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~450V or AC voltage 90V~264V
- Input Voltage Regulator up to 450V
- 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 450V.

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~450V. 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.

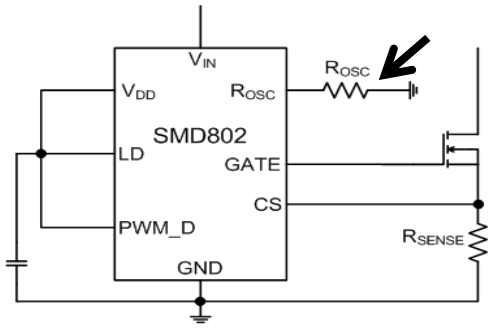


Fig.1 Constant frequency mode

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.

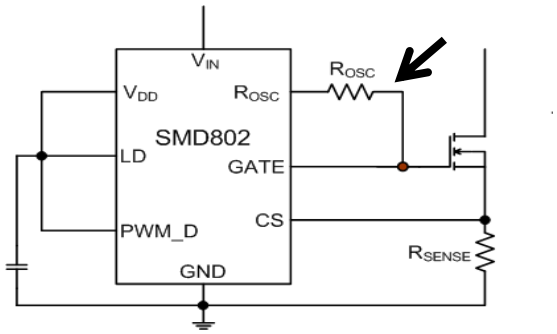
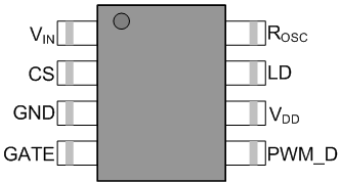


Fig.2 Constant-off time frequency mode

Package Reference



SOP-8

Top Marking

Ordering Information

Part Number	Package	Shipping	MOQ
SMD802BMSC	SOP-8	Tape & Reel	2,500

Pin Description

Pin	Name	Function
1	V_{IN}	Input Voltage, with 450V 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 450	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 +150°C	°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 :

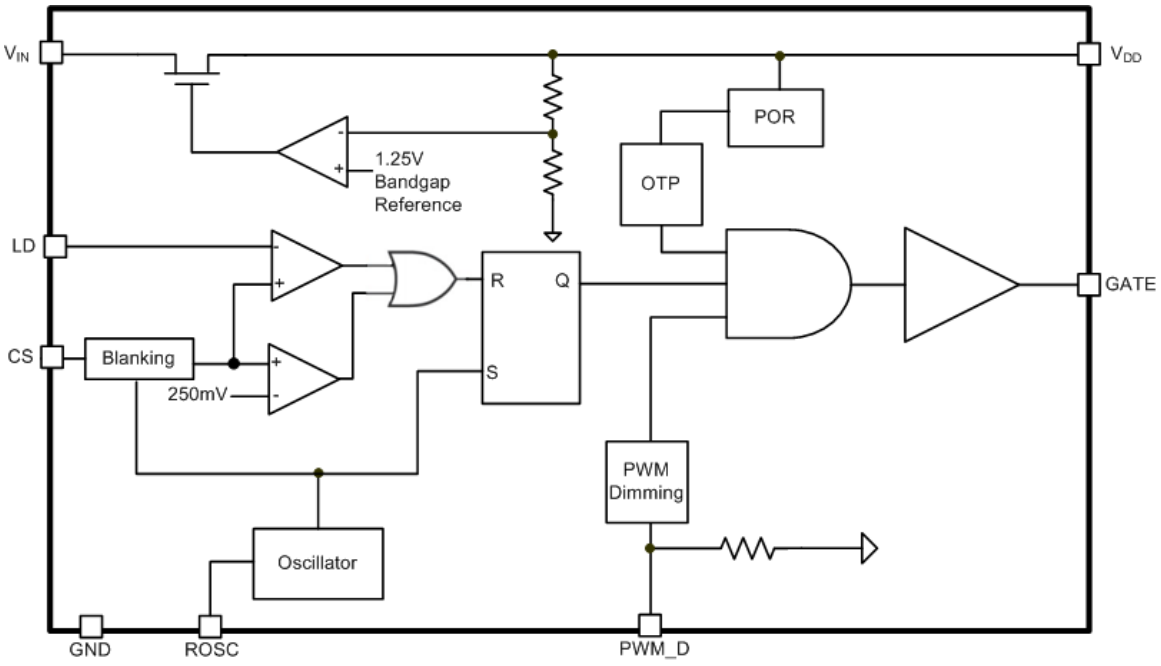


Fig.3 Function Block Diagram

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

Parameter	Test Conditions	Symbol	Min	Typ	Max	Units
Input supply voltage range	AC or DC input voltage	V_{IN}	8		450	V
Shut-Down mode supply current	Pin PWM_D to GND, V_{IN} = 15V	I_{INsd}		0.4	1	mA
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} = 0.55V_{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

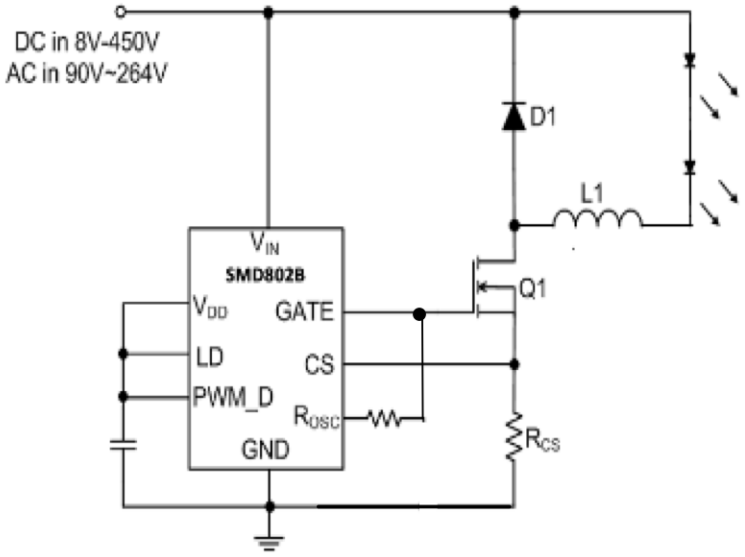


Fig.4 SMD802 constant-off time constant current buck converter

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 :

$$T_{OSC}\,(us) = \frac{R_{OSC}\,(K\Omega) + 22}{25}$$

If the resistor is connected between R_{OSC} pin and GATE pin, SMD802 operates in a constant-off time mode , and the above equation determines the constant-off time T_{OFF}.

For the operation frequency of the constant-off time mode,

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

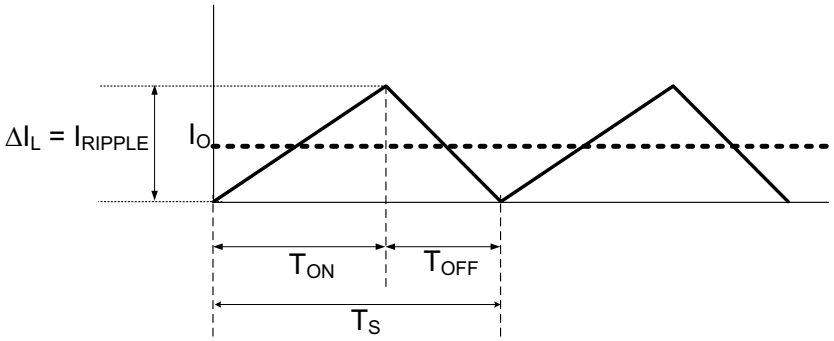
It is requested that the F_{OCS} should be located in 25KHz~300KHz, by considering

(1) The minimal operation frequency should be designed to be higher than the Audio band noise (20KHz in usual).

(2)The maximal operation frequency should be considered no larger than SMD802 core circuit design limitation (that is 300KHz).

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

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

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

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

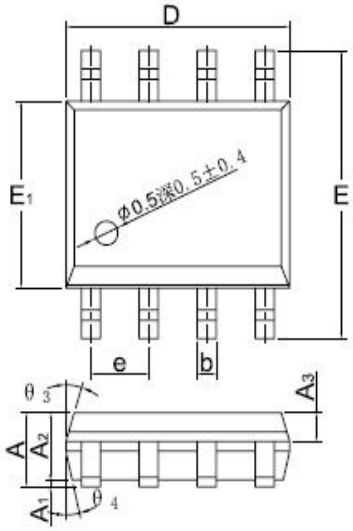
$$F_{OSC} = \frac{1 - D}{T_{OFF}}$$

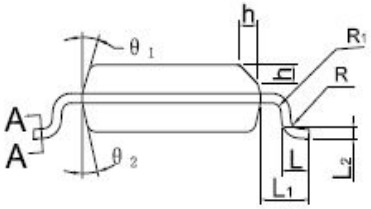
for a large Duty cycle operation (D > 50%), the frequency F_{OSC} will be automatically slow down because T_{ON} duration will be self-adjusted to perform the stable switching operation. That is, lower switching frequency for a larger Duty cycle, and higher switching frequency for a lower Duty cycle. The constant-off time mode operation of SMD802 supports Duty cycle up to 90%.

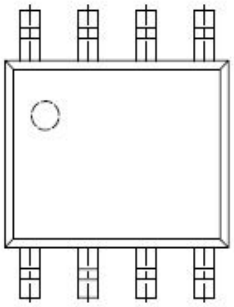
Package Dimensions (in inches)

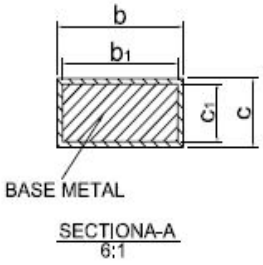
DIMENSIONS IN MILLIMETERS

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°
θ_1	11°	17°	19°
θ_2	11°	13°	15°
θ_3	15°	17°	19°
θ_4	11°	13°	15°









SECTIONA-A
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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