# WS3130 High Performance LED Driver

## Features

- Single stage PFC
- Primary side regulation without Secondary Feedback
- Quasi Resonance (QR) mode with Confidential
- Fly-back topology
- Real-Current control to meet accurate output current
- Very less components
- Programmable input AV voltage compensation
- Leading Edge Blanking on CS/FB pin
- Protection Features
- Building in hysteresis OTP
- VDD over voltage protection
- Cycle by cycle current limiting on CS pin
- Secondary peak current protection on CS pin
- Output short to GND protection
- Output programmable over voltage protection
- FB and CS pins default protection

## Applications

- LED lighting
- Down light
- Tube lamp
- PAR lamp
- Bulb

## General Description

The WS3130 is a single-power stage, isolated and primary side offline LED lighting regulator which achieves high power factor.

The proprietary real-current control method can control the LED current accurately from the primary side information.

It can significantly simplify the LED lighting system design by eliminating the secondary side feedback components and the opto-coupler.

The WS3130 integrates active power factor correction and works in Quasi Resonance mode (QRM) in order to reduce the MOSFET switching losses.

With a building in 700V start-up MOSFET, IC can eliminate the power loss caused by start-up resistors to provide a high efficiency solution for lighting applications.

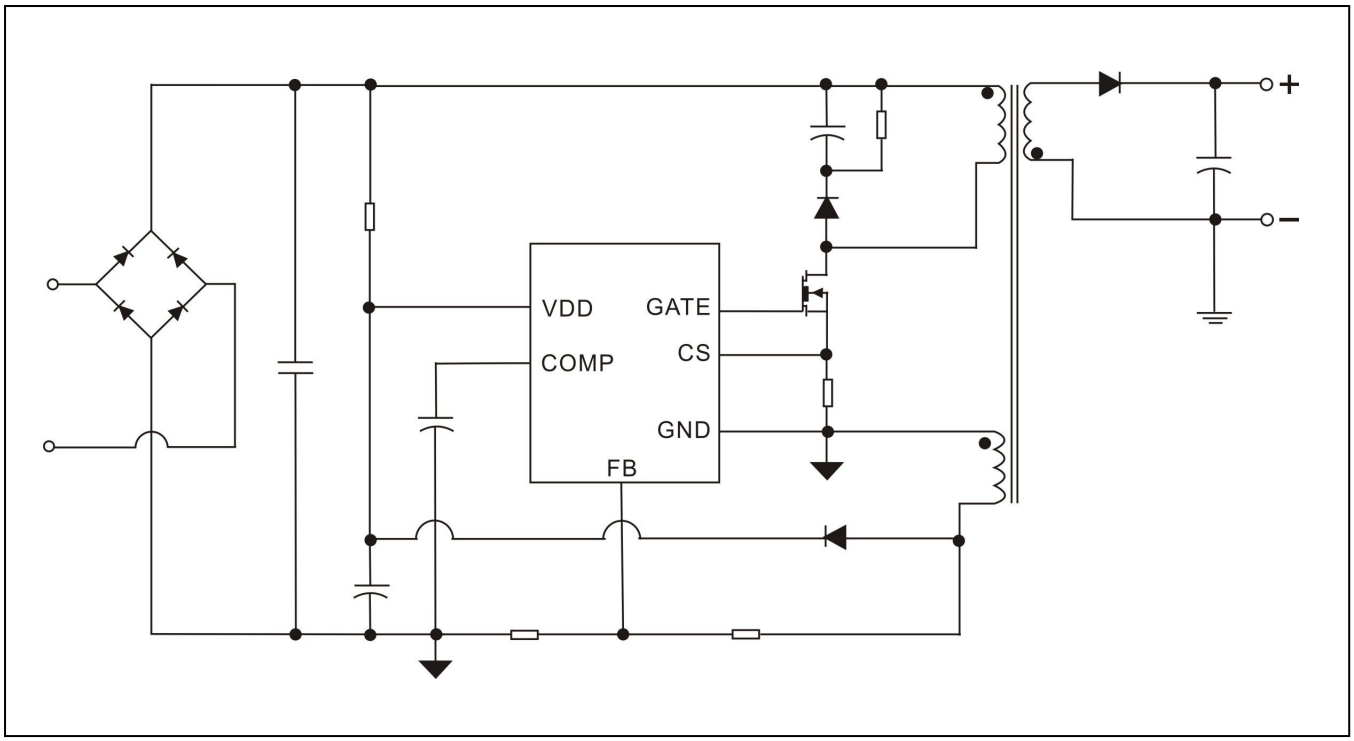
The external programmable line voltage compensation provides a more precise output current throughout the universal AC input voltage range.

The leading edge blanking circuit on the CS/FB input removes the signal glitch and results in reduced external components and system cost. The multi-protection features of WS3130

Greatly enhance the system reliability and safety. Features VDD and output over voltage protection; output short circuit protection cycle-by-cycle current limit and secondary peak current protection on CS pin, VDD UVLO and auto-restart and over-temperature protection. The driver output voltage is clamped at 18V to protect the external power MOSFET.

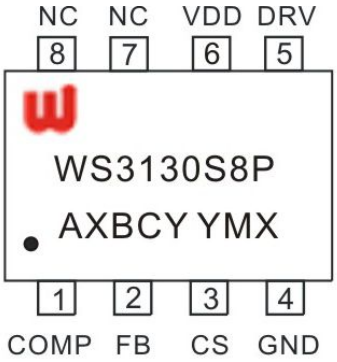
WS3130 is offered in SOP-8 packages.

## Typical Application Circuit




## Pin Definition and Device Marking

WS3130 is offered in SOP-8 packages，as shown below：

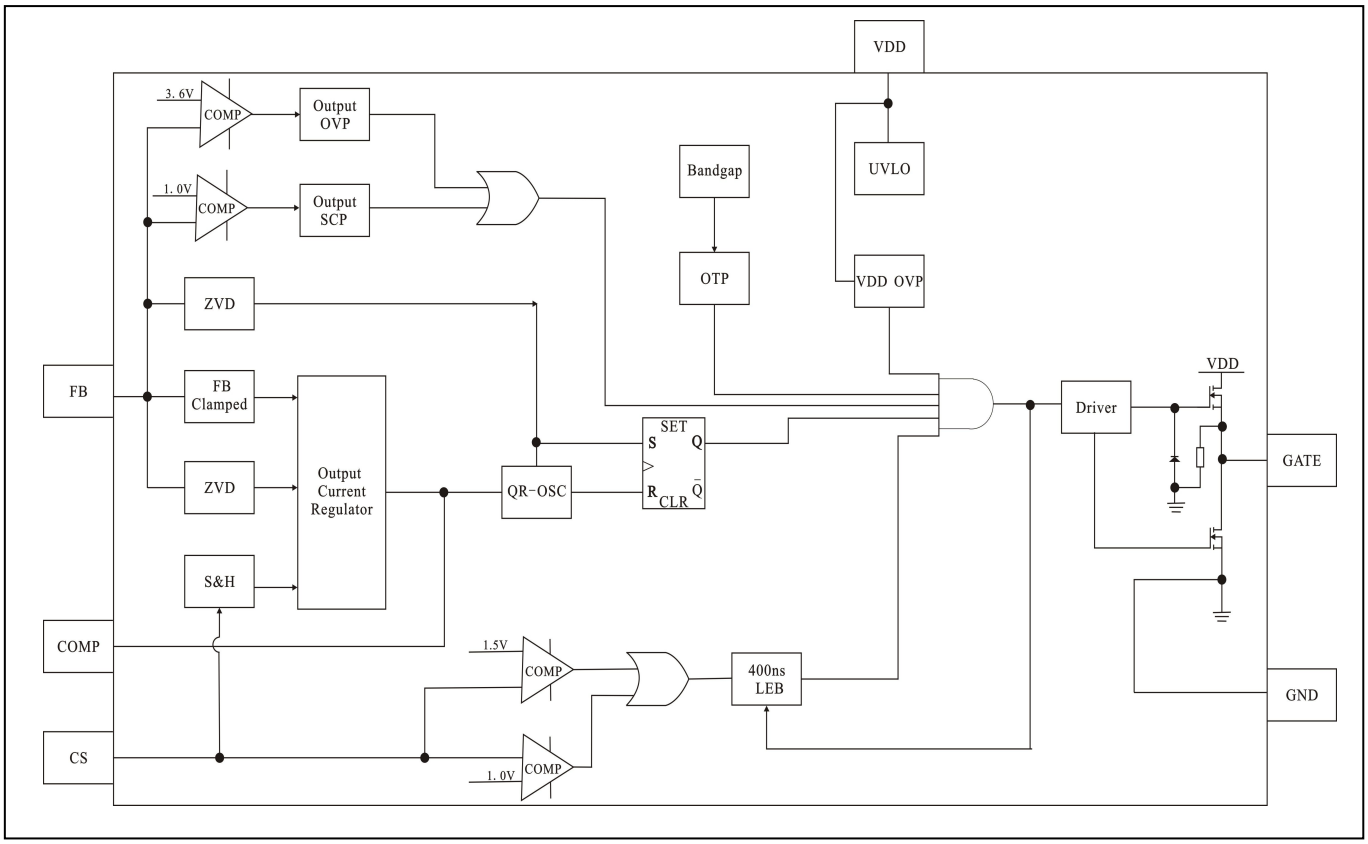



WS3130S8P
A：Product Code
X：Internal Code
BCY：Internal Code For QC
YMX：D/C

## Pin Function Description

| Pin Name | Pin No. DIP8/SOP8 | Pin Type | Function Description |
|---|---|---|---|
| COMP | 1 | I | Loop compensation for constant current regulation.Output of the OTA.The RC work is placed between it and GND. |
| FB | 2 | I/O | Detect output diode zero current to regulate output current.connect to a resistor divider for sensing the reflected voltage from auxiliarywinding |
| CS | 3 | I | Current sense pin, a resistor connects to sense the MOSFET current. |
| GND | 4 | POWER | Power Ground |
| DRV | 5 | O | Totem-pole output to drive the external power MOSFET Maximum Voltage is internally clamped to 18V. |
| VDD | 6 | POWER | Power supply |
| NC | 7/8 | / | NO connect |

## Block Diagram




## Ordering Information

| Package | IC Marking Information | Purchasing Device Name |
|---|---|---|
| 8-Pin SOP8, Pb-free | WS3130S8P | WS3130S8P |

## Recommended Operating Condition

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| VCC | VCC Supply Voltage | 10~28 | V |
| $T_A$ | Operating temperature | -20~85 | ℃ |

## Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | VCC pin input voltage | 28 | V |
| $V_{FB}$ | Feedback pin input voltage | -0.3~6 | V |
| $V_{CS}$ | Current sense pin input voltage | -0.3~6 | V |
| $V_{COMP}$ | Compensation pin voltage | -0.3~6 | V |
| $V_{DRV}$ | DRV pin input voltage | 18 | V |
| $T_J$ | Operating junction temperature | 150 | ℃ |
| $T_{STG}$ | Storage temperature range | -55~150 | ℃ |

**Note 1**: Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated in the Recommended Operating Conditions section are not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

## ESD Information

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{ESD-HBM}$ | Human body model on all pins | 2 | KV |
| $V_{ESD-MM}$ | Machine model on all pins | 200 | V |

## Electrical Characteristics(Unless otherwise specified，$T_A$=25℃，$V_{CC}$=15V)

| Symbol | Parameter | Test Conditions | MIN | Typ. | MAX | Unit |
|---|---|---|---|---|---|---|
| **VDD Pin** | | | | | | |
| $I_{OP}$ | Operating Current | Gate Open | | 1 | | mA |
| $VDD_{ON}$ | Turn-on Threshold Voltage | | | 16 | | V |
| $VDD_{OFF}$ | Turn-on Threshold Voltage | | | 9 | | V |
| $VDD_{OVP}$ | VDD Over Voltage Protection | | | 25 | | V |
| **CMP Pin** | | | | | | |
| $V_{REF}$ | Reference voltage for OTA input | | | 0.24 | | V |
| $I_{CMP\_SINK}$ | CMP maximal sink current | | | 50 | | uA |
| $I_{CMP\_SOURCE}$ | CMP maximal source current | | | 10 | | uA |
| $V_{CMP\_MAX}$ | CMP max. voltage | | | 4.0 | | V |
| **FB Pin** | | | | | | |
| $V_{FB\_SINK}$ | FB voltage when sink currentt | IFB_SINK=2mA | | 5.0 | | V |
| $V_{FB\_SOURCE}$ | FB voltage when source currentt | IFB_Source=4mA | -0.1 | GND | +0.1 | V |
| $V_{FB\_ZVD}$ | FB zero voltage detect | | | 0.2 | | V |
| $V_{FB\_OVP}$ | FB voltage when output OVP | | | 3.6 | | V |
| $V_{FB\_SCP}$ | FB voltage when trigger SCP | | | 1.0 | | V |
| **CS Pin** | | | | | | |
| $V_{CS1}$ | Cycle by Cycle current limited on CS | FB=0V | | 1.0 | | V |
| $T_{BLACK}$ | Leading-Edge Blanking Time | | 300 | 400 | 500 | nS |
| **Oscillator** | | | | | | |
| $F_{OSC\_MAX}$ | Maximal Frequency | | | 130 | | KHZ |
| $F_{OSC\_MIN}$ | Minimal Frequency | | | 30 | | KHZ |
| **GATE Drive Output (GATE Pin)** | | | | | | |
| $T_R$ | Rise Time | CL=1nF | | 200 | | nS |
| $T_F$ | Fall Time | CL=1nF | | 100 | | nS |
| **Over Temperature Protection** | | | | | | |
| $OTP_H$ | Over Temperature Lockout | | | 150 | | ℃ |
| $OTP_L$ | Over Temperature Resume | | | 125 | | ℃ |

## Operation

The WS3130 is a primary side control offline LED controller that incorporates all the features for performance LED lighting. LED current can be method form the primary side eliminate the unwanted harmonic noise injected onto the AC line.

## Startup

During start-up, the current can charge up the VDD hold capacitor. the turn on and turn off threshold of WS3130 are approximately 15V and 9V respectively. The 6V hysteresis voltage is implemented to prevent shutdown from a voltage dip during start-up.

## Quasi Resonance mode (QRM)

During the external power MOSFET on time (TON), the rectified input voltage is applied across the primary side inductor (Lm) and the primary current increases linearly from zero to the peak value (IPK).When the external power MOSFET turns off, the energy stored in the inductor forces the secondary side diode to be turn-on, and the current of the inductor begins to decrease linearly from the peak value to zero. When the current decreases to zero, the parasitic resonant of induct and all the parasitic capacitance makes the power MOSFET drain-source voltage decrease, this decreasing is also reflected on the auxiliary winding. The zero current detector in FB pin generates the turn on signal of the external MOSFET when the FB voltage is lower than 0.2V and ensures the MOSFET turn on at a valley voltage .As a result, there are virtually no primary switch turn-on losses and no secondary diode reverse-recover losses. It ensures high efficiency and low EMI noise.

## Active Power Factor Correction(APFC)

WS3130 is designed with quasi-resonance and constant on time $T_{on}$ to achieve high power factor under normal operation.The on time of WS3130 vary with input AC voltage $V_P Sin\varpi t$ and load condition and its value is constant basically because of very large loop compensaion capacitance on CMP pin.According to following equations,

$$I_{L-peak} = \frac{V_p Sin\varpi t}{L_m} \times T_{on} I_{L-avg} = \frac{V_p Sin\varpi t}{2 \times L_m} \times T_{on}^2 \times f_{osc}$$

The peak current $I_{L-peak}$ and average current $I_{L-avg}$ of transformer will be shaped as AC input sinusoid too beacause $T_{on}$ and $f_{osc}$ both are constant and then high power factor can be achieved.

## Real Current Regulator without Secondary Feedback

The proprietary real current control method allows the WS3130 to accurately control the secondary side LED current from the primary side information.The output LED mean current can be calculated approximately as:

$$I_{OUT} = \frac{1}{2} \times \frac{V_{REF}}{R_{CS}} \times \frac{N_P}{N_S}$$

Where $I_{OUT}$ is the secondary output current of LED, $V_{REF}$ is the inner reference voltage. $N_p$ is number of turns of primary winding and $N_s$ is number of turns of the secondary winding.

## Auto Starter

The WS3130 integrates an auto starter,the starter starts timing when the MOSFET is turned on,if FB fails to send out another turn on signal after 130 μ s,the starter will automatically send out the turn on signal which can avoid the IC unnecessary shut down by FB missing detecion.

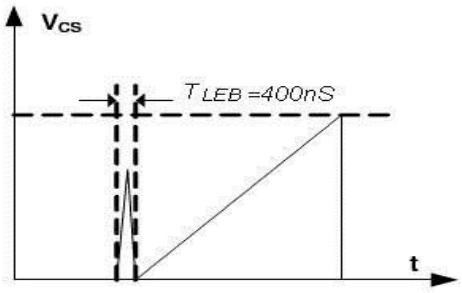
## Minimal Off Time

The WS3130 operates with variable switching frequency. The frequency is changing with the input instantaneous line voltage. To limit the maximum frequency and get a good EMI performance, WS3130 employs an internal minimum off time limiter—3.5μs, show as figure.

## Leading-Edge Blanking for CS pin

In order to avoid the premature termination of the switching pulse due to the parasitic capacitance discharging at MOSFET turning on,an internal leading edge blanking(LEB)

unit is employed between the CS Pin and the current comparator input.During the blanking time,the path,CS Pin to the current comparator input,is blocked.Figure shows the leading edge blanking.




## Output over Voltage Protection

Output over voltage protection can prevent the components from damage in the over voltage condition.The positive plateau of auxiliary winding voltage is proportional to the output voltage. The OVP uses the auxiliary winding voltage instead of directly monitoring the output voltage. Once the FB pin voltage is higher than 3.6V, the OVP signal will be triggered and latched, the gate driver will be turned off and the IC work at quiescent mode, the VDD voltage dropped below the UVLO which will make the IC shut down and the system restarts again.The output OVP setting point can be calculated as:

$$V_{OUT\_OVP} \approx 3.6 \times \frac{N_s}{N_{AUX}} \times \frac{R_{FBH} + R_{FBL}}{R_{FBL}}$$

$V_{OUT\_OVP}$ ……Output over voltge protection value

$N_{AUX}$ ……the auxiliary winding turns

$N_s$ ……the secondary winding turns

## Current Limit

The current limit circuit senses the current of inductor by CS pin. When this current exceeds the internal threshold, typical is 1.0V, the power MOSFET is turned off for the remainder of that cycle.

## Leading-Edge Blanking For FB Pin

As shown in Fig, when the power MOSFET is turned off, a damping voltage spike will occur at FB pin due to parasitic capacitance of power MOSFET and leak inductor of transformer. An internal leading edge blanking (LEB) was introduced to filter this noise.

## Output Short Circuit Protection

When the output short circuit happens, the positive plateau of auxiliary winding voltage is also near zero. The IC will shut down and restart again once FB voltage falls below 1.0V and lasts for about 20mS.

## Thermal Shut Down

The thermal shutdown circuitry senses the die temperature.The threshold is set at 150℃ typical with a 25℃ hysteresis.When the die temperature rises above this threshold (150℃),the 840X turn off the power MOSFET by DRV and remains turning off until the die temperature falls by 25℃,at which point it is re-enabled.

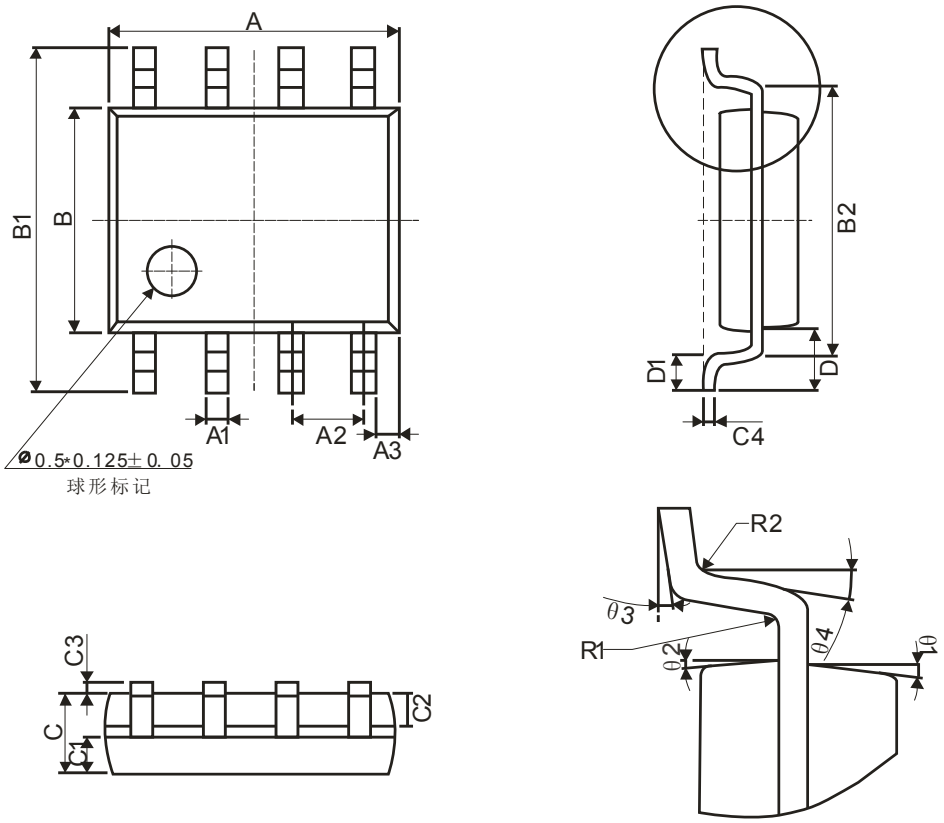
## VDD over Voltage Protection

WS3130 provides an over voltage protection circuit for VDD pin. The GATE output will shut down once the VDD voltage exceeds 25V (typical value), the IC would restart until VDD drops to 9.0V.

## Fault protection

There is several default protections were integrated in the WS3130 to prevent the IC from being damaged which including FB pin open or short, CS pin open.

## SOP-8 Package Information




| | Winsemi | | | |
|---|---|---|---|---|
| **Symbol** | **Dimensions in Millimeters** | | **Dimensions in Inches** | |
| | **Min** | **Max** | **Min** | **Max** |
| A | 4.70 | 5.10 | 0.185 | 0.201 |
| B | 3.70 | 4.10 | 0.146 | 0.161 |
| C | 1.30 | 1.50 | 0.051 | 0.059 |
| A1 | 0.35 | 0.48 | 0.014 | 0.019 |
| A2 | 1.27TYP | | 0.05TYP | |
| A3 | 0.345TYP | | 0.014TYP | |
| B1 | 5.80 | 6.20 | 0.228 | 0.244 |
| B2 | 5.00TYP | | 0.197TYP | |
| C1 | 0.55 | 0.70 | 0.022 | 0.028 |
| C2 | 0.55 | 0.70 | 0.022 | 0.028 |
| C3 | 0.05 | 0.225 | 0.002 | 0.009 |
| C4 | 0.203TYP | | 0.008TYP | |
| D | 1.05TYP | | 0.041TYP | |
| D1 | 0.40 | 0.80 | 0.016 | 0.031 |

**NOTE:**

1.We strongly recommend customers check carefully on the trademark when buying our product, if there is any question, please don't be hesitate to contact us.

2.Please do not exceed the absolute maximum ratings of the device when circuit designing.

3.Winsemi Microelectronics Co., Ltd reserved the right to make changes in this specification sheet and is subject to change without prior notice.

**CONTACT:**

Winsemi Microelectronics Co., Ltd.

ADD:Room 1002, East, Phase 2, HighTech Plaza,Tian-An Cyber Park,Chegongmiao, FuTian, Shenzhen, P.R. China

Post Code : 518040

Tel : +86-755-8250 6288

FAX : +86-755-8250 6299

Web Site : www.winsemi.com