

LED Backlight Controller

DESCRIPTION

The EUP2950A is a high performance controller for LED Backlight. The internal soft start function can reduce the inrush current. The device uses current mode, fixed frequency architecture to regulate the LED current, which is measured through an external current sense resistor. Its low 300mV feedback voltage reduces power loss and improves efficiency.

The EUP2950A offers external low frequency PWM dimming method for a wide range of dimming control.

The EUP2950A integrated multiple protections, such as over current protection (OCP), over voltage protection (OVP), Diode & Inductor short protection, LED cathode short to GND protection, Under Voltage Lockout (UVLO), Thermal Shutdown Protection (OTP), and LED open protection.

The EUP2950A is available in SOP-8 package to provide the best solution for PCB space saving and total BOM cost.

FEATURES

- 9V to 30V Input Voltage Range
- Current Mode PWM controller with good dynamic
- Internal Soft-Start
- External PWM Dimming Control
- Over Voltage Protection
- Over Current Protection
- Under Voltage Lockout
- Thermal Shutdown Protection
- LED cathode short to GND Protection
- LED Open Protection
- SOP-8 Package
- RoHS Compliant and 100% Lead (Pb)-Free

APPLICATIONS

- LCD Monitor
- LCD TV
- Flat panel display

Typical Application Circuit

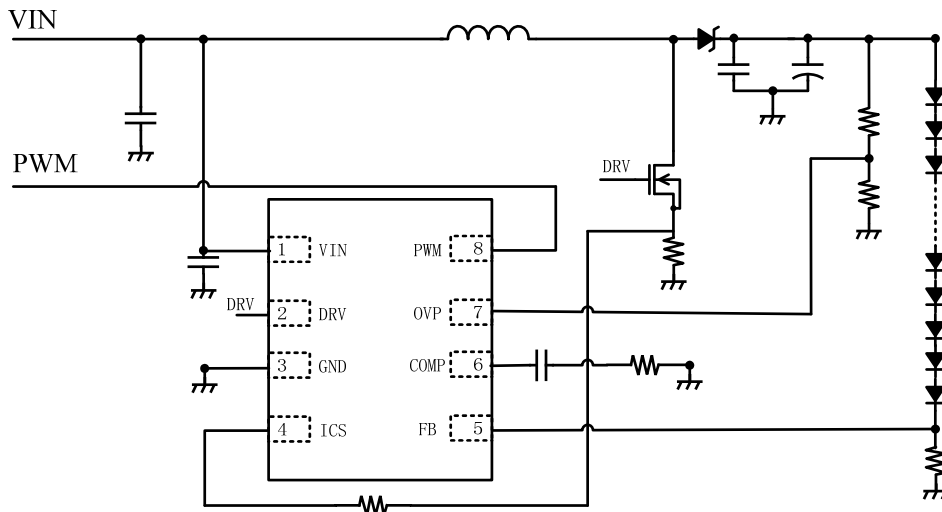


Fig 1 EUP2950A PWM Dimming for White LED Application

Block Diagram

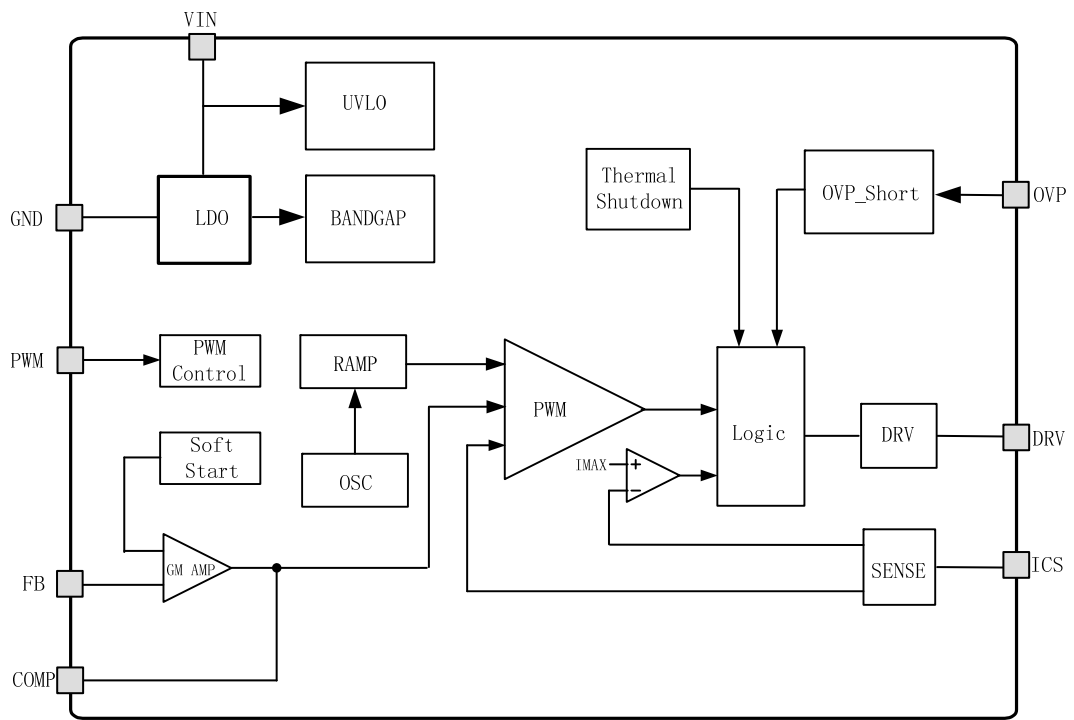


Fig 2 EUP2950A Block Diagram


Pin Configurations

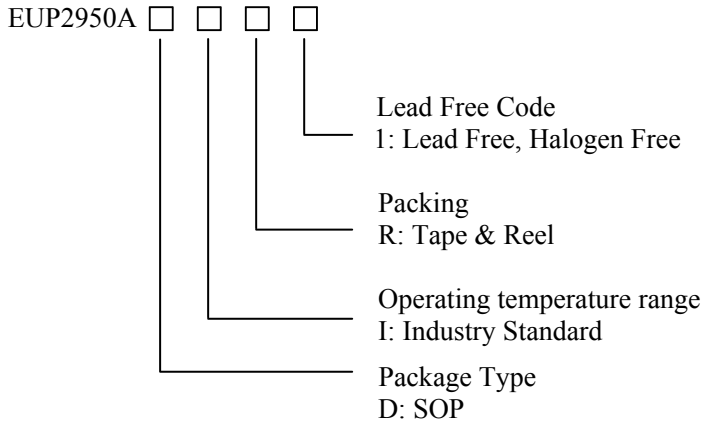
Package Type	Pin Configurations
SOP-8	

Pin Description

SOP-8	Pin Name	Descriptions
1	VIN	Power Supply Input
2	DRV	Gate Driver Output
3	GND	Ground
4	ICS	Current Sense Input
5	FB	LED Current Feedback Input
6	COMP	Boost Converter Loop Compensation Pin
7	OVP	Over Voltage Protection Sense Input
8	PWM	External PWM Dimming Control

Ordering Information

Order Number	Package Type	Marking	Quantity per Reel	Operating Temperature Range
EUP2950ADIR1	SOP-8	 XXXXX 2950A	2500	-40 °C to +85°C



Absolute Maximum Ratings (1)

- VIN, DRV, OVP to GND ----- -0.3V to 40V
- IVS, FB, COMP, PWM to GND ----- -0.3V to +6V
- Package Thermal Resistance
 θ_{JA} (8-Pin SOP) ----- 125°C/W
- Operating Temperature Range ----- -40°C to +85°C
- Maximum Junction Temperature ----- +150°C
- Storage Temperature Range ----- -55°C to +150°C
- Lead Temperature (soldering, 10s) ----- +260°C

Operating Conditions (2)

- Operating Temperature Range ----- -40°C to +85°C
- Supply Voltage , VIN----- 9V to 30V
- PWM Frequency ----- 100Hz to 1KHz

Note (1): Stress beyond those listed under “Absolute Maximum Ratings” may damage the device.

Note (2): The device is not guaranteed to function outside the recommended operating conditions.

Electrical Characteristics

(VIN=12V, PWM=5V, TA= 25°C. Unless otherwise noted.)

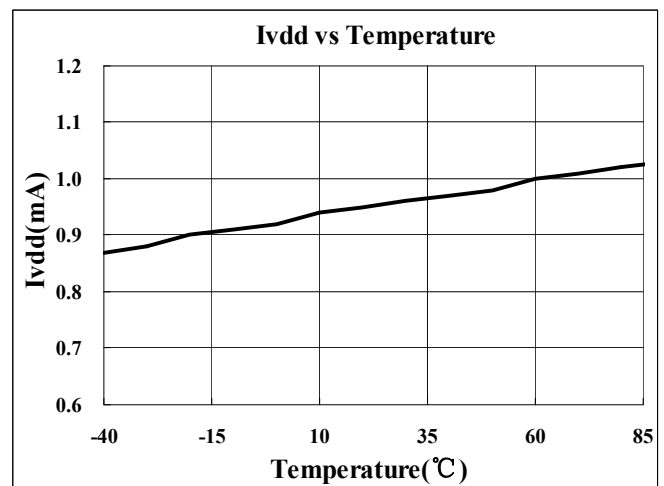
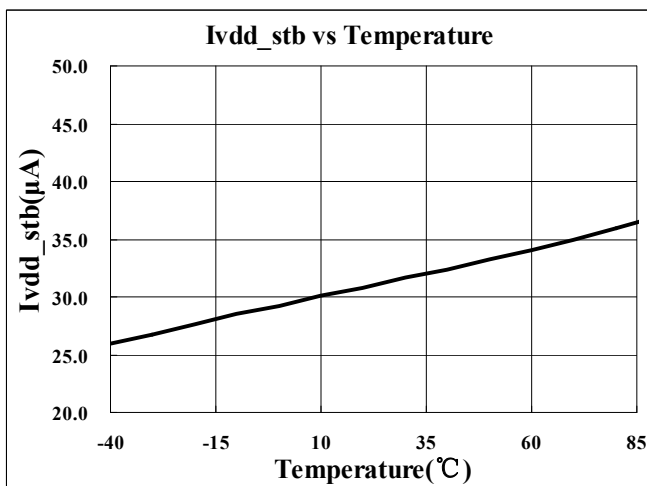
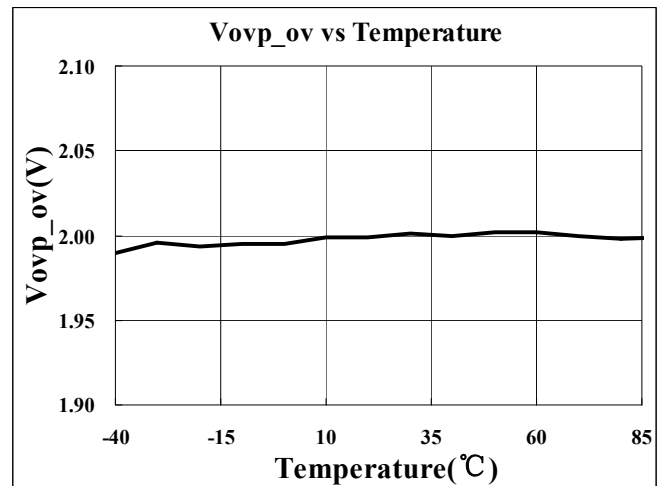
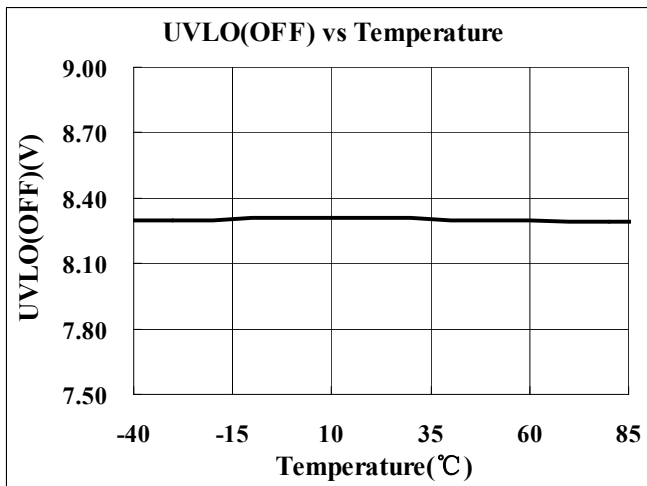
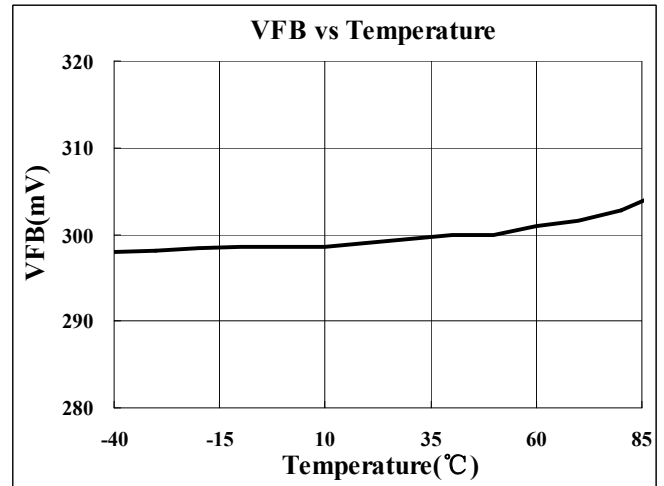
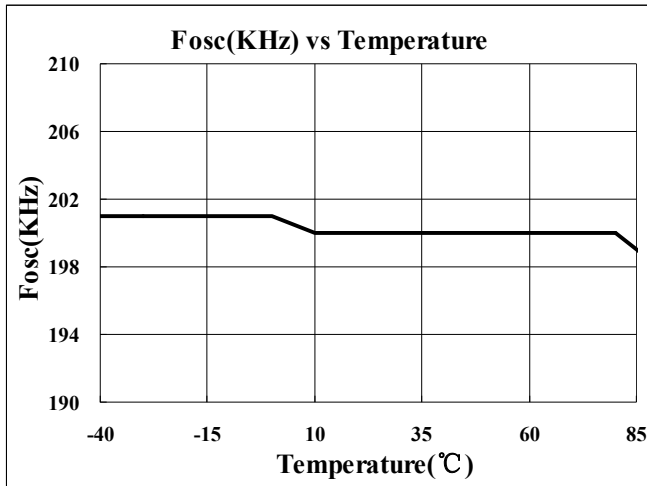
Symbol	Parameter	Conditions	EUP2950A			Unit
			Min	Typ	Max	
Current Consumption						
VIN	Input Voltage range		9		30	V
IVDD	Operating supply current	VIN=12V,PWM=5V no load		0.9		mA
IVDD_STB	Stand by current	PWM low > 50ms		35		μA
VDD UVLO						
UVLO (OFF)	UVLO			8.3		V
UVLO (Hys)	UVLO Hysteresis			0.8		V
PWM Control						
Fosc	Operation Frequency			200		KHz
Dmax	Maximum Duty Cycle			95		%
Error Amplifier						
Vref_ea	Reference Voltage			300		mV
Am ⁽¹⁾	Open loop voltage gain			70		dB
Gm ⁽¹⁾	Transconductance of EA			100		μA/V
ISOURCE ⁽¹⁾	Output source current			30		μA
ISINK ⁽¹⁾	Output sink current			60		μA
PWM to analog Dimming Control						
	PWM Duty		0		100	%
PWMH	PWM Logic input level high		2.5			V
PWML	PWM Logic input level low				1.3	V
Protection Threshold						
VOVP_OV	OVP	Threshold of output over voltage		2.0		V
VTH_OCP	OCP	Threshold of over current protection		350		mV
TOTP_ON	OTP			160		°C
VTH_CS	ICS high protection threshold	Diode & Inductor short		1.2		V
VTH_CMP	CMP high protection threshold			3.2		V

$V_{\text{OVP_UVLO}_1}$	OVP UVLO threshold	Normal operation		250		mV
$V_{\text{OVP_UVLO}_2}$		System startup		150		mV
Drv Output						
$T_{\text{rise}}^{(1)}$	Drv rise time	1nF Load		40		ns
$T_{\text{fall}}^{(1)}$	Drv fall time	1nF Load		20		ns

Note

⁽¹⁾These are guaranteed by design and characterization.

Typical Operating Characteristics



Application Information

General Operation

The EUP2950A is a high frequency, asynchronous boost converter. The device uses current mode, fixed frequency architecture to regulate the LED current, which is measured through an external current sense resistor.

The EUP2950A integrated multiple protect functions such as over current protection (OCP), over voltage protection (OVP), Diode & Inductor short protection, LED cathode short to GND protection, Under Voltage Lockout (UVLO), Thermal Shutdown Protection (OTP), and LED open protection. These protections will prevent the system from damage.

Startup

EUP2950A is enabled by applying a voltage of greater than approximately 2.5V to PWM pin. An internal 300k Ω pull down resistor is inserted between PWM pin and ground. When the first rising edge is applied to PWM input, the EUP2950A will power up immediately, and remains power up until the PWM input is lower than 1.3V for at least 50ms. At this time, the EUP2950A will enter standby mode and the power of EUP2950A will be lower than 35uA.

When PWM signal is active high, the EUP2950A checks the topology connection first. The chip monitors the OVP pin to see if the Schottky diode is connected or the boost output is shorted to GND. If the voltage of OVP pin is lower than 150mV, the output will be disabled. The EUP2950A will also check other faults(UVLO, OVP, Diode & Inductor short protection, LED Cathode Short to GND and OTP), if there is no fault, then the boost convert will boost up the output with the internal soft start.

UVLO

An under voltage lockage protection feature with a hysteresis of about 800mV is provided for VIN. When the voltage at this pin exceeds a threshold of approximated 8.3V, the IC starts the normal operation. If the voltage at VIN drops below a threshold of approximately 7.5V, the IC stops switching operation. The IC resumes switching operation when the voltage at VIN pin increases to a voltage above 8.3V.

LED Current Control

The EUP2950A regulates the LED current by setting the Current sense resistor connecting to FB pin and ground. The internal feedback reference voltage is 300mV. The LED current can be set from following equation easily.

$$I_{LED} = \frac{300mV}{R_{FB}}$$

In order to have an accurate LED current, precision resistors are preferred (1% is recommended).

Dimming Control

For controlling the LED brightness, the EUP2950A can perform the dimming control by applying a PWM signal to PWM pin, and the PWM signal frequency range is from 100 Hz to 1 KHz. The magnitude of the PWM signal should be higher than the maximum enable voltage of PWM pin, in order to let the dimming control perform correctly. The boost controller is turned on and off following the external PWM dimming. The voltage of FB Pin is set to 300mV with a logic High at PWM Pin, otherwise, the voltage of FB Pin is set to zero.

LED Open Protection

The LED open protection is achieved through the over voltage protection. If one or more LEDs are open, the FB pin is pulled to ground and the IC keeps charging the output voltage to a very high level. To prevent this happens, the output voltage is monitored through OVP Pin and the convert is shutdown if the voltage of OVP pin exceeds the predetermined level (2.0V). This protection is latched until EUP2950A restarts.

LED Cathode Short to GND Protection

FB Pin is connected to the Cathode of LED string. If the LED cathode is shorted to GND, the boost convert will continuous increase the output voltage until triggered the OVP threshold. If the OVP voltage rises to 2.0V, the boost will be turned off immediately. But in some condition, if the output voltage is limited by OCP protection before the output reach the OVP voltage, the gate of power MOSFET can never be turned off. In this case, the large current will go through both Schottky diode and power MOSFET, and cause permanent damage. So EUP2950A will monitor the voltage on COMP pin. If the voltage on COMP pin is continuously greater than 3.2V for 10ms, the gate output will be latched off until EUP2950A restarts.

Diode & Inductor Short Protection

When the Schottky diode or the inductor shorts, the current of the power MOSFET increasing significantly, which will lead to the device permanent damage if EUP2950A is continuously working. The voltage of CS PIN is monitored cycle by cycle. If the voltage on CS Pin is greater than 1.2V for continuous 17 cycles, EUP2950A will latch shutdown the gate output to prevent the MOSFET from permanent damage.

Vout Short to GND Protection

Vout short to GND condition is also monitored by OVP Pin. During the normal operation, when the voltage at OVP pin drops below a threshold of 0.25V, the Vout short to GND protection function is activated and the gate of power MOSFET is turned off. This state is latched until EUP2950A restarts.

Thermal Shutdown

Thermal shutdown protection circuit has been included to prevent the device from operation at unsafe junction temperatures above 160°C. In the event of a thermal overload condition the IC will automatically shutdown until EUP2950A restarts.

Setting the Over Voltage Protection

The LED open protection is achieved through the over voltage protection (OVP). In some cases, LED open failure results in the feedback voltage always zero. The part then

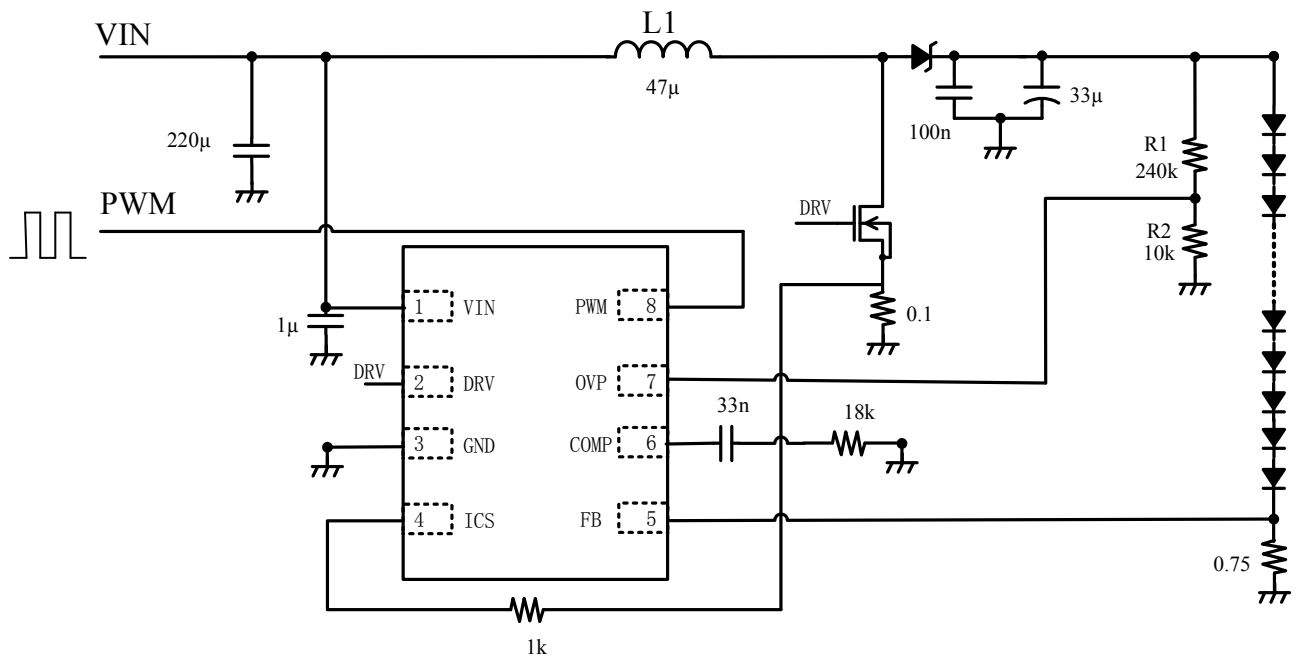
keeps boosting the output voltage higher and higher. If the output voltage reaches the programmed OVP threshold, the protection function will be triggered. To make sure the chip functions properly, the OVP setting resistor divider must be set with a proper value. The recommended OVP point is about 1.2 times higher than the output voltage for normal operation.

$$V_{OVP} = 2.0 \times \left(\frac{R_1 + R_2}{R_2} \right)$$

Table 1. EUP2950A Fault Protection

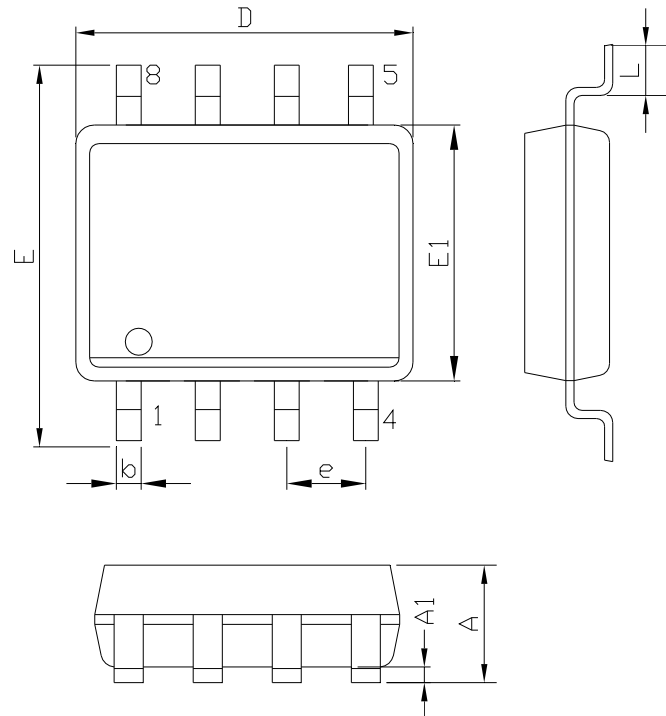
Faults	Trigger Conditions	Boost DC-DC
OVP shorted to GND	$V_{OVP} < 0.15V$ (startup)	When VOVP Lower than 0.15V, the Boost OFF. If OVP > 0.15V, Boost ON.
	$V_{OVP} < 0.25V$ (normal operation)	When VOVP Lower than 0.25V, the Boost will be turned off until EUP2950A restarts.
Diode & Inductor Short Protection	$V_{ICS} > 1.2V$ for continuous 17 cycles	The Boost will be turned off until EUP2950A restarts.
DC-DC Boost Output Exceeds OVP Threshold	$V_{OVP} > 2.0V$	When VOVP is greater than 2.0V, the boost controller will be turned off until EUP2950A restarts.
LED Cathode Short to GND	$V_{COMP} > 3.2V$	When VCOMP is greater than 3.2V, the boost controller will be turned off until EUP2950A restarts.
Thermal Fault (TJ > +160°C)	TJ > 160°C,	The boost controller will be turned off until EUP2950A restarts.
Current Limit	$V_{ICS} > 0.35V$	When VICS > 0.35V, the boost controller will be turned off immediately, and re-work next cycle.
Under Voltage Lockout Protection	$V_{IN} < 7.5V$	When VIN drops below 7.5V, the IC stops switching operation. The IC resumes switching operation when VIN increases to 8.3V.

Reference Application Circuit



Packaging Information

SOP-8L



SYMBOLS	MILLIMETERS			INCHES		
	MIN.	Normal	MAX.	MIN.	Normal	MAX.
A	1.35	-	1.75	0.053	-	0.069
A1	0.05	-	0.25	0.002	-	0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E1	3.70	3.90	4.00	0.146	0.154	0.157
E	5.80	6.00	6.20	0.228	0.236	0.244
L	0.40	-	1.27	0.016	-	0.050
b	0.31	-	0.51	0.012	-	0.020
e	1.27 REF			0.050 REF		