**WINSEMI**®

# High Precision PSR Constant Current LED Driver

## Features

- Built-in 650V Power MOSFET
- Constant current control without secondary sense and feedback circuit.
- No Auxiliary winding for sensing and supplying
- Ultra low operating current to improve efficiency
- Universal input voltage
- ±5% LED current accuracy
- LED short and open circuit protection
- VCC under-voltage protection
- Over temperature protection
- Available in SOP-7 package

## Applications

- LED bulb, spot light
- Other LED lighting

## Description

The WS9224 is a high precision primary-side feedback and regulation controller for LED lighting, it operates in constant current control mode and is designed to work in inductor current discontinuous conduction mode and especially suitable for fly back convertor under universal input.

The WS9224 integrates 650V power MOSFET. Since adopting primary sense and feedback control technology, the secondary sense and feedback circuit is eliminated. The loop compensation components are also removed while maintaining stability overall operating conditions.The operating current is very low, and it doesn't need the auxiliary winding for sensing the output current and supplying the chip. The low component counts and small system size are realized.

Since using the proprietary high accurate current sense method, the WS9224 realizes ±5% accuracy of LED current along with excellent line and load regulation.
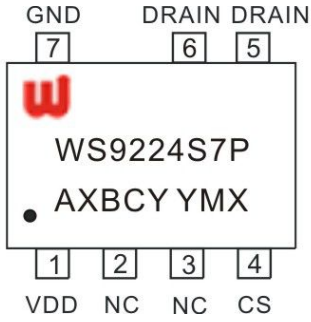
The WS9224 offers rich protection functions including LED open/short circuit protection, over-temperature protection, VCC under voltage protection.

## Typical Application
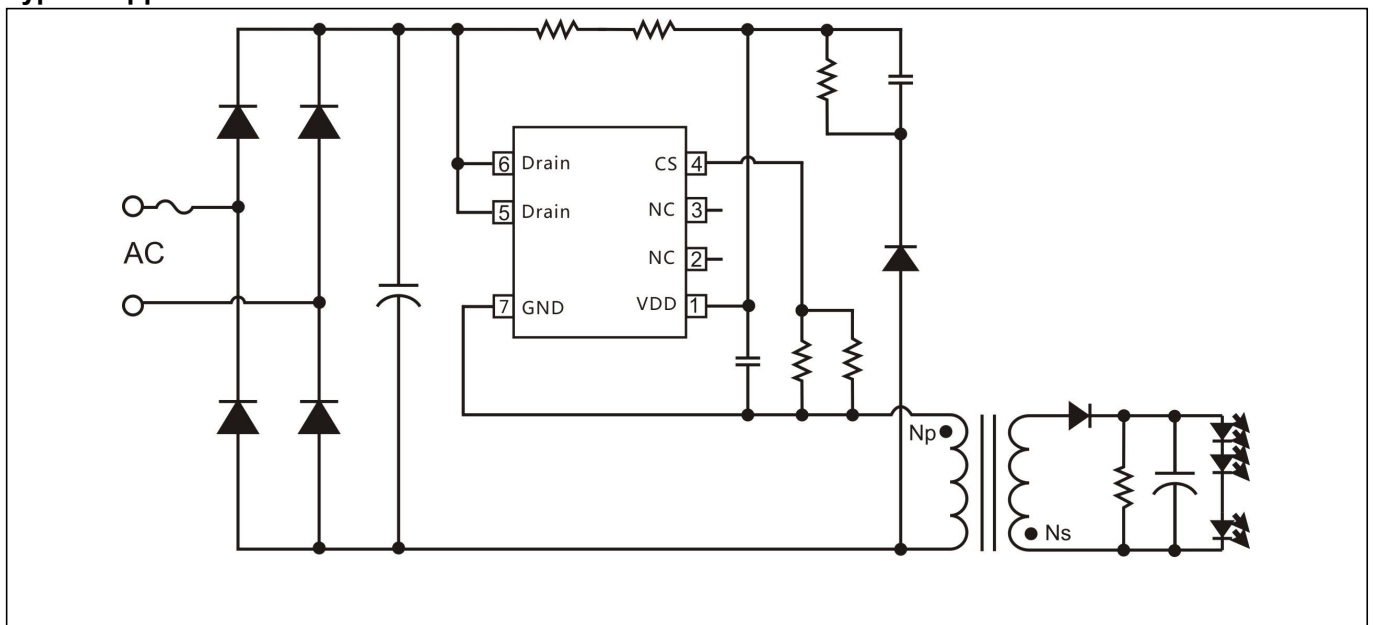
## Pin Configuration and Marking Information

The WS9224 is available in SOP-7 package，the top marking is shown as below:



WS9224S7P

A：Product Code

X：Internal Code

BCY：Internal Code For QC

YMX：D/C

## Pin Definition

| Name | Pin No. | Description |
|---|---|---|
| VCC | 1 | Power supply |
| NC | 2,3 | No connection, must be floated |
| CS | 4 | Current sense. This pin connects a current sense resistor to GND to detect the primary current of transformer. |
| DRAIN | 5,6 | Internal high voltage MOSFET Drain |
| GND | 7 | Ground |

## Internal Block Diagram
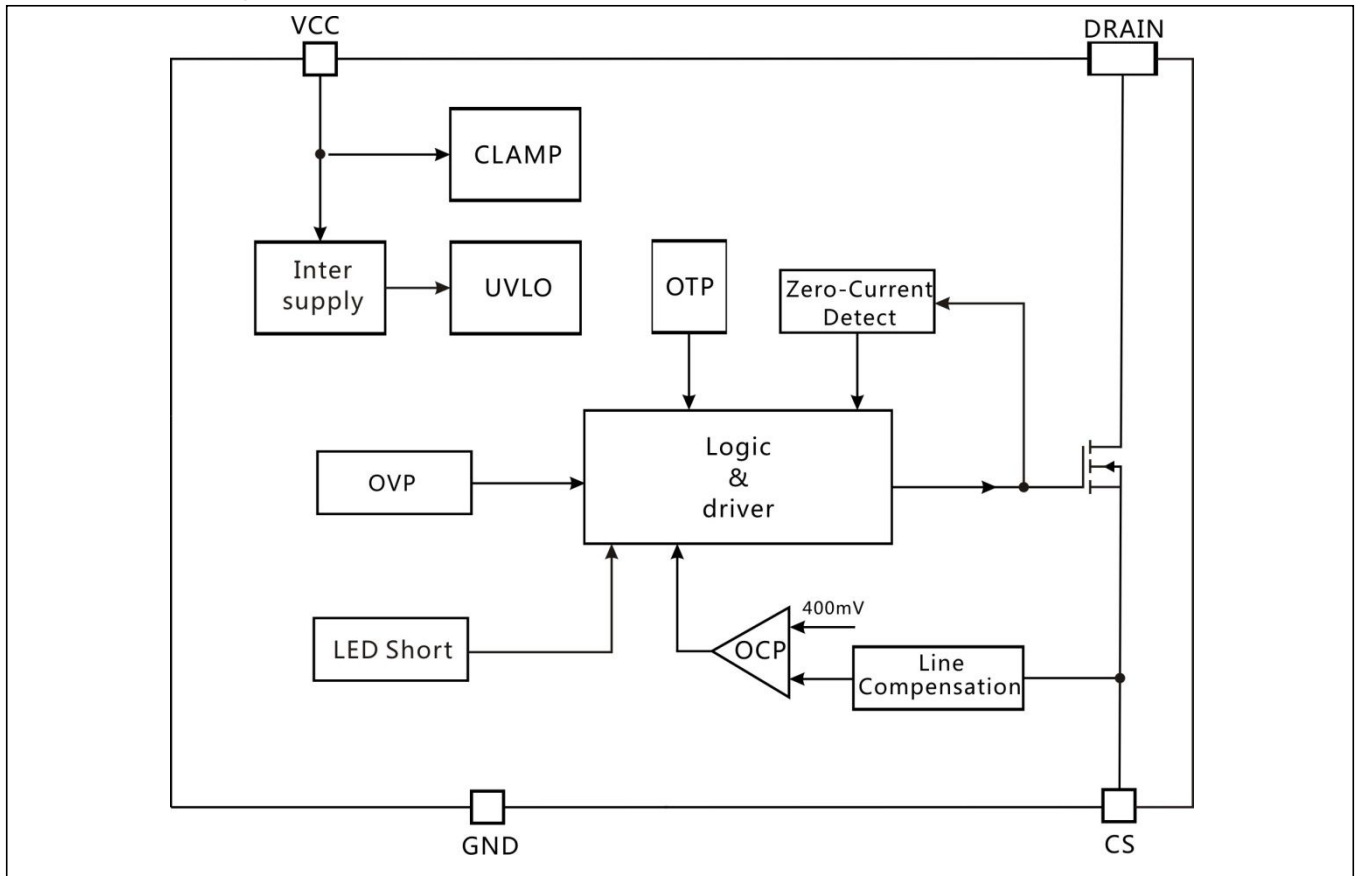


## Ordering Information

| Package | Marking | Part Number |
|---|---|---|
| 7-Pin SOP-7, Pb-free | WS9224S7P | WS9224S7P |

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## Recommended Operation Conditions

| Part Number | Package | Input voltage | Maximum output power |
|---|---|---|---|
| WS9224 | SOP7 | 175VAC-264VAC | <12W |
| | | 90VAC-264VAC | <8W |

## Absolute Maximum Ratings

| symbol | paramete | Range | unit |
|---|---|---|---|
| Icc_max | VCC pin maximum sink current | 2.5 | mA |
| Drain | Internal HV MOSFET drain voltage | -0.3~650 | V |
| CS | Current sense pin input voltage | -0.3~7 | V |
| TJ | Operating junction temperature | 165 | ℃ |
| TSTG | Storage temperature range | -55~165 | ℃ |

**Note 1:** Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device.

## Electrical Characteristics (Unless otherwise specified, VCC=8V and TA =25 ℃)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Supply Voltage Section** | | | | | | |
| $V_{CC\_Clamp}$ | VCC clamp voltage | 1mA | 17.8 | 18.8 | 19.8 | V |
| $UVLO_{off}$ | Turn-off threshold Voltage | | 14.3 | 15.3 | 16.3 | V |
| $UVLO_{on}$ | Turn on threshold Voltage | | 9 | 9.5 | 10 | V |
| $I_{ST}$ | VCC start up current | VCC= 13V | 150 | 205 | 250 | uA |
| $I_{OP}$ | VCC operating current | Fop=70KHz | | 140 | | uA |
| **Current Sense Section** | | | | | | |
| $V_{CS\_TH}$ | Threshold voltage for peak current limit | | 390 | 400 | 410 | mV |
| $T_{LEB}$ | Leading edge blanking time for current sense | | | 350 | | ns |
| $T_{DELAY}$ | Switch off delay time | | | 200 | | ns |
| **Internal driver Section** | | | | | | |
| $T_{off\_max}$ | Maximum Off Time | | | 310 | | us |
| $T_{off\_min}$ | Minimum Off Time | | | 3.5 | | us |
| $T_{on\_max}$ | Maximum On Time | | | 100 | | us |
| $T_{ons\_OVP}$ | Output OVP Threshold Time | | | 7 | | us |
| **MOSFET Section** | | | | | | |
| $R_{DS\_ON}$ | Static drain-source on-resistance | | | 8 | 9.5 | Ω |
| $BV_{DSS}$ | Drain-source breakdown voltage | | 650 | | | V |
| $I_{DSS}$ | Drain-source leakage current | | | | 1 | uA |
| **Over Temperature Protection** | | | | | | |
| $T_{REG}$ | Thermal Regulation Temperature | | | 150 | | ℃ |

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## Application Information

The WS9224 is a high performance power switch specially designed for LED lighting, with patent constant current control technology. The WS9224 integrates a 650V power MOSFET. The accurate LED current can be realized without opto-coupler, TL431 feedback circuit and auxiliary winding while minimizing the external component count, lowering the total bill of material cost.

## Start Up

The start-up current in WS9224 is designed to as low as 205uA. The VCC capacitor will be charged through the start-up resistor when the system is powered on. Once the VCC voltage reaches the start-up threshold, the WS9224 will start to switch. The WS9224 integrates a 19V zener for VCC clamping. Due to the ultra-low operating current, the auxiliary winding is not needed to supply the IC.

## Constant Current Control

Cycle-by-Cycle current sense is adopted in WS9224, the CS is connected to the current sense comparator, and the voltage on CS will be compared with the internal 400mV reference voltage, the MOSFET will be switched off when the voltage on CS reaches the threshold. The output of the comparator includes a 350ns leading edge blanking time.

The primary peak current is given by:

$$I_{P\_PK} = \frac{400}{R_{CS}}(mA)$$

The current in LED can be calculated by the equation:

$$I_{OUT} = \frac{I_{P\_PK}}{4} \times \frac{N_P}{N_S}$$

Where,

NP: primary winding turns of transformer

NS: secondary winding turns of transformer

IP_PK: peak current in MOSFET

## Power MOSFET

The WS9224 integrates a 650V power N-MOSFET. It can minimize the external component count and reduce the BOM cost and PCB size.

The WS9224 uses SOP-7 package. The recommended system output power is below 8W in universal input (90Vac~265Vac) application.

## Operating Switching Frequency

The WS9224 is designed to work in discontinuous conduction mode and no external loop compensation component is required while maintaining stability. The maximum duty cycle is limited to 42%. The maximum switching frequency at normal operation is suggested to set around 65KHz~70KHz. If the maximum frequency is set too high, it will affect the number of maximum series LED lamps. If set too low, the LED open circuit voltage will be too high.

The maximum and minimum switching frequency is limited in WS9224 to ensure the stability of system.

The switching frequency can be set by the formula:

$$f = \frac{Np^2 \times V_{LED}}{8 \times Ns^2 \times Lp \times I_{LED}}$$

Where, LP is the primary winding inductance of transformer.

## Protection Function

The WS9224 has integrated rich protection functions, LED open/short protection, CS resistor short circuit protection, VCC under voltage protection, over temperature protection, and so on. When the LED is open circuit, it will trigger over-voltage protection logic and latch, the system stops switching immediately.

When the LED short circuit is detected the system worksat low frequency (Fop=3KHz), so the power consumption is low. After the system enters into fault latch condition, the VCC voltage will fall until it reaches UVLO threshold. Then the system will re-start again. If the fault condition is removed, the system will recover to normal operation.

## PCB Layouts

The following rules should be followed in WS9224 PCB layout

### Bypass Capacitor

The bypass capacitor on VCC should be as close as possible to the VCC pin and GND pin.

### Ground Path

The power ground path for current sense should be short, and the power ground path should be separated from small signal ground path before the negative of the bulk capacitor.

### The Area of Power Loop

The area of main current loop should be as small as

possible to reduce EMI radiation, such as the primary current loop, the snubber circuit and the secondary rectifying loop.
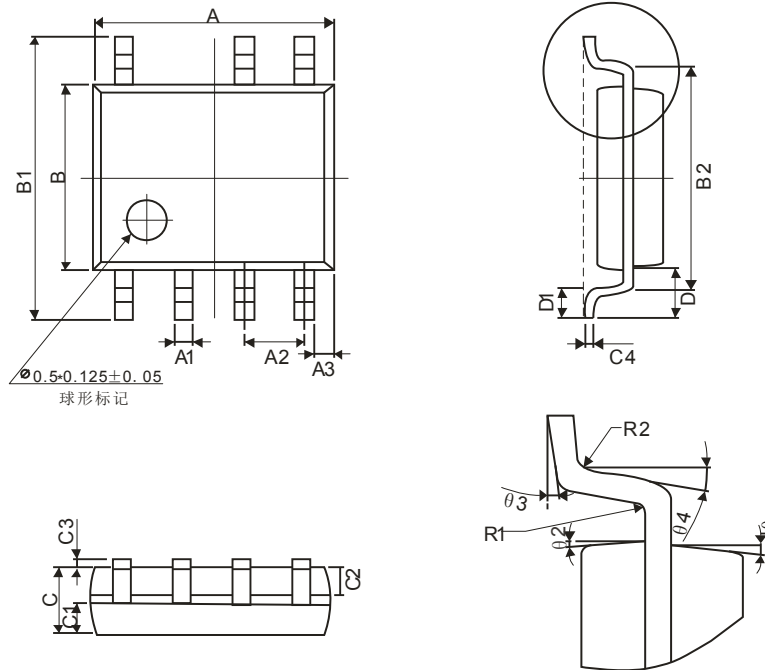
**NC Pin**

The NC pin must be left floating to satisfy the requirement of creepage distance.

**Drain pin**

To increase the copper area of drain for thermal consideration.

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**Package Information**
**SOP7 Package Outline Dimensions**



Ø0.5⁺0.125±0.05
球形标记

| | 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.

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