

Triac Dimmable Offline LED Driver

General Description

The VAS1106 is a constant current controller designed to be compatible with triac dimmers. A string of series/parallel LEDs is tapped at three locations, three integrated high voltage switches track the input sine wave voltage and turn on/off automatically. Voltage across each switch is minimized when conducting, providing high efficiency.

The VAS1106 includes a bleeder circuit to ensure proper triac operation by allowing current flow while the line voltage is low to enable proper firing of the triac. An input voltage detecting circuit ensures high efficiency by shutting down bleeder current when voltage is high enough to hold the triac operating.

VAS1106 is available in a SOP8-e package.

Application

- LED Lighting

Features

- Fit Triac Dimming
- No magnetics, no aluminum capacitors
- Automatically detect LED forward voltage

- Automatically adapt 1,2, 3 segments LEDs
- Up to 8W output
- 85% efficiency
- > 0.95 power factor
- Temperature Compensation
- Low conducted EMI without filters
- SOP8-e package

Ordering Information

Order Number	Package Type	Temp. Range
VAS1106ID08E	SOP8-e	-40 °C to 105°C

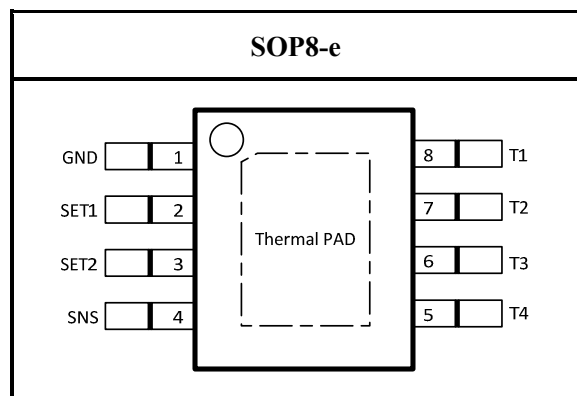
I: Industry, -40~85°C

D: SOP

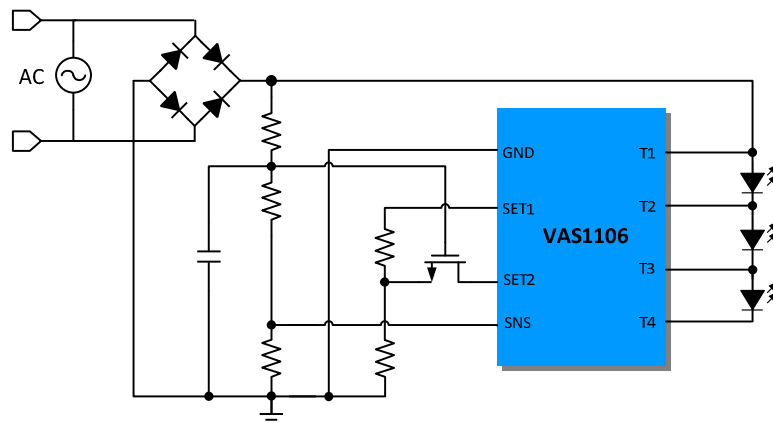
08: Pin Number

E: ROHS

Pin Configuration



Typical Application Circuit





Absolute Maximum Ratings ^(Note1)

Parameters	Maximum Ratings
T1~T4	-0.3V to 500V
SET1,SET2,SNS,VCC	-0.3V to 6V
Operating temperature range	-40°C to +105°C
Junction temperature	-40°C to +150°C
Storage temperature range	-65°C to +150°C
ESD human body model	2000V

Note1: Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

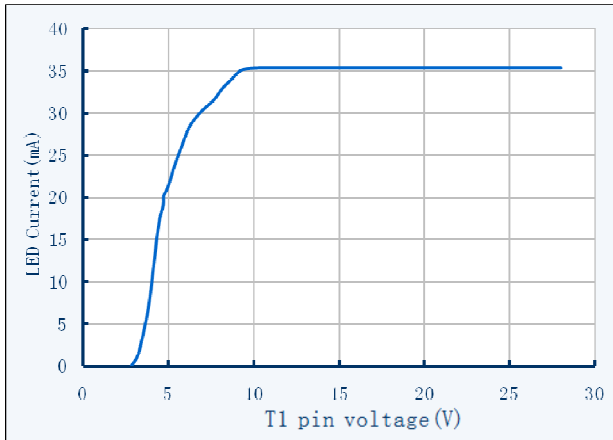
Electrical Characteristics ^(Note2)

Symbol	Parameter	Condition	SPEC			Unit
			Min.	Typ.	Max.	
VSUP	Input voltage range				500	V
ICC	Quiescent current	VT1=310V		300		μA
V _{SET2}	SET pin voltage			0.65		V
I _{ACCU}	Current accuracy	VT1=310V		±5		%
T _{SD}	OTP threshold			160		°C
R _{ΘJA}	Thermal resistance	SOP8-e		60		°C/W

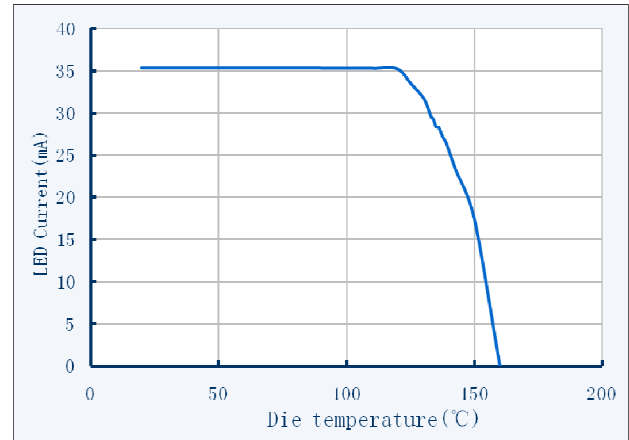
Note 2: Production testing of the device is performed at 25°C. Functional operation of the device and parameters specified over other temperature range, are guaranteed by design, characterization and process control.



Typical Performance Characteristics



LED current vs. T2 pin voltage

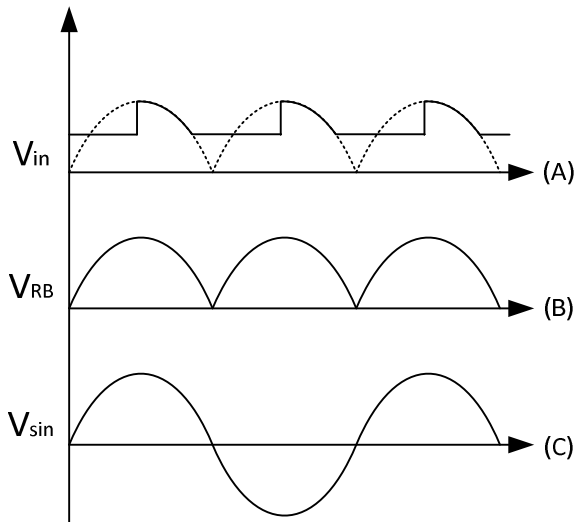


LED current vs. Die temperature

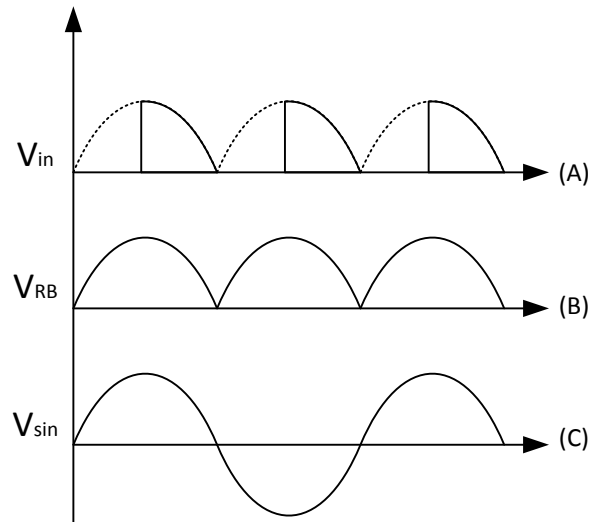
Application Information

1. Operating Theory

The AC main voltage waveform is a sine-wave, the rectifier bridge transfer the AC voltage to DC voltage, see (B) and (C). Figure (A) show typical triac dimmed voltage waveform.

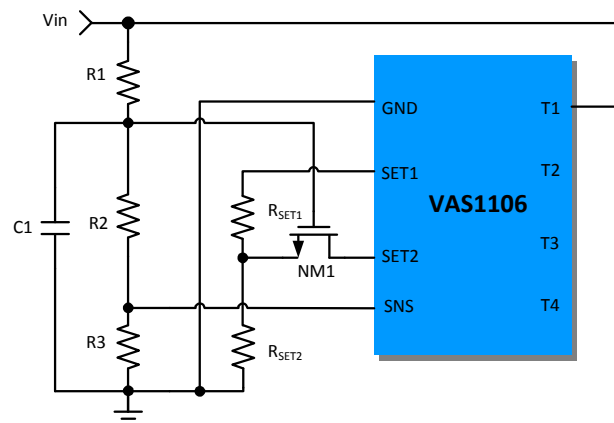


Voltage Waveforms After Triac Dimming
Without Bleeder Circuit

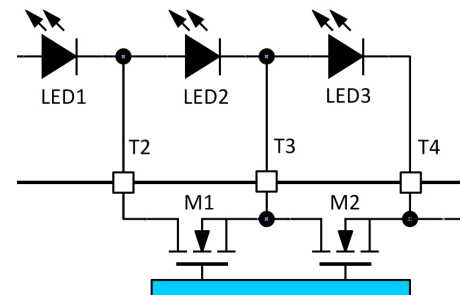


Voltage Waveforms After Triac Dimming With
Bleeder Circuit

In order to emulate an incandescent light bulb with any LED driver, the existing triac will require a small amount of holding



current throughout the AC line cycle. An external resistor



(R_{SET1} , R_{SET2}) and internal M0 perform this function. However the external holding current may reduce the circuit efficiency, the external current should be shutdown when the line voltage is high enough. An external series pass regulator

($R1$, $R2$, $R3$) translates the rectified line voltage to a level where can be sensed by the SNS pin on the VAS1106. The SNS pin voltage compare with the threshold voltage of 1.2V to determine whether the external current should be shutdown or not. NM1 is used to delay enable LED driver for preventing LED flash when dimmer just turn on.

Without triac dimmer the voltage after rectifier bridge is half-wave with 310V peak voltage for 220V AC (155V for 110V AC).

The VAS1106 integrated 3 high voltage switches, named M1 to M3, each of their drain and source connect one LED string, named LED1 to LED3. Initially, all the switches are on. If the half-wave voltage is higher than the LED1+LED2 forward voltage, M1 turn off, thus the current



flow through LED1 and LED2. If the half-wave voltage is higher than the LED1+LED2+LED3 forward voltage, M2 turn off, thus the current flow through LED1, LED2 and LED3.

For example, the LEDs are divided as 3 segments, each of them voltage is 150V, 60V and 60V. When the voltage rising to 150V+60V=210V, the LED1 and LED2 are fully turn-on, M1 turn-off. When the voltage rising to 150V+60V+60V=270V, the LED1, LED2 and LED3 are all fully turn-on, M2 turn off.

2. Set LED Current

The VAS1106 feature a programmable LED current using a resistor R_{SET2} . Use the following equation to calculate the sense resistor:

$$I_{LED} = \frac{0.65V}{R_{SET2}}$$

Change the value of R_{SET} can obtain the required constant current. The chip power consumption is $I_{LED} * V_D$, V_D is LED cathode voltage.

In order to get the higher accuracy of the LED output current ,an 1% or more high precision resistor is commented. If the environment temperature changes a lot, such as change in -25°C to 85°C, use the low temperature coefficient resistance to ensure that the resistance value is almost constant.

3. Set Bleeding Current

Resistors R_{SET1} and R_{SET2} are used to set bleeding current.

$$I_{Bleeder} = \frac{0.5V}{R_{SET1} + R_{SET2}}$$

4. Over-Heating Issue

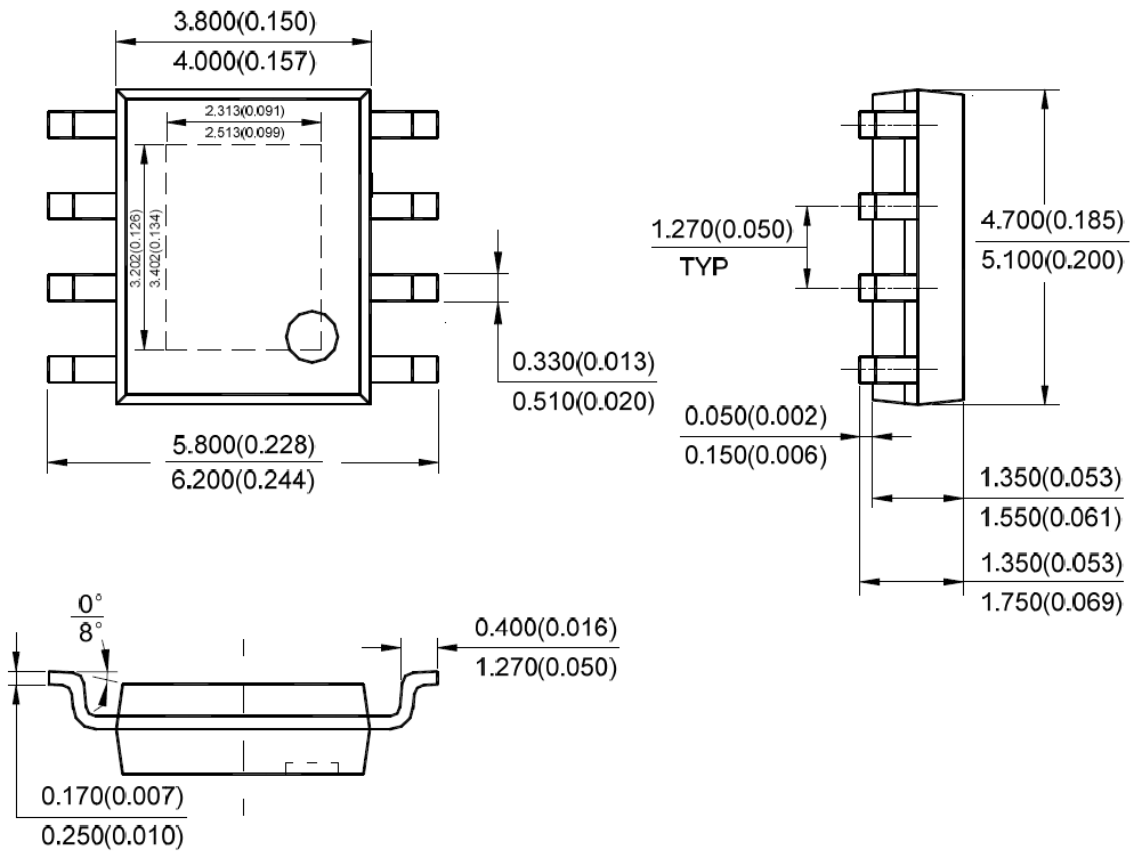
As the AC mains voltage rises, the LED cathode voltage will follow up, this will cause the chip overheating. The VAS1106 solve the issue by:

1) If the VAS1106 die temperature rise to 120°C (IC surface temperature is about 90°C), LED current started to decrease gradually, as the temperature reach 160°C, LED current dropped by half, this feature avoid the LED blinking.

2) If the temperature continues to increase to 160°C, VAS1106 enter thermal shutdown mode. When the temperature dropped to 120°C, VAS1106 re-start to work



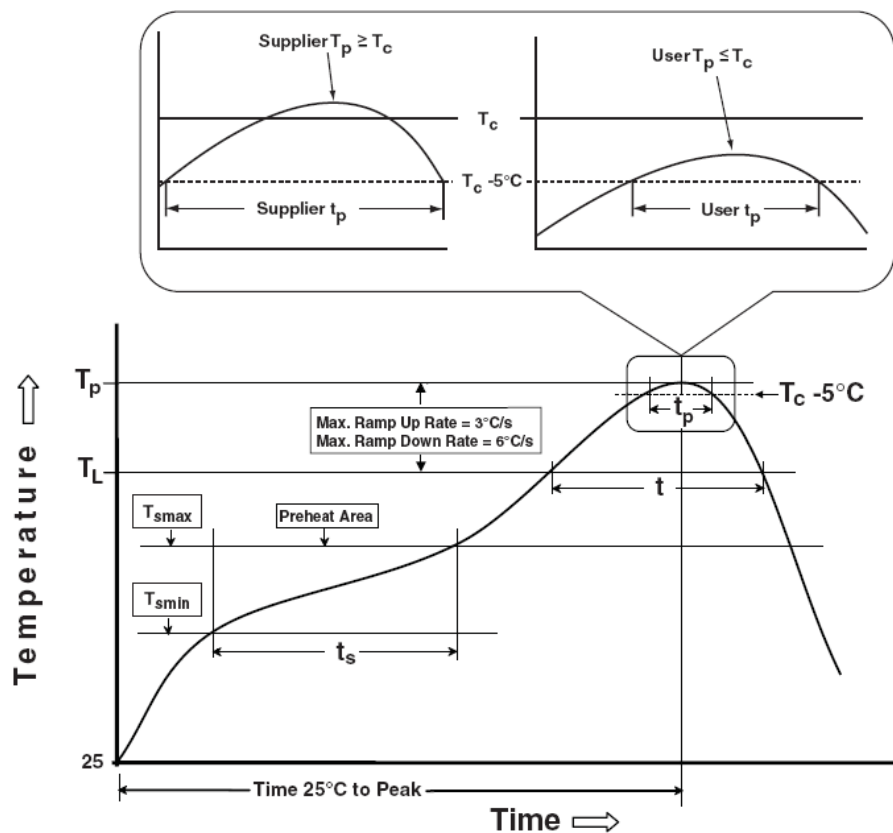
Package Information (SOP8-e)





Classification Reflow Profiles

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (T_p)*	Max 260°C
Time (t_p)** within 5°C of the specified classification temperature (T_c)	Max 30 seconds
Average ramp-down rate (T_p to T_{smax})	6°C/second max.
Time 25°C to peak temperature	8 minutes max.



Classification Profile



⚠ CAUTION

Storage Conditions

1) This product should be used within 12 months after delivered. Store in manufacturer's package keeping the seal of aluminum coated baggage or tightly re-closed box with the following conditions.
[Temperature: 8°C...30°C, Humidity: 30%...70% R.H.]

2) Keep the seal of aluminum coated baggage immediately before usage.

3) After breaking the seal of aluminum coated baggage, this product should be used within 1 week on the following conditions.

[Temperature: ≤30°C, Humidity: ≤60% R.H.]