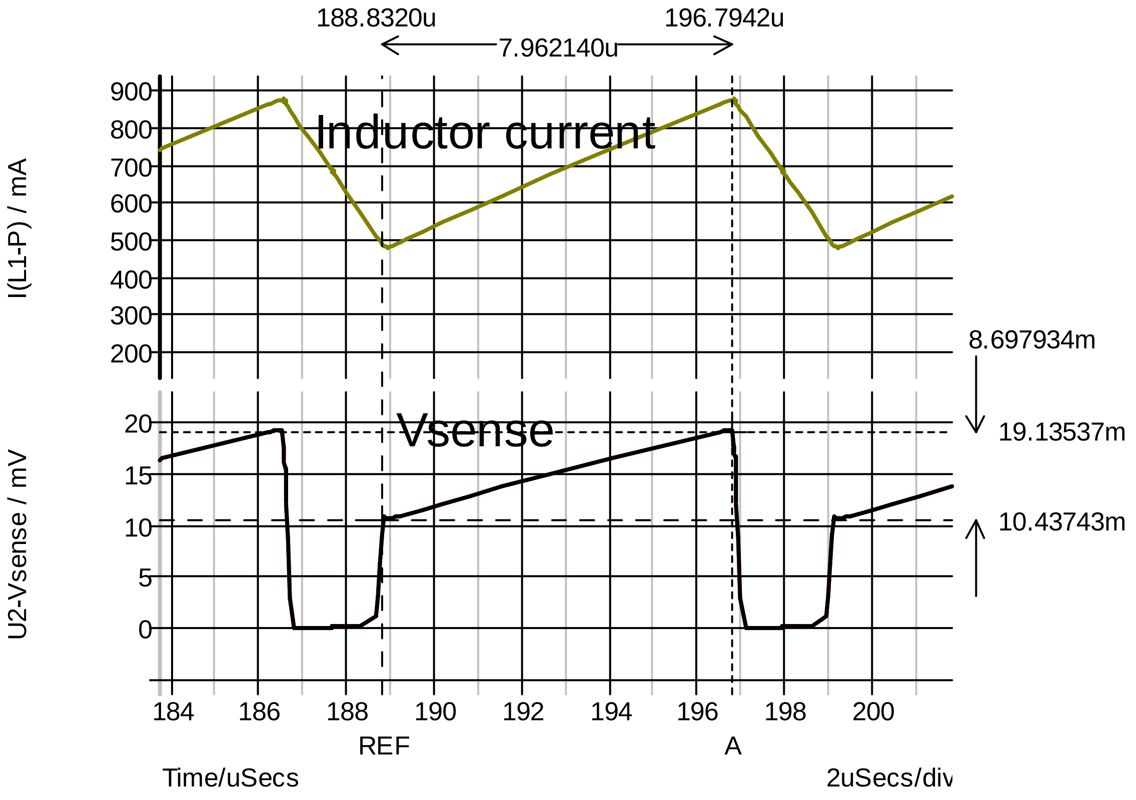


Figure 5: Sample Waveforms

Interpretation

The upper curve is the inductor current and this is not easy to measure without disturbing the circuit operation.
The lower curve is the voltage across the sense resistor which actually contains more information, but is less easy to interpret. This is the curve that can be seen from the test pad TP1.

The first thing to notice about this waveform is that the current starts from a non-zero value at the start of the on period. This shows that the circuit is operating in continuous mode.

The current rise on the lower trace looks straight which shows that the inductor resistance is not very high: if the resistances were high, the trace would sag towards the high current end and the circuit efficiency would be poor.

The voltage in the off period is close to zero, which shows that the transistor Vcesat is not reducing the efficiency significantly.

The ratio to on and off period is clearly defined showing that the circuit is operating cleanly. If the waveforms were not well defined there would be a fault in the operation; possibly too low an input Voltage

The maximum Voltage is about 20mV showing that the peak current is at the design level.

The minimum Voltage during the on period is about 10mV, so that the minimum current in this example is 500mA, and hence the average input current in this example is 750mA .

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