普 誠 科 技
Princeton Technology Corp.

Non-isolated Buck LED Driver

DESCRIPTION

The RS3822 is a high precision constant current controller, designed for non-isolated buck LED driver. It can operate under universal AC input or 12V~600V DC input. The RS3822 integrates 600V power MOSFET, so it can achieve excellent constant current performance with very few external components

The RS3822 uses high precision current sense circuit and patent method for constant current control, to achieve high precision output current and excellent line regulation. The RS3822 operates in inductor current critical mode. The LED current is constant over wide range of inductance variation and the LED output voltage, so the load regulation is excellent.

The RS3822 uses patent source driver architecture. The operation current is 200uA only, so the auxiliary winding is not needed. It can simplify the system design and reduce the system cost.

The RS3822 offers rich protection functions, including LED short circuit protection, current sense resistor short circuit protection and over temperature protection.

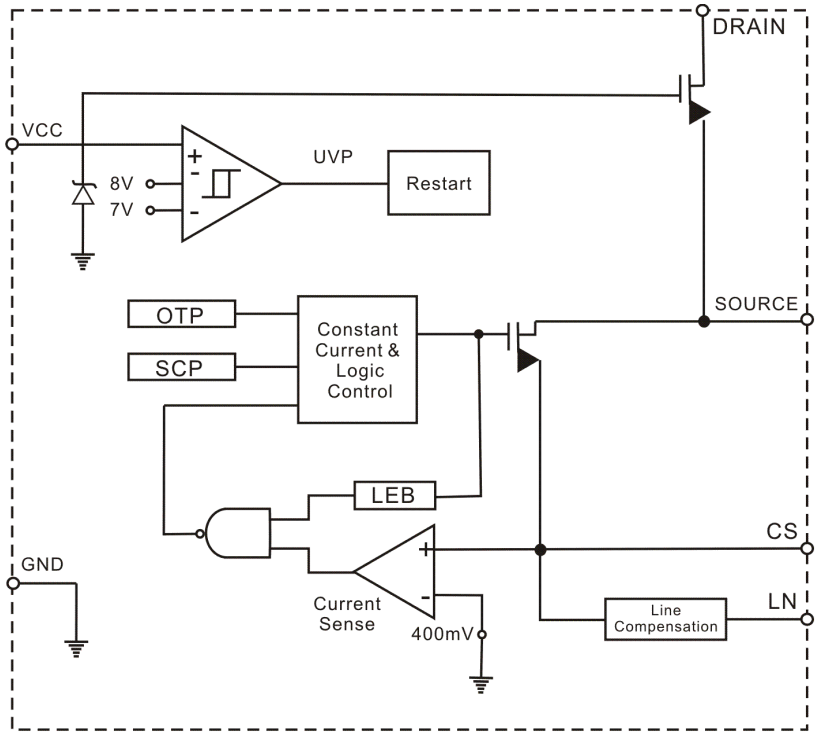
FEATURES

- Inductor Current Critical Mode, No Need to Compensate the Inductance Variation
- 600V MOSFET integrated
- Source Driver Structure, Not Need the Auxiliary Winding for VCC
- ±3% LED Current Accuracy
- Up to 93% System Efficiency
- LED Short Circuit Protection
- Current Sense Resistor Short Circuit Protection
- Over Temperature Protection
- Available in DIP-8 package

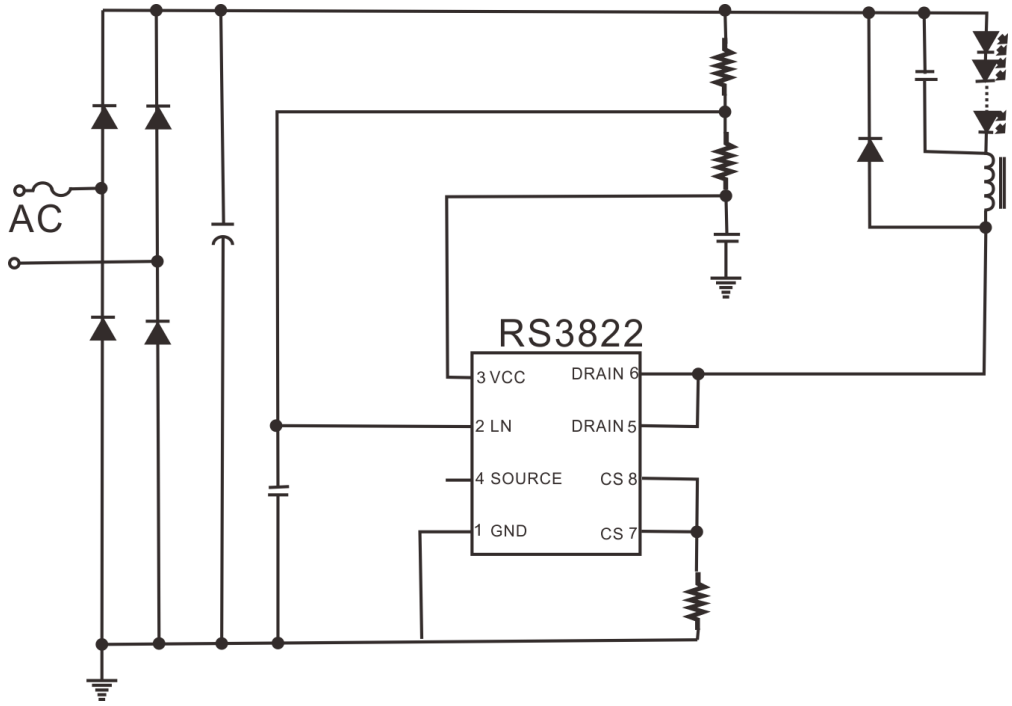
APPLICATIONS

- LED Bulb
- LED Candle light
- LED Spot light
- Decorative LED lighting

BLOCK DIAGRAM



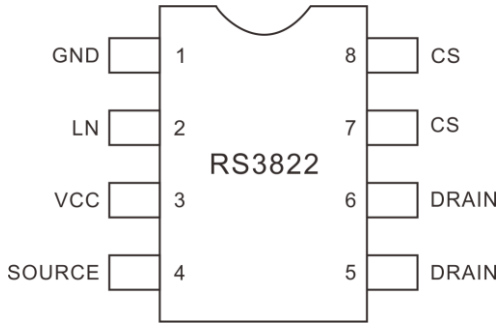
TYPICAL APPLICATION CIRCUIT



ORDER INFORMATION

Device	Device Code
RS3822 Y Z	**Y is package & Pin Assignments designator:** D : DIP-8 **Z is Lead Free designator:** P: Commercial Standard, Lead (Pb) Free and Phosphorous (P) Free Package G: Green (Halogen Free with Commercial Standard)

PIN CONFIGURATION



PIN DESCRIPTION

Pin Name	Description	Pin No.
GND	Ground	1
LN	Line compensation sense input	2
VCC	Power supply, clamp to 12.5V by internal Zener diode	3
SOURCE	Internal HV power MOSFET source	4
DRAIN	Internal HV power MOSFET drain	5,6
CS	Current sense input, the sense resistor is connected from CS to ground	7,8

FUNCTION DESCRIPTION

RS3822 is a constant current controller, designed for driving non-isolated buck LED power supply. RS3822 integrates 600V power MOSFET, and it uses patent constant current control method and source driver structure, excellent constant current characteristic is achieved with low counts components. Low cost and high efficiency of system is realized.

START UP

The Vcc will be charged through the startup resistor when the system is powered on. When the voltage on Vcc reaches the startup voltage threshold, the controller starts to switching. The Vcc voltage of RS3822 is clamped to 12.5V by internal Zener diode.

CONSTANT CURRENT CONTROL AND OUTPUT CURRENT SETTING

The RS3822 uses patent constant current control method, excellent constant current is achieved with low counts components. The RS3822 senses the peak current in inductor cycle by cycle. The CS Pin is connected to the input of internal current comparator, and compared with the internal 400mV reference voltage. The external power MOSFET will be turned off when the CS pin voltage reaches the voltage threshold. The comparator has a 350ns LEB timer to avoid mis-trigger.

The peak current in the inductor is given by:

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

The Rcs is the resistance of current sense resistor. The current in LED can be calculated by the following equation:

$$I_{LED} = \frac{I_{PK}}{2}$$

The I_{PK} is the peak current in inductor

LINE COMPENSATION

The RS3822 integrates line compensation function. The line voltage is sensed by the voltage difference between LN and Vcc pin. And the internal reference voltage of Vcs is compensated by a value proportional to the sensed line voltage. The excellent line regulation is achieved.
The line compensation coefficient is given by the following equation：

$$\Delta V_{CS} = -40 \times 10^{-3} \times (V_{LN} - V_{CC})$$

The V_{CS} is the reference voltage of the internal current sense comparator.
The V_{LN} is the voltage on LN pin.
The V_{CC} is the voltage on VCC pin.

SOURCE DRIVER STRUCTURE

The RS3822 uses the patent source driver structure. The typical operation current is as low as 200μA, the auxiliary winding is not need. So the system design is simple and the cost is low.

INDUCTANCE CALCULATION

The RS3822 is designed to work in inductor current critical mode, the energy will be stored in the inductor when the MOSFET is turned on. The turn on time is given by:

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

The L is the inductance.
The I_{pk} is the peak current in inductor.
The V_{IN} is the input rectified voltage.
The V_{LED} is the voltage on LED.

When the power MOSFET is turned off, the inductor current will decrease from the peak current to zero. The turn off time is given by:

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

The MOSFET will be turned on again when it detects the inductor current goes to zero. The inductance can be calculated by the following equation

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

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

The RS3822 internally set the minimum off time to 4us and maximum off time to 130us. When the inductance is very small, the t_{off} may goes below the minimum off time and the inductor current becomes discontinuous. So the output LED current will be smaller than the setting value. If the inductance is too large, the t_{off} may goes beyond the maximum off time and the inductor current becomes continuous. And the output LED current will be larger than the setting value. So it's very important to select a right inductance.

The RS3822 also internally set the maximum on time to 40us. When the input voltage is very low or LED output voltage is very high, the t_{on} may goes beyond the maximum on time. The power MOSFET will be turned off even the inductor current still below the setting value. So the output LED current will be smaller than the setting value.

PROTECTION FUNCTIONS

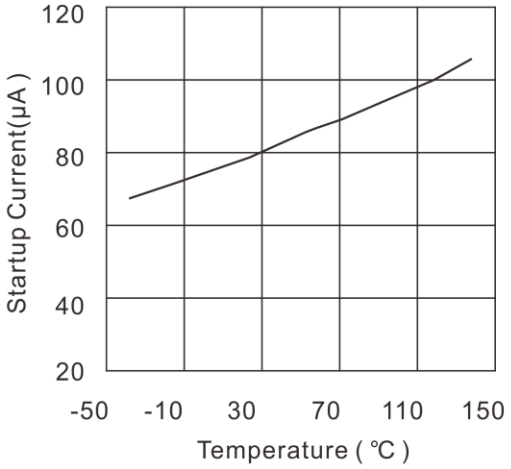
The RS3822 has many protection functions, including LED short circuit protection, current sense resistor short circuit protection and over temperature protection. All of the protection functions are designed to auto-recover.

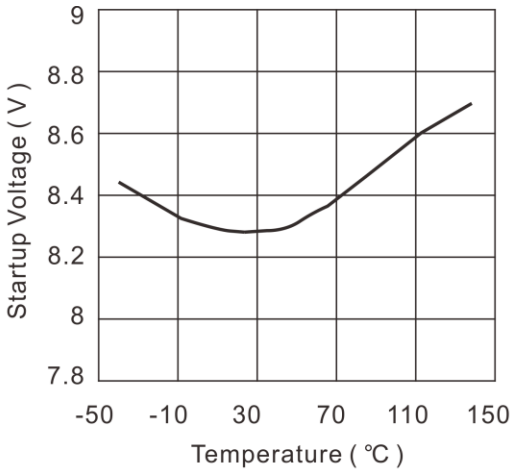
The over temperature protection circuitry in the RS3822 monitors the die junction temperature after start up. When the temperature rises to 150℃, the power MOSFET will be shut down immediately and maintains at switch off condition until the temperature on die falls 30℃ below the thermal protection trigger point.

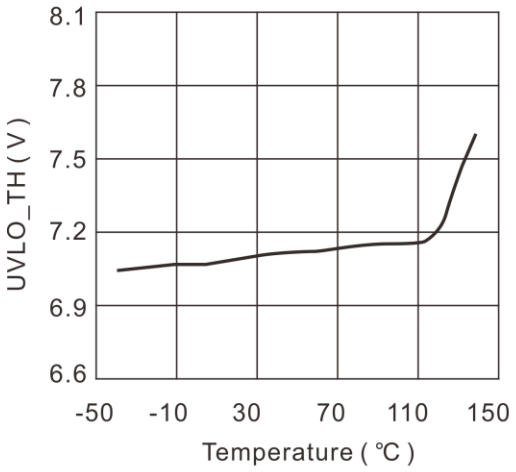
PCB LAYOUT

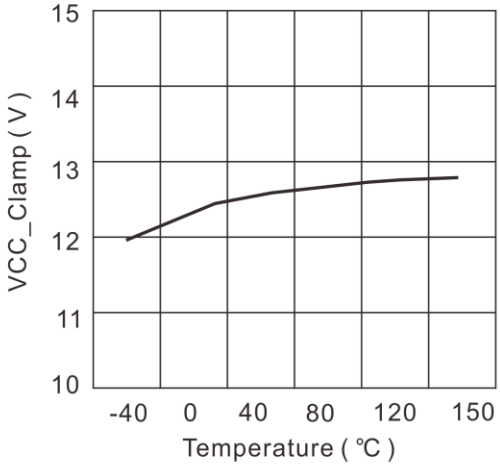
The following guidelines should be followed in RS3822 PCB layout:
Bypass Capacitor The bypass capacitor on V_{CC} pin should be as close as possible to the VCC and GND pins. Ground PathThe power ground path for current sense should be short, and the power ground path should be separated from small signal ground path before the negative node of the bus capacitor.
The Area of Power Loop
The area of main current loop should be as small as possible to reduce EMI radiation. And the controller should be placed away from the heat generator, such as the power diode.

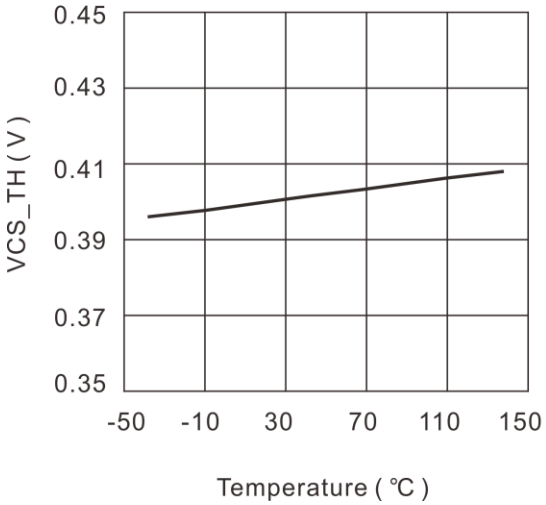
CHARACTERISTICS CURVE

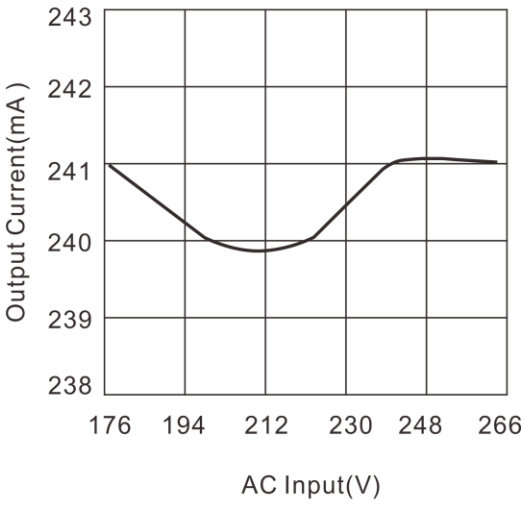


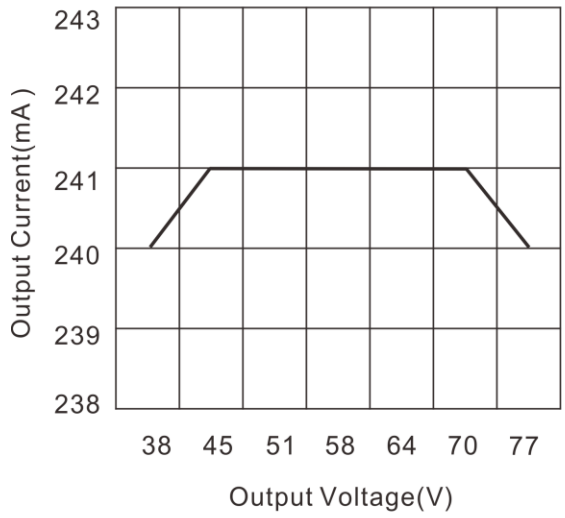


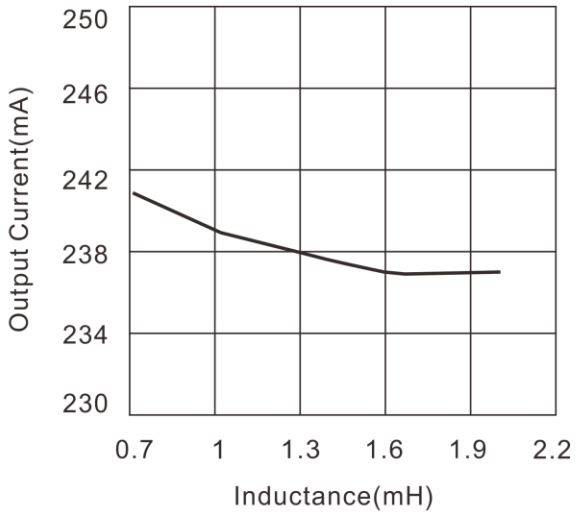


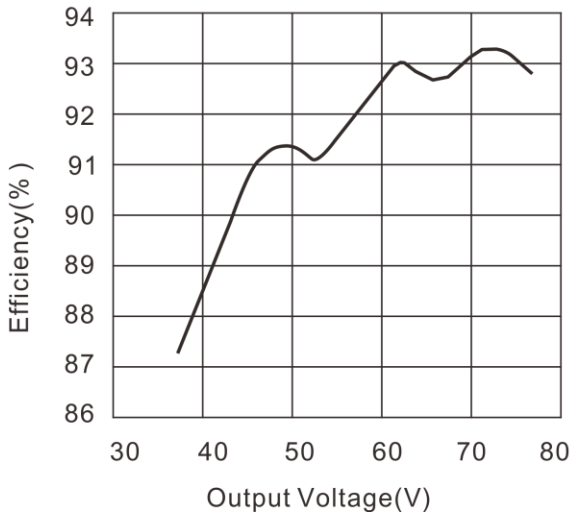












ABSOLUTE MAXIMUM RATINGS (Note1)

Parameter	Symbol	Range	Units
Internal HV MOSFET drain voltage	V_{DRAIN}	-0.3~600	V
VCC pin maximum sink current	I_{CC_MAX}	5	mA
Line compensation pin input voltage	LN	-0.3~18	V
Internal HV MOSFET source voltage	V_{SOURCE}	-0.3~18	V
Current sense pin input voltage	CS	-0.3~6	V
Power dissipation (note 2)	P_{DMAX}	0.5	W
Thermal resistance (Junction to Ambient)	θ_{JA}	150	℃/W
Operating junction temperature	T_J	-40 to 150	℃
Storage temperature range	T_{STG}	-40 to 150	℃
ESD (note3)		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.
2. The maximum power dissipation decrease if temperature rise, it is decided by T_{JMAX}, θ_{JA}, and environment temperature (T_A). The maximum power dissipation is the lower one between $P_{DMAX} = (T_{JMAX} - T_A)/ \theta_{JA}$ and the number listed in the maximum table.
3. Human Body mode, 100pF capacitor discharge on 1.5KΩ resistor

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC}=12V and T_A =25 ℃)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Supply Voltage Section						
V_{CC} Clamping Voltage	V_{CC_CLAMP}			12.5		V
V_{CC} Clamping Current	I_{DD_CLAMP}				5	mA
Vcc Start Up Voltage	V_{CC_ST}	V_{CC} Rise	7.2	8	8.8	V
Vcc Under VoltageLatch Out Hysteresis	V_{UVLO_HYS}	V_{CC} Falling		1		V
Start Up Current	I_{ST}	V_{CC}=V_{CC_ST} - 0.5V		70	150	μA
Operation Current	I_{OP}			200		μA
Current Sense Section						
Current Sense Voltage Threshold	V_{CS_TH}		390	400	410	mV
Leading Edge Blanking Time	T_{LEB}			350		ns
Turn Off Delay Time	T_{DELAY}			300		ns
Line Compensation Section						
Line CompensationRate	$\Delta V_{CS}/\Delta(V_{LN}-V_{CC})$			-40		mV/V
Over Temperature Section						
Thermal Shut DownTemperature	T_{SD}			150		℃
Thermal Shut Down Hysteresis	T_{SD_HYS}			30		℃
Internal HV MOSFET						
R_{DS_ON}	R_{DS_ON}	V_{CC}=12V		10		Ω
V_{DS}	V_{DS}		600			V
Internal Driver Section						
Minimum Demagnetization Time	T_{OFF_MIN}			4		μs
Maximum Demagnetization Time	T_{OFF_MAX}			130		μs
Maximum Turn OnTime	T_{ON_MAX}			45		μs

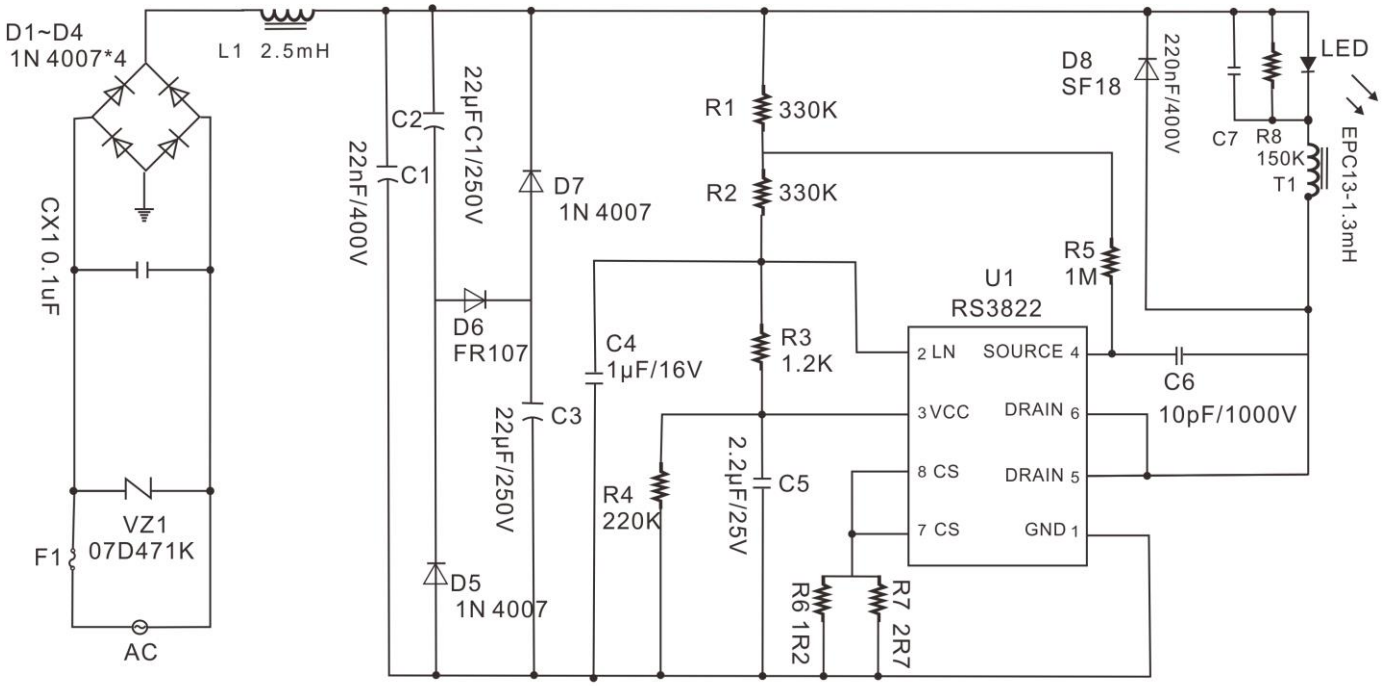
Note
1: production testing of the chip is performed at 25°C.
2: the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis.

RECOMMENDED OPERATION CONDITIONS

Parameter	Symbol	Range	Units
Output LED Current	I_{LED}	<135	mA

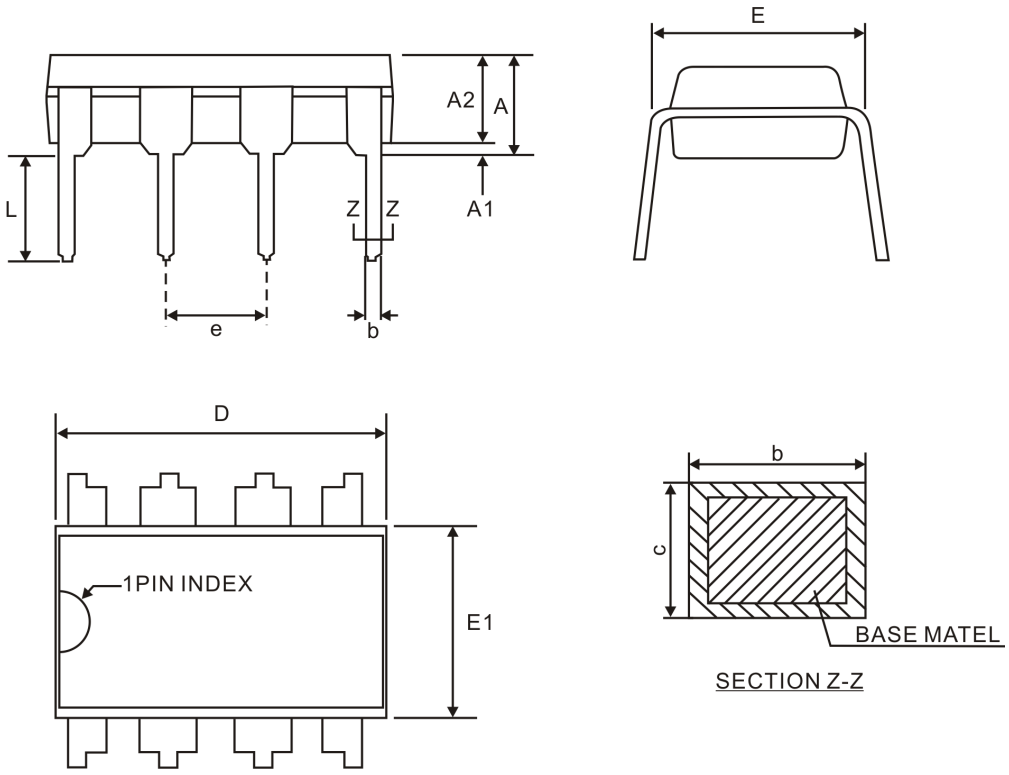
APPLICATION EXAMPLE

1. Specification
   - Input voltage：85VAC ~ 264VAC
   - Output LED voltage：20V ~ 56V
   - Output LED current：100mA
2. Schematic



PACKAGE INFORMATION

8-PIN, DIP, 300 MIL



Symbol	Dimensions (mm)		
	Min.	Nom.	Max.
A	-	-	4.80
A1	0.50	-	-
A2	3.10	3.30	3.50
b	0.38	-	0.55
c	0.21	-	0.35
e		2.54 BSC	
D	9.10	9.20	9.30
E	7.62	7.87	8.25
E1	6.25	6.35	6.45
L	2.92	3.30	3.81

Note:
1. Refer to JEDEC MS-001 BA
2. All dimensions are in millimeter.

IMPORTANT NOTICE

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