Product Specification

High Precision Non-Isolated Buck APFC LED Driver SIC9701

General Description

The SIC9701 is a constant current LED regulator with high current accuracy which applies to single stage step-down power factor corrected LED drivers.

High accuracy of output current is achieved by sampling the output current directly.Working in critical conduction mode operation reduces the switching losses and largely increases the efficiency.

The SIC9701 is supplied from the output directly, and auxiliary winding is not needed.

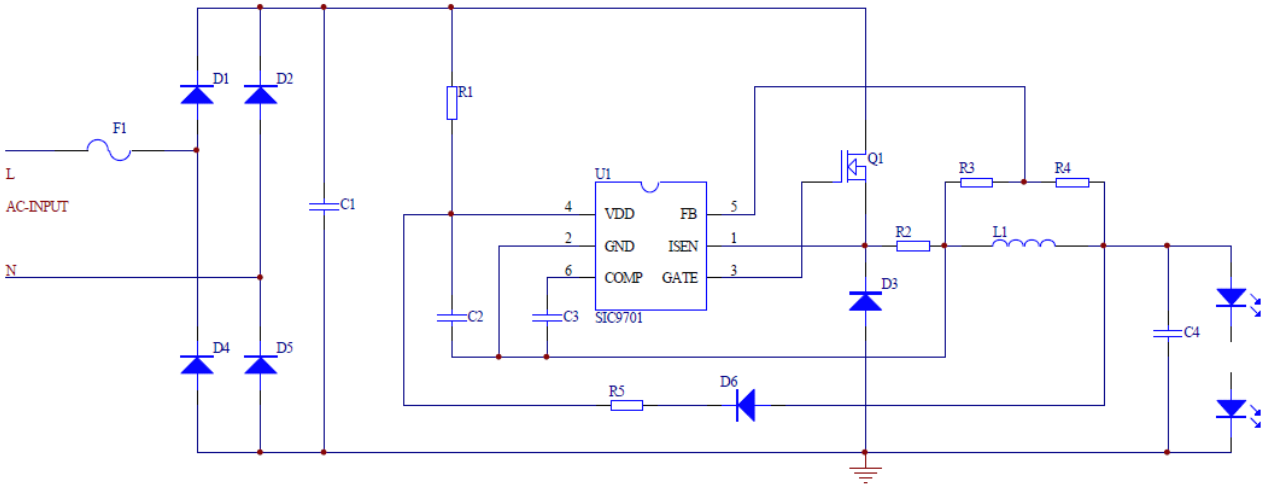
The SIC9701 has multi-protection functions which largely enhance the safety and reliability of the system, including V_{DD} over-voltage protection, V_{DD} UVLO, short-circuit protection, LED open protection, cycle-by-cycle current limit and over-temperature protection.

The SIC9701 available in Compact SOT23-6 package.

Features

·No auxiliary winding
·High current accuracy of line and load regulation
·High power factor with low output current-ripple
·Critical conduction mode
·High efficiency over wide operating range
·Cycle-by-cycle current limit
·LED short protection
·LED open protection
·Over-temperature protection

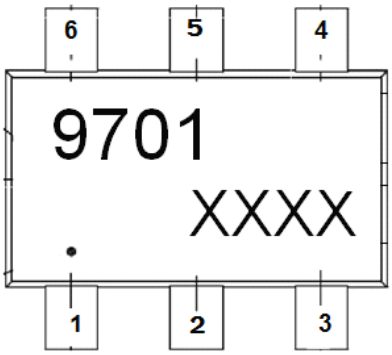
Typical Application



Ordering Information

Part Number	Package	Package Method	Marking
SIC9701(SOT23-6)	SOT23-6	Tape and Reel 3,000pcs/Roll	9701 XXXX

Pin Assignment



9701: Part Number(4 digits)

XXXX: Date Code(4 digits)

Pin Description

Pin	Pin Name	Description
1	ISEN	Output current sense Pin. The pin is used for output current control.
2	GND	Ground.
3	GATE	Gate Driver for the External Main MOSFET Switch.
4	VDD	Power Supply Pin. This pin supplies current to the internal start-up circuit. This pin must be bypassed with a capacitor nearby.
5	FB	Voltage Loop Feedback Pin. FB is used to detect LED open by sampling the output voltage.
6	COMP	Compensation Pin for Internal Error Amplifier. Connect a capacitor between the pin and GND to compensate the internal feedback loop.

Absolute Maximum Ratings

Parameter	Symbol	Description	Min	Max	Unit
Voltage	V_{DD_MAX}	Maximum Voltage On V_{DD} Pin		43	V
	V_{GATE_MAX}	Maximum Voltage On Gate Pin		18	V
	V_{MAX_ALL}	Maximum Voltage On All others Pins	-0.3	4.5	V
Power Dissipation (Ta=25°C)	P_{tot}	Maximum Power Dissipation in Ta=25°C		0.30	W
Thermal Resistance	Rthj-a	Thermal Resistance Junction-ambient		220	℃/W
Temperature	T_J	Operating Junction Temperature		150	°C
	T_{STG}	Storage Temperature Range	-55	150	°C
ESD		ESD Voltage for Human Body Mode		2,000	V

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

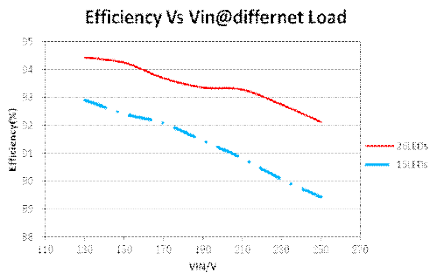
Electronic Characteristics

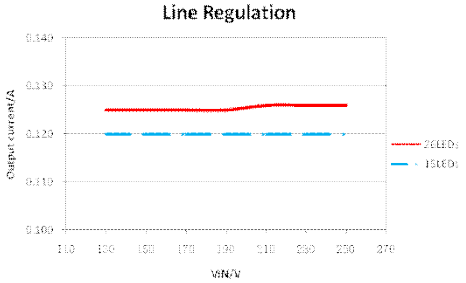
T_C=25°C， V_{DD} = 25V， unless otherwise specified

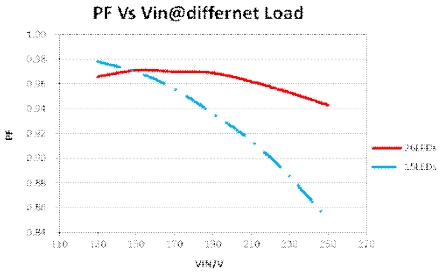
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
V_{DD} Turn-On Voltage	V_{DD_ON}		18	21.0	24	V
V_{DD} Turn-off Low Voltage	$V_{DD\_OFF\_L}$		6.4	7	8	V
V_{DD} Hysteresis	V_{DD_HYS}	V_{DD_ON}-$V_{DD\_OFF\_L}$		14		V
V_{DD} Over Voltage Threshold	V_{DD_OVTH}			43	46	V
V_{DD} Over Voltage Release Threshold	$V_{DD\_OV\_RLS}$		27	33	39	V
V_{DD} Shunt Regulator Current Limit	I_{DD_SHUNT}	V_{DD} = 58V	4	6	8	mA
V_{DD} Quiescent Current	I_Q	V_{DD}<V_{DD_ON}	19	25	31	uA
FB OVP Threshold	V_{FB_H}		2.6	2.9	3.2	V
V_{ISEN} Reference Voltage	V_{ISEN}		96	100	104	mV
V_{ISEN} Limit	V_{ISEN_LIMIT}		500	550	610	mV
Gate Output High	V_{GATE_H}		11	13	15	V
Leading Edge Blanking Time	T_{LEB}		500	750	1000	ns
Maximum Frequency	F_{MAX}			120	145	kHz
Maximum MOS On Time	T_{ONMAX}		17.5	20		us
t_r Gate Driver Output Rise Time	T_{GATE_R}	C_L=1nF 10% to 90%		20		ns
t_f Gate Driver Output Fall Time	T_{GATE_F}	C_L=1nF 90% to 10%		20		ns

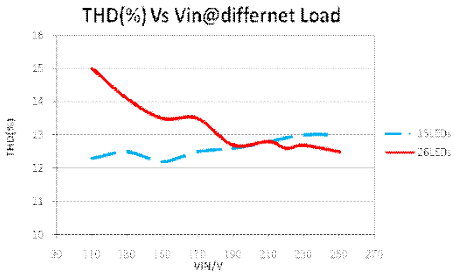
TYPICAL PERFORMANCE CHARACTERISTICS

VIN=85VAC~264VAC, VOUT=75V, Io=120mA, unless otherwise noted



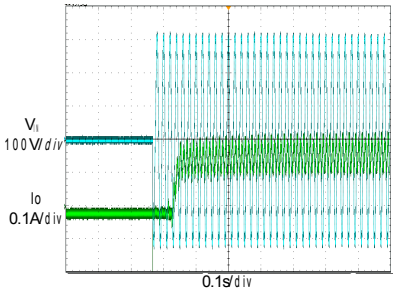






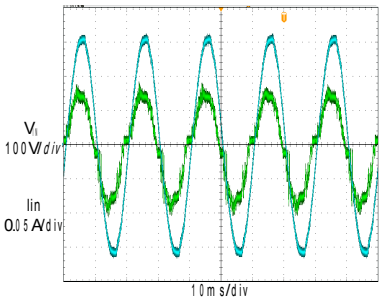
Start State

V_{IN}=220Vac,I_O=120mA,P_O=9W



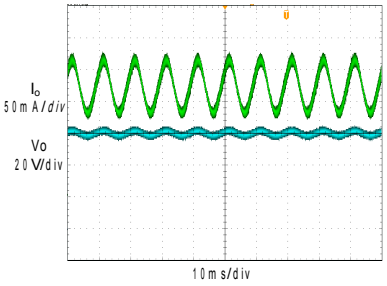
Steady State (Input)

V_{IN}=220Vac,I_O=120mA,P_O=9W



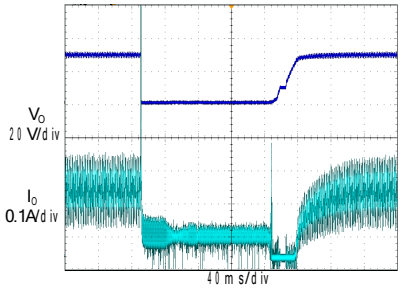
Steady State (Output)

V_{IN}=220Vac,I_O=120mA,P_O=9W



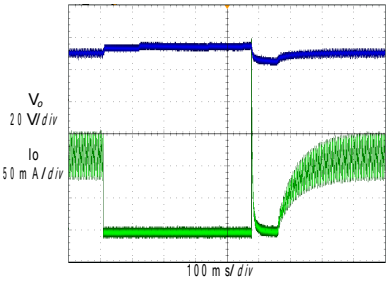
Short Circuit Protection

V_{IN}=220Vac,I_O=102mA,P_{IN}=0.39W

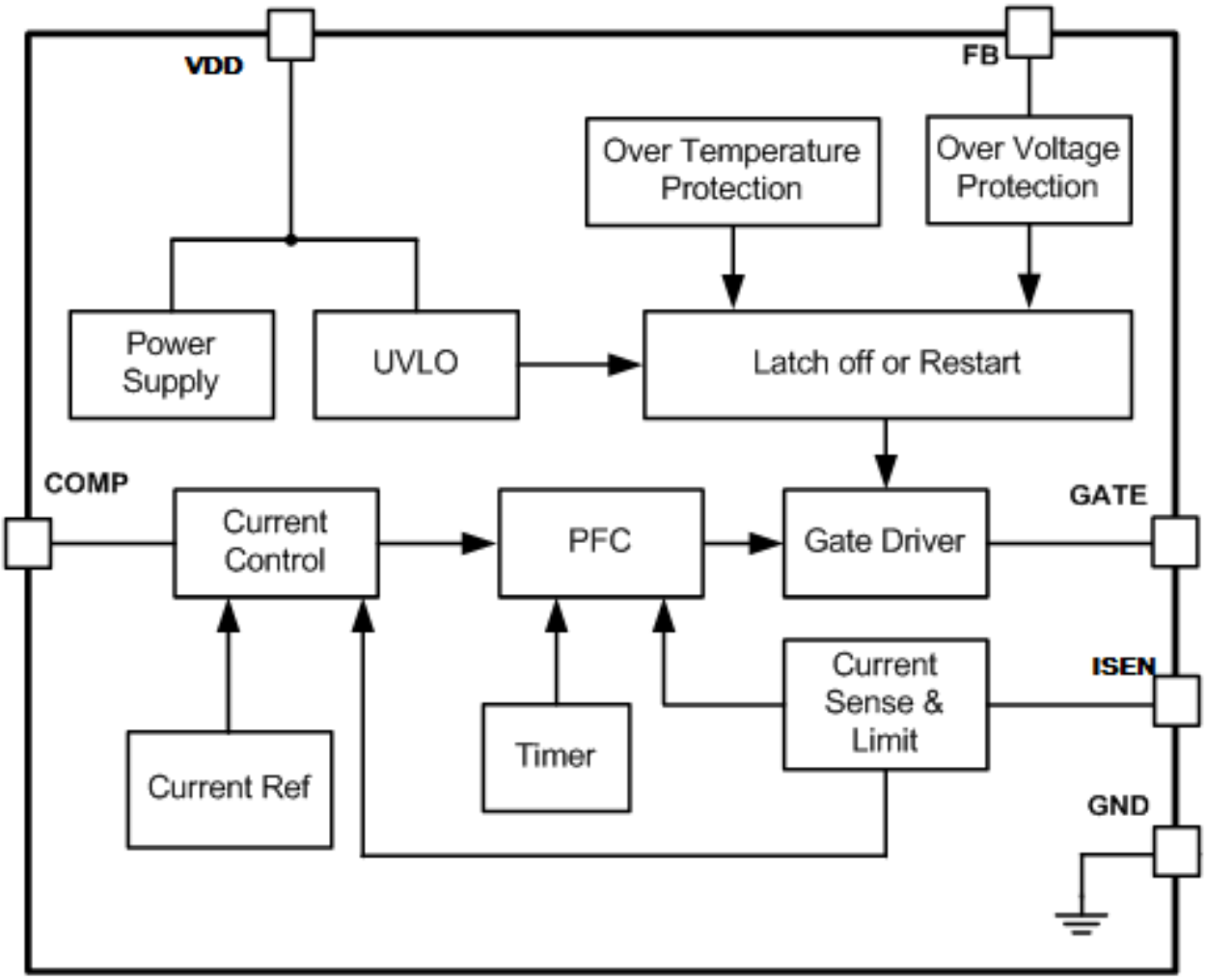


Open Circuit Protection

V_{IN}=220Vac,V_O=80V,P_{IN}=0.25W



Functional Block Diagram



Applications Information

FUNCTIONAL Description:

The SIC9701 is a constant current LED controller which applies to non-isolation step-down LED system with power factor correction. SIC9701 can achieve excellent line and load regulation, high efficiency and low BOM cost.

Start Up

When the pull-up resistor charges V_{DD} up to 21V, the gate drive signal begins to switch, and the output begins to provide power to the V_{DD} pin when the output is enough. An internal voltage clamp is attached to the VIN pin to prevent V_{DD} from being too high. An internal 10mA current pulls the V_{DD} down and stop switching when it is above 43V and restart switching when V_{DD} is pulled down to 35V. When V_{DD} is lower than 7.7V, it stops

switching.

Loop Compensation

An integrator configuration is applied to the output current feedback loop with a capacitor connected to the COMP pin. For offline applications, the crossover frequency should be set much less than the line frequency of 120Hz or 100Hz. To have a good PFC performance, a capacitor of 0.1μF connected to COMP pin is recommended.

Constant Current Control

The SIC9701 controls the output current from the information of the current sensing resistor. The output LED mean current can be calculated as:

$$I_{LED} = \frac{V_{REF}}{R_{ISEN}} (A)$$

Where

V_{REF} –100mV typically;

R_{ISEN} – The sensing resistor connected between ISEN and GND

Critical Conduction Mode Operation

SIC9701 works in the critical conduction mode of the inductor current. When the external power MOSFET turns on, the inductor current begins to increase from zero. The turn on time of the MOSFET can be calculated as:

$T_{ON} = 2\ I_{LED} \times L / (V_{IN} - V_{LED})$

Where,

L –inductance.

I_{LED} – output led current.

V_{IN} – input voltage after rectification and filtering.

V_{LED} – output LED voltage.

When the power MOSFET turns off, the inductor current begins to decrease. The power MOSFET turns on again when the inductor current is zero. The turn off time of the MOSFET can be calculated as:

$T_{OFF} = 2\ I_{LED} \times L / V_{LED}$

And the inductance of the system can be calculated as:

$L = V_{LED} \times (V_{IN} - V_{LED}) / (f \times 2 I_{LED} \times V_{IN})$

Where, f is the switching frequency. You may choose the minimum input voltage when you want to set up the minimum switching frequency.

Inductor selection guide:

Output current(mA)	Inductor(mH)
120	1.30
180	1.00
240	0.83
320	0.73

Over Temperature Protection

When SIC9701 is hotter than 150°C, the COMP voltage is pulled down by an internal current thus reduces the output current.

LED Open Protection

The output voltage can be detected by the FB pin. When the FB voltage is higher than 3.0V, the LED open protection is triggered and the power MOSFET gate driver stops switching. After several seconds, the gate driver starts switching again.

The recommended FB pin voltage is about 2.5Vat rated output， and it's pull-up resistor is typically in hundreds KΩ level.

LED short protection

SIC9701 judges LED short from the FB voltage. During a shorted LED condition, SIC9701 reduces the internal command current to a very low level and slows down the switching frequency to 1.25 kHz to decrease the output current.

If a LED short or LED open protection are false triggered by unreasonable PCB layout, a 20pF capacitor could be paralleled to FB pin and GND.

PCB Layout Guidelines

1. The VDD pin must be locally bypassed with a capacitor.
2. Make the area of the power loop as small as possible in order to reduce the EMI radiation.
3. The chip should be far away from the heating components, such as MOSFET, transformer and diode.
4. Note the chip ground is not connected to the cathode of the input capacitor as usual.

SOT23-6 封装机械尺寸
SOT23-6 MECHANICAL DATA

单位:毫米/UNIT：mm

符号/SYMBOL	最小值/min	典型值/nom	最大值/max
A	0.90		1.45
A1	0		0.15
A2	0.90		1.30
A3	0.60		0.70
b	0.35		0.49
C	0.08		0.22
D	2.80		3.00
E	2.60		3.00
E1	1.50		1.70
e	0.85		1.05
e1	1.85		2.00
L	0.35		0.60
θ	0		8°