TAIWAN SEMICONDUCTOR

RoHS COMPLIANCE

Preliminary　　　　　**TS19453**
AC/DC Programmable Current WLED Driver
w/PWM Dimming Control

SOP-8

Pin Definition:
1. Rsense　　8. Drain
2. Ground　　7. Drain
3. PWMD　　6. Drain
4. Vdd　　　5. Ground

General Description

The TS19453 is a PWM high efficiency programmable current LED driver with PWM dimming control IC. It allows efficient operation of LED strings from voltage source ranging up to 400VDC. It includes an internal high voltage switching MOSFET controlled with fixed off-time of approximately 12µS.

The LED string is driven at constant current, thus providing constant light output and enhanced reliability. The output current is internally programmable up to 50mA. The peak current control scheme provides good regulation of the output current throughout the universal AC line voltage range of 85~264VAC or DC input voltage of 20~400V

Features

- Adjust constant output current up to 50mA(typ)
- Universal 85~264VAC operation
- Over temperature protection with hysteresis
- PWM dimming
- Fixed off-time buck converter
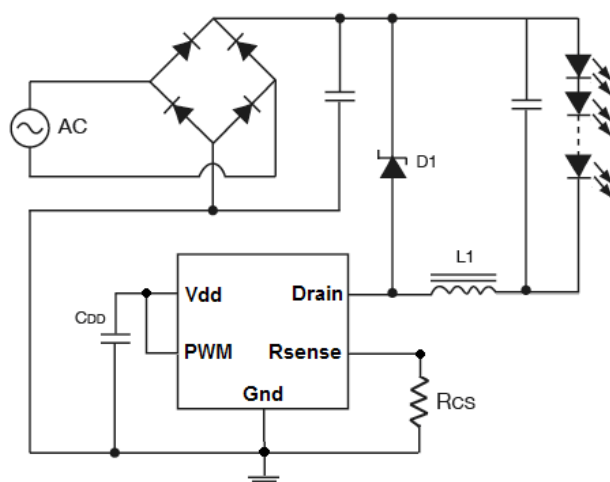- Internal 475V power MOSFET

Application

- Decorating LED lighting
- LED lamps with AC or DC operation.

Ordering Information

Part No.	Package	Packing
TS19453CS RLG	SOP-8	2.5Kpcs/13" Reel

Note: "G" denote for Halogen Free Product

Typical Application Circuit

Absolute Maximum Rating

| Parameter	Symbol	Limit	Unit
Input Voltage Range	V_{IN} to GND	~ +475	V
VDD to GND	V_{DD} to GND	~ 9	uA
PMWD, Rsense to GND		~ V_{DD}+0.3	uA
Power Dissipation @ T_A=25ºC	P_D	Internally Limited	W
Operating Ambient Temperature	T_{OPR}	-40 to +85	ºC
Storage Temperature Range	T_{STG}	-65 to +150	ºC
Thermal Resistance – Junction to Ambient	$R\theta_{JA}$	160	ºC/W

Note: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress rating only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Specifications (Ta = 25°C, V_{DRAIN}= 50V, unless otherwise noted)

Function Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Internal Regulator						
Internally Regulated Voltage	V_{DD}		--	7.5	--	V
Drain Supply Voltage	V_{DRAIN}		20	--	400	V
Undervoltage Lockout Threshold	UVLO	V_{DD} rising	4.8	--	--	V
Undervoltage Lockout Hysteresis	ΔUVLO	V_{DD} falling	--	200	--	mV
Supply Current	I_{DD}	$V_{DD(EXT)}$=8.0V	--	--	500	µA
Output (Drain)						
Breakdown Voltage	V_{BR}	Note 1	475	--	--	V
On Resistance	R_{DSON}	I_{DRAIN}=50mA	--	--	200	Ω
MOSFET Saturation current	I_{SAT}		100	150	--	mA
Current Sense Comparator						
Threshold Voltage	V_{TH}	Note 1	0.43	--	0.53	V
Leading edge Blanking delay	T_{BLANK}	Note 1,2	200	300	400	nS
Minimum Turn On-Time	$T_{ON(min)}$		--	--	650	nS
Off-Time Generator						
Turn On-Time	T_{OFF}		8	12	18	µS
PWMD						
PWMD Input Voltage	V_{PWMD}	High voltage	2.0	--	--	V
		Low voltage	--	--	0.8	
PWMD Pull Down Resistance	R_{PWMD}	VPWMD=5V	100	--	300	Ω

Note 1: The specification which apply over the full operating ambient temperature range of -40°C<T_A<+85°C
   2: Guaranteed by design

Block Diagram
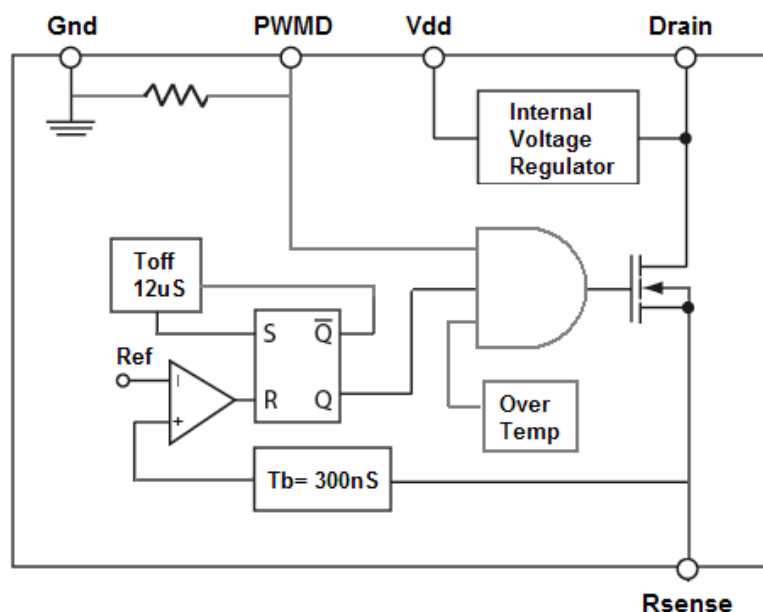
Function Description

The TS19453 is a PWM peak current controller for controlling a buck converter topology in continuous conduction mode (CCM). The output current is of converter that can be programmed by a single external resistor (Rsense), for the purpose of driving a string of LED, an external enable input (PWMD) is provided that can be utilized for PWM dimming of an LED string.

When the input voltage of 20~400V appears at the Drain pin, the internal high-voltage linear regulator seeks to maintain a voltage of 7.5VDC at the VDD pin. Until this voltage exceeds the internally programmed under-voltage threshold, the output switching MOSFET is non-conductive. When the threshold is exceeded, the integrated high-voltage switch turns on, pulling the Drain low, A 200mV hysteresis is incorporated with the undervoltage comparator to prevent oscillation.

When the voltage at Rsense exceeds 0.47V(typ), the switch turns off and the Drain output becomes high impedance, at the same time, a one shot circuit is activated that determines the off-time of the switch.

A "blanking" delay of 300nS is provided that presents false triggering of the current sense comparator due to the leading edge spike caused by circuit parasitic.

Application Information

The TS19453 is specifically designed for driving multi LED strings. It can be operated from either universal AC line range of 85~264VAC or 20~400VDC, and drives up to tens of high brightness LEDs. All LEDs can be run in series and this device regulates at constant current, yielding uniform illumination.

Selecting L1 and D1

There is a certain trade-off to be considered between optimal sizing of the output inductor L1 and the tolerated output current ripple. The required value of L1 is inversely proportional to the ripple current ΔI_O in it.

$$L1 = (V_O \times T_{OFF}) / \Delta I_O$$

V_O is the forward voltage of the LED string. T_{OFF} is the off-time of the TS19453. The output current in the LED string (I_O) is calculated as:

$$I_O = (Vth / Rsense) - (\Delta I_O / 2)$$

Where I_{TH} is the current sense comparator threshold, and Rsense is the current sense resistor. The ripple current introduces a peak-to-average error in the output current setting that needs to be accounted for. Due to constant off-time control technique used in the TS19453, the ripple current is independent of the input AC or DC line voltage variation. Therefore, the output current will remain unaffected by the varying input voltage.

Adding a filter capacitor across the LED string can reduce the output current ripple even further, thus permitting a reduced value of L1. However, one must keep in mind that the peak-to-average current error is affected by the variation of T_{OFF}. Therefore, the initial output current accuracy might be sacrificed at large ripple current in L1.

Another important aspect of designing an LED driver with TS19453 is related to certain parasitic elements of the circuit, including distributed coil capacitance of L1, junction capacitance and reverse recover of the rectifier diode D1, capacitance of the PCB traces C_{PCB} and output capacitance C_{DRAIN} of the controller itself. These parasitic elements affect the efficiency of the switching converter and could potentially cause false triggering of the current sense comparator if not properly managed. Minimizing these parasitic is essential for efficient and reliable operation.

Coil capacitance of inductors is typically provided in the manufacturer's data books either directly or in terms of the self-resonant frequency (SRF).

$$SRF = 1 / (2\pi\sqrt{(L * C_L)})$$

Application Information (Continue)

L is the inductance value, and C_L is the coil capacitance. Charging and discharging this capacitance every switching cycle causes high-current spikes in the LED string. Therefore, connecting a small capacitor $C_O(\sim100nF)$ is recommended to bypass these spikes.

Using an ultra-fast rectifier diode for D1 is recommended to achieve high efficiency and reduce the risk of false triggering of the current sense comparator. Using diodes with shorter reverse recovery time t_{rr} and lower junction capacitance C_J achieves better performance. The reverse voltage rating V_R of the diode must be greater than the maximum input voltage of LED lamps.

The total parasitic capacitance present at the Drain pin of the TS19453 can be calculated as:

$$C_P = C_{DRAIN} + C_{PCB} + CL + C_J$$

When the switching MOSFET turns on, the capacitance C_P is discharged into the Drain pin of the IC. The discharge current is limited to about 50mA typically. However, it may become lower at increased junction temperature. The duration of the leading edge current spike can be estimated as:

$$T_{PSIKE} = ((V_{IN} \times C_P) / (I_{SAT})) + t_{rr}$$

In order to avoid false trigger of the current sense comparator, C_P must be minimized in accordance with the following expression.

$$C_P =< (Isat * (T_{BLANK(min)} - t_{rr})) / Vin(max)$$

When $T_{BLANK(min)}$ is the minimum blanking time of 200nS, and Vin(max) is the maximum instantaneous input voltage.

Estimating Power Loss

Discharging the parasitic capacitance C_P in the the Drain output of TS19453 is responsible for the bulk of the switching power loss. It can be estimated using as:

$$P_{SWITCH} = ((C_P * V_{IN}^2 / 2) + (V_{IN} * I_{SAT} * t_{rr})) * F_S$$

F_S is the switching frequency and is the saturated Drain current of TS19453, the switching loss is the greatest at the maximum input voltage.

Disregarding the voltage drop at TS19453 and D1, the switching frequency is given as

$$F_S = (V_{IN} - V_{OUT}) / (V_{IN} * T_{OFF})$$

When the TS19453 is powered from full wave rectified AC input, the swithching power loss can be estimated as:

$$P_{SWITCH} = 1 / (2 * T_{OFF}) * ((V_{AC} * C_P + 2 * I_{SAT} * t_{rr}) * (V_{AC} - V_{OUT})))$$

When the TS19453 is powered from DC input voltage, conduction power loss can be estimated as:

$$P_{COND} = (D * I_{OUT}^2 * R_{ON}) + I_{DD} * V_{IN} * (1 - D)$$

EMI Filter

As with all off-line converters, selecting an input filter is critical to obtaining good EMI. A switching side capacitor, albeit of small value, is necessary in order to ensure low impedance to the high frequency switching currents of the converter. As a rule of thumb, this capacitor should be approximately 0.1~0.2µF/W of LED output power.
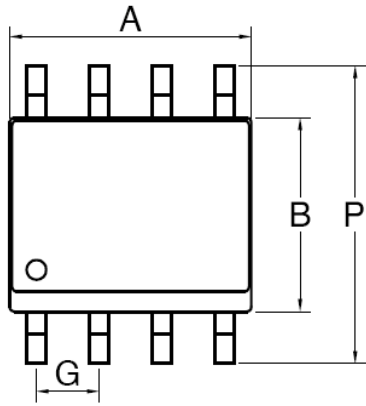
Typical Application Circuit

Typical Application Circuit for Universal 85~264VAC LED Lamps Driver (Non-Isolation)
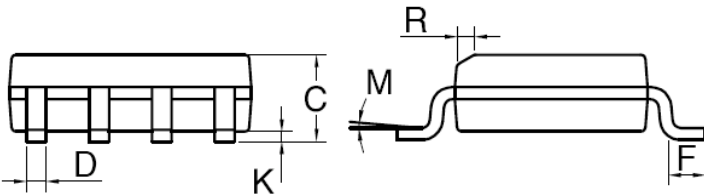
15pcs LED (VLED=49.5V), LED current 50mA
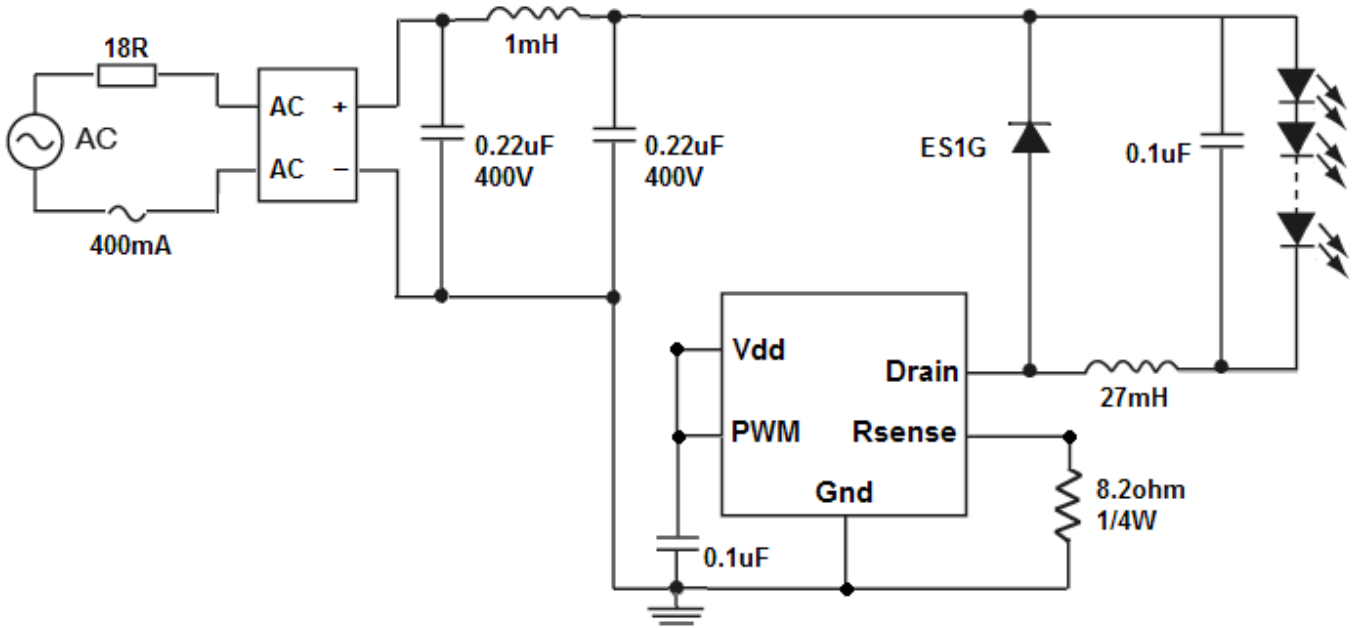
SOP-8 Mechanical Drawing

SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27BSC		0.05BSC	
K	0.10	0.25	0.004	0.009
M	0º	7º	0º	7º
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

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