ADJUSTABLE DC-DC BOOST CONVERTER WITH INTERNAL SWITCH IN TSOT23-5

DESCRIPTION

The ZXLD1615 is a PFM inductive boost converter designed to provide output voltages of up to 28V from a 2.5V to 5.5V input supply.

The ZXLD1615 includes the output switch and peak current sense resistor, and can provide up to 10mA output current at maximum output voltage. Higher current is available at lower output voltages.

Quiescent current is typically 60µA and a shutdown function is provided to reduce this current to less than 100nA in the 'off' state.

Nominal output voltage can be set up to a maximum of 28V by two external resistors and can be adjusted to lower values by a PWM control signal applied to the 'Enable' pin. Depending upon the control frequency, the PWM signal will provide either continuous (low ripple) or gated control. The PWM filter components are contained within the chip. Minimum output voltage is determined by the input supply.

The device is assembled in a low profile TSOT23-5 pin package.

ADVANCED FEATURES

- Internal 30V NDMOS switch
- True analog output voltage control via PWM with internal filter

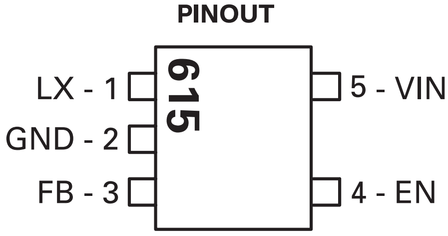
FEATURES

- Low profile TSOT23-5 pin package
- Internal PWM filter for flicker free output
- High efficiency (80% typ)
- Wide input voltage range: 2.5V to 5.5V
- Up to 250mA output current at 5V
- Low quiescent current: (60µA typ)
- 100nA maximum shutdown current
- Up to 1MHz switching frequency
- Low external component count

APPLICATIONS

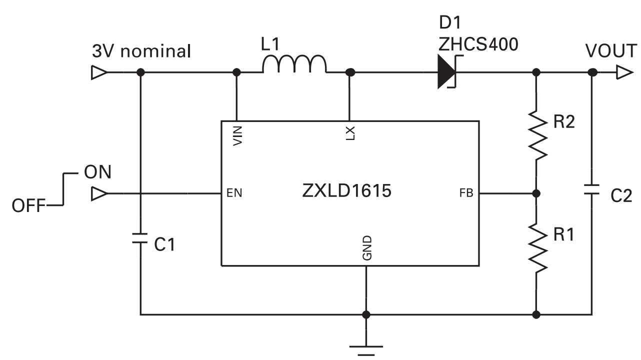
- LCD and OLED bias
- Cellular / mobile phones
- Digital cameras
- PDAs
- LCD modules
- Varactor and PIN diode bias
- Palmtop computers

PINOUT



TOP VIEW

TYPICAL APPLICATION CIRCUIT



ZETEX SEMICONDUCTORS

ABSOLUTE MAXIMUM RATINGS

(Voltages to GND unless otherwise stated)

Input voltage (V_{IN})	7V
LX output voltage (V_{LX})	30V
Switch output current (I_{LX})	500mA
Power dissipation (PD)	300mW
Operating temperature (T_{OP})	-40 to 85°C
Storage temperature (T_{ST})	-55 to 150°C
Junction temperature (Tj_{MAX})	125°C

ELECTRICAL CHARACTERISTICS: (Test conditions: V_{IN}=V_{EN}=3V, T_{AMB}=25°C unless otherwise stated[1])

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{IN}	Input voltage		2.5		5.5	V
I_{IN}	Supply current					
	Quiescent	V_{EN} = V_{IN}, I_{LX} = 0, Output not switching		60	100	µA
	Shutdown	V_{EN} = 0V		<10	100	nA
V_{FB}	FB pin control voltage		0.98		1.07	V
f_{LX}	Operating frequency	L=10µH, V_{OUT} =28V, 5mA load		600		kHz
T_{OFF}	LX output 'OFF' time		350	500		ns
T_{ON}[2]	LX output 'ON' time				5	µs
I_{LXpk}	Switch peak current limit	L=10µH, V_{OUT} =28V, 5mA load		320		mA
R_{LX}	Switch 'On' resistance			1.75		Ω
$I_{LX(leak)}$	Switch leakage current	V_{LX}=20V			1	µA
V_{ENH}	EN pin high level Input voltage	Device active	1.5		V_{IN}	V
V_{ENL}	EN pin low level Input voltage	Device in shutdown			0.4	V
I_{ENL}	EN pin low level input current	V_{EN} =0V			-100	nA
I_{ENH}	EN pin high level input current	V_{EN} =V_{IN}			1	µA
$T_{EN(hold)}$[3]	EN pin turn off delay	V_{EN} switched from high to low		120		µs
ΔT/T	PWM duty cycle range at 'EN' input for dc output voltage control	10kHz < f < 100kHz, V_{ENH} =V_{IN}	20		100	%
f_{LPF}	Internal PWM low pass filter cut-off frequency			4		kHz
A_{LPF}	Filter attenuation	f=30kHz		52.5		dB

NOTES:

1 Production testing of the device is performed at 25°C. Functional operation of the device over a –40°C to +85°C temperature range is guaranteed by design, characterization and process control.

2 Nominal 'on' time (TONnom) is defined by the input voltage (V_{IN}), coil inductance (L) and peak current (I_{LXpkdc}) according to the expression: $T_{ONnom} = \{I_{LX(pkdc)} \times L/V_{IN}\}$ +200ns

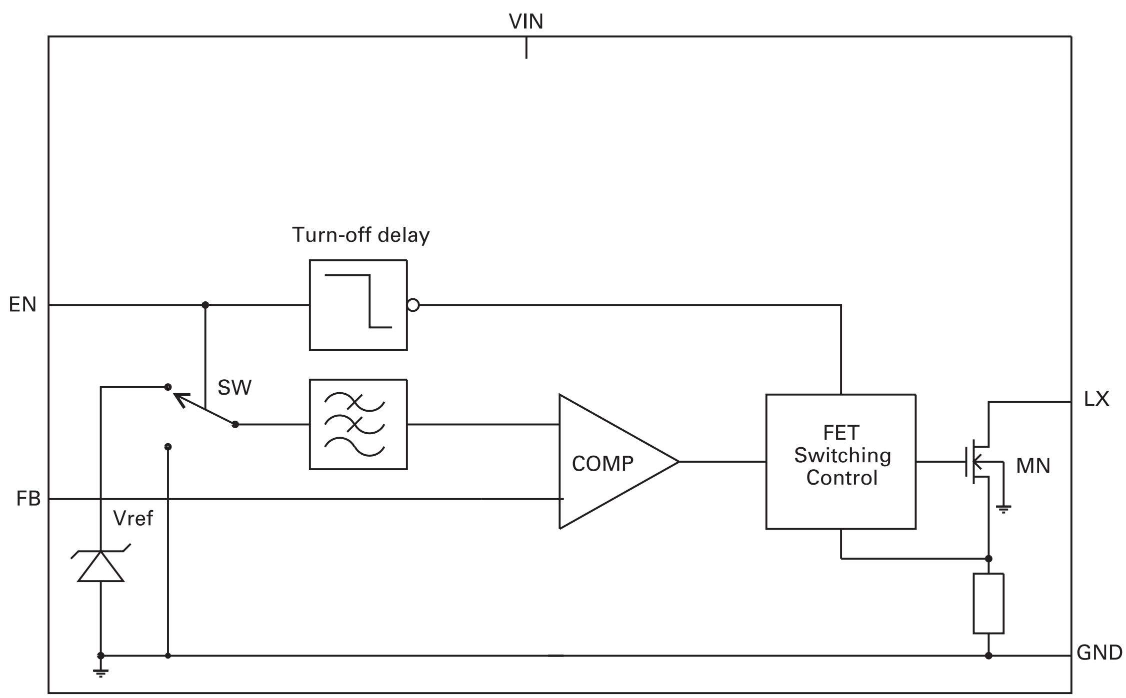
3 This is the time for which the device remains active after the EN pin has been asserted low. This delay is necessary to allow the output to be maintained during dc PWM mode operation.

4 The maximum PWM signal frequency during this mode of operation should be kept as low as possible to minimize errors due to the turn-off delay

PIN DESCRIPTION

Pin No.	Name	Description
1	LX	Output of NDMOS switch
2	GND	Ground (0V)
3	FB	Feedback pin for voltage control loop Nominal voltage 1.025V
4	EN	Enable input (active high to turn on device) Also used to adjust output current by PWM signal. Connect to V_{in} for permanent operation.
5	V_{IN}	Input voltage (2.5V to 5.5V). Decouple with capacitor close to device.

BLOCK DIAGRAM



Device Description

The device is a PFM flyback dc-dc boost converter, working in discontinuous mode.

With reference to the chip block diagram and typical application circuit, the operation of the device is as follows:

Control loop

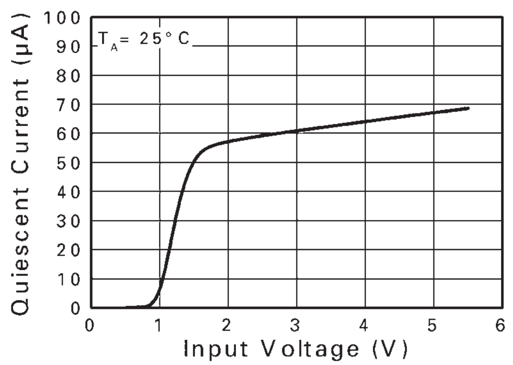
When 'EN' is high, the control circuits become active and the low side of the coil (L1) is switched to ground via NDMOS transistor (MN). The current in L1 is allowed to build up to an internally defined level (nominally 320mA) before MN is turned off. The energy stored in L1 is then transferred to the output capacitor (C2) via schottky diode (D1). The output voltage is sensed at pin 'FB' by external resistors R1 and R2 and compared to a reference voltage V_{REF} (1.025V nominal). A comparator senses when the output voltage is above that set by the reference and its output is used to control the 'off' time of the output switch. The control loop is self-oscillating, producing pulses of up to 5μs maximum duration (switch 'on'), at a frequency that varies in proportion to the output current. The feedback loop maintains a voltage of V_{REF} at the FB pin and therefore defines a maximum output voltage equal to V_{REF} *(R1+R2)/R1. The minimum 'off' time of the output switch is fixed at 0.5μs nominal, to allow time for the coil's energy to be dissipated before the switch is turned on again. This maintains stable and efficient operation in discontinuous mode.

PWM operation

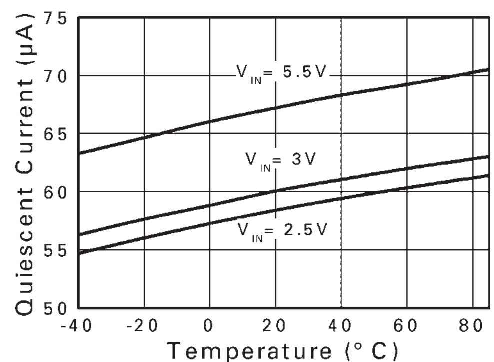
The internal circuitry of the ZXLD1615 is turned off when no signal is present on the 'EN' pin for more than 120μs (nominal). A low frequency signal applied to the EN pin will therefore gate the device 'on' and 'off' at the gating frequency and the duty cycle of this signal can be varied to provide an average output equal to V_{REF} *(R1+R2)/R1 x duty cycle. For best accuracy, the gating frequency should be made as low as possible (e.g. below 1kHz), such that the turn off delay of the chip is only a small proportion of the gating period

Further details of setting output current are given in the application notes.

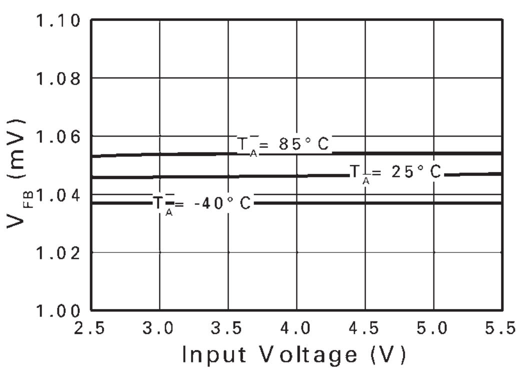
TYPICAL CHARACTERISTICS



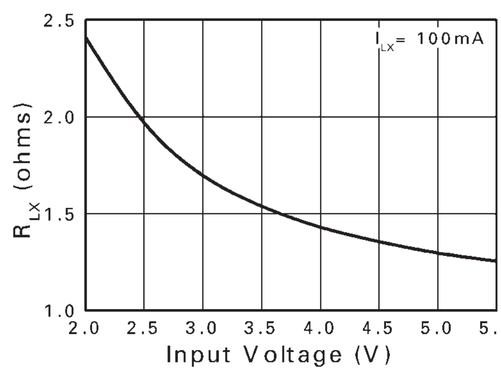
Quiescent Current vs Input Voltage



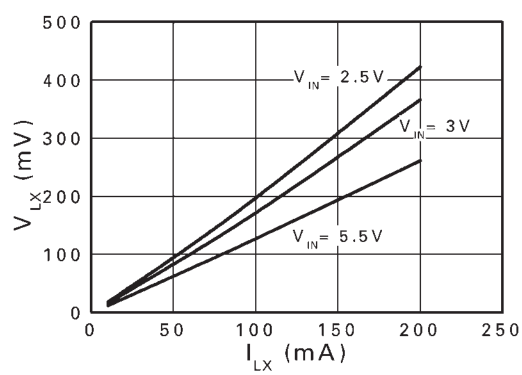
Quiescent Current vs Temperature



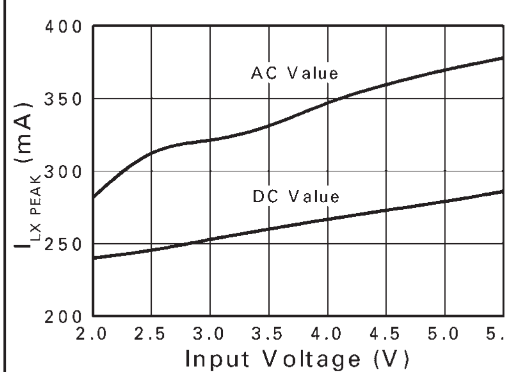
Feedback Voltage vs Input Voltage



LX (On) Resistance vs Input Voltage



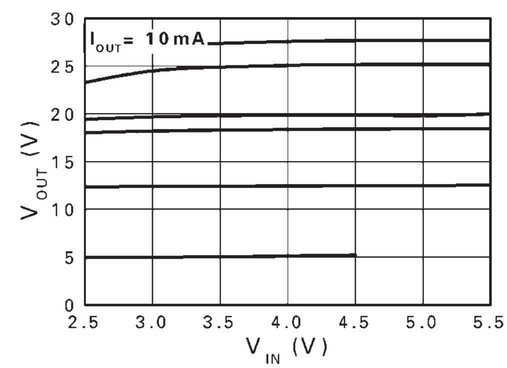
LX Voltage vs LX Current



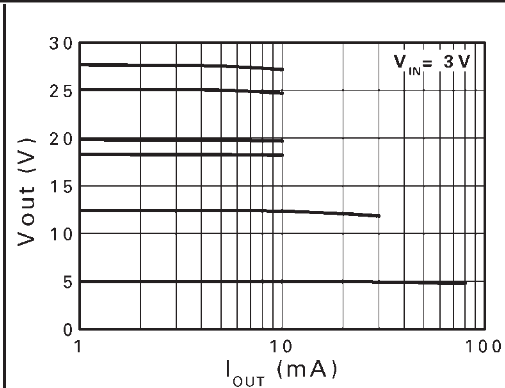
LX Peak Current vs Input Voltage

TYPICAL PERFORMANCE GRAPHS

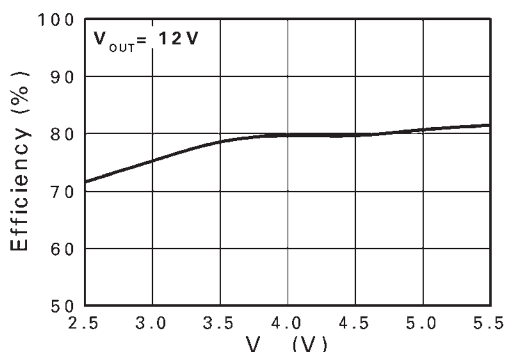
(For typical applications circuit at V_{IN}=3V, V_{OUT} = 12V, L=10µH Coilcraft DO1608C Series, TA=25 °C unless otherwise stated)



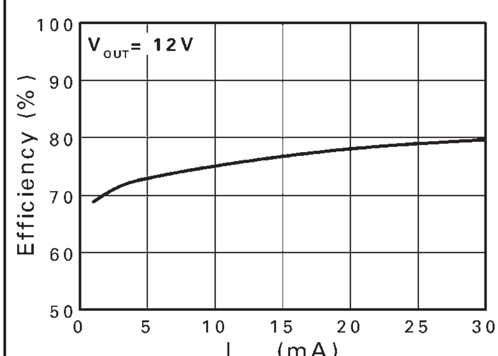
Line Regulation



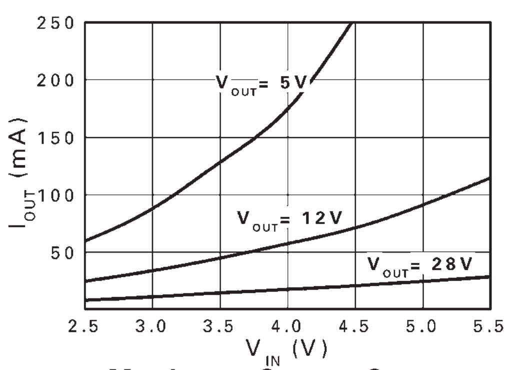
Load Regulation



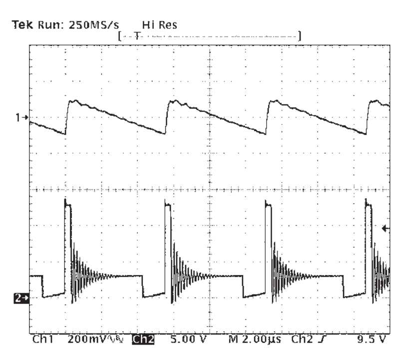
Efficiency vs V_{IN}



Efficiency vs I_{OUT}



Maximum Output Current



Output ripple and switching waveform

APPLICATIONS

Setting output voltage

The ZXLD1615 has an adjustable output voltage allowing the end user maximum flexibility. To set the output voltage a potential divider network is needed (see R1 and R2 in typical applications circuit).

The output voltage is determined by the equation:

$$V_{OUT} = V_{FB}\left(1 + \frac{R2}{R1}\right)$$

where VFB = 1.025V.

The following table gives suggested values for various output voltages.

Required output voltage	R1	R2
5V	270Ω	1MΩ
12V	91KΩ	1MΩ
18V	60KΩ	1MΩ
20V	55KΩ	1MΩ
25V	43KΩ	1MΩ
28V	39KΩ	1MΩ

Output voltage can be adjusted from $V_{IN} + V_F$ to the maximum output voltage rating of the internal switch, 30V.

Once the nominal output voltage has been set, it can be adjusted to a lower value by applying a pulse width modulated (PWM) control signal to the EN pin.

PWM adjustment permits the device to be turned on and the output voltage set by a single logic signal applied to the EN pin. No external resistors are required and the amplitude of the control signal is not critical, providing it conforms to the limits defined in the electrical characteristics.

Minimizing output voltage ripple

For applications requiring lower output ripple it may be necessary to add a small ceramic capacitor in parallel with R2. A value of 4.7pF is suitable for most output ranges.

Capacitor selection

A ceramic capacitor grounded close to the GND pin of the package is recommended at the output of the device. Surface mount types offer the best performance due to their lower inductance. A minimum value of 0.22μF is advised, although higher values will lower switching frequency and improve efficiency especially at lower load currents. A higher value will also minimize ripple when using the device to provide an adjustable dc output current.

A good quality, low ESR capacitor should also be used for input decoupling, as the ESR of this capacitor is effectively in series with the source impedance and lowers overall efficiency. This capacitor has to supply the relatively high peak current to the coil and smooth the current ripple on the input supply. A minimum value of 4.7μF is acceptable if the input source is close to the device, but higher values will improve performance at lower input voltages, when the source impedance is high. The input capacitor should be mounted as close as possible to the IC.

For maximum stability over temperature, capacitors with X7R dielectric are recommended, as these have a much smaller temperature coefficient than other types.

A table of recommended manufacturers is provided below:

Manufacturer	Website
Murata	www.murata.com
Taiyo Yuden	www.t-yuden.com
Kemet	www.kement.com
AVX	www.avxcorp.com

Inductor selection

The choice of inductor will depend on available board space as well as required performance. Small value inductors have the advantage of smaller physical size and may offer lower series resistance and higher saturation current compared to larger values. A disadvantage of lower inductor values is that they result in higher frequency switching, which in turn causes reduced efficiency due to switch losses. Higher inductor values can provide better performance at lower supply voltages. However, if the inductance is too high, the output power will be limited by the internal oscillator, which will prevent the coil current from reaching its peak value. This condition will arise whenever the ramp time ($I_{LX(peak)}$ x L/V_{IN}) exceeds the nominal 5μs maximum 'on' time limit for the LX output.

Recommended inductor values for the ZXLD1615 are in the range 6.8μH to 22μH. The inductor should be mounted as close to the device as possible with low resistance connections to the LX and V_{IN} pins.

Suitable coils for use with the ZXLD1615 are shown in the table below:

Part No.	L (μH)	DCR (Ω)	I_{SAT} (A)	Manufacturer
CMD4D11-100MC	10	0.457	0.5	Sumida www.sumida.com
DO1608-103	10	0.16	1.1	Coilcraft www.coilcraft.com
LQH31CN100	10	1.3	0.23	Murata www.murata.com
LB2012Y100MR	10	0.5	0.1	Taiyo Yuden www.t-yuden.com

Diode selection

The rectifier diode (D1) should be a fast low capacitance schottky diode with low reverse leakage at the working voltage. It should also have a peak current rating above the peak coil current and a continuous current rating higher than the maximum output load current.

The table below gives some typical characteristics for diodes that can be used with the ZXLD1615:

Diode	V_F @ 100mA (mV)	I_{FSM} (mA)	Ic (mA)	I_R at 30V (μA)	Package
ZHCS400	300	1000	400	15	SOD323
ZHCS500	300	1000	500	15	SOT23

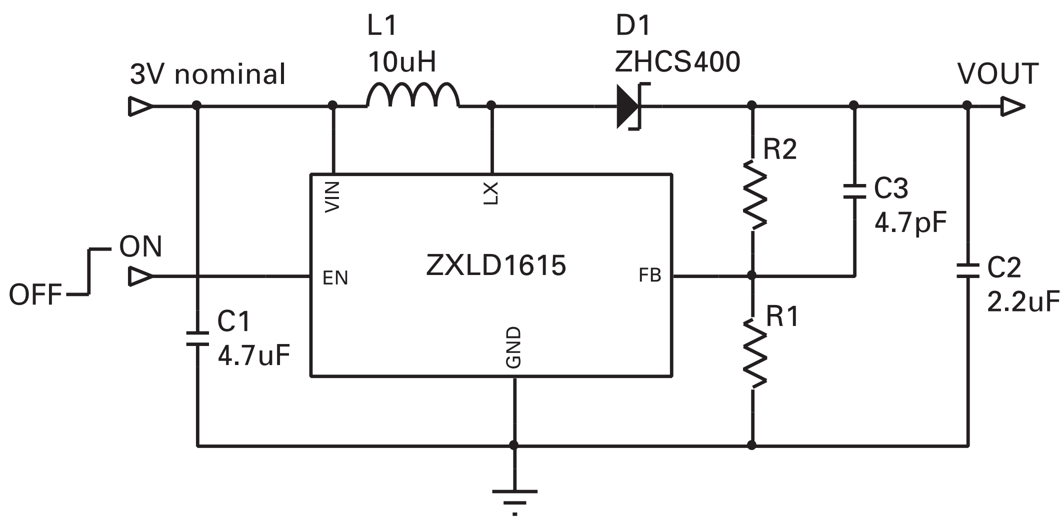
Layout considerations

PCB tracks should be kept as short as possible to minimize ground bounce, and the ground pin of the device should be soldered directly to the ground plane. It is particularly important to mount the coil and the input/output capacitors close to the device to minimize parasitic resistance and inductance, which will degrade efficiency. The FB pin is a high impedance input, so PCB track lengths to this should also be kept as short as possible to reduce noise pickup. Excess capacitance from the FB pin to ground should be avoided.

REFERENCE DESIGNS

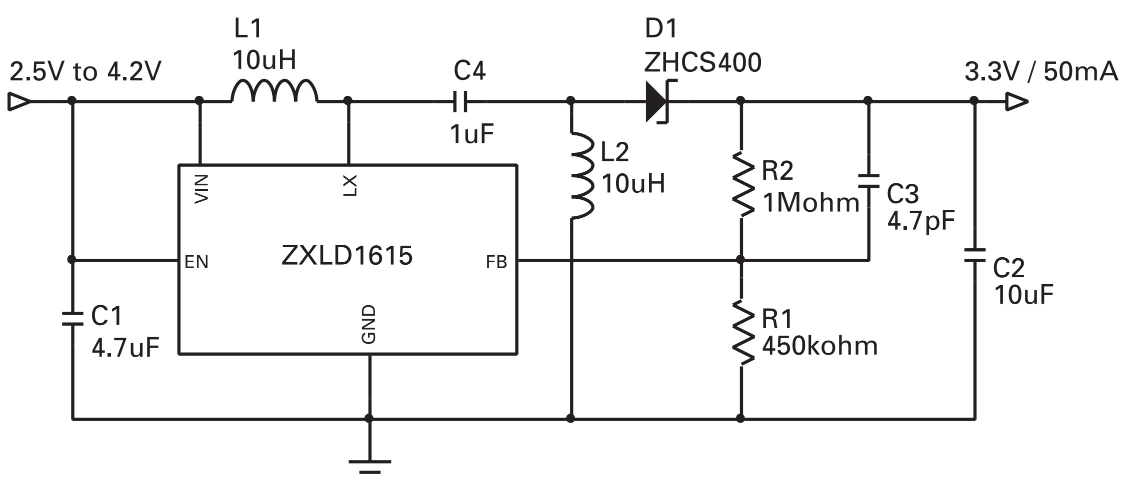
General Boost Converter

V_{IN}=2.5V to 5.5V, V_{OUT} up to 28V

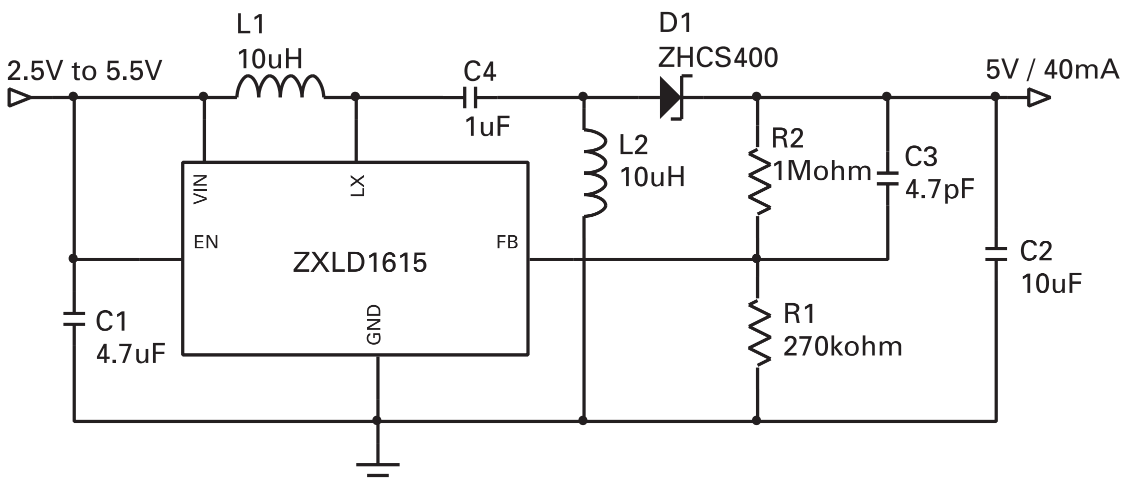


See page 7 in datasheet for R1 and R2 values for various output voltages.

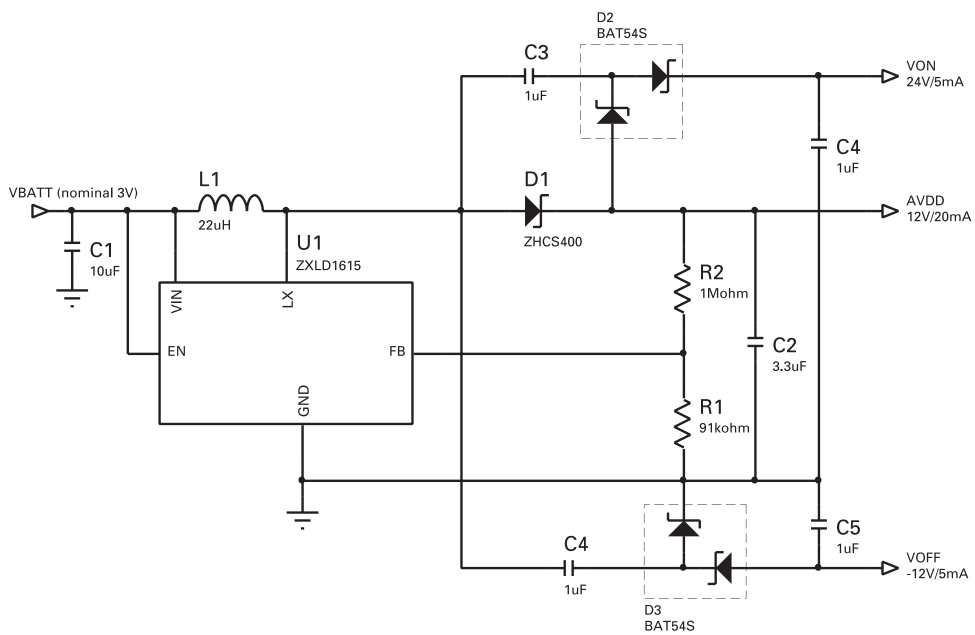
1 Cell Li-Ion to 3.3V Sepic Converter



1 Cell Li-Ion to 5V Sepic Converter



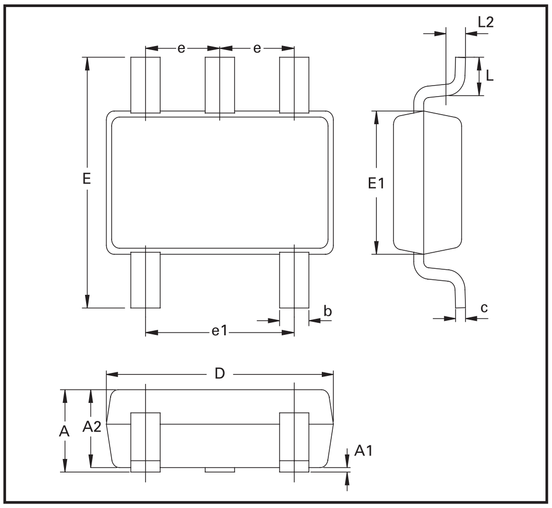
Triple Output Boost Converter for LCD or OLED Bias



Note: For all manufacturers listing please refer to application section on page 7 of this datasheet.

ZETEX SEMICONDUCTORS

PACKAGE OUTLINE



PACKAGE DIMENSIONS

DIM	Millimeters		Inches	
	MIN.	MAX.	MIN.	MAX.
A	-	1.00	-	0.0393
A1	0.01	0.10	0.0003	0.0039
A2	0.84	0.90	0.0330	0.0354
b	0.30	0.45	0.0118	0.0177
c	0.12	0.20	0.0047	0.0078
D	2.90 BSC		0.114 BSC	
E	2.80 BSC		0.110 BSC	
E1	1.60 BSC		0.062 BSC	
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.074 BSC	
L	0.30	0.50	0.0118	0.0196
L2	0.25 BSC		0.010 BSC	
Q	4°	12°	4°	12°

ORDERING INFORMATION

DEVICE	DEVICE DESCRIPTION	TEMPERATURE RANGE	PART MARK	TAPING OPTIONS
ZXLD1615ET5	Boost converter in SOT23-5	-40°C to +85°C	615	TA, TC

TA reels 3,000 devices, TC reels 10,000 devices

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