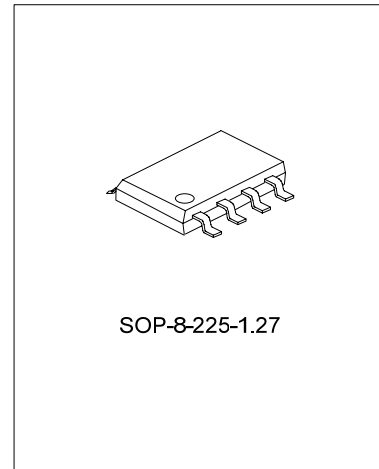


## 1A High Power LED Driver with 6~36V Input

### DESCRIPTION

The SD42524 is a step-down PWM control LED driver with a built-in power MOSFET. It achieves 1A continuous output current in 6~36V input voltage range. It provides thermal shutdown circuit, current limit circuit and PWM dimming circuit.

The SD42524 adopts current mode control which provides fast transient response and simple loop stabilization design. It has high efficiency up to more than 96%, and has excellent constant current characteristic when the input/output voltage changed, with the excellent current accuracy within  $\pm 1\%$



### FEATURES

- \* 6-36V input voltage range
- \* Maximum 1A output current
- \*  $0.40\Omega$  built-in power MOSFET
- \* Integrate Jitter function
- \* Thermal compensation
- \* PWM dimming function
- \* 280kHz fixed frequency
- \* Excellent constant current accuracy  $\pm 1\%$
- \* High efficiency up to 96%
- \* Thermal shutdown
- \* Cycle-by-cycle over current protection

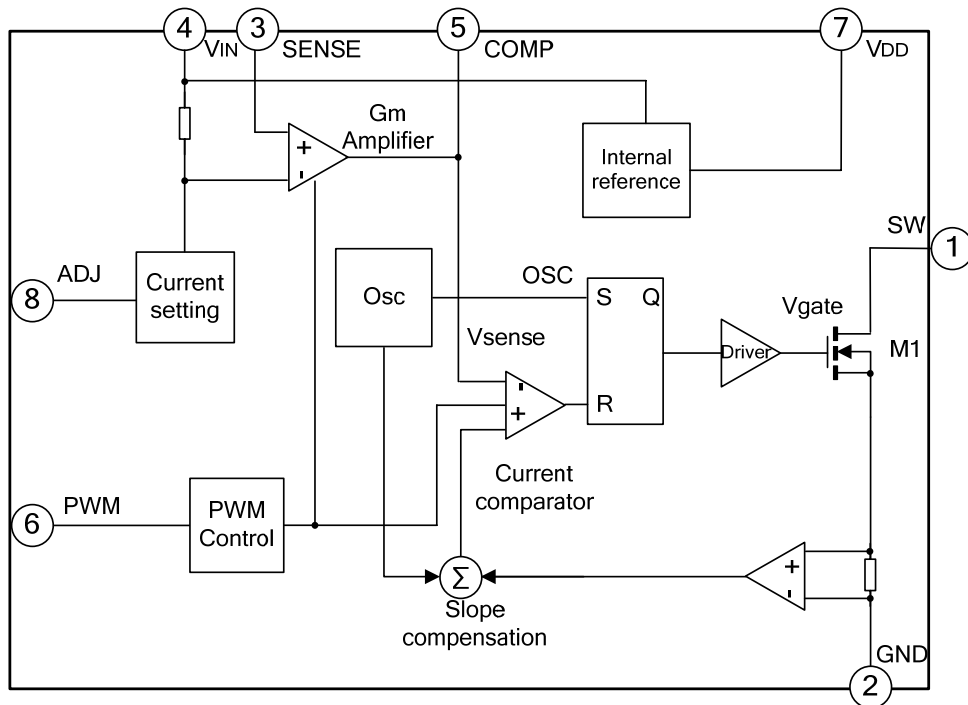
### APPLICATIONS

- \* MR16 LED spotlight
- \* LED illuminance
- \* LED street lamp

### ORDERING INFORMATION

Part No.	Package	Marking
SD42524	SOP-8-225-1.27	SD42524

**BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATING**

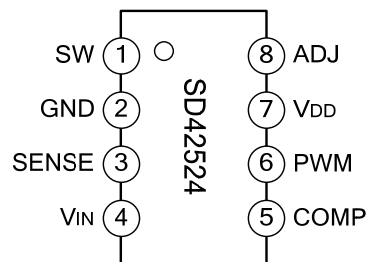
Characteristics	Symbol	Ratings	Unit
Supply Voltage	V <sub>IN</sub>	40	V
Switch Voltage	V <sub>SW</sub>	-1~V <sub>IN</sub> +1	V
PWM Voltage	V <sub>PWM</sub>	-0.3~6	V
Comp Voltage	V <sub>COMP</sub>	-0.3~6	V
SENSE voltage	V <sub>SENSE</sub>	-0.3~V <sub>IN</sub>	V
Junction Temperature	T <sub>j</sub>	150	°C
Lead Temperature	T <sub>L</sub>	260	°C
Storage Temperature	T <sub>STG</sub>	-65~150	°C
Input Voltage	V <sub>IN</sub>	6~40	V
Operating Temperature	T <sub>OPR</sub>	-40~125	°C

**ELECTRICAL CHARACTERISTICS** (Unless otherwise specified, V<sub>IN</sub>=12V, I<sub>OUT</sub>=700mA, T<sub>amb</sub>=25°C)

Characteristics	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V <sub>IN</sub>		6		36	V
Operating Current	I <sub>IN</sub>	V <sub>CC</sub> =6/40V, V <sub>PWM</sub> =5V		1.5	2.0	mA
Upper Switch Leakage	I <sub>L</sub>	V <sub>SW</sub> =36V		0	5	μA
Current Limit	I <sub>LIM</sub>	V <sub>IN</sub> =SENSE=12V	1.6	1.9	2.2	A
Maximum Duty Cycle	D <sub>max</sub>	3LED, V <sub>IN</sub> =9V	--	93	95	%

Characteristics	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Oscillator Frequency	fosc		250	280	320	kHz
PWM Dimming on Voltage	VPWMON	VPWM is from 0V to 5V, On voltage	2.2	2.4	2.6	V
PWM Dimming Off Voltage	VPWMOFF	VPWM is from 5V to 0V, Off voltage	2.0	2	2.1	V
PWM pull-down current	IPWM1	VPWM=0V		0		μA
PWM pull-up current	IPWM2	VPWM=5V		25		μA
COMP Clamp Voltage	VCOMP	Open without load	1.6	1.9	2.2	V
Switch Transistor on Resistance	RON	1LED, IOUT=1A	--	0.40	0.6	Ω
VDD voltage	VDD	No load	5.0	5.2	5.4	V
ADJ threshold voltage	VADJ	VADJ is from 5V to 0V, when output current decreases	1.20	1.22	1.25	V
Sampling Voltage Threshold	VIN-VSENSE	Drop voltage between VIN and SENSE	--	88	--	mV

## PIN CONFIGURATION



## PIN DESCRIPTION

Pin No.	Pin Name	I/O	Description
1	SW	I	Power output.
2	GND	O	Ground.
3	SENSE	I	Current sense pin.
4	VIN	O	Input supply voltage.
5	COMP	I/O	Compensation pin, connects to external capacitor.
6	PWM	I	PWM dimming pin, connects PWM signal to change the output current.
7	VDD	I	5V reference output.
8	ADJ	I	Thermal compensation pin/linear dimming pin.

## FUNCTION DESCRIPTION

The SD42524 is a current mode LED driver. The voltage on compensation pin COMP is proportional to the current delivered to the load.

At the beginning of a cycle: the upper transistor M1 is off; the COMP pin voltage is higher than the current sense

amplifier output; and the current comparator's output is low. The rising edge of the 280KHz CLK signal sets the RS Flip-Flop whose output turns on M1 thus VIN, Rs, LED, inductor and M1 comprises a circuit loop and the inductor current increases. The inductor current is sensed and amplified by the current sense amplifier. Ramp compensation is summed to current sense amplifier output and compared to the Gm amplifier output by the current comparator. When the current sense amplifier plus ramp compensation signal exceeds the comp pin voltage, the RS Flip-Flop is reset and the chip reverts to its initial M1 off state. The inductor energy storage released via the circuit loop composed by Rs, LED, inductor and M1 and the current decreases. When next clock cycle arrives, the upper transistor M1 is on to enter next switch cycle. If the current sense amplifier plus slope compensation signal does not exceed the comp voltage in one cycle, then the falling edge of the CLK resets the Flip-Flop.

The Gm amplifier compares the output current with the threshold current (threshold current is set by internal). When the output current is higher than threshold current, the COMP pin's voltage is lower down. Since the COMP pin's voltage is proportional to the peak inductor current a decrease in its voltage decreases current delivered to the output. When the output current is lower than threshold current, the COMP pin's voltage is up while the output current increases. The output current is stable at the set value by adjusting the circuit loop.

### 1. PWM dimming function

SD42524 has internal PWM dimming function. When PWM voltage is connects to high level, the chip is working normally; when PWM voltage is open or connects to low level, COMP pin disconnects with the chip, the charge of the capacitor is in hold state, voltage level holds, and the output of current comparator is high, transistor is off without output current. When PWM signal is high, COMP pin is connected with the chip to improve the startup speed of the chip. Adjust the output current by control the duty of external PWM signal.

The minimum setup time of SD42524 PWM dimming is less than 20μS, and the maximum PWM dimming ratio is up to 500:1. When high dimming ratio is needed, the dimming frequency is recommended 500Hz below; or else the dimming frequency can be up to 2 KHz. When PWM pin is low, output is shutdown. In normal station, LED pin holds above 2V, and if the LED or other components have electric leakage which makes the LED pin is low and caused change on PWM dimming, the output capacitor is recommend to be increased, then the LED level will not be too low when shutdown to maintain the normal PWM dimming.

### 2. Output current setting

The output current is determined by the sampling resistor and setting voltage. The sampling voltage of VIN-VSENSE(Drop voltage on Rs) is 88mV, and adjust the output current by adjusting the sampling resistor Rs (refer to Typical Application Circuit).

$$I_{OUT} = \frac{V_{IN} - V_{SENSE}}{R_S}$$

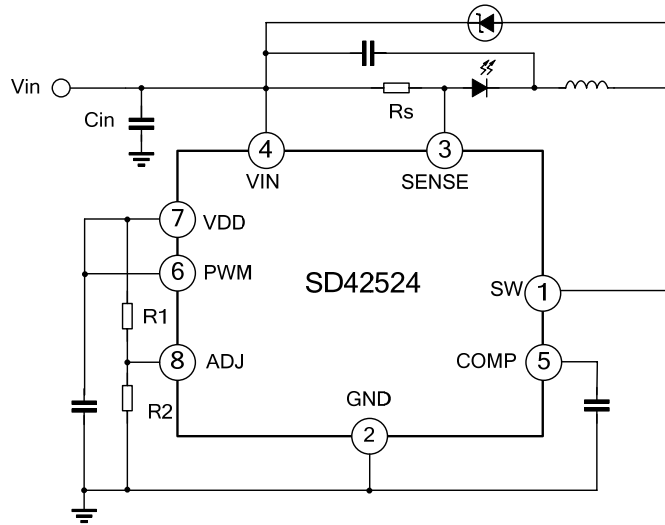
### 3. Current limiting

SD42524 has internal current limiting function, and the voltage on COMP is clamped at about 1.9V, the output current of the power MOSFET is limited at about 1.9A by current comparator.

### 4. Frequency jitter

SD42524 has internal frequency jitter function to improve the EMI performance of the system. The internal frequency is hopping in a very small range to reduce the single frequency radiation which simplifies the EMI design.

5. Thermal compensation and linear dimming function



SD42524 has linear dimming and thermal compensation functions.

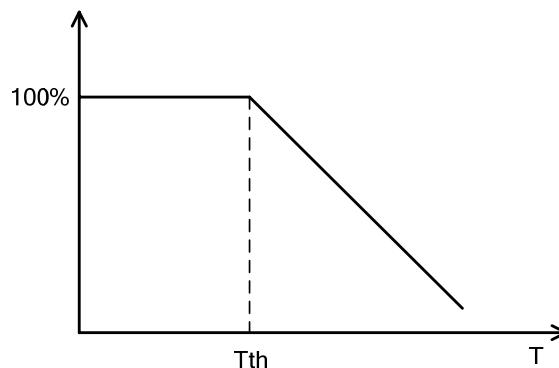
Linear dimming function: Set the output current by adjust the ratio of R1 and R2. The relation between voltage on pin ADJ and output current Iout is shown below:

$$V_{ADJ} \geq 1.22V, I_{out} = \frac{0.088}{R_s}$$

$$0.1V < V_{ADJ} < 1.22V, I_{out} = \frac{0.088}{R_s} \times \frac{V_{ADJ}}{1.22}$$

Thermal compensation function: the application circuit is shown above, use NTC resistor to take place of R2 for thermal compensation. In normal temperature, the voltage on R2 is higher than 1.22V, and 100% current is delivered to output; when LED temperature detected by R2 is higher than the setting value Tth, the voltage on R2 is lower than 1.22V, and output current will decrease following the rising temperature. Connect NTC R2 with other resistor in series to get different LED falling curves under different current.

If thermal compensation and linear dimming are not used, connect ADJ to VDD.



The relation between LED output current and temperature

## COMPONENTS SELECTION

### 1. Input Capacitor Selection

The input capacitor provides the pulse current when the power MOSFET is on, and charge the capacitor when the power MOSFET is off, thus to keep the stability of the input voltage. The input capacitor is recommended to be more than 10 $\mu$ F, which can reduce the peak current drawn from input source and the switch noise. The input capacitor should be near to the input pin in real routing.

### 2. Output Capacitance Selection

Parallel connecting a capacitor between the two ends of LED can reduce the output voltage ripple accordingly reduce the ripple current of LED, while this capacitor will not effect the operating frequency and efficiency, but the start time will be longer by reducing the rising speed of the voltage on LED. The larger the output capacitor is, the smaller the current ripple on LED is. It is recommend use the capacitor of 2.2 $\mu$ F or larger.

### 3. Inductance Selection

The inductance is used to keep the output current constant, the bigger the inductance is, the smaller the output current ripple is; while the bigger the physical size is, the bigger the series-wound resistor is. The selected effective current (RMS current rating)of inductance current should be bigger than the maximum output current, and the saturation current should be 30% bigger than maximum output current. In order to improve the efficiency, the series-wound resistor (DCR) of inductance should be smaller than 0.2 $\Omega$ .

The relation between inductance and ripple:

$$L = V_{OUT} * \frac{V_{IN} - V_{OUT}}{V_{IN} * f * \Delta I}$$

Where: L: Inductance value

F: Oscillator frequency

$\Delta I$  is ripple current

When select inductance, you should consider the combination of various factors to select suitable inductance.

### 4. Diode Selection

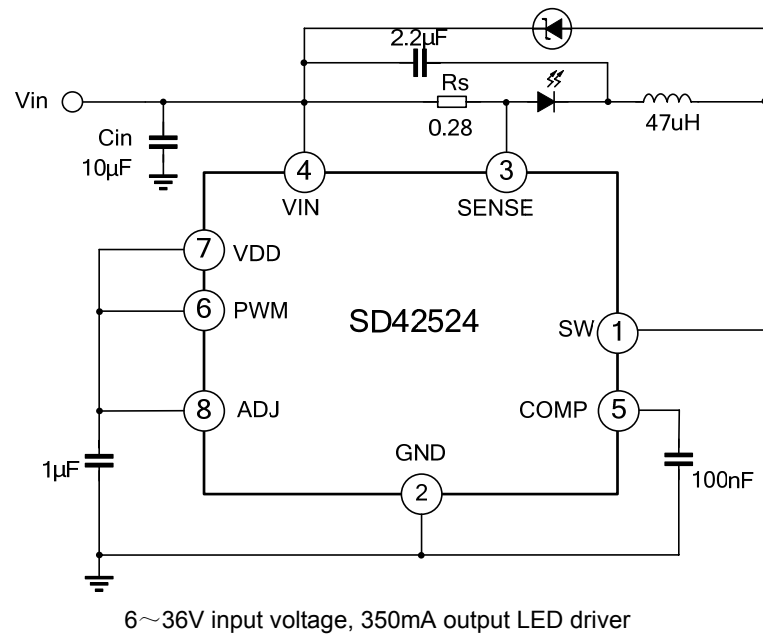
SD42524 is a non-synchronous step-down adjuster, so the diode should provide continuous current when the power MOSFET is off. Because the forward voltage of Schottky diode is small, and the reverse continuous current time is short, so it is usually used for continuous current. During the power MOSFET is conducting, the diode will withstand high voltage, so the reverse voltage of selected diode should be bigger than the input voltage. The average current through the diode is  $I_D$ :

$$I_D = (1-D) * I_{LED}$$

$I_{LED}$  is the current of LED

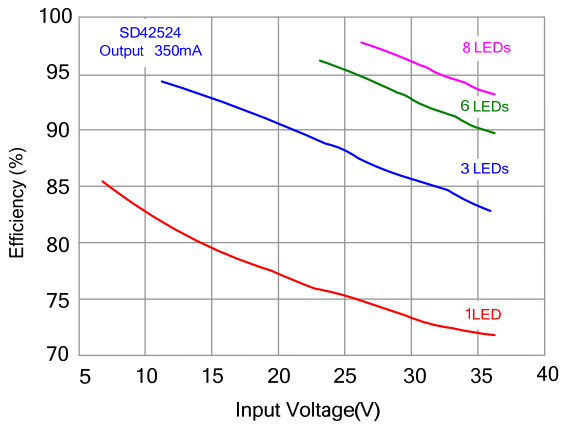
When the input voltage is high with a small duty,  $I_D$  increases, so the selected maximum continuous current diode should be bigger than the output current.

TYPICAL APPLICATION CIRCUIT

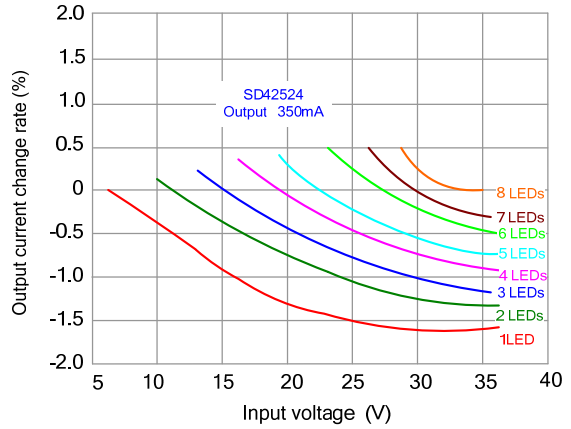


Note: The circuit and parameters are reference only, please set the parameters of the real application circuit based on the real test .

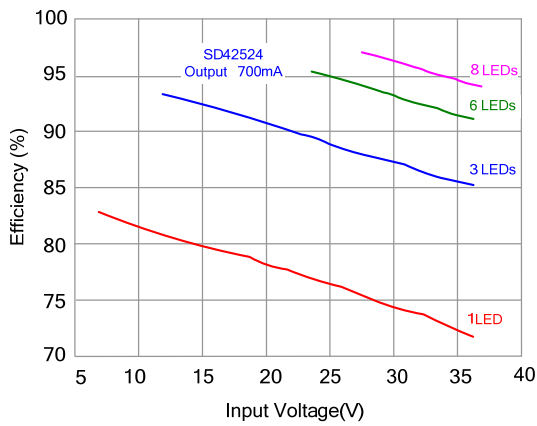
**ELECTRICAL CHARACTERISTICS CURVE**



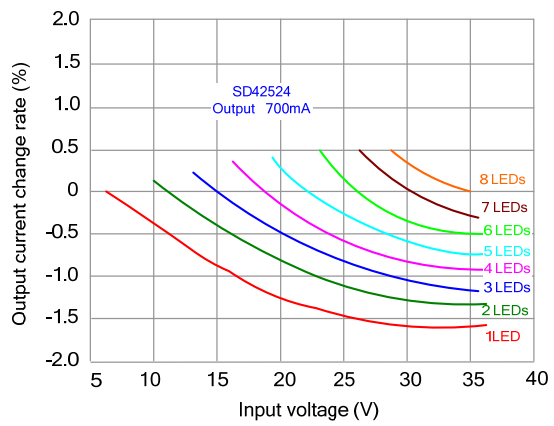
Output 350mA efficiency changed following the input voltage



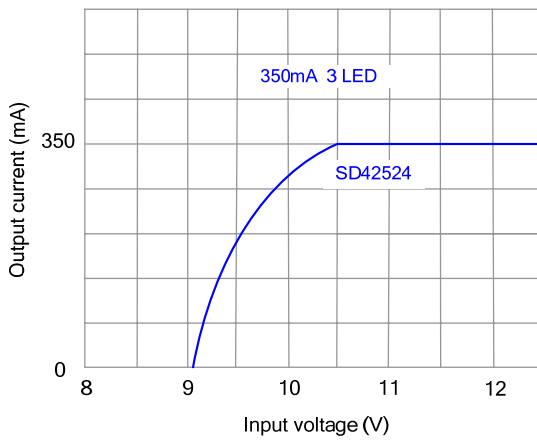
Output 350mA current change rate following the input voltage change



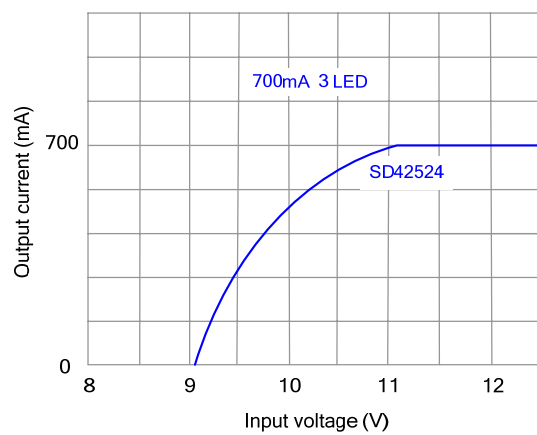
Output 700mA efficiency changed following the input voltage



Output 700mA current change rate following the input voltage



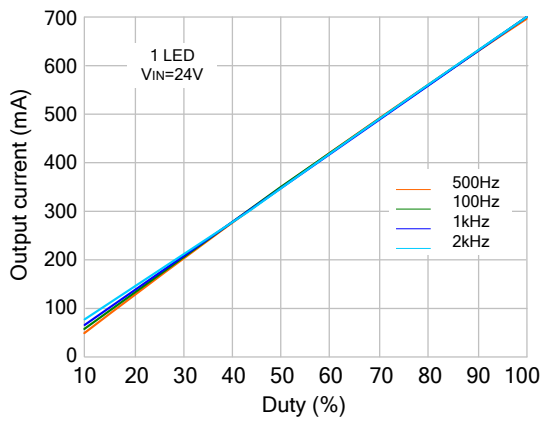
Output current change curve when input voltage is close to output voltage(350mA)



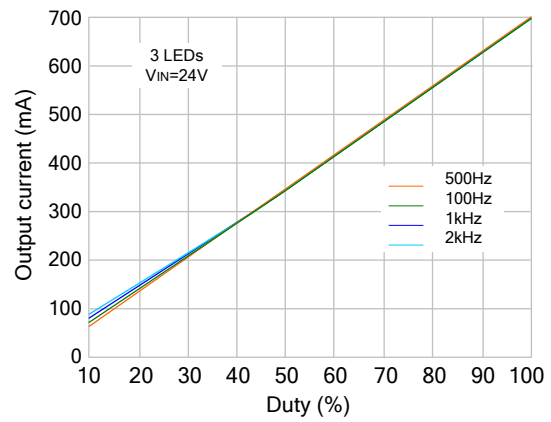
Output current change curve when input voltage is close to output voltage(700mA)



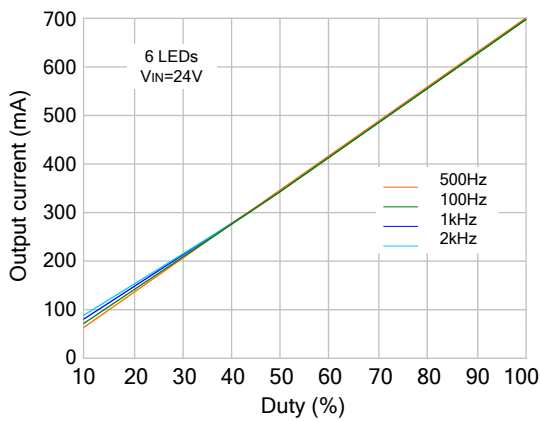
**ELECTRICAL CHARACTERISTICS CURVE(continued)**



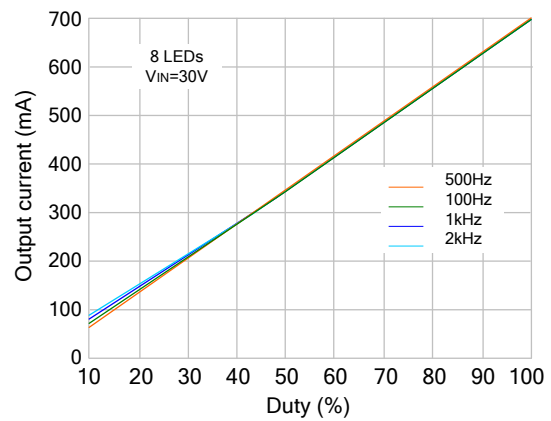
*PWM dimming behavior of 1 LED(700mA)*



*PWM dimming behavior of 3 LEDs(700mA)*



*PWM dimming behavior of 6 LEDs(700mA)*

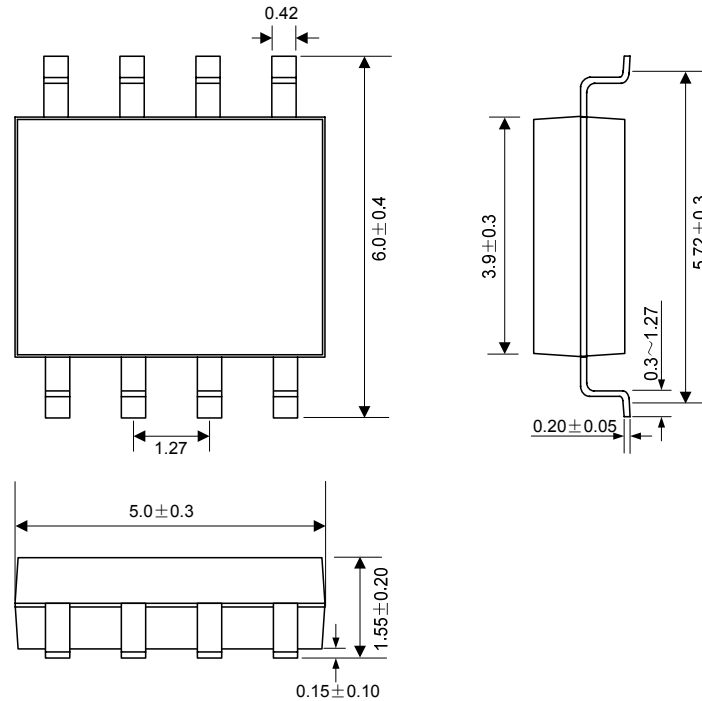


*PWM dimming behavior of 8 LEDs(700mA)*

PACKAGE OUTLINE

SOP-8-225-1.27

UNIT: mm



**HANDLING MOS DEVICES:**

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed for dispatch in antistatic/conductive containers.

**Disclaimer:**

- Silan reserves the right to make changes to the information herein for the improvement of the design and performance without further notice!
- All semiconductor products malfunction or fail with some probability under special conditions. When using Silan products in system design or complete machine manufacturing, it is the responsibility of the buyer to comply with the safety standards strictly and take essential measures to avoid situations in which a malfunction or failure of such Silan products could cause loss of body injury or damage to property.
- Silan will supply the best possible product for customers!

**Attachment****Revision History**

Data	REV	Description	Page
2009.05.19	1.0	Original	
2009.06.26	1.1	Modify the "FUNCTION DESCRIPTION"	