# ZXLD1370/1EV4 User Guide
## 1.5A 40W Buck-Boost LED Driver

## General Description

The ZXLD1370/1 EV4 1.5A board uses the Buck-Boost topology working at Boundary Conduction Mode. It can perform step-down or boost up power conversion according to the output LEDs load vs. input voltage. It is designed for driving a high LED current from a wide range voltage source. The board can operate from an input supply between 10V and 30V and provides an externally adjustable output current of up to 1.5A. The ZXLD1370/1 EV4 board can provide more than 40 watts of output power.

## Key Features

- Wide input voltage range: 10V to 30V
- Up to 1.5A output current
- Single pin on/off and brightness control using DC voltage or PWM
- Up to 1MHz switching frequency
- ±5% output current accuracy
- Inherent open-circuit LED protection
- High-Side Current Sense
- Hysteretic Control: No Compensation
- Adjustable output LED Current
- TSSOP-16EP package for large output power application
- RoHS compliant

## Applications

- High lumen LED Bulb
- Automotive high power LED lamp

## ZXLD1370/1 EV4 Specifications

| Parameter | Value |
|---|---|
| Input Voltage | 10 to 30$V_{DC}$ (1371)<br>10 to 20$V_{DC}$ (1370) |
| Output Power | 30 – 40W |
| LED Current | 1.5A (Adjustable) |
| LED Voltage | 27V |
| Efficiency | ~85% |
| Number of LEDs | 9 LEDs in series (Under Tested) |
| XYZ Dimension | 3.00 ” x 3.25” x 0.5” |
| ROHS Compliance | Yes |

## Evaluation Board

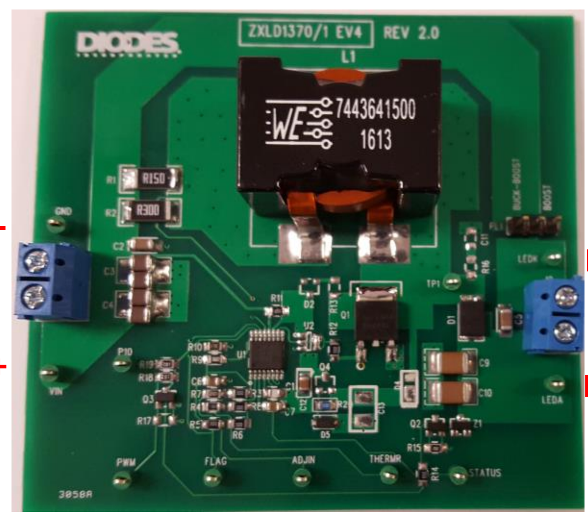



**Figure 1: Top View**

## Connection Instructions

Input Voltage: 10 to 30$V_{DC}$ (DC+, DC-)
LED Outputs: LED+ (Red), LED- (Black)

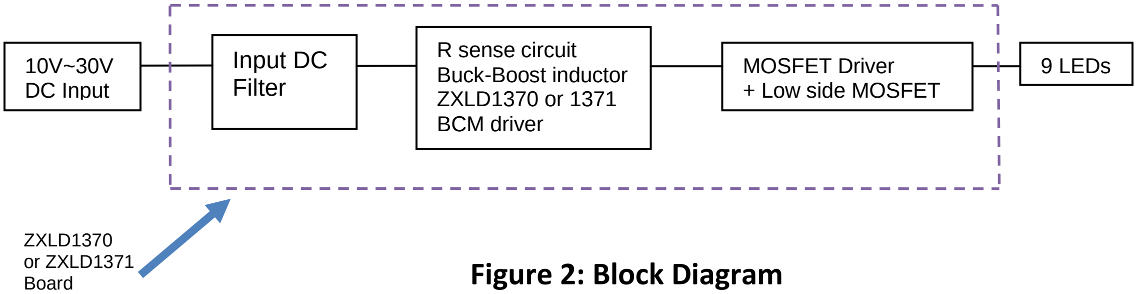



**Figure 2: Block Diagram**

## Evaluation Board Schematic

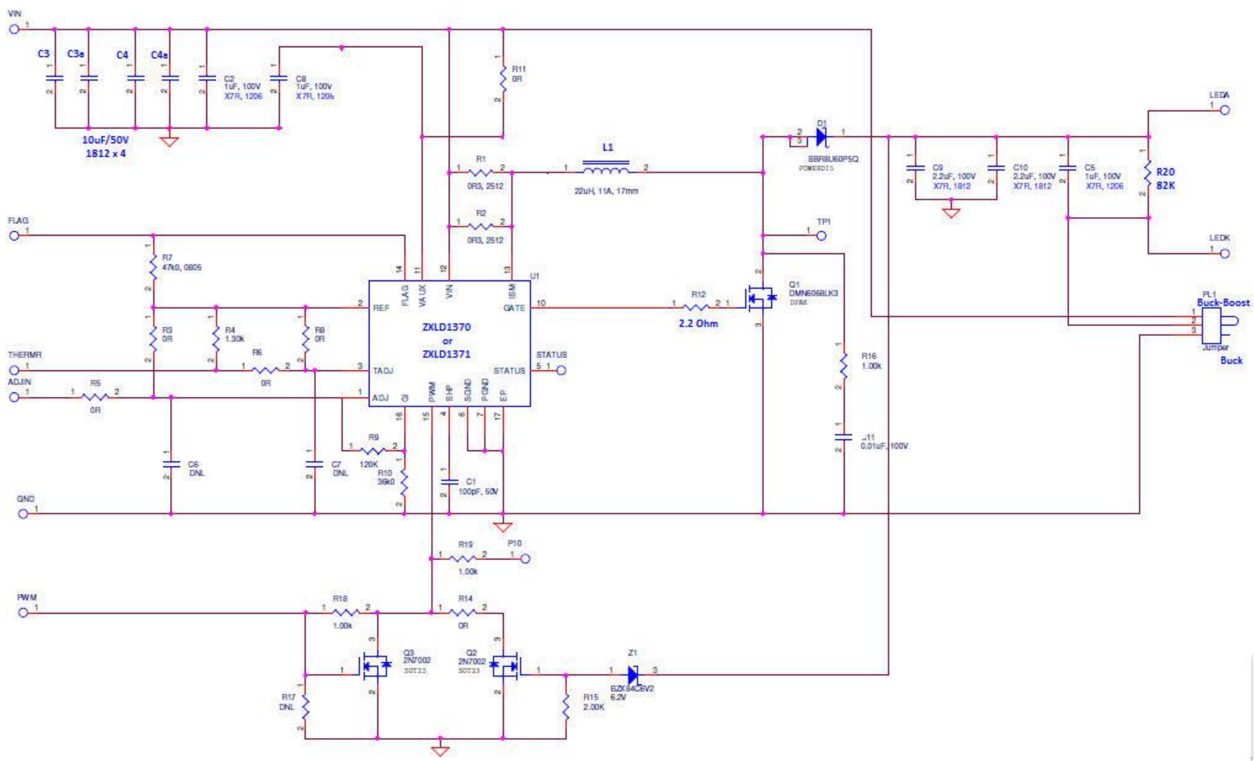



**Figure 3: Evaluation Board Schematic**

## Evaluation Board Layout

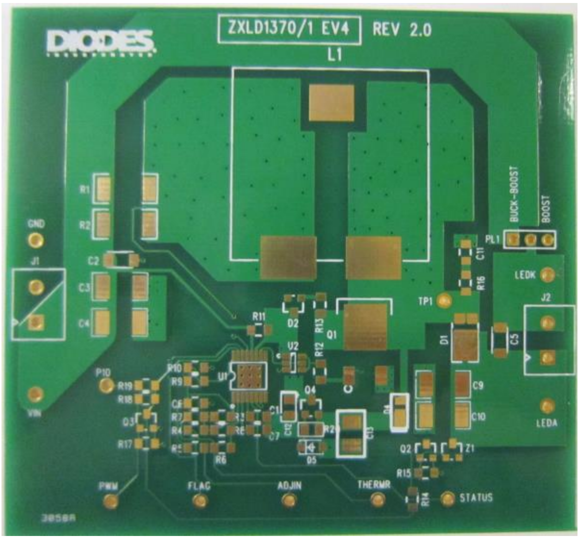



**Figure 4: PCB Board Layout Top View**

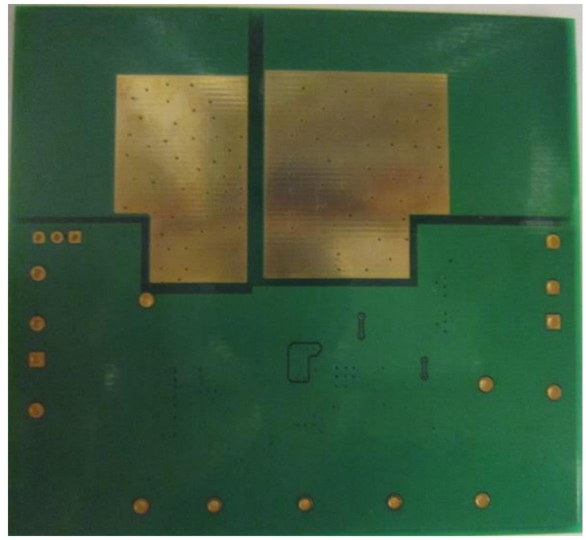


**Figure 5: PCB Board Layout Bottom View**

## Quick Start Guide

1. By default, the evaluation board is preset at 1.5A LED current by R1 & R2.
2. Ensure that the DC source is switched OFF or disconnected.
3. Connect the 15$V_{DC}$ power supply to two test points of “DC input” on the left side of the board.
4. Connect the anode wire of external LED string to LED+ output test point.
5. Connect the cathode wire of external LED string to LED- output test point.
6. Turn on the main switch. LED string should light up.

## Bill of Material

| # | Name | Quantity | Part number | Manufacturer | Description |
|---|---|---|---|---|---|
| 1 | U1 | 1 | ZXLD1370EST16TC or ZXLD1371EST16TC | Diodes Inc | LED Driver TSSOP16L |
| 2 | U2 | 0 | Not fitted | | |
| 3 | Q1 | 1 | DMN6068LK3 | Diodes Inc | MOSFET 60V/8.5A DPAK |
| 4 | Q2 | 1 | 2N7002 | Diodes Inc | MOSFET 60V/115mA SOT23 |
| 5 | Q3 | 0 | Not fitted | | |
| 6 | D1 | 1 | PDS3100 | Diodes Inc | Freewheeling diode 100V/3A PowerDI5 |

| | | | | | |
|---|---|---|---|---|---|
| 7 | D2 | 0 | Not fitted | | |
| 8 | D3 | 0 | Not fitted | | |
| 9 | Z1 | 1 | BZX84B39 | Diodes Inc | 39V 350mW Zener Diode SOT23 |
| 10 | L1 | 1 | 7443641500 | Wurth | 15µH/30A SMD 28.5x19.5x18.5mm |
| 11 | C1 | 1 | C0805C102K3RACTU | Kemet | 1000pF Cer Cap 25V 10% X7R 0805 |
| 12 | C2 | 2 | C1206C104K5RAC7867 | Kemet | 1µF Cer Cap 50V 10% X7R 1206 |
| 13 | C3, C3A, C4, C4A | 4 | C1812X106K050T | Holy Stone | 10µF Cer Cap 50V 10% X7R 1812 |
| 14 | C5 | 2 | GRM31CR72A105KA01L | Murata | 1µF Cer Cap 100V 10% X7R 1206 |
| 15 | C6 | 1 | GRM21BR61E106KA73L | Murata | 10µF Cer Cap 25V 10% X5R 0805 |
| 16 | C7 | 1 | C0805C104K5RACTU | Kemet | 0.1µF Cer Cap 50V 10% X7R 0805 |
| 17 | C8 | 1 | C1206X475K050T | Holy Stone | 4.7µF Cer Cap 35V 10% X7R 1206 |
| 18 | C9, C10 | 2 | C1812X225K050T | Holy Stone | 2.2µF Cer Cap 50V 10% X7R 1812 |
| 19 | C11 | 0 | Not fitted | | |
| 20 | R1 | 1 | RLP73K3AR15JTE | TE Connectivity | 0.15Ω Resistor 2W 1% 2512 |
| 21 | R2 | 2 | RLP73K3AR30JTE | TE Connectivity | 0.30Ω Resistor 2W 1% 2512 |
| 22 | R3, R5, R6, R8, R11, R14 | 6 | CRCW08050000Z0EA | Vishay | 0 Ω Resistor 1/8W 0805 |
| 23 | R4 | 1 | RC0805FR-071K3L | Yageo | 1.3kΩ Resistor 1/8W 1% 0805 |
| 24 | R7 | 1 | RC0805FR-0747KL | Yageo | 47kΩ Resistor 1/8W 1% 0805 |
| 25 | R9, R10 | 2 | RC0805FR-0736KL | Yageo | 36kΩ Resistor 1/8W 1% 0805 |
| 26 | R12 | 1 | RC0805FR-072R2L | Yageo | 2.2Ω Resistor 1/8W 1% 0805 |
| 27 | R13 | 1 | RC0805FR-075R11L | Yageo | 5.1Ω Resistor 1/8W 1% 0805 |
| 28 | R15, R17 | 2 | RC0805FR-0720KL | Yageo | 20kΩ Resistor 1/8W 1% 0805 |
| 29 | R16, R18, R19 | 3 | RC0805FR-071KL | Yageo | 1kΩ Resistor 1/8W 1% 0805 |
| 30 | R20 | 1 | RC0805FR-0782KL | Yageo | 82kΩ Resistor 1/8W 1% 0805 |
| 31 | J1 | 1 | 1776244-2 | TE Connectivity | TERM BLOCK 2POS SIDE ENTRY 5MM |
| 32 | PL1 | 1 | 800-10-003-10-001000 | Mill-Max | SIP HEADER 3 POS |
| 33 | Vin, GND, PWM, TP1, LEDA, LEDK | 6 | 5121K-ND | Keystone | Test point |

## OPERATION

In Buck-boost mode the LED current is sensed by the series resistor (R1//R2). An output from the control loop drives the input of a comparator. The comparator drives the gate of the external NMOS switch transistor via 'GATE' pin. When the NMOS switch is on, current flows from VIN, via (R1//R2), inductor and switch to ground and increases until a high value is reached. Then, GATE goes low, the switch turns off and the current flows through (R1//R2), the inductor, D1 and the LED, to 'VIN' (Buck-boost mode). When the inductor current has gone low, 'GATE' goes high, and the cycle of events repeats. The circuit oscillates. The average current in the LEDs is equal to the average of the maximum and minimum threshold currents. The ripple current (hysteresis) is equal to the difference between the thresholds. The average current in the LED is always less than the average current in the inductor and the ratio between these currents is set by the values of resistors R9 and R10. The peak current in the LED is equal to the peak current in the inductor. The control loop keeps the average LED current at the level set by the voltage on the 'ADJ' pin. Loop compensation is achieved by C1.

## PWM Terminal (PWM output current control/dimming)

The LED current can be adjusted digitally, by applying a low frequency PWM logic signal to the 'PWM' pin to turn the controller on and off. This will produce an average output current proportional to the duty cycle of the control signal. During PWM operation, the device remains powered up and only the output switch is switched by the control signal.

The device can be shut down by taking the PWM pin to < 0.4V with a short to 0V or suitable open collector NPN, or open drain NMOS transistor, for >15ms. In the shutdown state, most of the circuitry inside the device is off and the quiescent current will be typically 90µA.

## Functional Performance (9 series LEDs @1.5A)

| MFG | Board Type | VIN ($V_{DC}$) | $I_{IN}$ (A) | $P_{IN}$ (W) | $V_{LED}$ (V) | $I_{LED}$ (A) | $P_{LED}$ (W) | Fs Switching Freq (Hz) | **Efficiency (%)** |
|---|---|---|---|---|---|---|---|---|---|
| Diodes Inc | ZXLD1370/1EV4 Module Board | 10 | 5.04 | 50.4 | 27.43 | 1.42 | 39.01 | 412K | 77.5 |
| | | 12 | 4.40 | 52.7 | 28.00 | 1.55 | 43.40 | 404K | 82.4 |
| | | 15 | 3.34 | 50.1 | 27.26 | 1.55 | 42.25 | 416K | 84.3 |
| | | 18 | 2.68 | 48.3 | 27.36 | 1.52 | 41.59 | 420K | 86.1 |
| | | 20 | 2.37 | 47.4 | 27.20 | 1.51 | 41.07 | 460K | 86.7 |
| | | 24 | 1.92 | 45.9 | 27.48 | 1.44 | 39.57 | 510K | 86.0 |
| | | 30 | 1.53 | 45.9 | 27.40 | 1.44 | 39.46 | 560K | 85.5 |

## Functional Performance

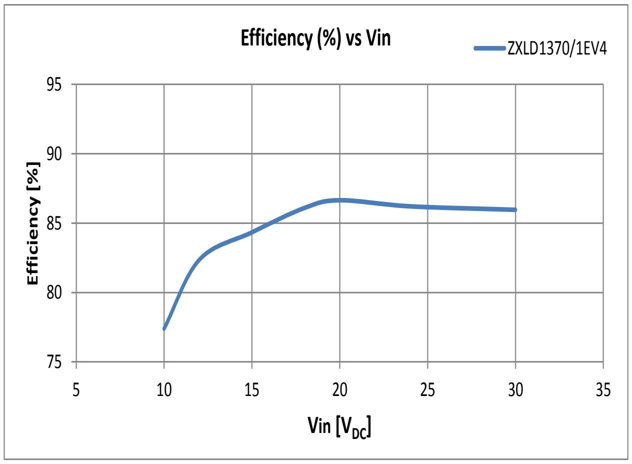



Figure 1. Efficiency vs. Vin

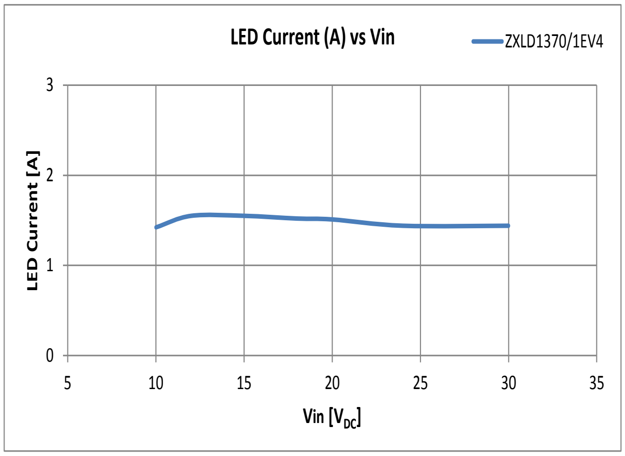



Figure 2. LED Current vs. Vin

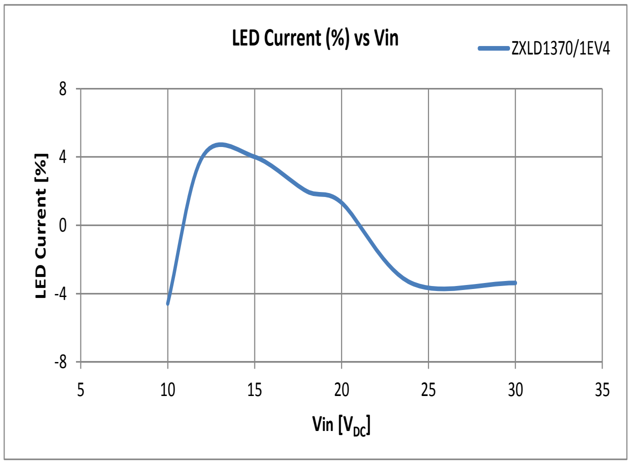
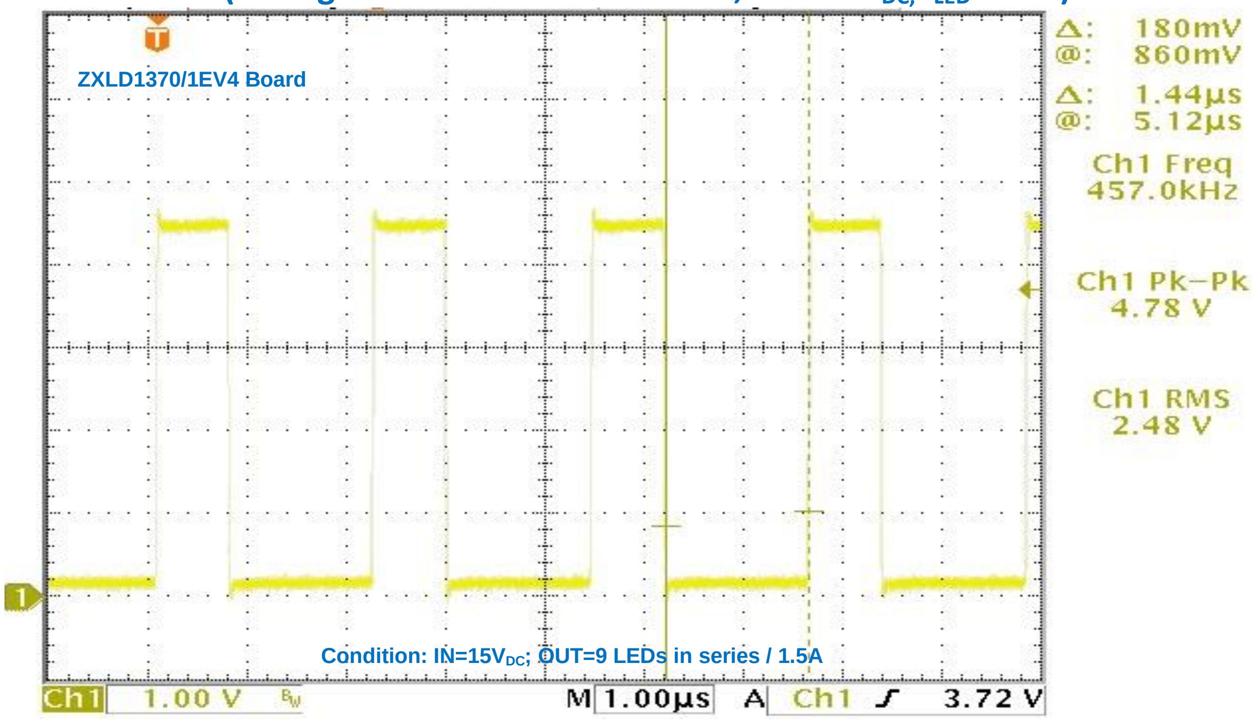
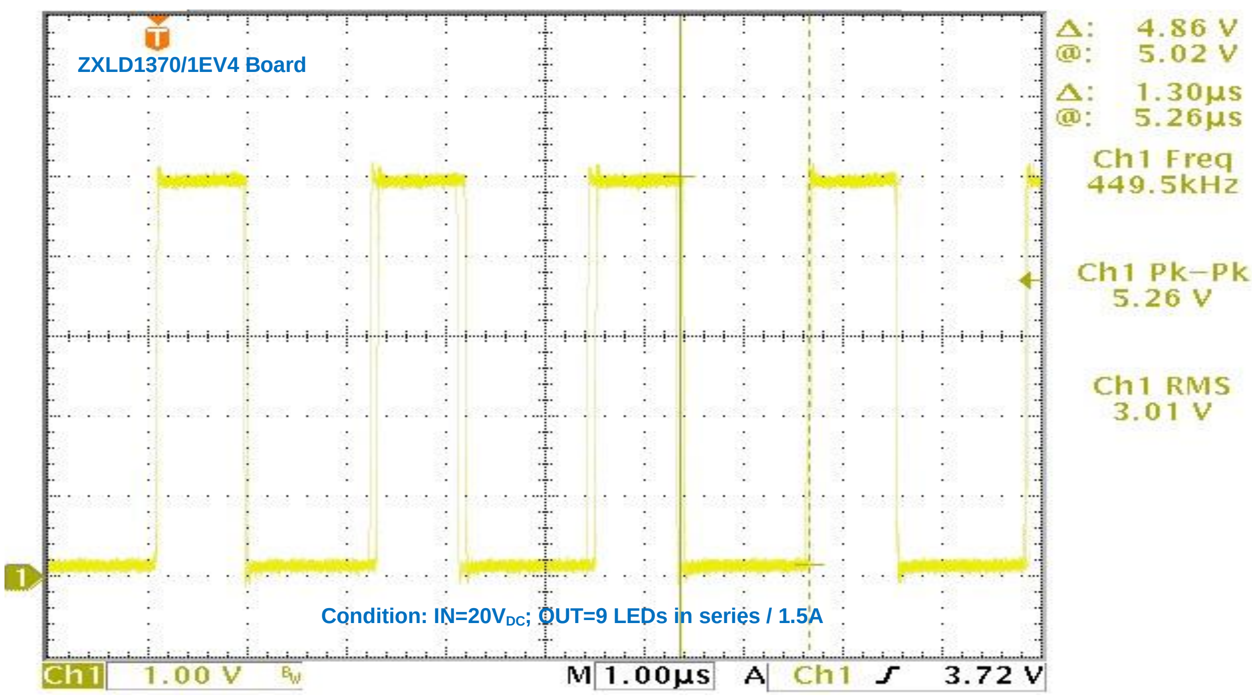



Figure 3. LED Current (%) vs. Vin

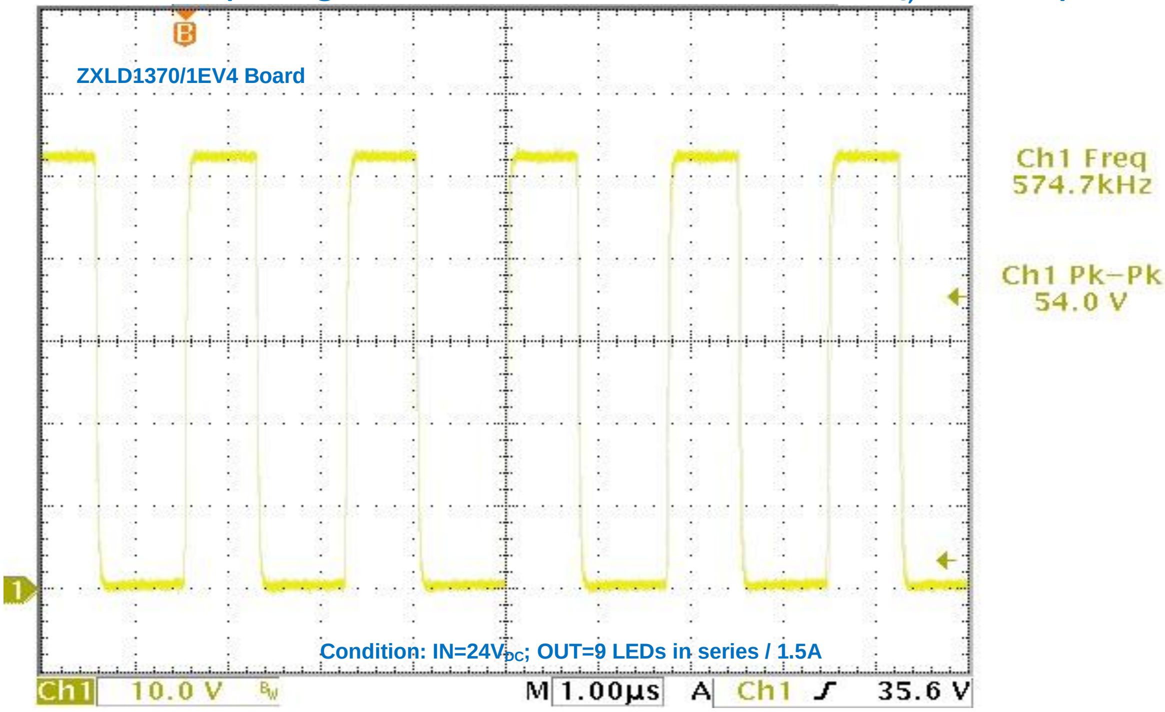
## Waveform #1 (Voltage across Drain and Source, Vin=15V$_{DC,}$ I$_{LED}$=1.5A)



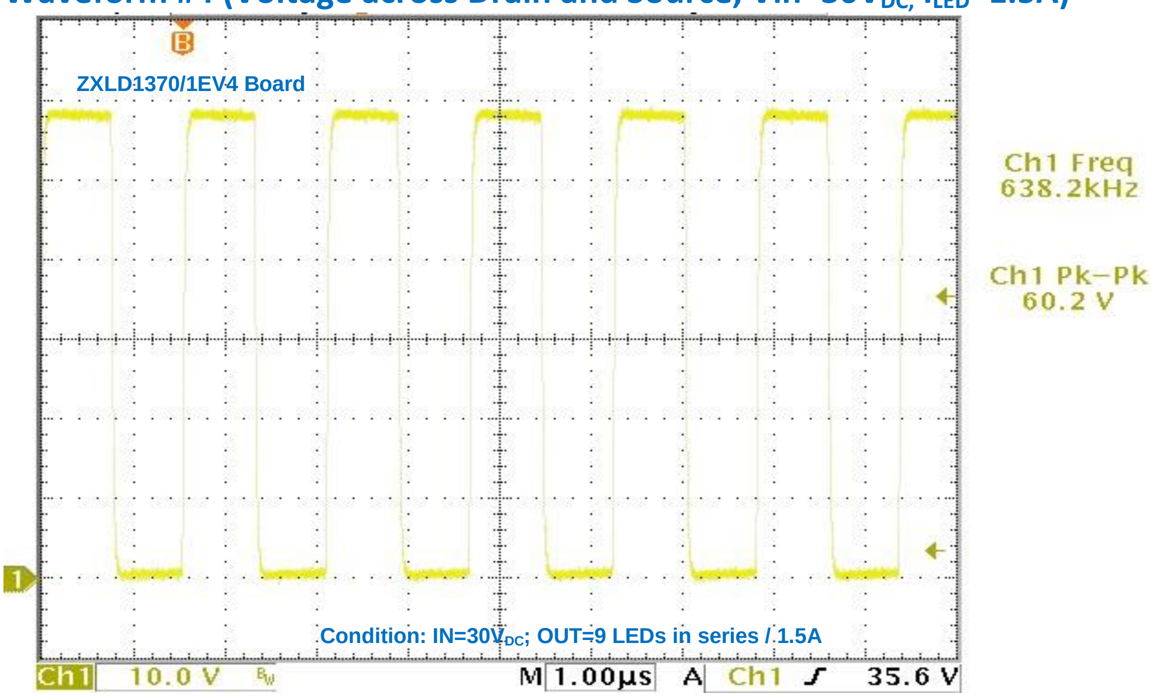

## Waveform #2 (Voltage across Drain and Source, Vin=20V$_{DC,}$ I$_{LED}$=1.5A)



## Waveform #3 (Voltage across Drain and Source, Vin=24V$_{DC}$, I$_{LED}$=1.5A)




## Waveform #4 (Voltage across Drain and Source, Vin=30V$_{DC}$, I$_{LED}$=1.5A)



## Waveform #5 (Output Voltage Ripple, Vin=20$V_{DC,}$ $I_{LED}$=1.5A)