DESCRIPTION

SM2601B is a flyback LED constant current driver chips a precision double-winding primary feedback. Chip in discontinuous inductor current mode is particularly suitable for 85VAC ~ 265VAC full voltage input range of low-power isolated LED lighting systems.

SM2601B uses source-driven approach and proprietary dual-winding transformer control technology to feedback LED output current LED constant current output can be achieved without the use of an auxiliary winding of the transformer. Meanwhile SM2601B low operating current without auxiliary winding to supply power to the chip.

SM2601B work in the primary side feedback mode, the primary side feedback information which can achieve high-precision LED constant current output, does not need an opto-coupler, secondary feedback circuitry and any compensation circuitry. Additionally, SM2601B internal integration of 650V power tube, so that only a few external components, to achieve high-precision LED constant current output, significantly simplifies the design of LED lighting systems.

SM2601B wide operating voltage range for 85VAC ~ 265VAC full voltage range of the AC input. Meanwhile SM2601B integrates several protection features to ensure stable and reliable system. Including VCC supply voltage protection, LED open-circuit protection, LED short-circuit protection and over temperature protection.

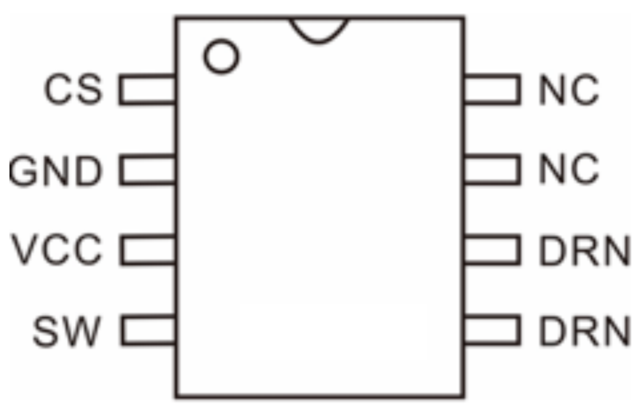
FEATURES

- Integrated 650V power MOSFET
- PSR mode, no secondary feedback circuit
- Dual transformer winding control technology
- Low operating current without auxiliary power winding
- Wide input voltage range
- ± 5% LED current accuracy
- VCC power clamp
- LED open-circuit protection
- LED short-circuit protection
- Chip supply voltage protection
- Over temperature protection
- Auto-restart function
- System is small, low cost BOM
- Use SOP8L package

APPLICATION

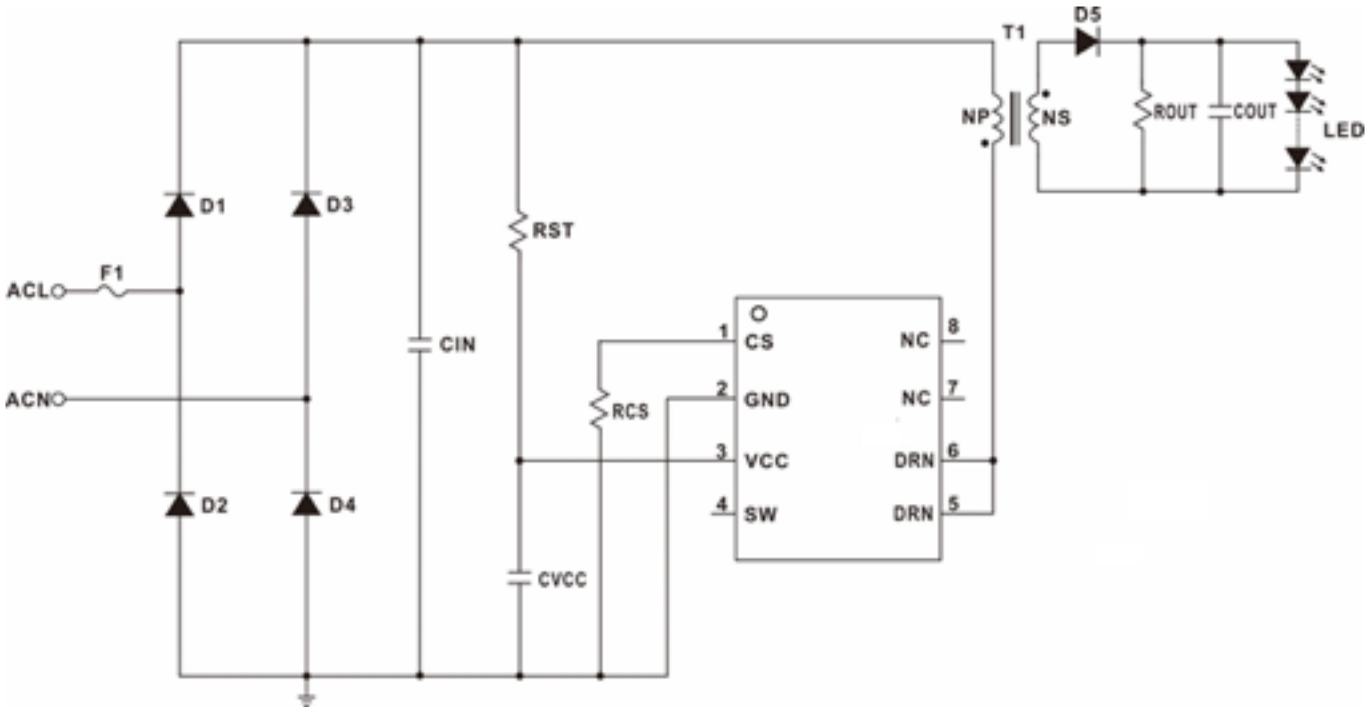
- GU10 LED Spotlight
- E17 / E27 LED candle light
- LED Bulb
- Other LED Lighting

PIN OUT



SOP8L

TYPICAL APPLICATION CIRCUIT



PIN DESCRIPTION

Pin #	Name	Description
1	CS	Transformer primary winding peak current detection terminal connected to ground resistance
2	GND	Ground
3	VCC	Power supply
4	SW	High voltage power source inside MOSFET
5, 6	DRN	Internal high-voltage power MOSFET drain
7, 8	NC	Not connected

RECOMMENDED PARAMETERS (NOTE 1)

Parameter	Value	Unit
VCC, SW Voltage to GND	-0.3~+20	V
DRN Voltage to GND	-0.3~+650	V
CS Voltage to GND	-0.3~+6	V
VCC supply current	5	mA
Power Loss	0.6	W
Storage Temperature	-50~+150	°C
Operating junction Temperature	-40~150	°C
ESD (HBM)	2000	V
ESD (MM)	200	V

RECOMMEND OPERATING RANGE

Parameter	Symbol	Operating Condition	Value	Unit
Output Power	P_{OUT}	Input Voltage 85VAC~265VAC	5	W
Switching Frequency	F_{OSC}	Normal working	50~60	kHz

Note 1:
Absolute Maximum Ratings indicate limits beyond which the chip could be damaged. Recommended operating range is the range within the chip is working properly, but do not guarantee specific performance indicators. Electrical parameters of the device are defined in the operating range and ensure that DC and AC electrical specifications under particular performance test conditions. For the upper and lower limits are not given parameters, the specification does not guarantee its accuracy, but its typical good indication of device performance.

ELECTRICAL PARAMETERS

(Normal Operation，Ta=25°C，VCC=18V)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
Power Up						
V_{ST}	Start up voltage for VCC	V_{VCC} rise		17		V
V_{UV}	Under voltage lockout for VCC	V_{VCC} fall		9.5		V
V_{CLP}	Clamping voltage for VCC	I_{VCC}=1mA		19		V
I_{ST}	Startup current for VCC	V_{VCC}= V_{ST} -1V		45		μA
I_{OP}	Operating current for VCC	F_{OSC}=60kHz		110		μA
Current Control						
V_{REF}	Transformer primary winding peak current detection threshold		485	500	515	mV
T_{LEB}	Current detecting leading edge blanking time			500		ns
T_{DELAY}	Switch off delay			200		ns
Timing Control						
T_{DIS_MIN}	Minimum demagnetization time			5		μs
T_{DIS_MAX}	Maximum demagnetization time			240		μs
D_{MAX}	Maximum duty cycle			42		%
MOSFET						
R_{ON}	Drain source resistance	V_{GS}=18V/ I_{DS}=0.5A		17		Ω
B_{VDSS}	Breakdown voltage	V_{GS}=0V/ I_{DS}=250μA	650			V
I_{LEAK}	Leakage current	V_{GS}=0V/ V_{DS}=650V			1	μA
Over Temperature protection						
T_{SD}	Over temperature protection			150		°C
T_{HYS}	Over temperature protection hysteresis			125		°C

BLOCK DIAGRAM

APPLICATION NOTES

SM2601B is a flyback LED constant current driver chips a precision double-winding primary feedback. Chip in discontinuous inductor current mode is especially suitable for 85VAC ~ 265VAC full voltage input range of low-power isolated LED lighting systems. SM2601B uses source-driven approach and proprietary dual-winding transformer control without auxiliary transformer winding detection can be achieved LED constant current output. Additionally, SM2601B internal integration of 650V power tube, so that only a few external components to complete the design of LED lighting systems, saving the cost and size of the system.

Boot Process

After the system bus voltage capacitor charging through the startup resistor to VCC, VCC when the voltage reaches the turn-on threshold of the chip, SM2601B internal control circuit to work. When the chip needed in operating current is very low, so no auxiliary winding supply. When the VCC voltage rises to chip clamp voltage, VCC will be clamped. When the VCC voltage drops to chip off voltage, SM2601B under-voltage lockout.

Output current setting

When the power transistor starts conducting current transformer primary winding ramp up from scratch, while the CS pin voltage is also ramp up. When CS pin voltage reaches the transformer primary winding peak current detection threshold voltage, the power transistor is turned off. Peak current transformer primary winding is as follows:

$$I_{P\_PK} = \frac{V_{REF}}{R_{CS}} = \frac{500}{R_{CS}}(mA)$$

Wherein, VREF for the transformer primary winding peak current detection threshold; RCS for the transformer primary winding peak current sense resistor value.

In the power transistor turned off, the energy stored in the transformer is transferred from the primary winding to the secondary winding, the secondary winding and at this time the peak primary current have the following relationship:

$$I_{S\_PK} = I_{P\_PK} \times \frac{N_P}{N_S}$$

Wherein, NP is the number of turns of the primary winding of the transformer; Ns is the transformer secondary winding turns.

During the power MOSFET turns off, the transformer secondary winding start demagnetization, when the secondary winding current at a constant slope begins to decrease. SM2601B constant current control system, so that the transformer secondary winding demagnetization time and idle time are equal. Therefore, LED average current output and a secondary winding peak current relationship as follows:

$$I_{LED} = \frac{1}{2} \times I_{S\_PK} \times \frac{T_{DIS}}{T_{DIS}+T_{FREE}} = \frac{1}{4} \times I_{S\_PK}$$

Among them, the demagnetization time TDIS transformer secondary winding; TFREE idle time transformer secondary winding.

Therefore, LED output average current can be expressed as:

$$I_{LED} = \frac{1}{4} \times \frac{500mV}{R_{CS}} \times \frac{N_P}{N_S}$$

From the above equation, LED average current output by the transformer turns ratio, CS resistors and chip reference voltage of 500mV decision on the inductance of the transformer is not sensitive.

Transformer Primary Inductance

SM2601B in discontinuous inductor current mode, the chip internal control transformer secondary winding demagnetization time equal to the idle time. SM2601B operating frequency can be represented by the formula:

$$f_s = \frac{1}{T_{DIS}+T_{FREE}} = \frac{1}{2 \times T_{DIS}}$$

Demagnetization time transformer secondary winding can be represented by the following formula:

$$T_{DIS} = \frac{LS \times I_{S\_PK}}{V_{LED}}$$

Wherein, L is the inductance of the transformer secondary winding; VLED output LED voltage.
First transformer inductance and secondary winding turns ratio has the following relationship:

$$\frac{LP}{LS} = \frac{N_P^2}{N_S^2}$$

Wherein, L is the inductance of the transformer primary winding.
Therefore, SM2601B operating frequency can be represented by the formula:

$$f_s = \frac{NP^2 \times V_{LED}}{8 \times NS^2 \times LP \times I_{LED}}$$

It can be seen from the above formula, when the transformer OK, the system operating frequency increases with the output LED voltage rises.

SM2601B system limits the minimum and maximum time demagnetization de-magnetization time. If the chip's operating frequency is set too low, the transformer secondary winding demagnetization time is too large, which would make the output of the LED open-circuit protection voltage is too high; if the chip operating frequency is set too high, the demagnetization of the transformer secondary winding time is too small, which makes output LED open-circuit protection voltage is too low to affect the normal work. Therefore, we should choose the right transformer primary winding inductance and the primary winding turns ratio, making the system work in the appropriate frequency range, and can be both system efficiency and EMI. In normal operation, the maximum operating frequency of the system is recommended set to 50kHz ~ 60kHz.

In addition, SM2601B also limits the maximum duty cycle of the system. During normal operation, the duty cycle of the system can be represented by the formula:

$$D = \frac{N_P \times V_{LED}}{2 \times N_S \times V_{DC}}$$

Wherein the input line voltage VDC rectified current. It can be seen from the above formula, the maximum duty cycle of the output voltage, the minimum input voltage, the system's biggest. So, the choice of the transformer primary winding turns ratio, the system should be such that the maximum duty cycle of the duty cycle is less than the system limit.

Protective Function

SM2601B integrates several protection features to ensure stable and reliable system. They include open LED protection, LED short circuit protection, over temperature protection and chip supply under-voltage protection.

When LED short circuit, the secondary winding of the transformer demagnetization time the system will be greater than the maximum demagnetization time, so the system works in 4KHz low frequency and low power consumption. When the LED is open, the system will still charges the output capacitor, the output voltage will gradually rise, the secondary winding of the transformer demagnetization time will gradually decrease. When the transformer secondary winding demagnetization time is less than the minimum system demagnetization time, it will trigger the protection logic chips and locked, the system immediately stop work and access to protected status.

Once the system enters the locked state, the system will go into auto-restart mode. The system has finished auto-restart, if the abnormal situation persists, the system will work in hiccup mode until the abnormalities removed.

SM2601B over-temperature protection function which can prevent damage to the chip temperature. When the chip's junction temperature reaches 150°C, the system will stop working immediately, and remains off until the junction temperature drops to 125°C.

PCB Layout

SM2601B during the PCB layout, it is recommended according to the following rules:

Ground

Current sense resistor power ground traces as short as possible, and the power ground wire to the ground as well as chips and other small signal ground separately. These eventually converge to the ground input bus capacitor ground.

Bypass capacitor

VCC bypass capacitor should be as close to the VCC pin and the GND pin.

Power loop area

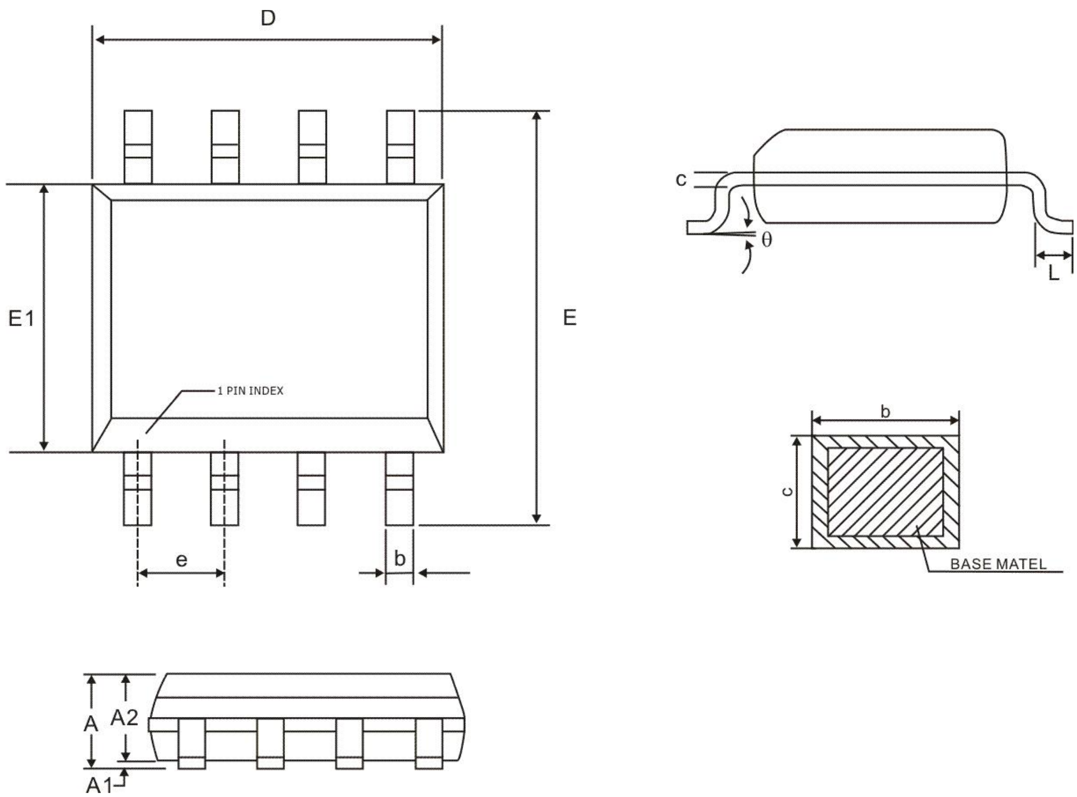
Power loop area should be as small as possible, such as a transformer primary winding, power management, CS resistors, capacitors input current loop area and a secondary winding, output diode and output capacitors current loop area. This will improve the EMI characteristics of the system.

Thermal Considerations

When PCB traces, we recommend increasing the DRN pin copper area, so the heat of the SM2601B would be beneficial.

PACKAGE DIMENSIONS

SOP8L



Symbol	Millimetre		
	Min	**Typ**	**Max**
A	1.35	1.60	1.77
A1	0.08	0.15	0.28
A2	1.20	1.40	1.65
b	0.33	-	0.51
c	0.17	-	0.26
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC.		
L	0.38	0.60	1.27
θ	0°	-	8°

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