

IS31LT3909 Preliminary

High PF and Single-Stage fly-back LED Driver with TRIAC Dimming Support

General Description

IS31LT3909 LED driver IC is a peak current detection fly-back configuration controller with active Power factor correction. The IC operates in constant off time mode to simplify circuit design. In addition, IS31LT3909 supports the special feature of TRIAC dimming. Operating power factors (PF) of over 0.9 are easily attainable due to the active power factor correction. Efficiency of 85% is typical with very few external components required.

IS31LT3909 is offered in an MSOP-8 package to minimize PCB area. Operating temperature range is $-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$.

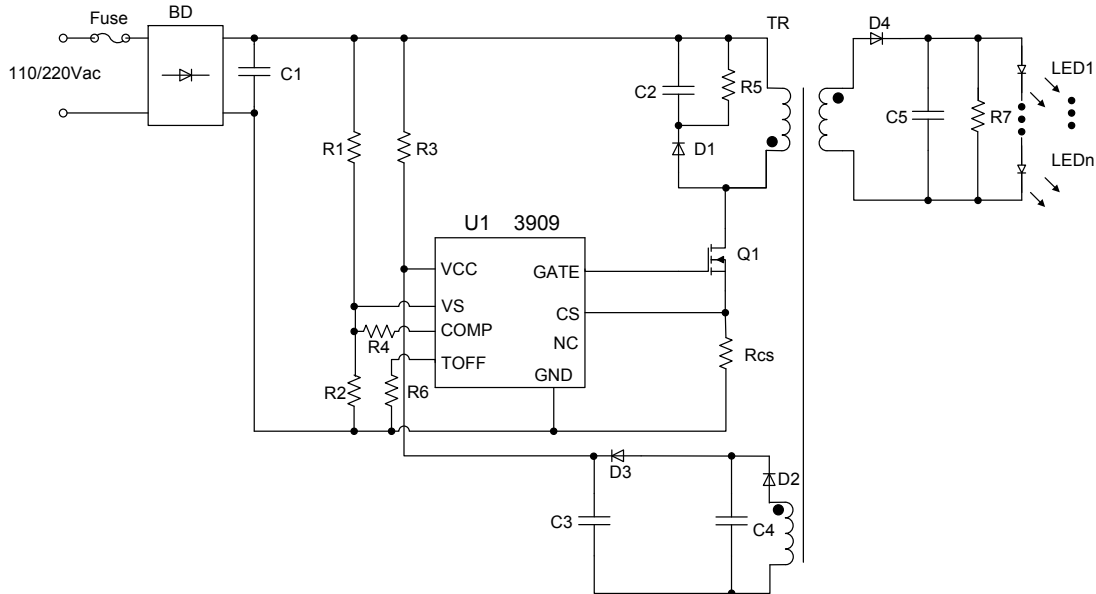
Features

- Supports TRIAC dimming
- No secondary feedback loop
- PF greater than 0.9
- High Efficiency (Typical 85%)
- Very few external components
- Open circuit protection
- Short circuit protection

Applications

- General LED lighting
- Dimmable LED lighting

Typical Application Circuit

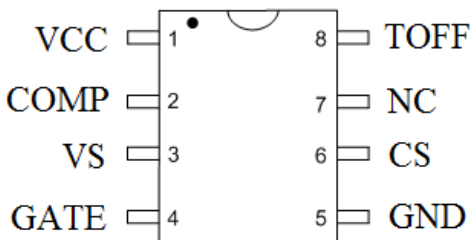


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- a.) the risk of injury or damage has been minimized;
- b.) the user assume all such risks; and
- c.) potential liability of Integrated Silicon Solution, Inc is adequately protected under the circumstances

Pin Configuration

Package	Pin Configurations
MSOP-8	

Pin Description

Pin Name	Pin Number	Description
VCC	1	VCC pin. All internal currents are drawn through this pin
COMP	2	Line regulation compensation pin
VS	3	Line voltage sense Pin
GATE	4	This pin connects to the external NMOS' gate
GND	5	Ground pin. All internal currents return through this pin.
CS	6	Current detect pin, uses an external resistor to sense the peak inductor current.
NC	7	No connect. Must be left unconnected for normal operation.
Toff	8	This pin sets the off time for the switch by connecting a resistor between this pin and GND.

ORDERING INFORMATION
INDUSTRIAL RANGE: -40°C TO +85°C

Order Part No.	Package	QTY/Reel
IS31LT3909-SLS2-TR	MSOP-8, Lead-free	2500



Absolute Maximum Ratings

Parameter	Range	Unit
VCC, GATE pin to GND	-0.3 – 33.0	V
CS, VS, COMP, Toff pin to GND	-0.3 - 5.5	V
VCC pin input current	10	mA
Junction temperature	-40 – 150	°C
Device storage temperature	-65 - 150	°C
ESD (Human Body model)	2000	V

Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Electrical Characteristics

(VCC=16V, VS=5V, CS=0, TOFF=250k, COMP=floating, Temp=25°C unless otherwise stated)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VCC	Input voltage range		8		24	V
V _{OVP}	Over voltage protection threshold			26	28.5	V
I _{dis}	OVP discharge current	VCC=Vovp		4	5.5	mA
UVLO(L)	Undervoltage lockout low threshold	VCC falling		7.2		V
UVLO(H)	Undervoltage lockout high threshold	VCC rising		16		V
I _{IN}	Quiescent Current	VCC=12V		450	600	uA
I _{IN,UV}	Input current in UVLO	VCC=6V		200	300	uA
V _{CS,TH}	Current sense threshold		0.52	0.55	0.58	mV
T _{BLANK}	Current sense blanking time	Vcs=Vcs_th+50mV		500		ns
Toff	Off time	R _{EXT} =250KΩ	9.8	10	10.2	us
V _S	V _S pin input voltage range		0.25		2.5	V
V _{gate_max}	GATE output maximum voltage	VCC=20V		17.5	19	V
Trise	GATE rise from 0 to 6V			100		ns
Tfall	GATE fall from VCC to 0.1*VCC			50		ns
Tdelay	Delay to GATE output	Vcs=Vcs_th+0.02V		60		ns
T _P	Over temperature protection threshold			150		°C
ΔT _P	Over temperature protection hysteresis			20		°C
V _{OCP}	Over current protection			0.75	0.9	V
Toff_reset	Over current protection Toff delay	Vc=Vcs_th+100mV		500		us

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from the luminaire, however, in some cases of higher power luminaires, the step change in current can be observed. This is a onetime only event which occurs as the power is applied to the circuit.

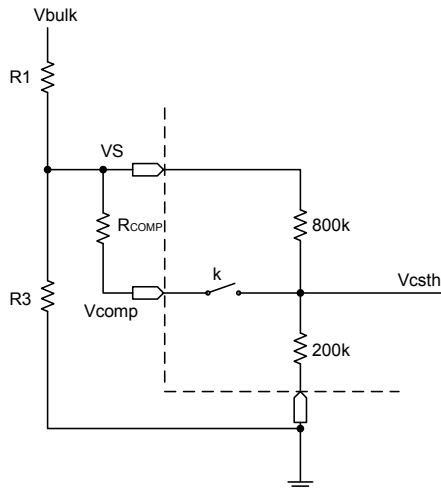


Figure 2 – VCOMP operation

Open circuit voltage protection

Figure 3 shows the circuitry used to implement output open circuit protection. The voltage of the auxiliary winding is proportional to the output voltage, and, thus, can be used to detect output over-voltage conditions. When the auxiliary winding voltage exceeds the preset value of the over-voltage detection threshold, as sensed at the VCC input pin, the controller will stop the switching action for a long period of time. After that time has expired, and if the VCC pin has fallen below the OVP threshold, the IC will attempt to resume normal operation. As shown below: D2, D3, C4 and C3 form the sensing circuit. C3 and C4 are used to filter the auxiliary peak value during the fly-back cycle. The output voltage value which will trigger the OVP cycle is equal to the VCC OVP threshold value, 26V typical, times the turns ratio of the secondary and auxiliary windings of the transformer.

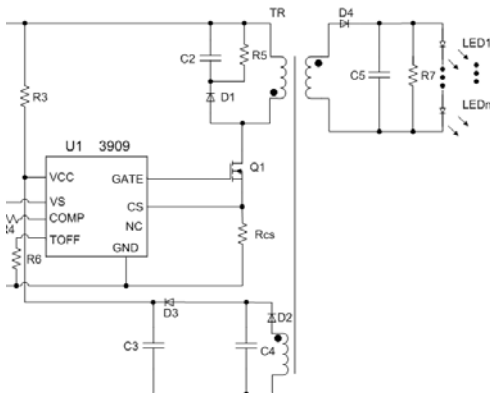


Figure 3

TRIAC dimming

IS31LT3909 supports operation with a wide variety of commercially available TRIAC dimmer switches. The TRIAC dimmer is inserted in series with the line of the mains supply to enable this feature as shown in Figure 4. Rotating, or sliding the dimmer position produces a chopped waveform to the controller circuit, the IC detects the supply voltage's duty cycle and adjusts the power to the output proportionally.

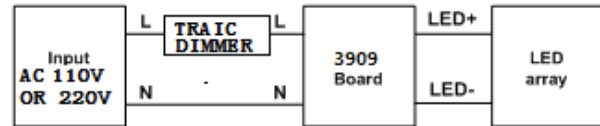


Figure 4

Power MOS selection

The required power MOSFET parameters are determined by the input voltage and the transformer's parameters. Compute the MOSFET voltage rating requirement using the following formula:

$$V_{ds} = V_{CC_{MAX}} + V_r + V_l + V_y$$

V_{ds} : MOSFET tolerance

$V_{CC_{MAX}}$: input DC voltage maximum, when the AC input 265V, $V_{CC_{MAX}}$ is: $265 * 1.414 = 375V$.

V_r : for transformer design take the reflected voltage, designed by the user. Generally set in the range of 75 ~ 85V.

V_l : the primary of the transformer leakage inductance generated spike voltage, when using an RCD voltage clamp, this value should be in the range of 100 ~ 120V.

V_y : allowance, Generally 10%.

RCD circuit design

The RCD circuit, as shown in Figure 5, consists of R5, C2 and D1. Typical C2 capacitance range is 102 ~ 103, with a voltage tolerance rating that must be greater than the MOSFET's Vds voltage. For most applications, use a 1kV capacitor and choose D1 to be FR107 or ES1J. The value of R5 is generally on the order of a few 10's of kΩ. These values must be verified through bench debugging, using an oscilloscope voltage probe to measure the VDS voltage. Verify that the maximum input voltage is less than the MOSFET voltage tolerance. A good rule of thumb is to ensure about 50V margin. The value of R5 will affect the VDS voltage as well as the efficiency. Too large a value for R5 causes VDS to become very large, while too low a value for R5 causes excessive power loss reducing efficiency.

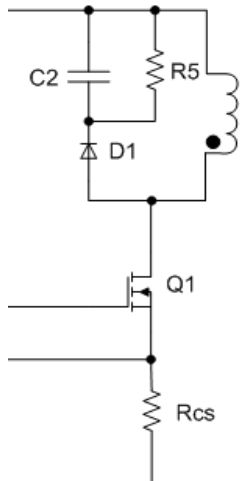


Figure 5

The secondary rectifier diode setting

A Schottky diode is recommended as the secondary side rectifier diode for the best efficiency. A Schottky diode's forward voltage drop is low, which can enhance the power efficiency. Choose a diode with a current rating value of 2 times above the average output current. The reverse voltage rating is determined by:

$$V_{dr} = V_{out} + V_{CCmax} * NP / NS$$

Vdr: the diode reverse breakdown voltage

Vout: output voltage

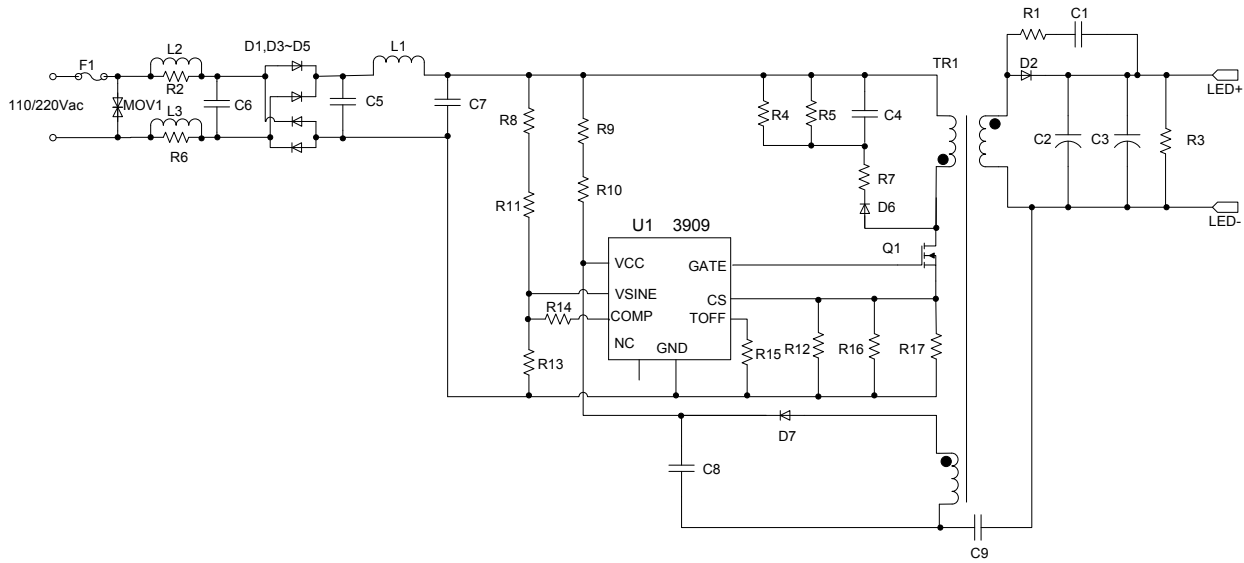
VCCmax: maximum input DC voltage

NP: the transformer primary winding

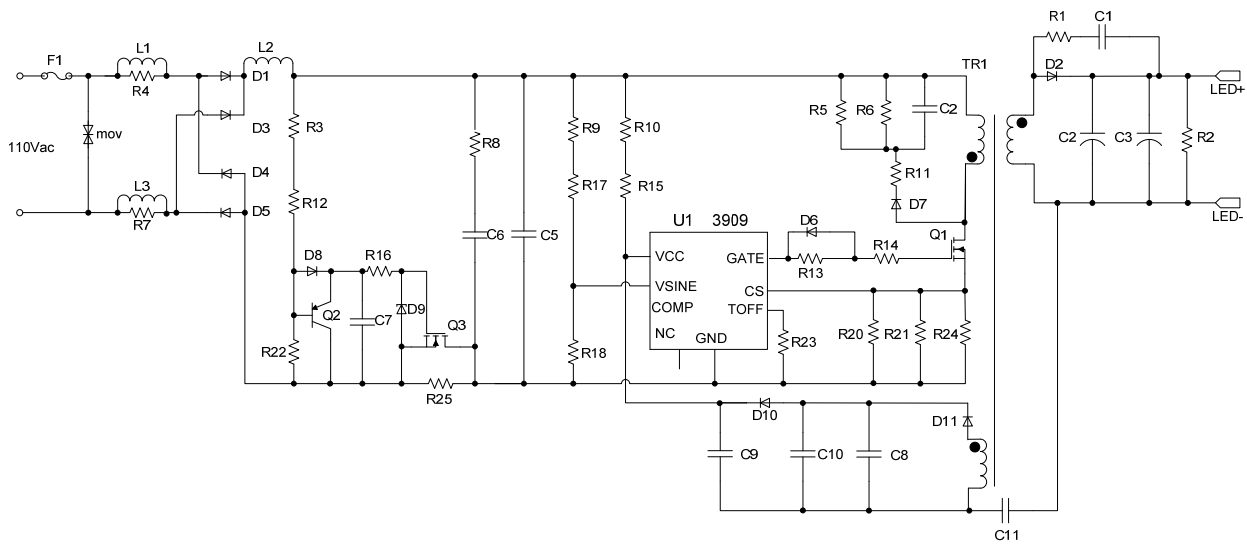
NS: the transformer secondary winding

The actual choice of diode reverse breakdown voltage must be greater than Vdr, 20 ~ 30V allowance.

Appendix: Reference application circuit



NO-Dimming application



Dimming application

Package Information

MSOP-8

