High Current Boost LED Driver

General Description

VAS1350 is a PFM mode boost LED driver with external power MOSFET. By adjust external sense resistor, VAS1350 can deliver up to several amperes output current and suitable for high power LED array applications.

VAS1350 operates from a 5V to hundreds of voltages input range. Its overvoltage protection can avoid damage to circuit of open load and a dedicated analog/PWM input (ADJ) enables a wide range of pulsed dimming from 0 to 100%.

VAS1350 provide excellent protection functions, such as MOSFET over current protection, RCS short protection, ROVP short to ground protection, RFB short protection, UVLO and over heat protection, LED open protection.

VAS1350 is available with SOP8 package.

Application

- Landscape lighting
- Street lamp
- Indoor LED lighting
- LED backlighting

Features

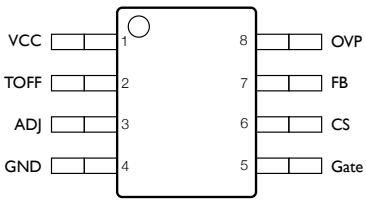
- 10V gate driver
- Multiple protections
  - R_{FB} short and R_{CS} short protection
  - OVP short-to-GND protection
  - Output over voltage protection
  - Over temperature protection
- Wide input range up to hundreds of voltages in system
- No compensation capacitors

Ordering Information

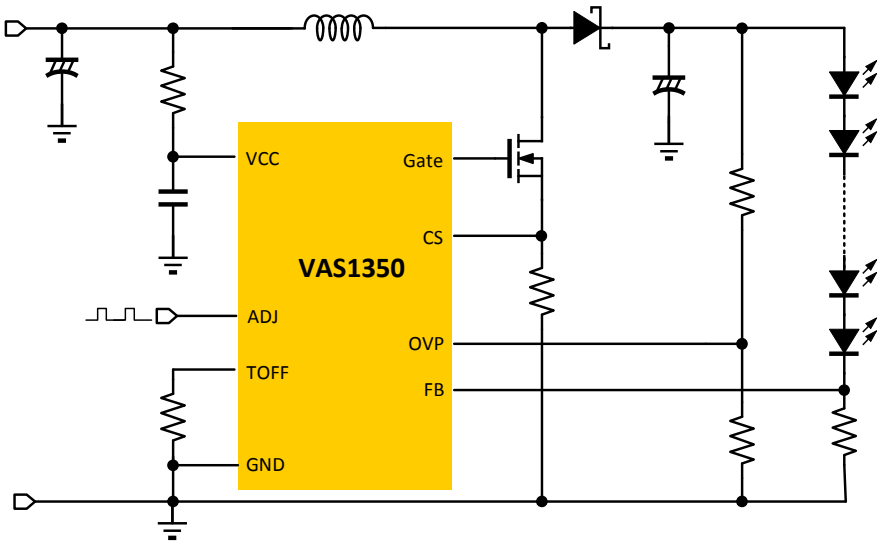
Order Number	Package Type	Temp. Range
VAS1350ID08E	SOP8	-40 °C to 85°C

Pin Configuration

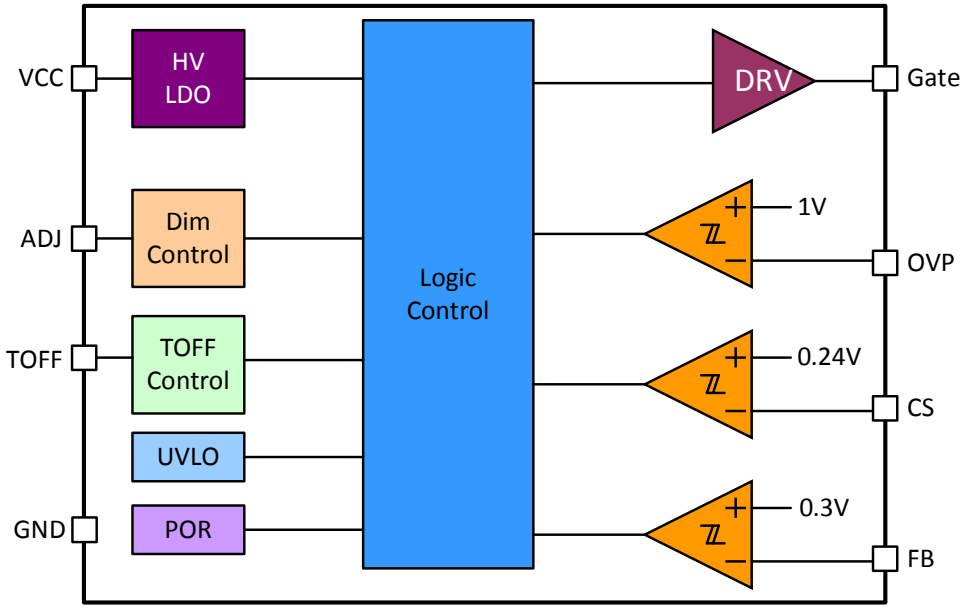
SOP8



Typical Application Circuit



Block Diagram



PIN Description

PIN NO.	Name	Description
1	VCC	Power supply input.
2	TOFF	Set the shortest off time of the NMOS by connecting a resistor
3	ADJ	Multi-function On/Off and brightness control pin: • Drive to voltage below 0.5V to turn off output current • Leave floating for normal operation, PIN CS threshold V_{CSTH}=0.24V, PIN FB threshold V_{FBTH}=0.3V • Drive with DC voltage (0.5V<V_{ADJ}<2.4V) to adjust CS/FB threshold from 50mV/66mV to 0.24V/0.30V. • Drive with a PWM signal to adjust output current : adjustment range 0% to 100%
4	GND	Ground
5	GATE	Gate Drive Output. Connect to the gate of an external N-MOSFET
6	CS	The input peak current detecting pin
7	FB	The output current sense pin
8	OVP	Overvoltage protection detecting pin. If the pin voltage higher than 1V, the NMOS closed.

Absolute Maximum Ratings (Note1)

Parameters	Maximum Ratings
VCC to GND	-0.3V to 44V
GATE to GND	-0.3V to 18V
CS, ADJ, TOFF, OVP, FB to GND	-0.3V to 6V
Junction temperature range	-40°C to +150°C
Storage temperature range	-65°C to +150°C
ESD (HBM)	2000V

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Electrical Characteristics

Test Condition(note 2): VIN=12V, T_A=25°C (unless otherwise specified)

Symbol	Parameter	Condition	SPEC			Unit
			Min.	Typ.	Max.	
V_{INDC}	Input Voltage Range		5		40	V
UVLO	Under Voltage Lockout	VCC Rising		4.5		V
ΔUVLO	UVLO Hysteresis			200		mV
I_Q	Quiescent Current	VCC=12V		250	400	uA
V_{CSTH}	Input Peak Current Threshold	ADJ=5V	215	240	265	mV
T_{BLANK}	Input Current Blacking time	VCS=VCSTH+50mV		300		ns
T_{OFF}	Minimum Constant Off time	Rext=24KΩ		1		μs
V_{ADJ}	Peak Current Control Threshold Low			0.5		V
	Peak Current Control Threshold High			2.4		V
T_{SD}	OTP Threshold			160		°C
T_{SD-HYS}	OTP Hysteresis			20		°C
V_{FBTH}	Output Current Feedback Threshold		0.285	0.3	0.315	V
V_{OVP-TH}	Over Voltage Protection Threshold		0.95	1	1.05	V

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

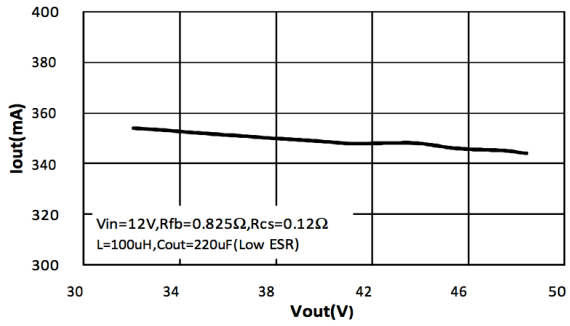


Fig. 2 VIN & IOUT

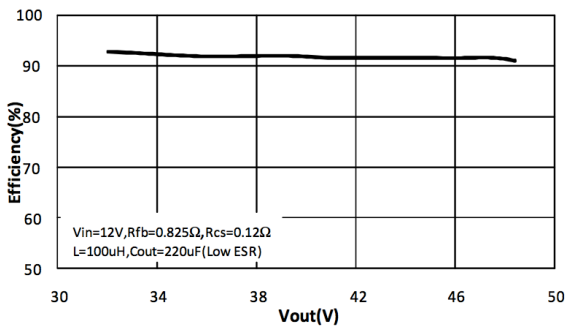


Fig. 3 VIN &Efficiency

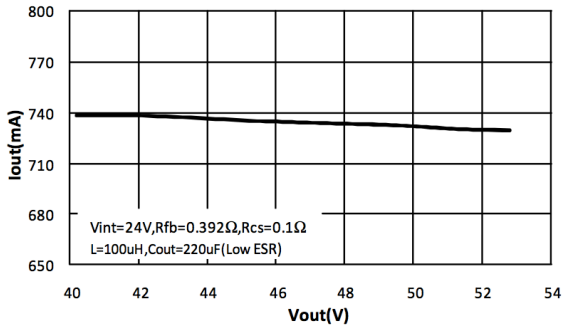


Fig. 4 VOUT & IOUT

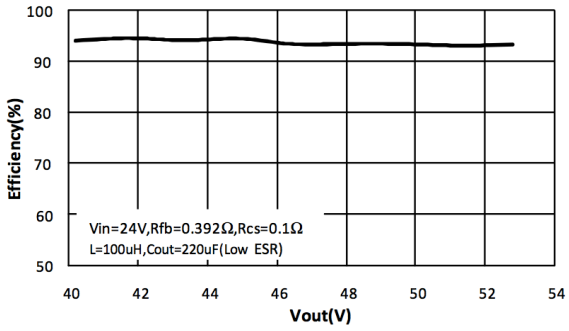
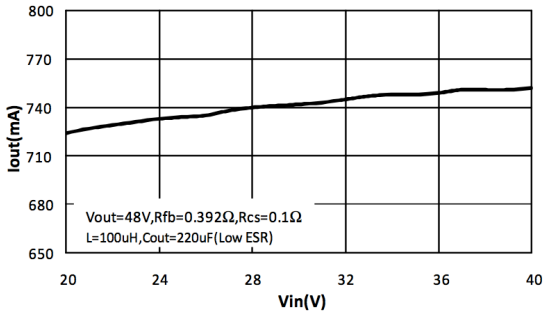


Fig. 5 VOUT & Efficiency



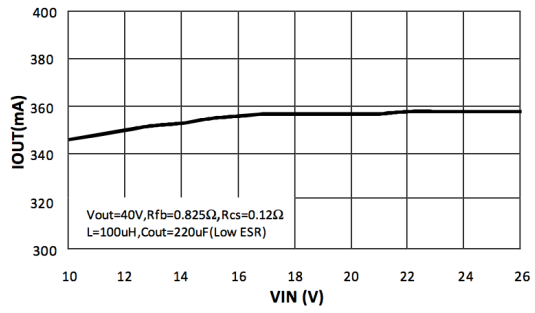
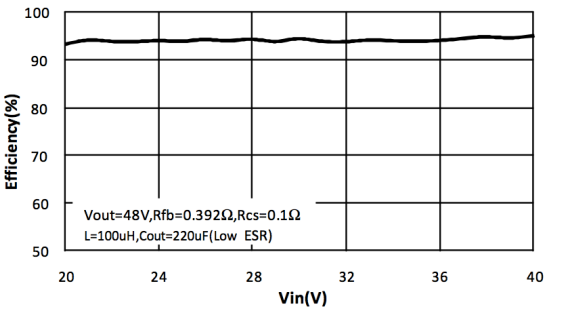


Fig.6 VIN & IOUT



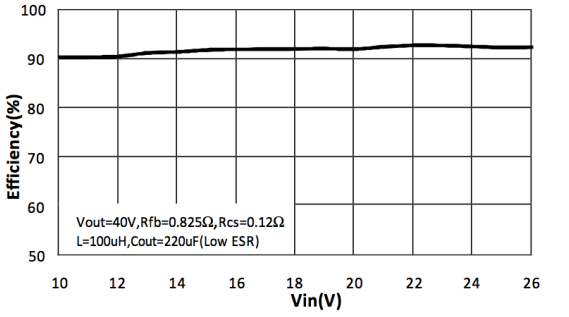


Fig. 7 VIN & Efficiency

Application Information

1. Power supply voltage >40V application

When power supply voltage is great than 40V, a input resistor and a low ESR ceramic capacitor is needed to clamp the voltage at VCC pin.

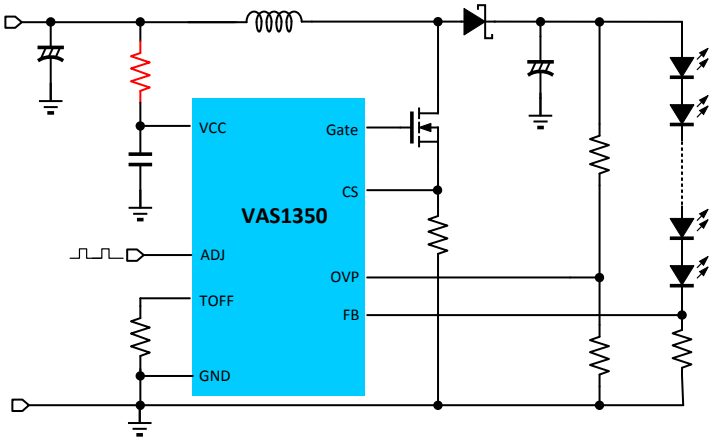


Fig. 8 Power supply voltage >40V application

2. Under voltage Lock-out

When VCC voltage drops and is less than 4.3V, VAS1350 stop operation; when VCC voltage rises and great than 4.5V, VAS1350 restart to operation.

3. LED Current Setting
LED current can be set by:

$$I_{LED} = \frac{0.3}{R_{FB}}$$

In order to get more accuracy LED current, 1% or high accuracy resistor is recommended.

4. Over Voltage Setting

In some cases, LED open for example, the FB connect to GND by a small resistor, the FB voltage almost is 0V, VAS1350 continue to work at maximum duty cycle and output voltage rises. When the OVP voltage(which is VOUT voltage resistor divider) rise to $V_{OVP\text{-}TH}$(1.05V typical), VAS1350 internal logic force external MOSFET OFF, then output voltage drops, when OVP voltage drops to $V_{OVP\text{-}TH}$-0.1(0.95V typically), VAS1350 internal logic release and chip work agin.

In most cases, output OVP voltage should set to 1.2 times or 5V greater normal operation voltage,

$V_{OVP} = V_{OVP-TH} \times (1 + \frac{R_1}{R_2})$, R1 is upper resistor connect between OVP to VOUT, R2 is lower resistor that connect between OVP to GND.

5. Dimming

VAS1350 has both analog and PWM dimming by utilize multifunction ADJ pin, the function describe as below:

1) Drive to voltage below 0.5V to turn off output current

2) Leave floating for normal operation, PIN CS threshold V_{CSTH}=0.24V, PIN FB threshold V_{FBTH}=0.3V

3) Drive with DC voltage (0.5V<V_{ADJ}<2.4V) to adjust CS/FB threshold from 50mV/66mV to 0.24V/0.30V linearly.

4) Drive with a PWM signal to adjust output current, adjustment range 0% to 100%

When use PWM dimming mode, a additional N-MOSFET is recommended to add to improve LED color temperature.

6. Input Current Peak Control

VAS1350 limit the input current peak by set R_{CS} which connect between CS and GND. The input average current can get by:

$$I_{avg(IN)} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times \eta}$$, the η is system efficiency, say 90%

Mostly, set input peak current 1.5 times average current is enough,

$$I_{peak(IN)} = 1.5 \times I_{avg(IN)} = \frac{V_{CSTH}}{R_{CS}}$$

Where V_{CSTH} value determined by ADJ pin:

If 0.5V≤V_{ADJ}≤2.4V ,then V_{CSTH} = V_{ADJ}/10

If V_{ADJ}>2.4V, then V_{CSTH} =0.24V

If ADJ floating, then V_{CSTH}=0.24V

7. Input Capacitor Selection

Input capacitor provide transient current for system, a 100uF or larger, low ESR capacitor is recommended.

8. Minimum Turn-Off time Setting

Minimum turn-off time is necessary for VAS1350 startup. The time is set by an external resistor R_{EXT}. $T_{OFF(MIN)}$=1us is recommended in most application.

The minimum turn-off time is set by the formula:

$$T_{OFF(MIN)} = 40 \times 10^{-12} \times R_{EXT}$$

9. Inductor selection

The inductor quantity is related to system working frequency. Larger inductor quantity reduce lower working frequency and switching dissipation on MOSFET, but larger inductor need more copper line and increase ESR, the conductor dissipation increases. The system work frequency calculate formula:

$$f = 1/(T_{ON} + T_{OFF})$$

Inductor current ripple:

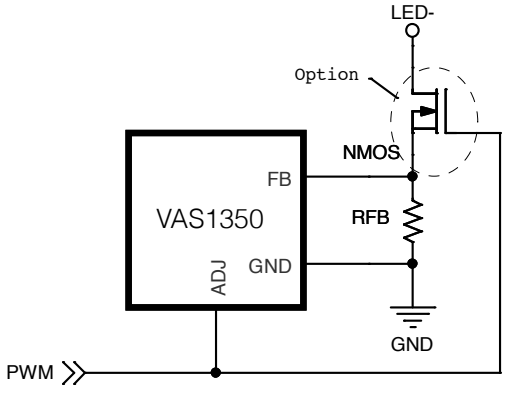
$$I_{RIPPLE} = 2 \times (I_{peak(IN)} - I_{avg(IN)})$$

NMOS turn on time T_{ON} :

$$T_{ON} = \frac{I_{RIPPLE} \times L}{V_{IN} - I_{avg(IN)} \times (R_L + R_{DS(ON)} + R_{CS})}$$

NMOS turn-off time T_{OFF} :

$$T_{OFF} = \frac{I_{RIPPLE} \times L}{V_{OUT} + V_D - V_{IN} - I_{avg(IN)} \times R_L}$$



Note: MUST guarantee $T_{OFF} > T_{OFF(MIN)}$ at normal operation

V_{IN}: Power supply voltage (V)

V_{OUT}: Output voltage (V)

I_{RIPPLE}: Inductor current ripple (A)

L: Inductor quantity (H)

$I_{PEAK(IN)}$: Inductor peak current (A)

$I_{AVG(IN)}$: Input average current （A）

R_L: Parasitic resistance of inductor (Ω)

$R_{DS(ON)}$: NMOS conduct resistance (Ω)

V_D: Schottky diode forward voltage (V)

VAS1350 recommend the system working frequency is from 20KHz to 200KHz, 20KHz or less working frequency will induce audio noise, 200KHz or higher will induce higher power dissipation and reduce system efficiency.

The inductor rated current must greater than ripple current.

10. Output Capacitor

22uF or larger, low ESR, aluminum capacitor is recommended.

11. Schottky Diode

The Schottky diode rated current should great than output current and reverse block voltage should great than output OVP voltage.

12. N-MOSFET

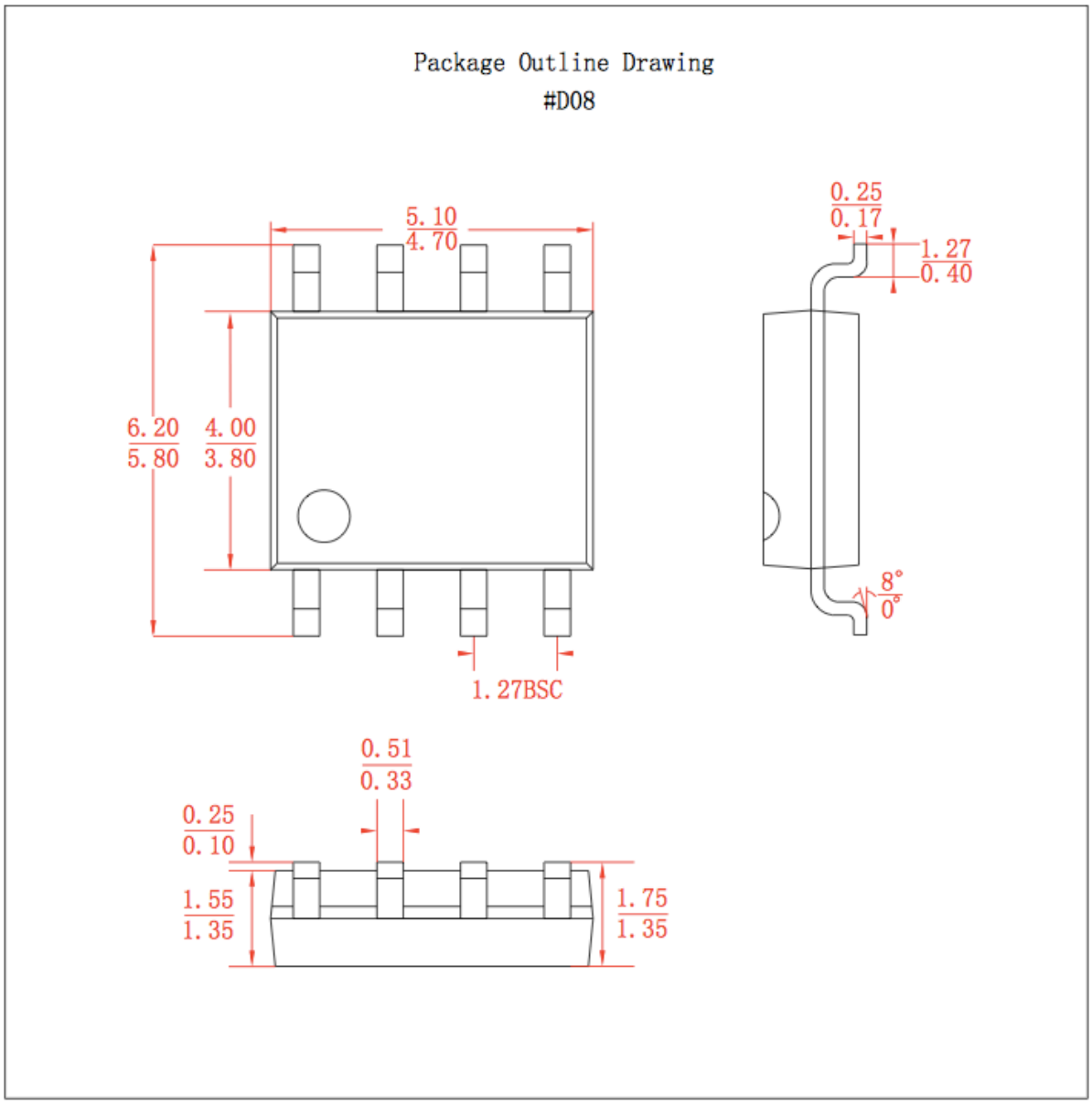
The N-MOSFET break-down voltage must larger than the output OVP voltage.

The MOSFET R_{DSON} is related to its power dissipation and system efficiency.

$$P_{LOSS} = I_{M1}^2 \times R_{DS(ON)} = \left(\frac{V_{OUT} \times I_{OUT} \times Duty}{V_{IN} \times \eta} \right)^2 \times R_{DS(ON)}$$

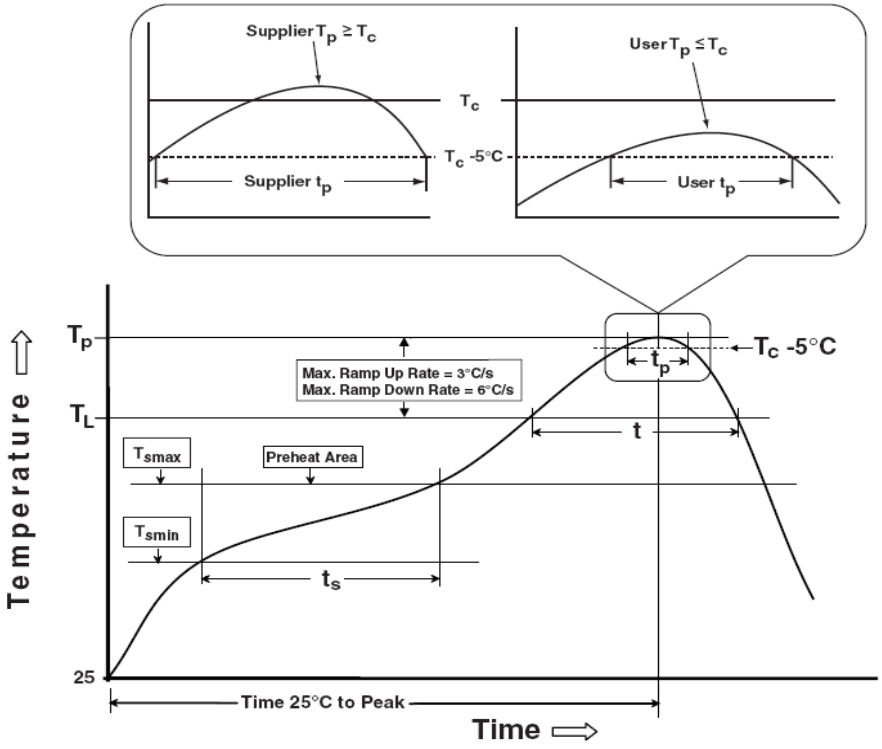
A N-MOSFET with rated current 5 times input peak current is recommended.

Package Information (SOP8)



Classification Reflow Profiles

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (Tsmin) Temperature max (Tsmax) Time (Tsmin to Tsmax) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (Tsmax to Tp)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (Tp)*	Max 260°C
Time (tp)** within 5°C of the specified classification temperature (Tc)	Max 30 seconds
Average ramp-down rate (Tp to Tsmax)	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.]