AN1196

Setting up Simplis Model to Change AL8890Q from Low- to High-Side Current Sensing

XueZheng Ding, Application Systems Manager, Diodes Incorporated

Introduction

The AL8890 is a synchronous buck converter with internal compensation and switching frequency adjustable up to 2.5MHz. The device integrates a 120mΩ high-side power MOSFET and a 55mΩ low-side power MOSFET to provide high-efficiency DC-DC conversion. The AL8890 enables a continuous load current of up to 3.5A. The device features current-mode control operation, which enables easy loop stabilization to support a wide range of output loading.

The ZXCT1009 is a high-side current sense monitor. Using this device eliminates the need to disrupt the ground plane when sensing a load current. It takes a high-side voltage developed across a current shunt resistor and translates it into a proportional output current. A user-defined output resistor scales the output current into a ground-referenced voltage.

The AL8890 is suitable for direct low-side current-sensing LED drivers requiring constant current output. To change to high-side current sensing, the AL8890 can add a high-side current-sense circuit (ZXCT1009) to change the topology from low-side to high-side; see Figure 1.

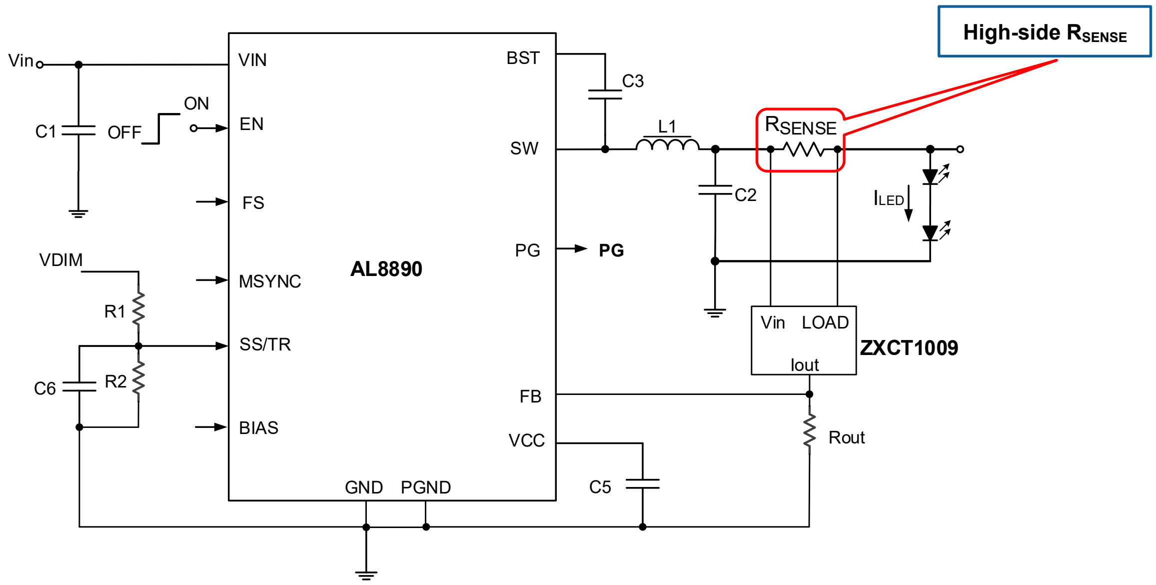

Figure 1. AL8890Q application circuit with ZXCT1009

Current-Sense Resistor

The current-sense resistor can be calculated as below:

$$R_{SENSE} = \frac{100 \times \frac{V_{FB}}{R_{OUT}}}{I_{LED}}$$

Where,

R_{SENSE} is the high-side current-sense resistor.

R_{OUT} is the resistor connect to the I_{OUT} pin of the ZXCT1009.

V_{FB} is the FB reference of the AL8890Q.

I_{LED} is the constant output current needed by the LED.

Input Capacitor

The input capacitor reduces the surge current drawn from the input supply and the switching noise from the device. The input capacitor must sustain the ripple current produced during the on-time on the upper MOSFET. Hence, it must have a low ESR to minimize the losses.

The RMS current rating of the input capacitor is a critical parameter that must be higher than the RMS input current. As a rule of thumb, select an input capacitor which has an RMS rating greater than half of the maximum load current.

Due to large di/dt through the input capacitors, electrolytic or ceramics should be used. If a tantalum must be used, it must be surge protected. Otherwise, capacitor failure may occur. For most applications, a 10µF ceramic capacitor is sufficient and a 0.1µF parallel capacitor is also recommended for improving stability.

Inductor

Calculating the inductor value is a critical factor in designing a buck converter. For most designs, the following equation can be used to calculate the inductor value:

$$L = \frac{V_{IN(TYP)}}{4 \times \Delta I_L \times f_{SW}}$$

Where ΔI_L is the inductor ripple current and f_{SW} is the buck converter switching frequency.

Choose the inductor ripple current to be 30% to 40% of the maximum load current. The maximum inductor peak current is calculated from:

$$I_{L(MAX)} = I_{LED} + \frac{\Delta I_L}{2}$$

Peak current determines the required saturation current rating, which influences the size of the inductor. Saturating the inductor decreases the converter efficiency while increasing the temperatures of the inductor and the internal MOSFETs. Hence, choosing an inductor with the appropriate saturation current rating is important.

To achieve the highest efficiency, the inductor's DC resistance should be as low as possible. Use a larger inductance for improved efficiency under light-load conditions.

Output Capacitor

The output capacitor value depends on the total series resistance of the LED string, r_D, and the switching frequency, f_{SW}. The capacitance required for the target LED ripple current is calculated using the equation below:

$$C_O = \frac{\Delta I_L}{8 \times f_{SW} \times r_D \times \Delta I_{LED}}$$

Where ΔI_{LED} is the maximum ripple current of I_{LED}.

SIMPLIS Simulation Set Up

Key parameters:

- V_{IN}=24V, Io=3.5A with 1-5 LEDs
- F_{SW}=500kHz
- L=10µH, C_{OUT}=30µF, R_{SENSE}=22.8mΩ

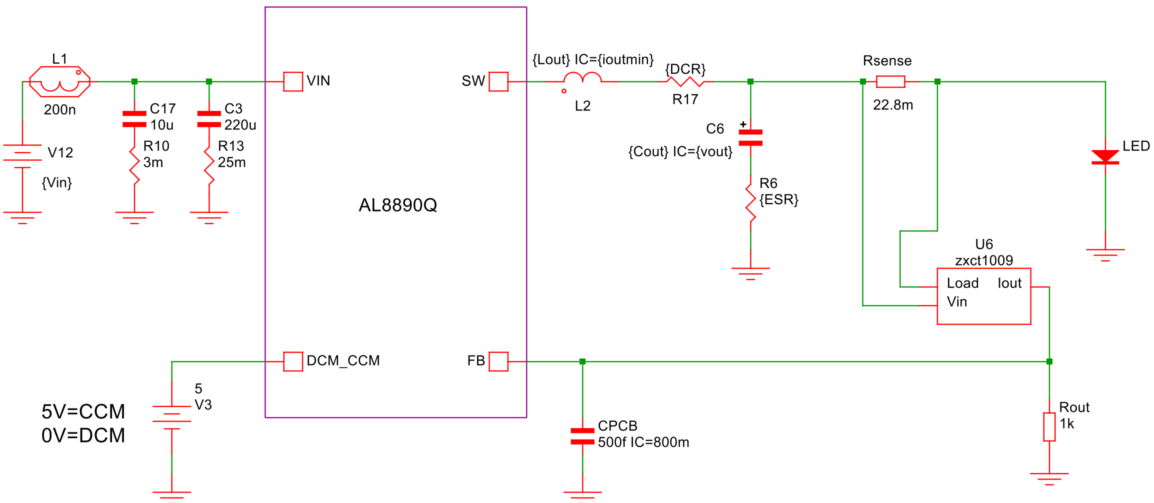

Figure 2. SIMPLIS schematic set up Io=3.5A, AL8890Q with ZXCT1009

Simulation Results

V_{SW}	I_{LED}	V_{OUT}

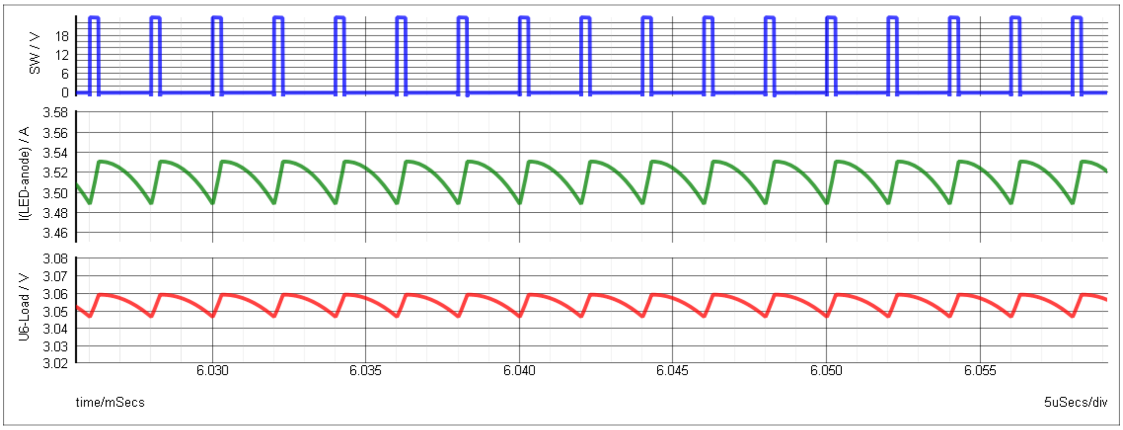

Figure 3. One LED load

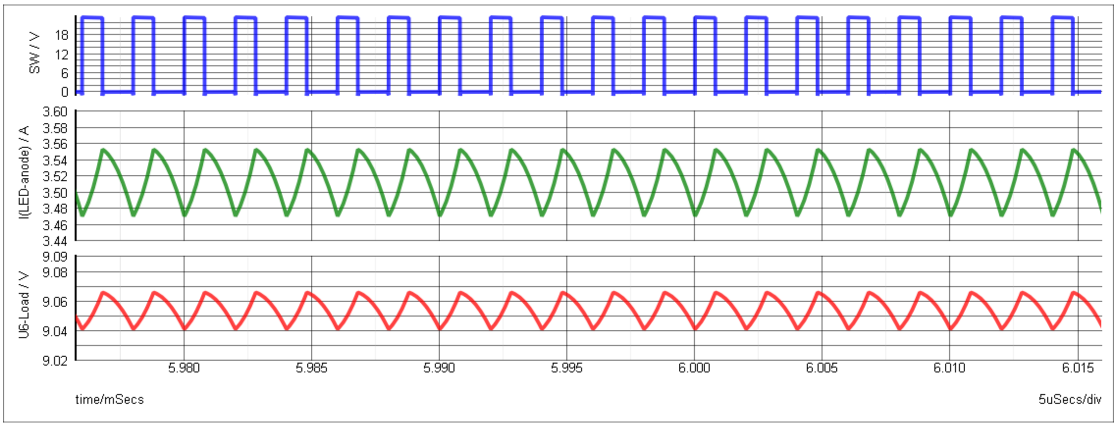

Figure 4. Three LED loads

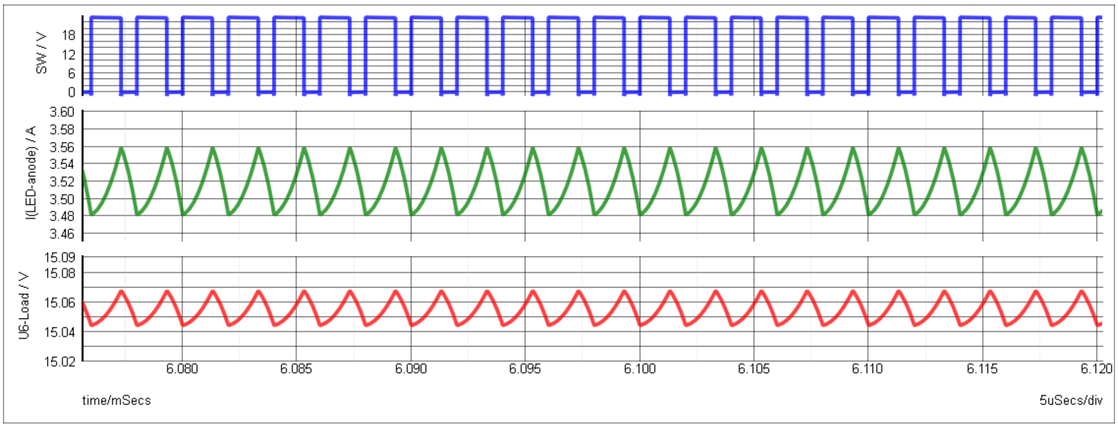

Figure 5. Five LED loads

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