

ZXSC310EV4



ZXSC310EV4 EVALUATION BOARD USER GUIDE

DESCRIPTION

The ZXSC310EV4, Figure 1, is a double sided evaluation board for the ZXSC310 boost LED driver. The evaluation board is preset to drive about 200mA into a single LED from a single 1.5V battery, or an external choice of LEDs. There is provision on this evaluation board for the Lumileds™ REBEL™ LED (distributed by Future Lighting Solutions www.FutureLightingSolutions.com) but this is not fitted by default.

The operating voltage is nominally 1.5 volts, but can be up to 8 volts. The 10uH inductor used in the circuit is based on this nominal supply, which should be connected 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.

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.

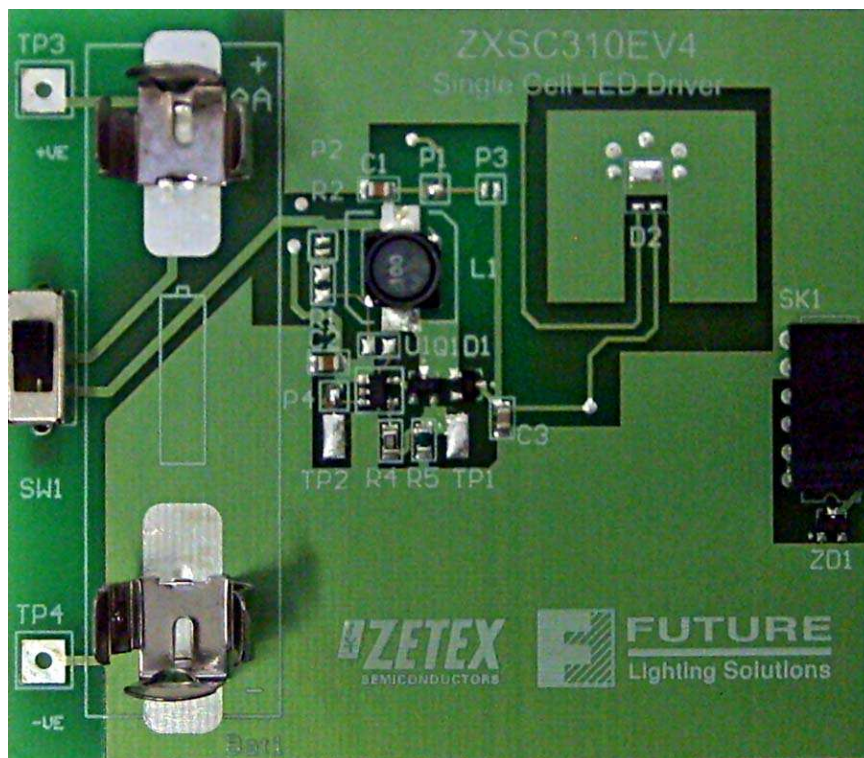


Figure 1: ZXSC310EV4 evaluation board

ZXSC310EV4



ZXSC310 DEVICE 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 5 μ A, 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, particularly in LCD backlight applications for 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. These 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:

ZXSC310 DEVICE FEATURES

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

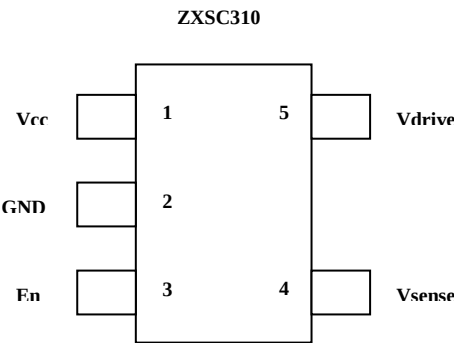
DEVICE APPLICATIONS

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

ZXSC310EV4



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

ORDERING INFORMATION

EVALBOARD ORDER NUMBER
ZXSC310EV4

DEVICE ORDER NUMBER
ZXSC310E5TA

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

ZXSC310EV4



ZXSC310EV4 EVALUATION BOARD REFERENCE DESIGN

The ZXSC310EV4 may be configured in several ways; the default configuration as delivered is effectively configured to the reference design in Figure 2. The target application is a driver for torches or other high powered LED applications.

The input voltage should be in the range 0.8V to 8V, with the board being laid out to include a single cell 1.5V battery. The input current at 1.5V will be about 600mA when driving a single white LED, and the LED current will be about 200mA. The operating frequency will be about 250kHz under these circumstances.

Design Procedure

In this case, the objective 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.

Other transistors could be used, but the ZXTN25012 is optimised for this type of application and has an excellent combination of V_{cesat} and gain at 1A. If another transistor is used the value of the sense resistor will probably have to be increased, causing a reduction in output current.

The choice of inductor is a compromise between size on the one hand and price on the other. 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 needs to have low forward voltage at 1A: the ZHSC1000 comes in a SOT23 package and has a V_f of about 400mV at 1A.

The output capacitor could be regarded as not really necessary, as the flicker that results from it's omission is not visible, but it does help 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.

The Zener diode ZD1 is included to protect the circuit in case there is no load: without it, the output voltage would rise until something breaks over.

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

Schematic Diagram

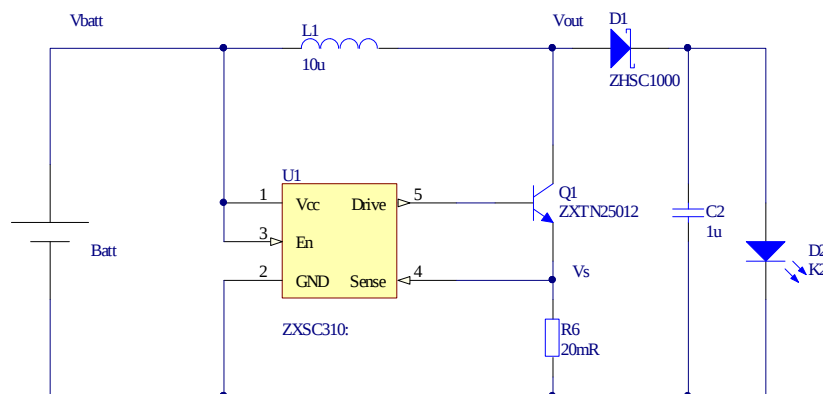


Figure 2: Conceptual Schematic for the evaluation board ZXSC310EV4

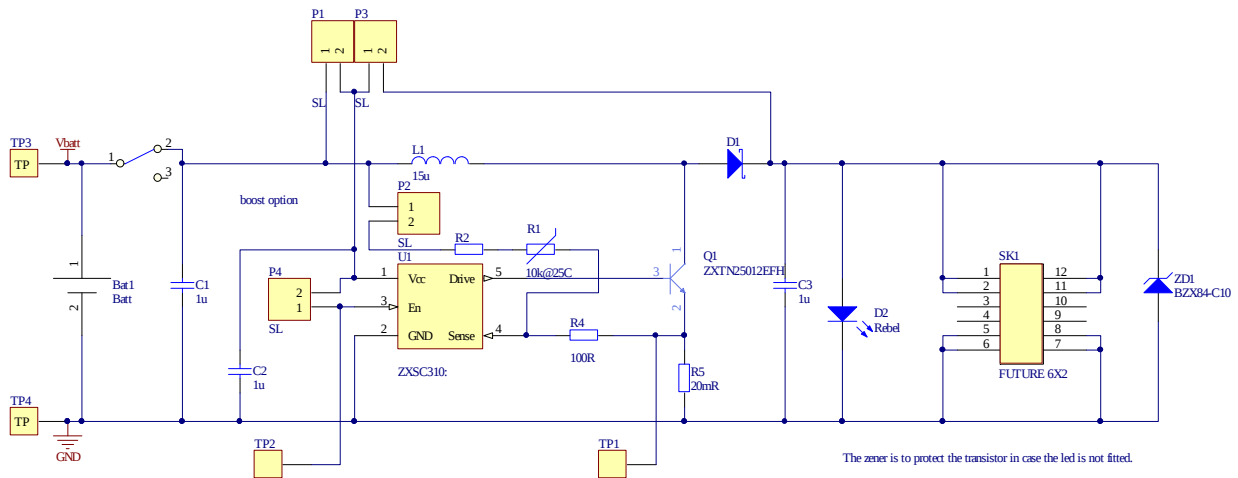


Figure 3: Actual schematic for ZXSC310 EV4

Differences between the Actual and Conceptual Schematics

The actual board has several different configurations, some of which are not appropriate for this application.

There are two points to note, firstly that R4 is not needed in this application, but as the PCB has a footprint in it's position it needs a low (or zero) value resistor fitted.

Secondly the LED is not fitted for this application; rather it is 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 if there was an open circuit load. It is not needed for applications where the LED is permanently connected.

Solder Links

For operation as described, solder links P1 and P4 should be shorted and P1 and P2 left open.

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 1.5 μ s. 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 4

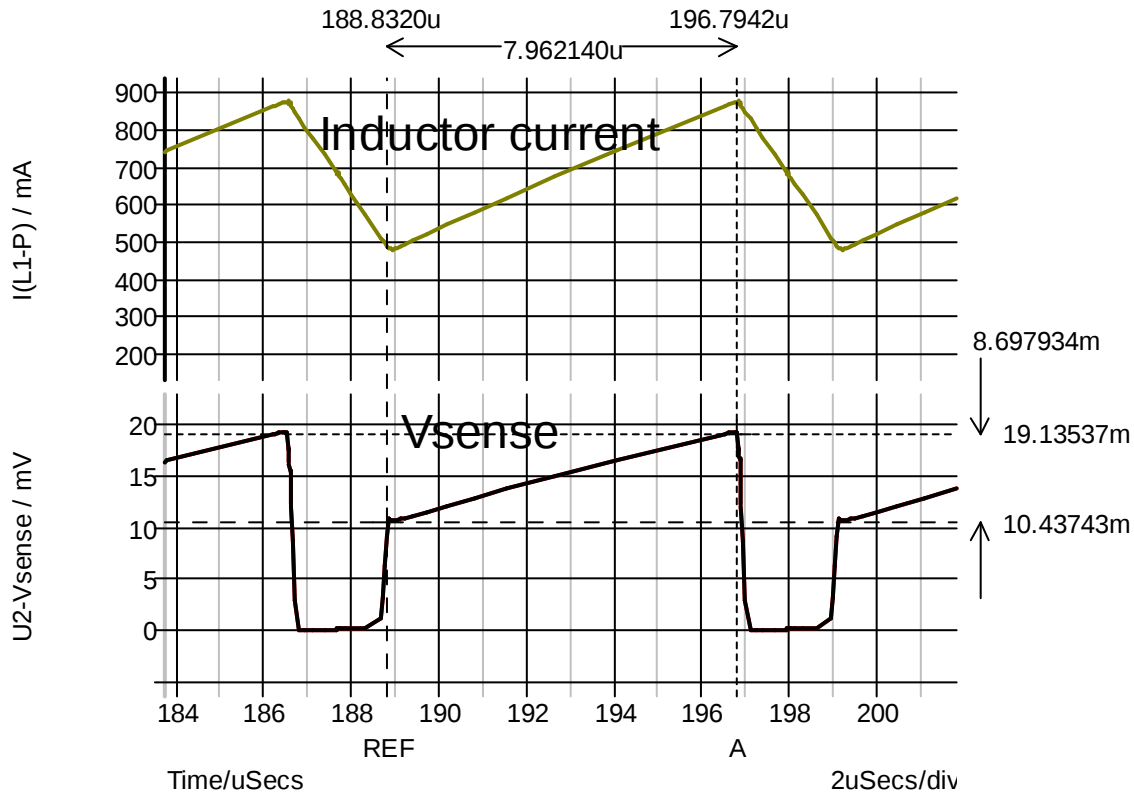


Figure 4: Sample Waveforms

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.

ZXSC310EV4



The voltage in the off period is close to zero, which shows that the transistor V_{cesat} 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 .

ZXLD1360EV6 Component list

Designator	Value	Footprint	Part No	Manufacturer	Quantity
Bat1	Batt holder	custom	Rapid 18-3505	Keystone	1
C1, C2	1uF, 10V	0805	GRM21BR71A105KA01L NMC0805X7R105K10	Murata NIC	2
C3	1uF, 16V	0805	GRM21BR71C105KA01L NMC0805X7R105K16	Murata NIC	1
D1	ZHCS1000	SOT23	ZHCS1000	ZETEX	1
D2	Rebel	Rebel basic	LXML-PWC1-0040	Luxeon	0
L1	10uH 1.5A	NPIS73100	NPIS73T100MTRF	NIC	1
Q1	ZXTN25012EFH	SOT23	ZXTN25012EFH	ZETEX	1
R1	10k	0805	SMD 10k@25C 0805 NTC Thermistor	Generic	0
R2	10k	0805	Resistor	Generic	0
R4	100R	0805	Resistor	Generic	1
R5	20mR	0805	Resistor	Generic	1
SK1	N/A	DIL12	6 way socket, 5535676-5	Tyco	1
SW1	Slide switch, SPDT	Slide sw	Rapid 76-0266		1
U1	ZXSC310E5	SOT23-5	ZXSC310E5	ZETEX	1
ZD1	BZX84-C10 350mW	SOT23A		Generic	1

The solder pad on the underside of the LED is connected to a heat-dissipating copper plane on the top and bottom layers, and is electrically isolated from all other connections on the board.

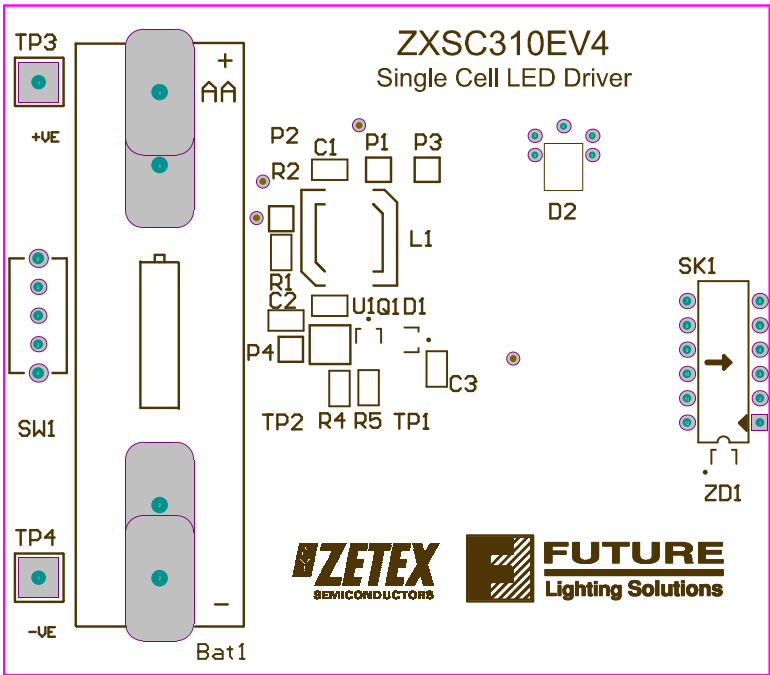


Figure 3: Component layout

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.
SK1	The socket is designed to accept a Future Luxeon Series 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 Lumileds™ Luxeon® emitter board to connector SK1. (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.

Definitions

Product change

Zetex Semiconductors reserves the right to alter, without notice, specifications, design, price or conditions of supply of any product or service. Customers are solely responsible for obtaining the latest relevant information before placing orders.

Applications disclaimer

The circuits in this design/application note are offered as design ideas. It is the responsibility of the user to ensure that the circuit is fit for the user's application and meets with the user's requirements. No representation or warranty is given and no liability whatsoever is assumed by Zetex with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Zetex does not assume any legal responsibility or will not be held legally liable (whether in contract, tort (including negligence), breach of statutory duty, restriction or otherwise) for any damages, loss of profit, business, contract, opportunity or consequential loss in the use of these circuit applications, under any circumstances.

Life support

Zetex products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Zetex Semiconductors plc. As used herein:

- A. Life support devices or systems are devices or systems which:
1. are intended to implant into the body
- or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.
- B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Reproduction

The product specifications contained in this publication are issued to provide outline information only which (unless agreed by the company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or be regarded as a representation relating to the products or services concerned.

Terms and Conditions

All products are sold subjects to Zetex' terms and conditions of sale, and this disclaimer (save in the event of a conflict between the two when the terms of the contract shall prevail) according to region, supplied at the time of order acknowledgement.

For the latest information on technology, delivery terms and conditions and prices, please contact your nearest Zetex sales office.

Quality of product

Zetex is an ISO 9001 and TS16949 certified semiconductor manufacturer.

To ensure quality of service and products we strongly advise the purchase of parts directly from Zetex Semiconductors or one of our regionally authorized distributors. For a complete listing of authorized distributors please visit: www.zetex.com/salesnetwork

Zetex Semiconductors does not warrant or accept any liability whatsoever in respect of any parts purchased through unauthorized sales channels.

ESD (Electrostatic discharge)

Semiconductor devices are susceptible to damage by ESD. Suitable precautions should be taken when handling and transporting devices. The possible damage to devices depends on the circumstances of the handling and transporting, and the nature of the device. The extent of damage can vary from immediate functional or parametric malfunction to degradation of function or performance in use over time. Devices suspected of being affected should be replaced.

Green compliance

Zetex Semiconductors is committed to environmental excellence in all aspects of its operations which includes meeting or exceeding regulatory requirements with respect to the use of hazardous substances. Numerous successful programs have been implemented to reduce the use of hazardous substances and/or emissions.

All Zetex components are compliant with the RoHS directive, and through this it is supporting its customers in their compliance with WEEE and ELV directives.

Product status key:

"Preview"	Future device intended for production at some point. Samples may be available
"Active"	Product status recommended for new designs
"Last time buy (LTB)"	Device will be discontinued and last time buy period and delivery is in effect
"Not recommended for new designs"	Device is still in production to support existing designs and production
"Obsolete"	Production has been discontinued

Datasheet status key:

"Draft version"	This term denotes a very early datasheet version and contains highly provisional information, which may change in any manner without notice.
"Provisional version"	This term denotes a pre-release datasheet. It provides a clear indication of anticipated performance. However, changes to the test conditions and specifications may occur, at any time and without notice.
"Issue"	This term denotes an issued datasheet containing finalized specifications. However, changes to specifications may occur, at any time and without notice.

Europe	Americas	Asia Pacific	Corporate Headquarters
Zetex GmbH Kustermann-park Balanstraße 59 D-81541 München Germany Telefon: (49) 89 45 49 49 0 Fax: (49) 89 45 49 49 49 europe.sales@zetex.com	Zetex Inc 700 Veterans Memorial Highway Hauppauge, NY 11788 USA Telephone: (1) 631 360 2222 Fax: (1) 631 360 8222 usa.sales@zetex.com	Zetex (Asia Ltd) 3701-04 Metroplaza Tower 1 Hing Fong Road, Kwai Fong Hong Kong Telephone: (852) 26100 611 Fax: (852) 24250 494 asia.sales@zetex.com	Zetex Semiconductors plc Zetex Technology Park, Chadderton Oldham, OL9 9LL United Kingdom Telephone (44) 161 622 4444 Fax: (44) 161 622 4446 hq@zetex.com

© 2006 Published by Zetex Semiconductors plc.