# SMD802MS/SMD802MSC/SMD802BMSC Datasheet

## Buck Contoller For LED Applications : Built-in High-V Input Regulator Constant-off Time Frequency Mode With Analog or PWM Dimming

### Features

- Operate at DC voltage 8V~500V or AC voltage 90V~264V
- Input Voltage Regulator up to 500V
- Support driving current up to several Ampere.
- Programmable oscillation frequency setting by external resistor up to 300KHz.
- Supports Fixed frequency mode (Only used for Duty Cycle < 50%) and Constant-off time frequency mode (Especially for Duty Cycle > 50%)
- Supports Analog dimming (LD) and PWM dimming (PWM_D)
- Tolerance of CS pin voltage is ≦ ±4%
- 1%~100% PWM dimming
- Over Temperature Protection
- SOP-8 package

### Description

The SMD802 is a Buck Converter integrated with High Voltage Input Regulator up to 500V.

The SMD802 works in constant frequency mode or constant-off time frequency mode by external resistor connection.

The SMD802 is also suitable for DC in or Battery input with DC range from 8V~500V. Especially for the severe situation of the input voltage variation. SMD802 can work with high reliability under any high input voltage transient.

The SMD802 supports PWM dimming with duty ration from 1% to 100%. The multi-chip SMD802 design can be programmed by MCU for RGBW color harmonious illumination application.

### Applications

- Stage Illumination
- CAR Lighting
- DC power LED Lighting
- General Lighting

## Frequency Mode Circuit

**Constant Frequency Mode:**
The mode is used only for Duty Cycle ($V_{OUT}/V_{IN}$) < 50%. The buck circuit is easy to design as no feedback compensation is required, thus only few components is required.

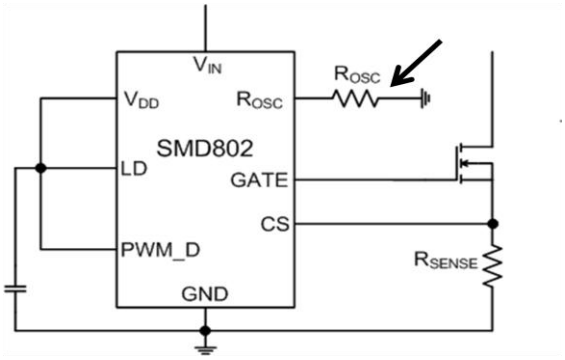



**Fig.1 Constant frequency mode**

**Constant-Off Time Frequency Mode :**
For Duty Cycle ($V_{OUT}/V_{IN}$) greater than 50%, the mode must be used, otherwise, the output current will be at a sub-harmonic of the switching frequency caused instability.

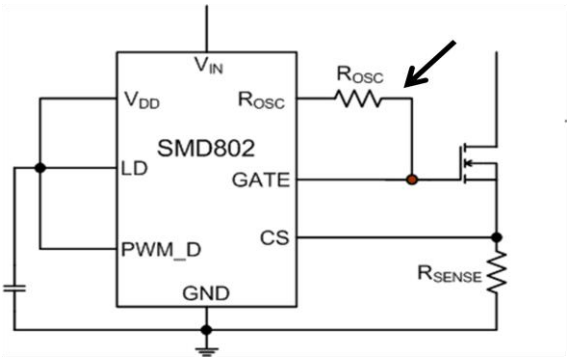
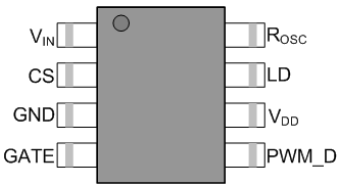



**Fig.2 Constant-off time frequency mode**

## Package Reference




SOP-8

## Top Marking


## Ordering Information

| Part Number | Package | Shipping | MOQ |
|---|---|---|---|
| SMD802MS<br>SMD802MSC<br>SMD802BMSC | SOP-8 | Tape & Reel | 2,500 |

## Pin Description

| Pin | Name | Function |
|---|---|---|
| 1 | $V_{IN}$ | Input Voltage, with 500V regulator built-in. |
| 2 | CS | Current Sense pin by an external sense resistor. When the voltage of this pin over the internal 250mV, the output is in OFF cycle. |
| 3 | GND | Ground. |
| 4 | GATE | Output to drive MOSFET. |
| 5 | PWM_D | PWM dimming input pin. When pulled to Ground or left OPEN (Internal 100KΩ pull-down to GND), there is no switching output. When pulled to High, the switching output operates normally. |
| 6 | $V_{DD}$ | Power supply for internal circuit. |
| 7 | LD | Linear dimming pin by change the current sense threshold voltage. |
| 8 | $R_{OSC}$ | Setting the operation frequency by an external resistor. To operate in contsnat frequency mode the resistor is connected between ROSC and Ground. To operate in constant-off frequency mode, the resistor is connected between ROSC and GATE. |

## Absolute Maximum Rating (Note 1)

| Item | Rating | Unit |
|---|---|---|
| $V_{IN}$ to GND | -0.5 to 500 | V |
| GATE to GND | -0.3 to (VDD+0.3) | V |
| LD, PWM_D to GND | -0.3 to (VDD-0.3) | V |
| CS pin voltage | -0.3 to (VDD+0.3) | V |
| VDD | Maximal 13.5 | V |
| Continuous Power Dissipation (TA = 25°C) (Note 1) | 630 | mW |
| Operational junction temperature ($T_J$) | -40 °C to OTP | °C |
| Storage temperature range ($T_{STG}$) | -65°C to 150°C | °C |

Note 1: Exceeding these ratings could cause damage to the device. All voltages are with respect to ground.

## Block Diagram :

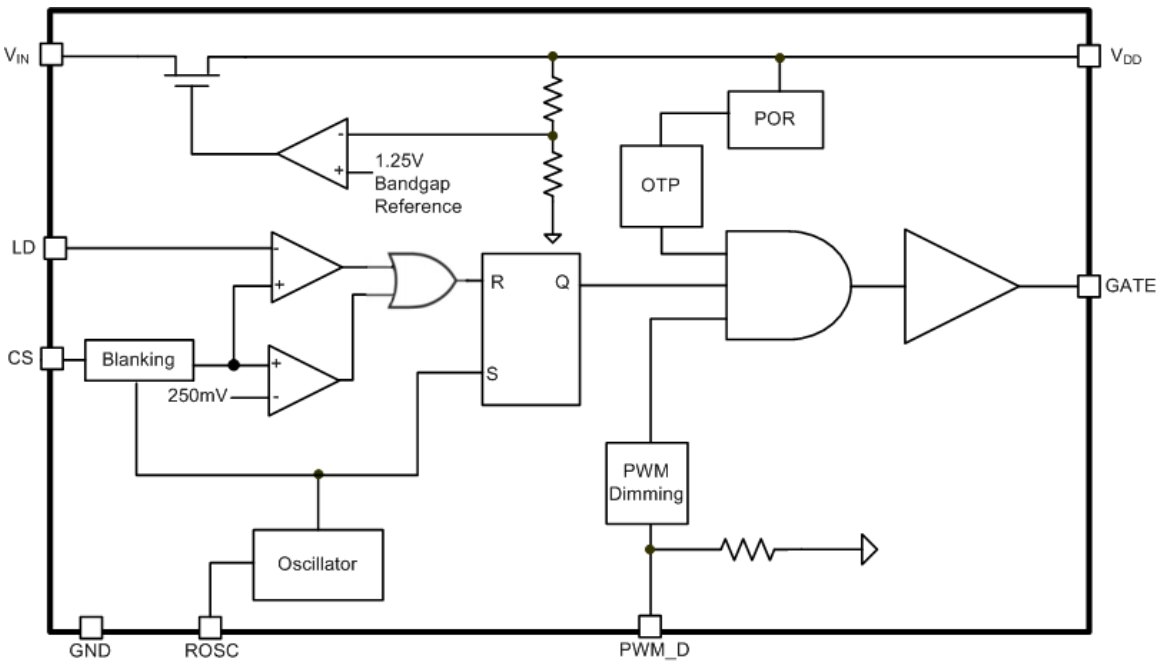



**Fig.3 Function Block Diagram**

**Electrical Characteristics** Unless otherwise specified, $T_A$=25°C~85°C, VDD=12$V_{DC}$

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Input supply voltage range | AC or DC input voltage | $V_{IN}$ | 8 | | 500 | V |
| Shut-Down mode supply current | Pin PWM_D to GND, $V_{IN}$ = 15V | $I_{INsd}$ | | 0.4 | 1 | mA |
| Internally regulated voltage | $V_{IN}$ = 15-500V, $I_{DD(ext)}$=0, pin Gate open | $V_{DD}$ | 7.0 | 7.5 | 8.0 | V |
| Internal supply VDD voltage | An external voltage applied to pin VDD | $V_{DDmax}$ | | | 13.5 | V |
| VDD under voltage lockout threshold | $V_{IN}$ rising | UVLO | 6.45 | 6.7 | 6.95 | V |
| VDD under voltage lockout hysteresis | $V_{IN}$ falling | ΔUVLO | | 520 | | mV |
| Pin PWM_D input low voltage | $V_{IN}$ = 15V | $V_{EN(lo)}$ | | | 1.0 | V |
| Pin PWM_D input high voltage | $V_{IN}$ = 15V | $V_{EN(hi)}$ | 2.4 | | | V |
| Pin PWM_D pull-down resistance | $V_{EN}$ = 5V | $R_{EN}$ | 50 | 100 | 150 | kΩ |
| Current sense pull-in threshold voltage | @TA = -40°C to +85°C | $V_{CS(hi)}$ | 240 | 250 | 260 | mV |
| GATE high output voltage | $I_{OUT}$ = 10mA | $V_{GATE(hi)}$ | $V_{DD}$ -0.3 | | $V_{DD}$ | V |
| GATE low output voltage | $I_{OUT}$ = -10mA | $V_{GATE(lo)}$ | 0 | | 0.3 | V |
| Oscillator frequency at fixed frequency mode | $R_{OSC}$ = 1.00MΩ | $f_{OSC}$ | 20 | 24 | 30 | kHz |
| | $R_{OSC}$ = 226kΩ | | 80 | 96 | 120 | |
| Maximum Oscillator PWM Duty Cycle | $F_{PWMhf}$ = 25kHz, at GATE, CS to GND. | $D_{MAXhf}$ | | | 100 | % |
| Current sense blanking interval | $V_{CS}$ = 0.55$V_{LD}$, $V_{LD}$ = $V_{DD}$ | $T_{BLANK}$ | 200 | 280 | 360 | ns |
| Delay from CS trip to GATE lo | $V_{IN}$=20V, $V_{LD}$ = 0.15, $V_{CS}$ = 0 to 0.22V after $T_{BLANK}$ | $t_{DELAY}$ | | | 300 | ns |
| GATE output rise time | $C_{GATE}$ = 500pF | $t_{RISE}$ | | 25 | 50 | ns |
| GATE output fall time | $C_{GATE}$ = 500pF | $t_{FALL}$ | | 20 | 50 | ns |
| Thermal shut down | | $T_{SD}$ | | 150 | | °C |

## Constant-off time frequency mode reference circuit

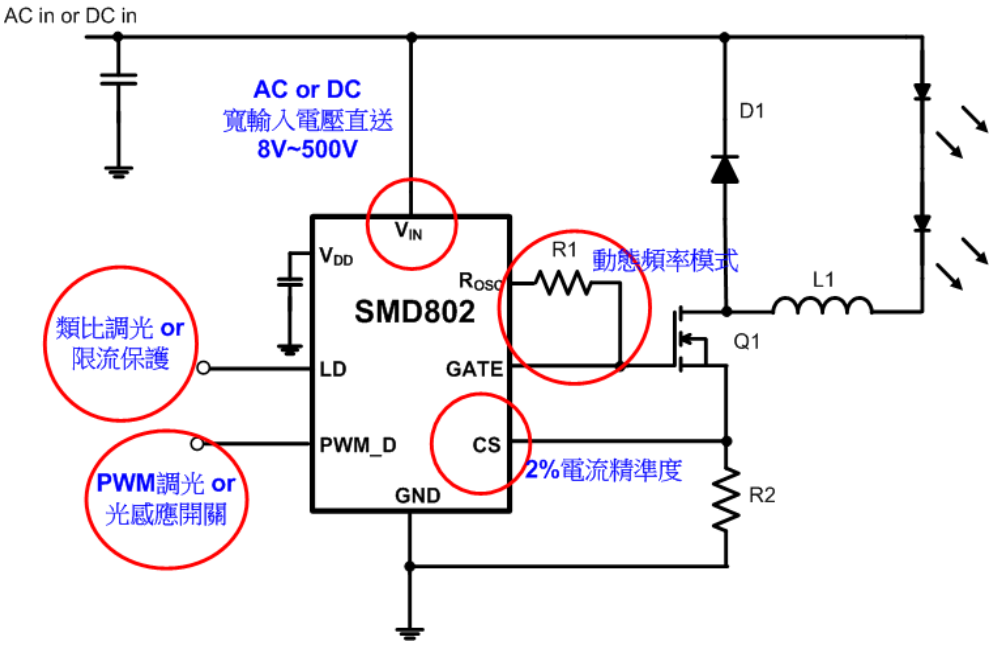



**Fig.4 SMD802 constant-off time constant current buck converter**

To design the constant-off time buck converter circuit, as shown in Fig.4, the following 4 parameters are calculated :

(1) Constant-off time $T_{OFF}$

(2) Resistor $R_{OSC}$ for maximal switching frequency

(3) Inductor $L_1$ for the peak-to-peak ripple current of output LED current

(4) Sense resistor $R_{CS}$ for LED peak current

**Defined the constant-off time and $R_{OSC}$**

For fixed frequency mode, the resistor $R_{OSC}$ is connected between ROSC pin and GND pin, the oscillator time period is given by :

$$T_{OSC}\,(us) = \frac{R_{OSC}\,(K\Omega) + 22}{25}$$ and the fixed frequency is $$F_{OSC}\,(KHz) = \frac{25}{R_{OSC}\,(K\Omega) + 22}$$

If the resistor is connected between $R_{OSC}$ pin and GATE pin, SMD802 operates in a constant-off time mode , the off-time is

$$T_{OFF}\,(us) = \frac{R_{OSC}\,(K\Omega)}{25}$$

and

$$F_{OSC} = \frac{1 - D}{T_{OFF}} = \frac{1 - \frac{V_{LED}}{V_{IN}}}{T_{OFF}}$$

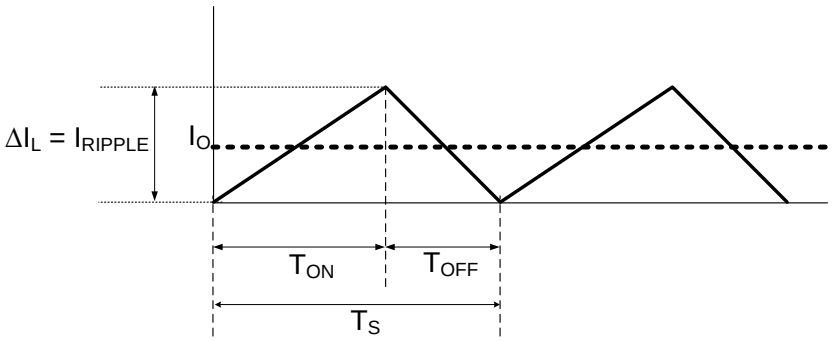
However, it is requested that the $F_{OCS}$ should be located in 25KHz~300KHz, by considering

(1) Audio band noise and

(2)SMD802 core circuit limitation.

**Define the inductor :**

To keep the circuit in continuous conduction mode (CCM), the maximum ripple current should be less than the twice the minimum load current.




Boundary between CCM and DCM

The minimum average inductor current to maintain in CCM is given by

$$I_O = \frac{\Delta I_L}{2} = \frac{I_{RIPPLE}}{2}$$

The minimum value of inductor to maintain in CCM can be determined by

$$\Delta V_L = L \times \frac{\Delta I_L}{\Delta t} = L \times \frac{I_{RIPPLE}}{T_{ON}} = L \times \frac{2 \times Io}{T_{ON}}$$

$$L = \frac{V_{out}\,(V_{in(max)} - V_{out})}{V_{in(max)} \times F_{OSC} \times I_{RIPPLE}}$$ Buck Mode

For constant-off time mode, the equation above can be modified as :

$$L = \frac{V_{LED} \times T_{OFF}}{0.3 \times I_{LED}}$$

where the ripple is 30% of LED current.

**Define the peak current sense resistor**

The LED peak current is derived from the current sense resistor $R_{CS}$,
can be set by using :

$$R_{CS} = \frac{0.25}{I_{PEAK}} \quad \text{where} \quad I_{PEAK} = I_{LED} + (1/2)\, I_{RIPPLE}$$

**Frequency variation vs Duty in constant-off time mode**

Since $T = T_{ON} + T_{OFF}$ ,

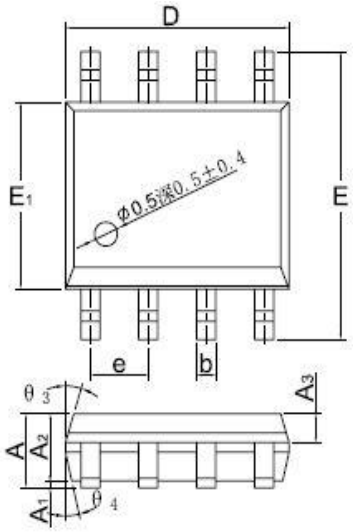
$$F_{OSC} = \frac{1 - D}{T_{OFF}}$$

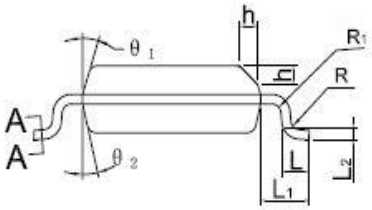
$T_{OFF}$ is constant, and for a large Duty cycle switching (normally for output voltage close to input voltage or higher current up to 2A output), the frequency $F_{OSC}$ will slow down because cycle-on duration is larger and cycle-off duration is constant, so that in the overall switching cycle the buck circuit operation is always stable.

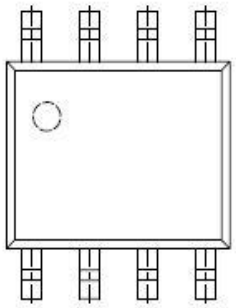
## Package Dimensions (in inches)

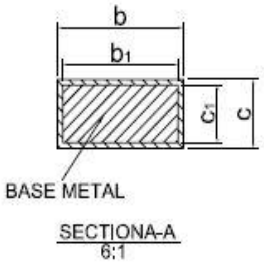
DIMENSIONS IN MILLIMETERS

| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | 1,35 | 1,55 | 1,75 |
| $A_1$ | 0,10 | —— | 0,25 |
| $A_2$ | 1,25 | 1,40 | 1,65 |
| $A_3$ | 0,50 | 0,60 | 0,70 |
| b | 0,39 | —— | 0,49 |
| $b_1$ | 0,28 | —— | 0,48 |
| c | 0,10 | —— | 0,25 |
| $c_1$ | 0,10 | —— | 0,23 |
| D | 4,80 | 4,90 | 5,00 |
| E | 5,80 | 6,00 | 6,20 |
| $E_1$ | 3,80 | 3,90 | 4,00 |
| e | 1,27BSC | | |
| L | 0,45 | —— | 1,00 |
| $L_1$ | 1,04REF | | |
| $L_2$ | 0.25BSC | | |
| R | 0,07 | —— | —— |
| $R_1$ | 0,07 | —— | —— |
| h | 0,3 | 0,4 | 0,5 |
| | 0° | —— | 8° |
| $\theta$ | 11° | 17° | 19° |
| $\theta_1$ | 11° | 13° | 15° |
| $\theta_2$ | 15° | 17° | 19° |
| $\theta_3$ | 11° | 13° | 15° |






SECTIONA-A
6:1

NOTES:

1. DIMENSIONS IN MILLIMETERS ( ANGLES IN DEGREES ).
2. ALL DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
3. ALL DIMENSIONS MEET JEDEC STANDRAD MS-012F