WS9841 High Efficiency TRIAC dimmable LED

Features

- TRIAC dimmable
- Internal 300V Power MOSFET
- Critical Conduction Mode Operation
- Ultra Low Operating Current
- ±5% LED Output Current Accuracy
- LED Open Protection
- LED Short Protection
- Current Sensing Resistor Short Protection
- VCC Under Voltage Protection
- Thermal Regulation Function
- Available in SOP-8 Package

Typical Appliction

- LED Candle Light
- LED Bulb
- Other LED Lighting

Description

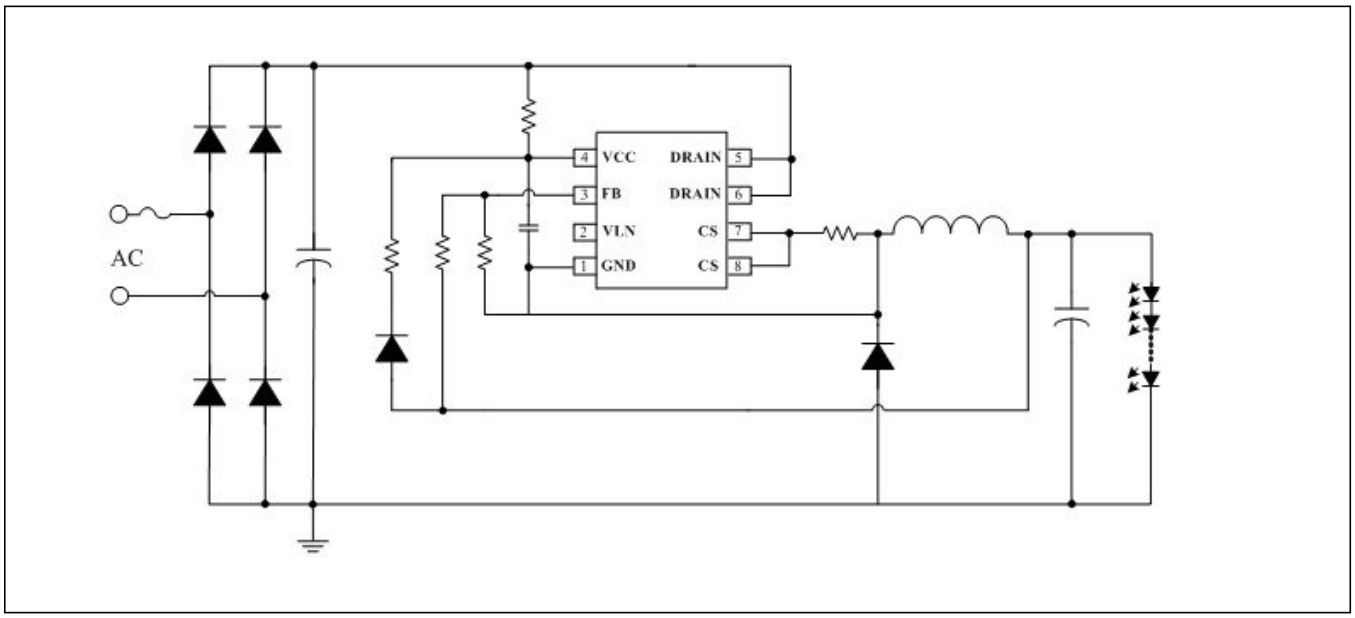
The WS9841 is a high efficiency TRIAC dimmable LED driver. The device operates in critical conduction mode and is suitable for buck, buck-boost or fly-back LED lighting.

The WS9841 integrates a 300V power MOSFET. It utilizes patent pending MOSFET driving technique and current sensing method. The operating current of the IC is very low. With very few external components count, it can achieve excellent constant current performance, so the system cost and size are greatly reduced.

The WS9841 offers rich protection functions to improve the system reliability, including LED open circuit protection, LED short circuit protection, VCC under voltage protection, CS resistor short circuit protection and thermal regulation function.

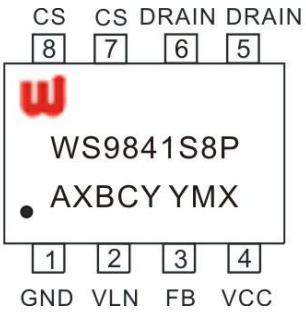
The WS9841 is available in a SOP-8 Package.

Typical Application Circuit



Pin Definition and Device Marking

WS9841 is available in SOP-8 package：

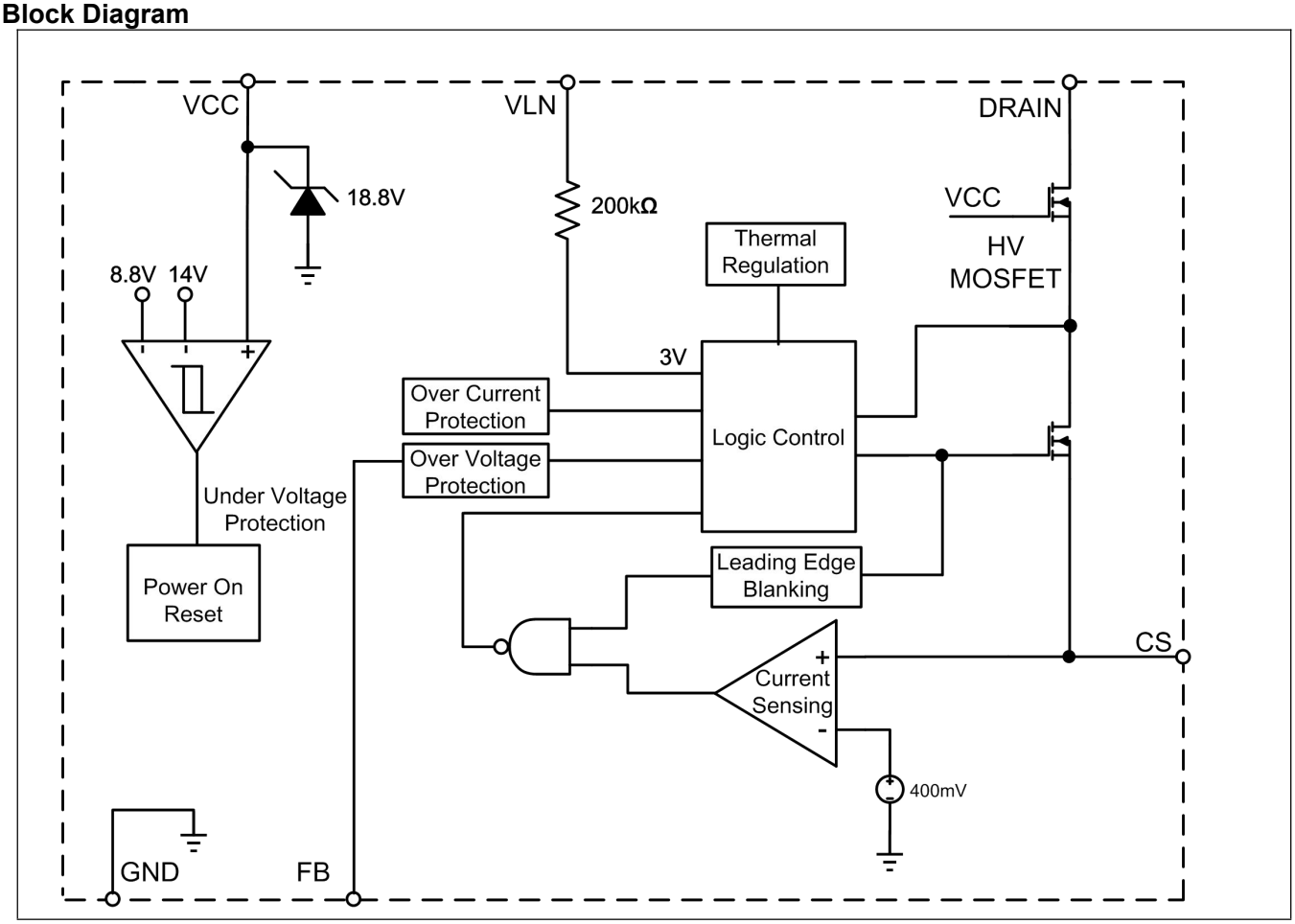


WS9841S8P：Product Code
A：Product Code
X：Internal Code
BCY：Internal QC Code
YMX：D/C

Package Pin Definition

Pin name	Pin No.	Description
GND	1	Ground
VLN	2	Line Voltage Detecting Pin
FB	3	Over Voltage Protection Detecting Pin.
VCC	4	Power Supply Pin
DRAIN	5,6	Internal HV Power MOSFET Drain.
CS	7,8	Current Sense Pin. Connect a sensing resistor between this pin and GND pin.

Block Diagram



Ordering Information

Package	Marking	Part Number
8-Pin SOP-8, Pb-free	WS9841S8P	WS9841S8P

Absolute Maximum Ratings

Symbol	Parameter	Limit	Unit
I_{CC_MAX}	VCC pin maximum sink current	10	mA
DRAIN	Internal HV MOSFET drain voltage	-0.3~300	V
CS	Current sense pin input voltage	-0.3~6	V
FB	Over voltage protection detecting pin voltage	-0.3~6	V
VLN	Line voltage detecting pin voltage	-0.3~6	V
P_{DMAX}	Power dissipation (note 2)	0.45	W
θ_{JA}	Thermal resistance (Junction to Ambient)	145	℃/W
T_J	Operating junction temperature	-40 to 150	℃
T_{STG}	Storage temperature range	-55 to 150	℃
	ESD (note 3)	2	KV

Note 1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. Under "recommended operating conditions" the device operation is assured, but some particular parameter may not be achieved. The electrical characteristics table defines the operation range of the device, the electrical characteristics is assured on DC and AC voltage by test program. For the parameters without minimum and maximum value in the EC table, the typical value defines the operation range, the accuracy is not guaranteed by spec.

Note 2: The maximum power dissipation decrease if temperature rise, it is decided by TJMAX, θ JA, and environment temperature (TA). The maximum power dissipation is the lower one between PDMAX = (TJMAX - TA)/ θ JA and the number listed in the maximum table.

Note 3: Human Body mode, 100pF capacitor discharge on 1.5KΩ resistor

Electrical Characteristics

Conditions: (Notes 4, 5) (Unless otherwise specified, VCC=15V and TA =25 ℃)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage Section						
VCC Clamp Voltage	V_{CC_CLAMP}	1mA		18.8		V
VCC Turn On Threshold	V_{CC_ON}	V_{CC} Rising		14		V
VCC Turn off Threshold	V_{CC_UVLO}	V_{CC} Falling		8.8		V
VCC Startup Current	I_{ST}	V_{CC}= V_{CC-ON} - 1V		120	180	uA
VCC Operating Current	I_{OP}	F_{OP}=70KHz		90	150	uA
Current Sense Section						
Threshold Voltage for Peak Current Limit	V_{CS_TH}		380	400	420	mV
Threshold Voltage for Peak Current Limit When Output Short	V_{CS_SHORT}	Output Short		200		mV
Leading Edge Blanking Time for Current Sense	T_{LEB}			350		ns
Switch Off Delay Time	T_{DELAY}			200		ns
Line Voltage Feed Forward Threshold	V_{VLN_TH}			3		V
Internal Time Control Section						
Minimum OFF Time	T_{OFF_MIN}			2.5		us
Maximum OFF Time	T_{OFF_MAX}			250		us
Maximum On Time	T_{ON_MAX}			10		us
Over Voltage Protection Section						
FB Over Voltage Protection Threshold	V_{FB_OVP}			1		V
MOSFET Section						
Static Drain-source On-resistance	R_{DS_ON}	VGS=15V/IDS=0.5A		3		Ω
Drain-Source Breakdown Voltage	B_{VDSS}	VGS=0V/IDS=250uA	300			V
Power MOSFET Drain Leakage Current	I_{DSS}	VGS=0V/VDS=300V			1	uA
Thermal section						
Thermal Regulation Temperature	T_{REG}			150		℃

Note 4: production testing of the chip is performed at 25° C.

Note 5: the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis.

Function Description

The WS9841 is a high efficiency TRIAC dimmable LED driver IC, specially designed for Buck, Buck-boost or Fly-back LED lighting. The WS9841 integrates a 300V power MOSFET. Utilizing patent pending MOSFET source driving technique, it can achieve excellent constant current performance with very few external components count, so the system cost and size are greatly reduced.

Start Up

After system powered up, the VCC pin capacitor is charged up by the start up resistor. When the VCC pin voltage reaches the turn on threshold, the internal circuits start operating. The WS9841 integrates an 18.8V zener diode to clamp the VCC voltage. After the output voltage is established, VCC is supplied by the output voltage.

Constant Current Control

Cycle by Cycle current sense is adopted in WS9841, the CS pin is connected to the current sense comparator, and the voltage on CS pin is compared with the internal 400mV reference voltage. The MOSFET will be switched off when the voltage on CS pin reaches the threshold.

The peak inductor current is given by:

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

Where, RCS is the current sense resistor value. The CS comparator includes a 350ns leading edge blanking time.

The VLN pin detects the TRIAC dimmer conducting angle to adjust the LED driver output current. The application circuit of the VLN pin is shown in Figure 4. When the VLN pin voltage is higher than 3V, the threshold for peak current limit VCS_TH decreases linearly as shown in Figure 5. When the VLN pin is not used, it can be grounded or floated.

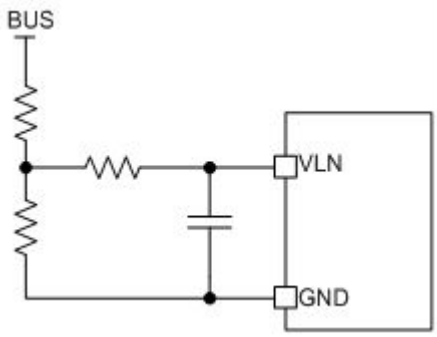


Figure 4. VLN pin application circuit

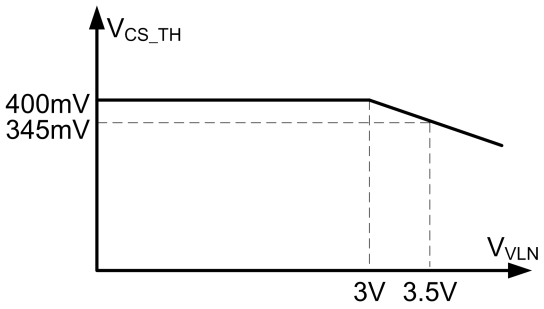


Figure 5. Relationship of VLN voltage and VCS_TH

Inductor Selection

The WS9841 works under inductor current critical conduction mode. When the power MOFET is switched on, the current in the inductor rises up from zero, the on time of the MOSFET can be calculated by the equation:

$$t_{on} = \frac{L \times I_{PK}}{V_{IN} - V_{LED}}$$

Where,

L is the inductance value.

VIN is the DC bus voltage after the rectifier bridge.

VLED is the voltage on the LED.

The maximum on time of the MOSFET is set to 10us internally.

After the power MOSFET is switched off, the current in the inductor decreases. When the inductor current reaches zero, the power MOSFET is turned on again by IC internal logic. The off time of the MOSFET is given by:

$$t_{off} = \frac{L \times I_{PK}}{V_{LED}}$$

The inductance can be calculated by the equation:

$$L = \frac{V_{LED} \times (V_{IN} - V_{LED})}{f \times I_{PK} \times V_{IN}}$$

Where, f is the maximum system switching frequency, which is proportional to the input voltage. So the minimum switching frequency is set at lowest input voltage, and the maximum switching frequency is set at highest input voltage.

Over Voltage Protection

The FB pin is used to detection the output voltage for over voltage protection (OVP). The FB pin threshold is 1V.

The resistor divider of the FB pin can be set as:

$$\frac{R_{FBL}}{R_{FBL}+R_{FBH}}=\frac{1}{V_{OVP}}$$

Where,

RFBL is the lower resistor of the resistor divider

RFBH is the higher resistor of the resistor divider

VOVP is the over voltage protection set value.

For maximizing the system efficiency, the lower resistor is recommended to be around 5KΩ.

Protection Function

The WS9841 offers rich protection functions to improve the system reliability, including LED open/short protection, CS resistor short protection, VCC under voltage protection, thermal regulation.

When the LED is open circuit, the system will trigger the over voltage protection and stop switching.

When the LED short circuit is detected, the system works at low frequency (4kHz), and the CS pin turn off threshold is reduced to 200mV. So the system power consumption is very low. At some catastrophic fault condition, such as CS resistor shorted or inductor saturated, the internal fast fault detection circuit will be triggered, the system stops switching immediately.

After the system enters into fault condition, the VCC voltage will decrease until it reaches the UVLO threshold, then the system will re-start again. If the fault condition is removed, the system will recover to normal operation.

Thermal Regulation

The WS9841 integrates thermal regulation function. When the system is over temperature, the output current is gradually reduced; the output power and thermal dissipation are also reduced. The system temperature is regulated and the system reliability is improved. The thermal regulation temperature is set to 150℃ internally.

PCB Layout

The following rules should be followed in WS9841 **PCB layout:**

Bypass Capacitor

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

FB Pin

The feedback resistor divider should be as close as possible to the FB pin, and the trace must keeps away from dynamic node of the inductor and Drain pin trace, otherwise the FB pin OVP function might have risk to be mis-triggered by the system noise.

VLN Pin

The VLN pin resistor divider and capacitor should be as close as possible to the VLN pin, and the VLN node should be away from the high voltage switching nodes.

Ground Path

The power ground path for current sense resistor should be short and wide, and it should be as close as possible to the IC GND pin. The IC signal ground for FB resistors should be connected to the IC GND pin with short traces and should be away from the power ground path.

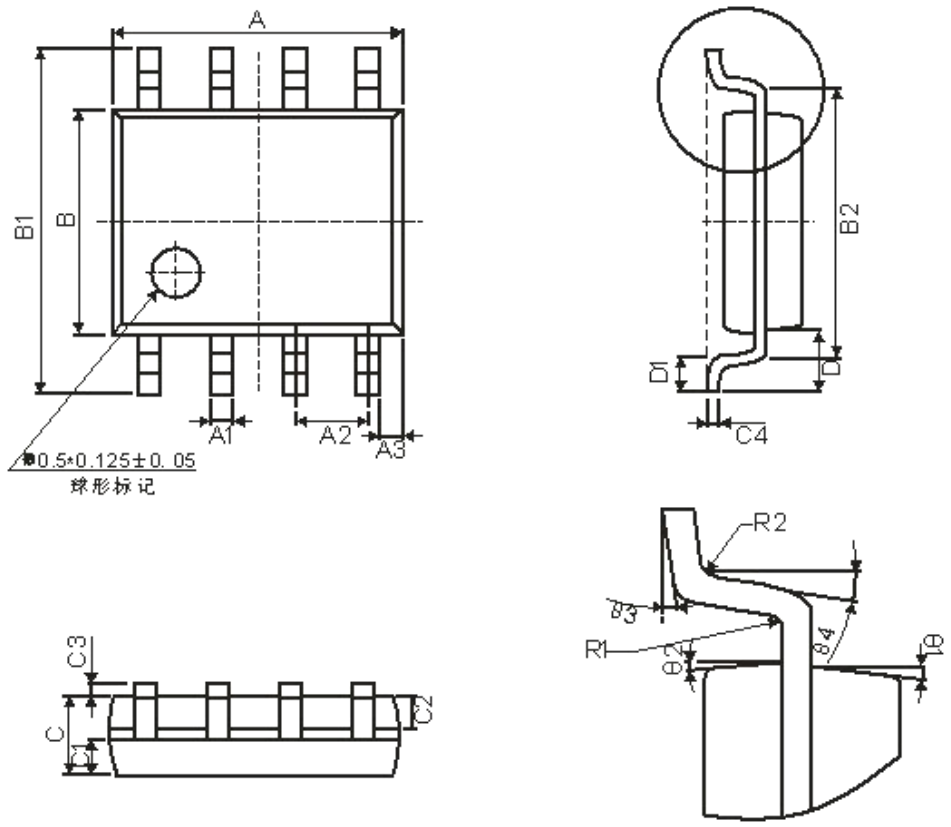
The Area of Power Loop

The area of main current loop should be as small as possible to reduce EMI radiation, such as the power MOSFET, the output diode and the bus capacitor loop.

DRAIN Pin

To increase the copper area of DRAIN pin for better thermal dissipation. However, too large copper area may compromise the EMI performance.

SOP8 Package Dimension



Symbol	Winsemi			
	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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