# JW19989A/JW19989B JW19989C/JW19989E

**Non-isolated Buck LED Driver Regulator**

## DESCRIPTION

JW19989A/JW19989B/JW19989C/JW19989E(JW19989X series) is a non-isolated constant current LED regulator with high current accuracy which applies to single stage step-down LED drivers. Operating in the boundary mode makes it high efficiency and low radiation. Patented algorithms ensure good current accuracy and excellent line/load regulations.

JW19989X series is supplied from the line directly without auxiliary winding or external capacitor, which can lower the system BOM cost.

With unique sampling techniques, JW19989X series has multi-protection functions which can largely enhance the safety and reliability of the system, including LED short protection, LED open protection and over-temperature protection.



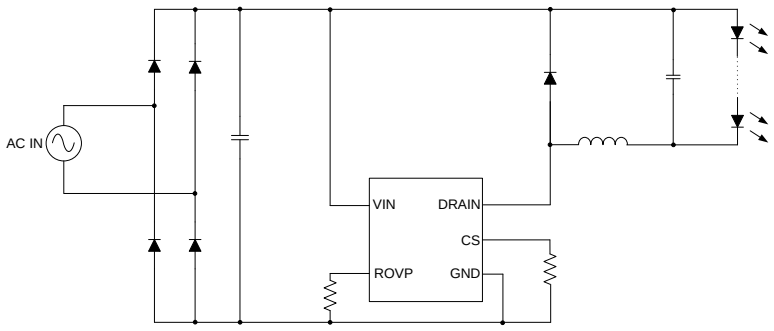
## FEATURES

- 500V MOSFET Integrated
- Excellent Line/load Regulation
- Boundary Mode Operation
- EN Function
- High Efficiency
- LED Short Protection
- LED Open Protection
- ESOP6 Package

## APPLICATIONS

- LED Driver

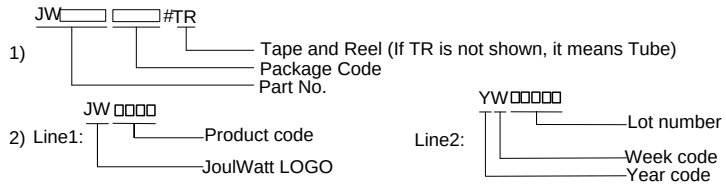
## TYPICAL APPLICATION



## ORDER INFORMATION

| DEVICE[1)] | PACKAGE | TOP MARKING[2)] | ENVIRONMENTAL[3)] |
|---|---|---|---|
| JW19989AESOPC#TR | ESOP6 | J19989A<br>YW□□□□□ | Green |
| JW19989BESOPC#TR | ESOP6 | J19989B<br>YW□□□□□ | Green |
| JW19989CESOPC#TR | ESOP6 | J19989C<br>YW□□□□□ | Green |
| JW19989EESOPC#TR | ESOP6 | J19989E<br>YW□□□□□ | Green |

Note：



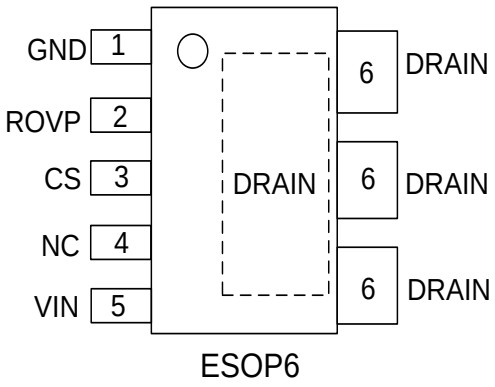

3) All JoulWatt products are packaged with Pb-free and Halogen-free materials and compliant to RoHS standards.

## DEVICE INFORMATION

| DEVICE | MOS BV | MOS RDSON |
|---|---|---|
| JW19989AESOPC#TR | 500V | 8Ω |
| JW19989BESOPC#TR | 500V | 4.4Ω |
| JW19989CESOPC#TR | 500V | 2.9Ω |
| JW19989EESOPC#TR | 500V | 1.8Ω |

## PIN CONFIGURATION

**TOP VIEW**




ESOP6

## ABSOLUTE MAXIMUM RATING[1)]

VIN Voltage ..... 700V
CS Voltage.....-0.3V to 8V
ROVP Voltage..... -0.3V to 8V
DRAIN Voltage .....500V
Junction Temperature[2)3)].....-40ºC to + 150ºC
Storage Temperature .....-40ºC to +150ºC

## RECOMMENDED OPERATING CONDITIONS

VIN Voltage .....400V
Operating Junction Temperature .....-25ºC to 125ºC

## RECOMMENDED OUTPUT VOLTAGE

JW19989X series.....>10V

**Note：**

**1)** Exceeding these ratings may damage the device. These stress ratings do not imply function operation of the device at any other conditions beyond those indicated under RECOMMENDED OPERATING CONDITIONS.

**2)** The JW19989X series includes thermal protection that is intended to protect the device in overload conditions. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

**3)** The device is not guaranteed to function outside of its operating conditions.

## ELECTRICAL CHARACTERISTICS

| *$T_A$=25℃, unless otherwise stated* | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Item** | | **Symbol** | **Condition** | **Min.** | **Typ.** | **Max.** | **Units** |
| Threshold of VIN Power On[4)] | | $V_{IN\_ON}$ | $V_{IN}$ rising | | 5 | 20 | V |
| VIN Quiescent Current | | $I_Q$ | $V_{IN}$~40V | | 200 | 220 | μA |
| Reference Voltage | | $V_{REF}$ | | 390 | 402 | 420 | mV |
| CS Minimum Voltage | | CSmin | | | 50 | | mV |
| Neon Switch VIN Sink Current | | $I_{NNSK}$ | | | 540 | | μA |
| MOS Max On Time | | $T_{ONMAX}$ | | 30 | 42 | 55 | μs |
| MOS Min On Time[4)] | | $T_{ONMIN}$ | | | 0.6 | 0.8 | μs |
| MOS Max Off Time_1 | | $T_{OFFMAX\_1}$ | | 280 | 400 | 528 | μs |
| MOS Max Off Time_2 | | $T_{OFFMAX\_2}$ | | 28 | 40 | 53 | μs |
| EN Low Voltage Threshold | | $V_{EN\_L}$ | | 0.16 | 0.2 | 0.24 | V |
| OVP Threshold[4)] | | $V_{O\_OVP1}$ | $R_{OVP}$=7.5K | 66 | 75 | 84 | V |
| | | $V_{O\_OVP2}$ | $R_{OVP}$=18K | 108 | 120 | 132 | V |
| | | $V_{O\_OVP3}$ | $R_{OVP}$ ~float | 216 | 240 | 264 | V |
| OVP Hic-cup Time[4)] | | $T_{OVP\_HC}$ | | | 400 | 440 | ms |
| Drain-Source Voltage | JW19989X series | $BV_{DSS}$ | Vg=0V Ids=250μA | 500 | | | V |
| MOS $R_{DSON}$ | JW19989A | $R_{DS\_ON}$ | Vg=15V Ids=0.5A | | 8 | 9 | ohm |
| | JW19989B | | | | 4.4 | 5.2 | |
| | JW19989C | | | | 2.9 | 3.5 | |
| | JW19989E | | | | 1.8 | 2.25 | |
| DS Leakage Current | JW19989X series | $I_{DSS}$ | Vg=0V Vds=500V | | 1 | 5 | μA |
| Thermal Protection Threshold[4)] | | $OTP_{CHIP}$ | | 140 | 150 | 160 | ℃ |

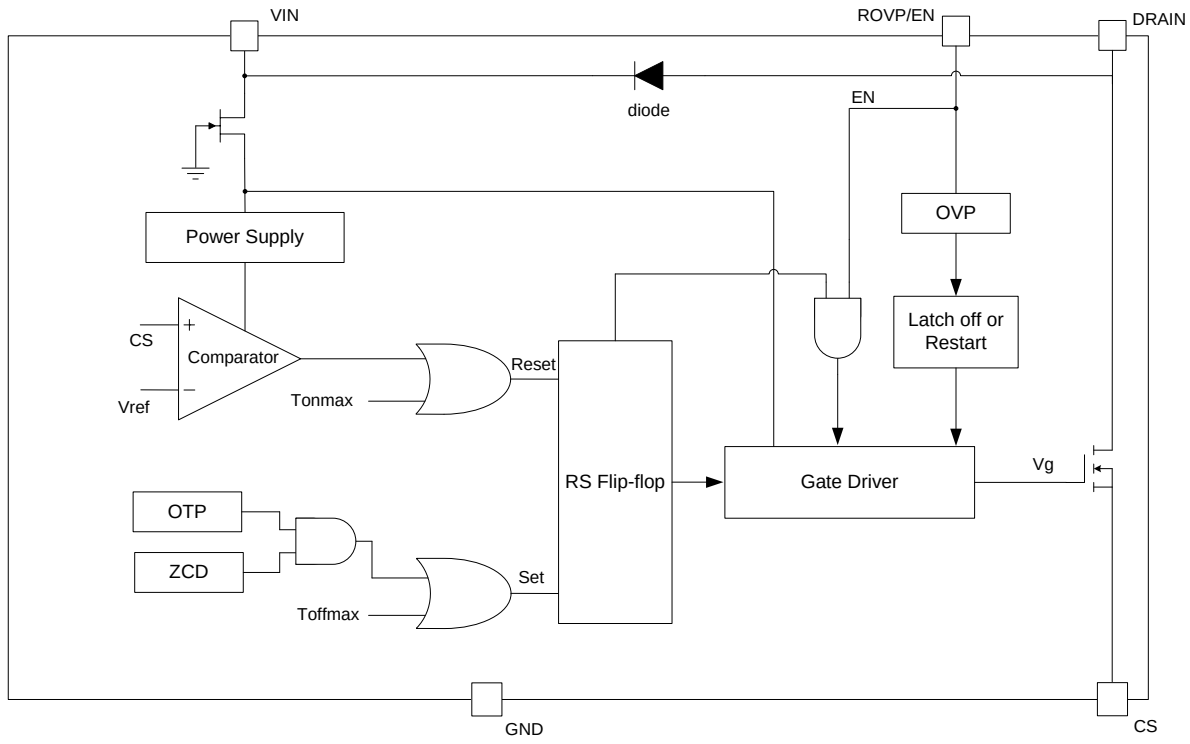
**Notes:**

**4)** Guaranteed by design.

## PIN DESCRIPTION

| Pin ESOP6 | Name | Description |
|---|---|---|
| 1 | GND | Chip ground |
| 2 | ROVP | LED OVP set pin |
| 3 | CS | Current sensing pin |
| 4 | NC | No connection |
| 5 | VIN | Power supply |
| 6,E-Pad | DRAIN | The drain of internal power MOSFET |

## BLOCK DIAGRAM



## FUNCTIONAL DESCRIPTION

The JW19989X series is a constant current LED regulator, which applies to non-isolation step-down LED system.JW19989X series can achieve excellent line and load regulations, high efficiency and low system cost with few peripheral components.

### Start Up

When the VIN exceeds $V_{IN\_ON}$, the gate driver will start to switch after a 10ms' delay.

### Constant Current Control

JW19989X series controls the output current from the information of the current sensing resistor. The output LED average current can be calculated as:

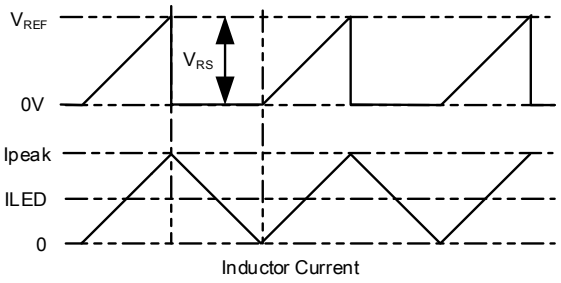
$$I_{LED} \approx V_{REF} / (2*R_{CS})$$

Where,

$V_{REF}$ is the reference voltage;

$R_{CS}$ – the sensing resistor connected between the pin CS and chip GND.

The inductor current and $V_{RS}$ waveforms are as follows:

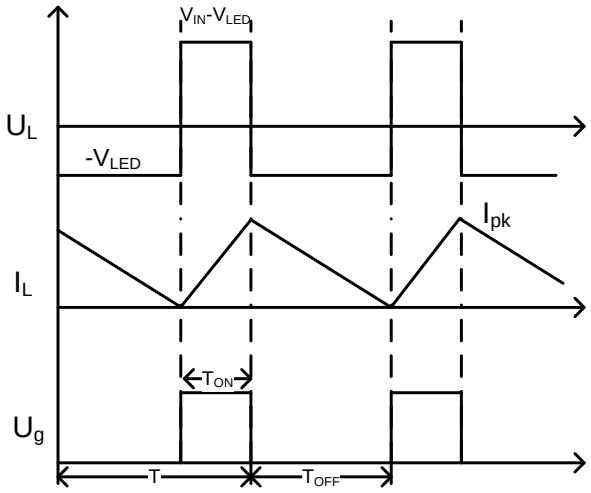



Where,

$V_{RS}$ – the voltage between pin CS and chip GND.

### Critical Conduction Mode Operation

JW19989X series works in the critical conduction mode of the inductor current. When the power MOSFET turns on, the inductor current increases from zero linearly. 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.

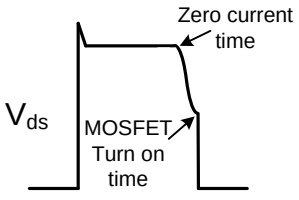
$V_{IN}$ – input voltage after rectification and filtering.

$V_{LED}$ – output voltage.

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

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

JW19989X series works in quasi-resonant mode. When the inductor current decreases to zero, resonance takes place between the power inductor, MOSFET output capacitors and stray capacitors. JW19989X series can detect the zero-current signals of the inductor, and turn on the MOSFET in the valley, which can reduce the power loss and the EMI radiation. If JW19989X series cannot get the zero current signals, the turn-off time will be $T_{OFFMAX\_1}$.



## Over Temperature Protection

When the junction temperature is higher than $OTP_{CHIP}$,JW19989X series works in DCM by increasing the turn-off time of the MOSFET to decrease the LED current and help the chip cooling.

## LED Open Protection

In the LED open condition, the output voltage increases and the duty of each cycle increases accordingly. When the VIN*D is larger than $V_{O\_OVP}$ (Setup by $R_{OVP}$), the power MOSFET is shut down and restarts after $T_{OVP\_HC}$ (400ms typical). The following table shows the $V_{O\_OVP}$ design guide:

| OVP Pin | $V_{O\_OVP}$(V) |
|---|---|
| $R_{OVP}$=7.5K | 75V |
| $R_{OVP}$=18K | 120V |
| $R_{OVP}$ ~Float | 240V |
| $R_{OVP}$~Short | Shut down |

## LED Short Protection

When the output is shorted,JW19989X series stops switching for $T_{OFFMAX\_1}$ until the next pulse.

## PCB Layout Guidelines

1. Make the area of the power loop as small as possible in order to reduce the EMI radiation.
2. JW19989X series should be kept away from noisy and heating components, such as power inductor and diode.

## APPLICATION REFERENCE

*Note: Information in the following reference design sections is not part of JoulWatt component specification. Customers are responsible for determining suitability of components chosen for their purposes and should validate their design implementation to make sure the proper system functionality.*

This reference design is suitable for 32W non-isolated step-down LED driver, using JW19989C, with high efficiency and excellent line regulation.

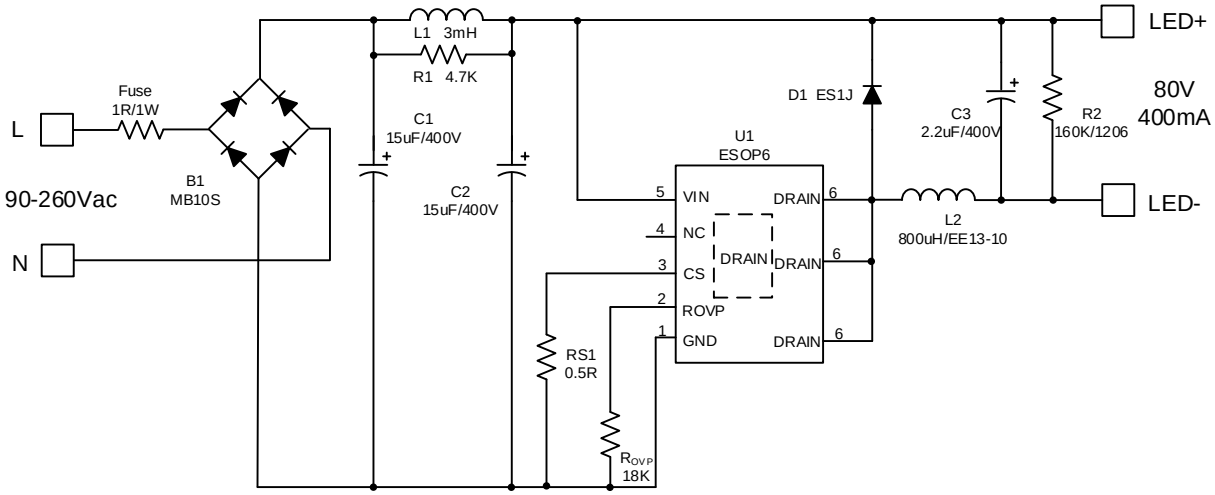
**Reference ：**

$V_{IN}$: 90VAC~260VAC

$V_{OUT}$: 80V

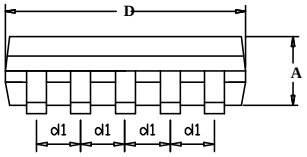
$I_{OUT}$: 400mA

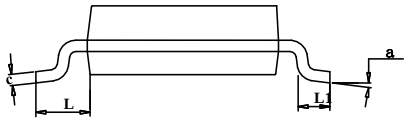
PF: >0.5

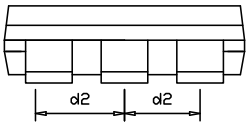


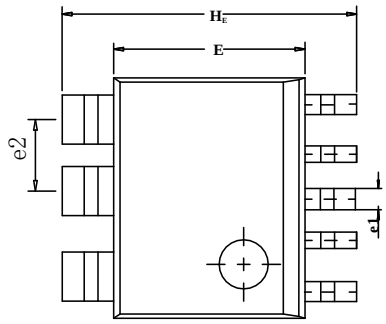
## PACKAGE OUTLINE

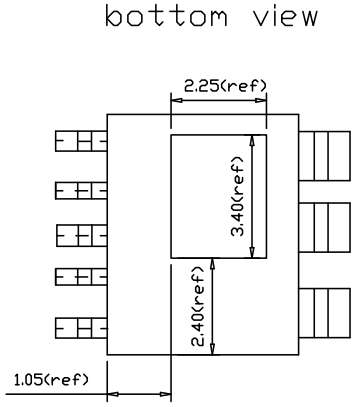
ESOP6 UNIT: mm




| Unit | | A | C | D | E | HE | d1 | d2 | e1 | e2 | L | L1 | a | ∠ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 1.25 | 0.22 | 6.4 | 4.1 | 6.1 | 1.35 | 2.05 | 0.45 | 1.65 | 1.15 | 0.80 | 0.2 (ref) | 12° |
| | typ | 1.15 | 0.20 | 6.2 | 3.9 | 6.0 | 1.30 | 2.00 | 0.40 | 1.60 | 1.05 | / | | |
| | min | 1.05 | 0.15 | 6.0 | 3.7 | 5.9 | 1.25 | 1.95 | 0.35 | 1.55 | 0.95 | 0.40 | | |
| mil | max | 49 | 9 | 252 | 161 | 240 | 53 | 81 | 18 | 65 | 45 | 31 | 8 (ref) | |
| | typ | 45 | 8 | 244 | 154 | 236 | 51 | 79 | 16 | 63 | 41 | / | | |
| | min | 41 | 6 | 236 | 146 | 232 | 49 | 77 | 14 | 61 | 37 | 16 | | |

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