GENERAL DESCRIPTION

OB33510 is a highly integrated and cost effective Light Emitting Diode (LED) driver optimized for LCD monitor and LCD TV backlighting application. It provides a high performance LED backlight solution with minimized BOM count.

The OB33510 build-in Power MOSFET and contains a PWM boost driver which uses current mode control and fixed frequency operation to regulate the LED current. The LED current is sensed through an external current sense resistor. The voltage across the sensing resistor is compared with reference level of 400mV, the error is amplified to control the pulse width of the power switch thus to regulate the current flowing the LED.

The OB33510 offers PWM to analog dimming method for a wide range of dimming control.

The OB33510 offers comprehensive protection such as power MOSFET over current protection (OCP), output over voltage protection (OVP), Diode & Inductor short protection, LED cathode short to GND protection, IC power supply under voltage lockout (UVLO), and LED open protection.

FEATURES

- Current Mode PWM Control With Good Dynamic Response
- 9V to 30V Input Voltage Range
- Built in 100V power MOSFET
- PWM to analog Dimming Mode
- Over Voltage Protection
- Over Current Protection
- Under Voltage Lockout (UVLO)
- Thermal Shutdown
- Diode & Inductor Short Protection
- LED cathode short to GND Protection
- SOP-8 Package

APPLICATIONS

- LCD Monitor
- LCD TV
- Flat panel display

TYPICALICAL APPLICATION

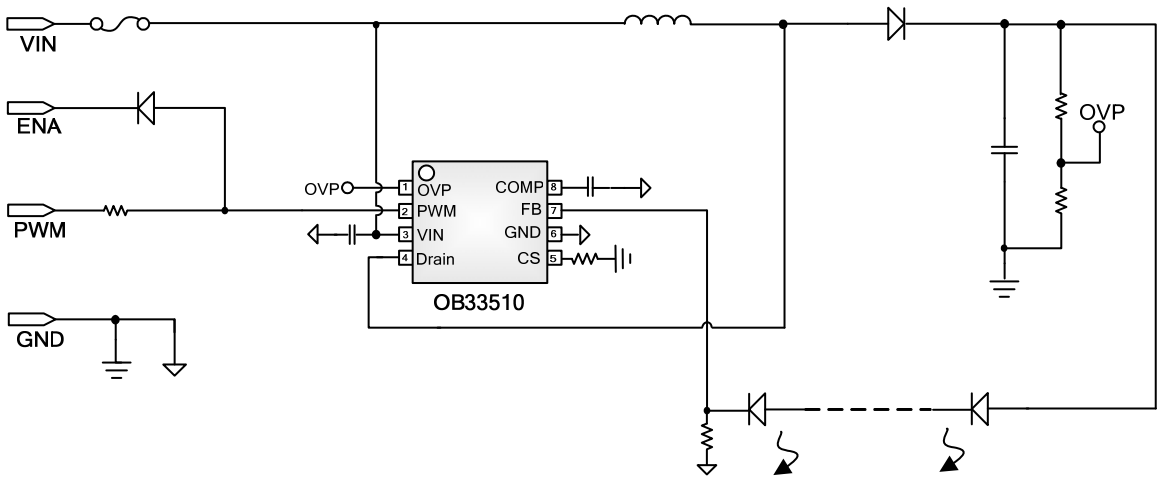
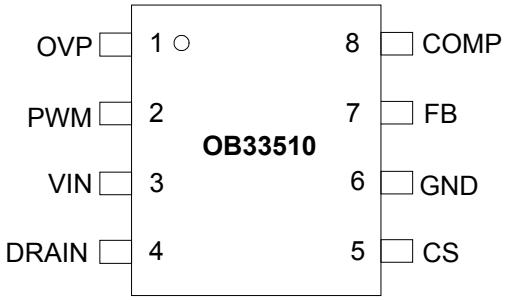


Figure1. OB33510 Typical Application Schematic

GENERAL INFORMATION

Pin Configuration



Ordering Information

Part Number	Description
OB33510CP	SOP8, pb-free in tube
OB33510CPA	SOP8, pb-free in T&R

Package Thermal Characteristics

Parameter	Value
Thermal Resistance θJA (SOP)	110℃/W
Thermal Resistance θJC (SOP)	30℃/W

Absolute Maximum Ratings

Parameter	Value
VIN ,OVP to GND	-0.3V to 33V
CS,FB,COMP, PWM to GND [2]	-0.3V to 7V
DRAIN to CS (100V Mos) [3]	-0.3V to 100V
Operating Ambient Temp. T_A	-40℃ ~ 85℃
Operating Junction Temp. T_J	-40℃~ 150℃
Min/Max Storage Temp. T_{stg}	-55℃ ~150℃
Lead Temp. (10 Sec)	260℃

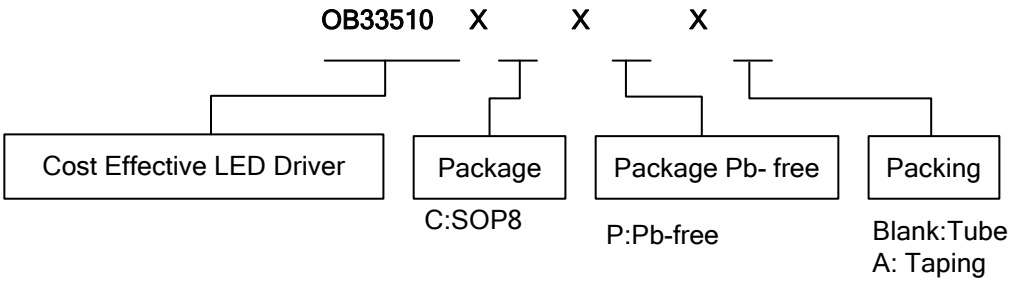
Note1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

Note2: Rating value refers to DC only. For small duty cycle pulse in less than 100ns in one period (typical 8.33us), negative spike value is relaxed to -5V.

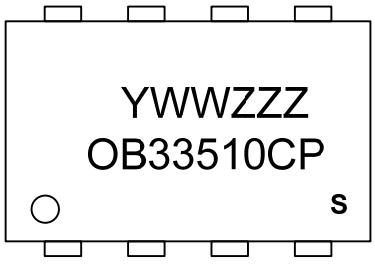
Note3: Rating value refers to DC only. For small duty cycle pulse in less than 50ns in one period (typical 8.33us), negative spike value is relaxed to -3V.

Recommended Operating Range

Parameter	Value
Vin Voltage	9V to 30V
PWM to analog Dimming Frequency	5KHz to 50Khz



Marking Information



Y:Year Code
WW:Week Code(01-52)
ZZZ:Lot Code
C:SOP8 Package
P:Pb-free Package
S:Internal Code(Optional)

TERMINAL ASSIGNMENTS

No.	Name	I/O	Pin Function
1	OVP	I/O	Over voltage protection sense input
2	PWM	I/O	PWM signal input pin for analog dimming control
3	VIN	Power	Power supply input
4	DRAIN	I/O	Built in MOS drain pin
5	CS	I/O	Current sense input
6	GND	GND	Ground
7	FB	I/O	LED current feedback input
8	COMP	I/O	Boost converter loop compensation pin

Functional Block Diagram

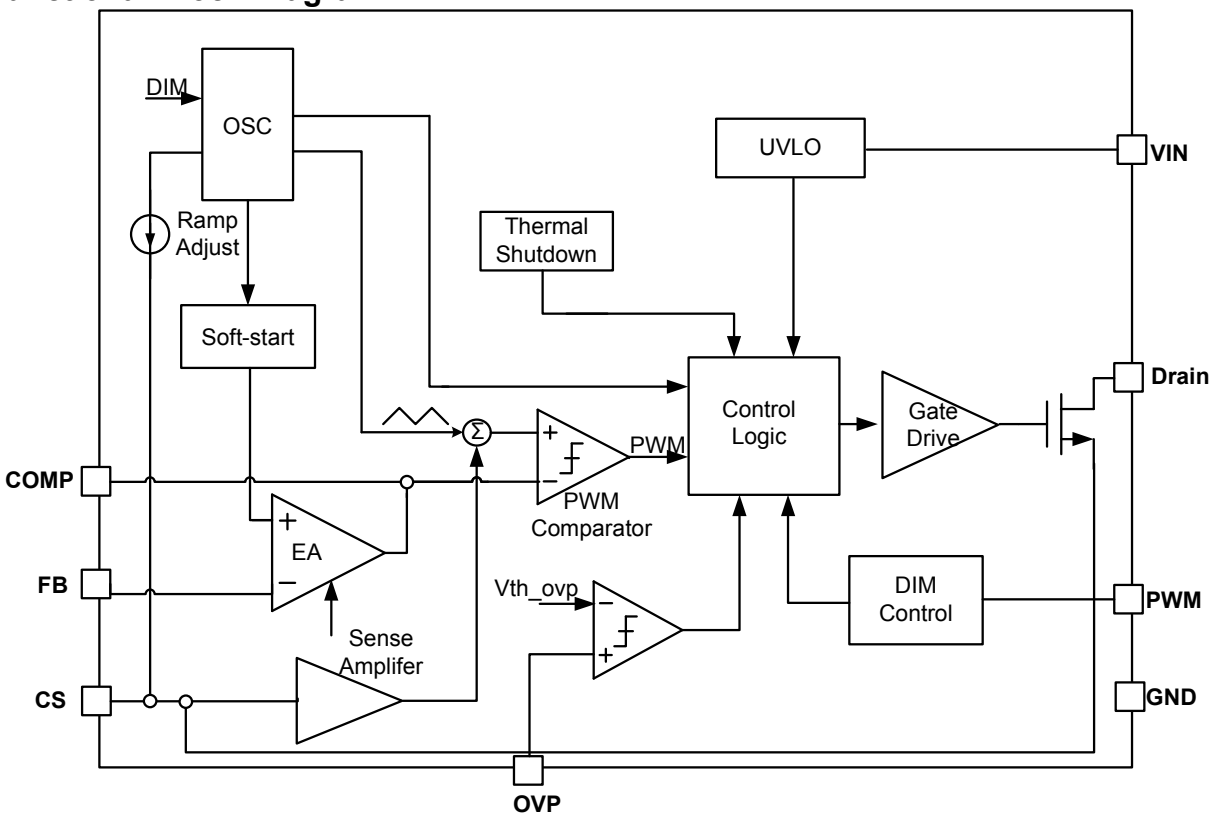


Figure2. OB33510 Functional Block Diagram

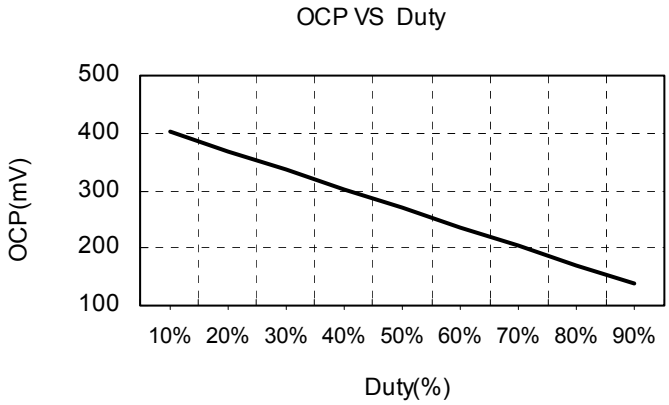
Electrical Characteristics

VIN=12V,PWM=5V, T_A=25℃, if not otherwise noted.

Parameter	Symbol	Conditions	Min	Typical	Max	Units
Current Consumption						
Input voltage range			9	-	30	V
Operating supply current	I_{VDD}	VIN=12V,PWM=5V	-	4.5	5.5	mA
Stand by current	I_{VDD_STB}	PWM low >20ms sleep mode	-	130	180	uA
VDD UVLO						
UVLO	UVLO(OFF)		7.8	8.3	8.8	V
UVLO Hysteresis	UVLO(Hys)			800		mV
Soft start						
Soft start slope	I_{sst_slop}			22		mV/ms
PWM Control						
Operating frequency	F_{OSC}		110	120	130	KHz
Max duty cycle	D_{max}		93	95	97	%
Error Amplifier						
Reference voltage	V_{ref_ea}	PWM Duty=100%	392	400	408	mV
		PWM Duty=50%	194	200	206	mV
		PWM Duty=30%	116.4	120	123.6	mV
Open loop voltage gain	A_m			70		dB
Transconductance of EA	Gm			100		uA/V
Output source current	I_{source}			40		uA
Output sink current	I_{sink}			60		uA
PWM to analog Dimming Control						
PWM duty			0	-	100	%
PWM Logic input level	high		2.6			V
	low				0.9	V
Protection Threshold						
OVP	$V_{OVP\ OV}$	Threshold of output over voltage	1.9	2.0	2.1	V
OCP[3]	V_{th_OCP}	Threshold of over current protection (duty=80%)	102	170	238	mV
OCP debounce time[4]	$t_{de\ OCP}$				40	ns
OTP ON[4]	T_{OTP_ON}			160		℃
CS high protection threshold	VTH_CS	Diode or Inductor short	0.8	0.95	1.1	V
CMP high protection threshold	VTH_CMP	FB short to GND	2.9	3.2	3.5	V
OVP UVLO threshold	$V_{OVP\ UV}$	Normal operation		250		mV
		System startup		150		mV

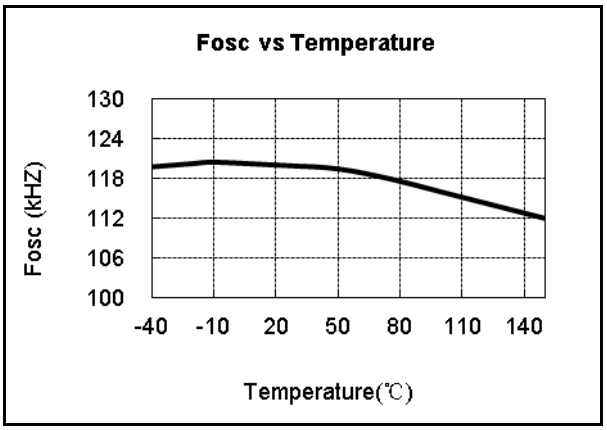
Power MOSFET Section						
Parameter / **Product**	**BVdss(V)** MOSFET Drain-Source Breakdown Voltage			**Rds,on(mΩ)** On resistance (Id=10A)		
	Min	Typ.	Max	Min	Typ.	Max
OB33510	100				100	

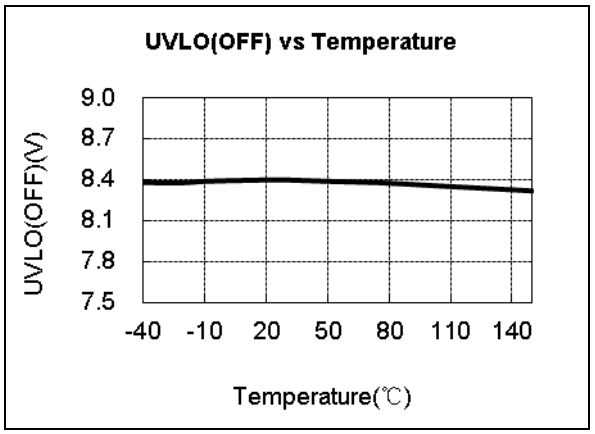
Note3： OCP vs duty cycle

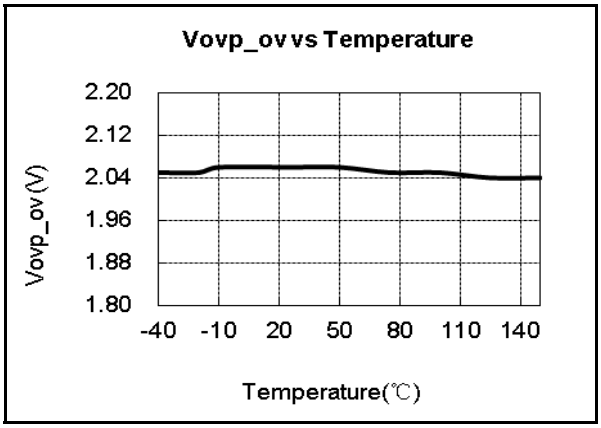


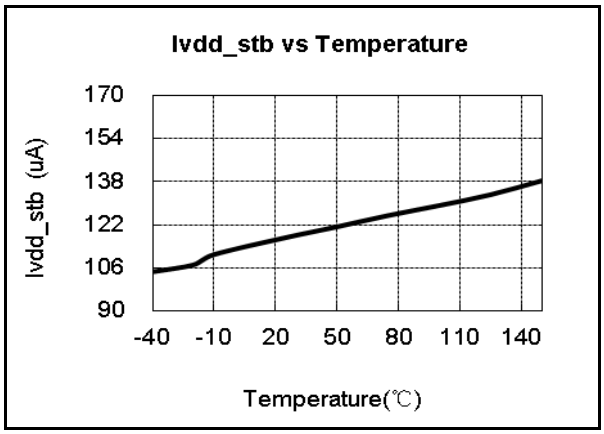
Note4： Guaranteed by design

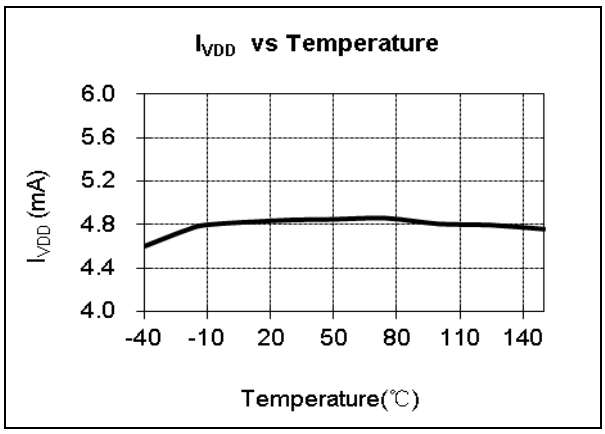
CHARACTERIZATION PLOTS

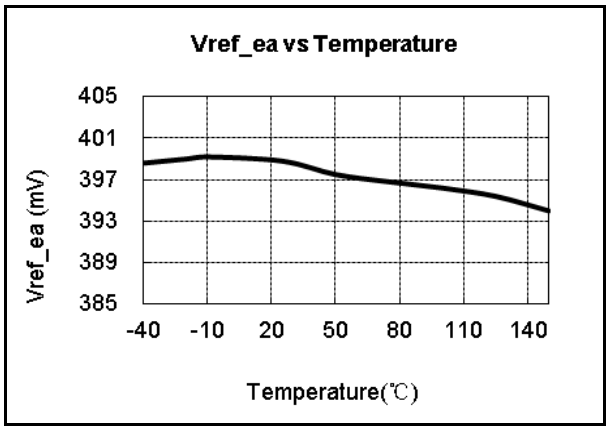


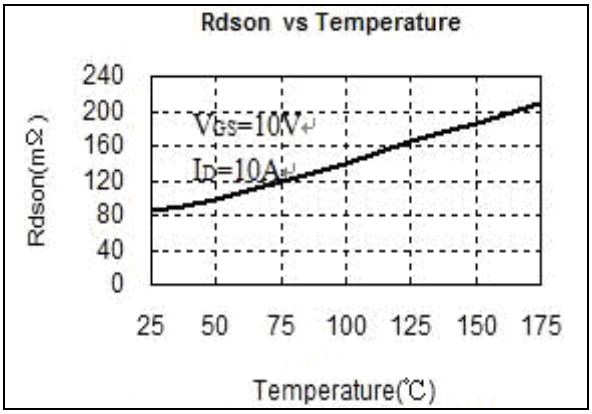












Function Description

General Operation

The OB33510 is a build-in Power MOSFET for boost DC-DC converters in a constant frequency mode . The MCM implements a peak current mode control scheme and an internal transconductance amplifier to accurately control the output current over a wide input and load conditions.

Low frequency PWM dimming input that can accept an external control signal with a duty ratio of 1%-100%.

OB33510 offers comprehensive protection features to protect the system in various fault conditions such as LED open protection, output over voltage protection (OVP), the cathode of LED short to GND protection(CMP high), Diode & Inductor short protection(CS high). The cycle-by-cycle current limit function limits the maximum current flowing through the build-in MOSFET. The over temperature protection ensures that the system will not run into condition of thermal runaway and blow up.

Startup

OB33510 is enabled by applying a voltage of greater than approximately 2.5V to PWM pin. An on-chip internal 220KΩ pull down resistor is inserted between PWM pin and ground. When the first rising edge is applied to PWM input, the OB33510 will power up immediately, and remains power up until the PWM input is lower than 1.3V for at least 20ms(typical), at this time the chip will enter standby mode. At standby mode, the power of theOB33510 will be lower than 130uA (typical).

Once OB33510 is enabled the internal 5V regulator will be activated to source a current less than 6mA to the whole chip.

When PWM is active high, the OB33510 checks the topology connection first. The chip monitors the OVP pin to see if the Schottky diode (boost diode) is connected or the boost output is short to GND, if the voltage at OVP pin is lower than 150mV, the output will be disabled. The OB33510 will also check other faults (UVLO, CS high, CMP high, FB high, OCP and OTP), if there is no fault, then the boost converter will boost up the output with the internal soft start.

UVLO

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

LED Current Regulation

The LED current is sensed by current sense resistors connected between pin FB and GND

The sensed error signal is amplified and compared to the CS pin sensing current signal plus the slope compensation to determine the on-time of the switching MOSFET. The error amplifier sources or sinks the current to the COMP pin to adjust the required inductor current as the load changes. The slope-compensation signal is added to the current-sense signal to improve the stability at high duty cycles.

The error amplifier reference is set by internal reference voltage and the PWM duty cycle at PWM pin.

The average LED current is approximated by the following equation；

$$I_{LED}[mA] = \frac{400 * DUTY_{PWM}[mV]}{R_{FB}[\Omega]}$$

At light loading, the OB33510 automatically skips some pulses to improve efficiency and prevent over charging the output capacitor. In this pulse-skipping mode, the inductor current ramps up for a minimum on-time (typical 360ns), then deliver the stored energy to the output. The switch remains off until another pulse is needed to boost the output voltage.

Dimming Control

The LED brightness is controlled by the PWM signal at PWM pin which has different duty cycle. OB33510 can accept an external PWM signal to PWM pin in the range of 5KHz to 50KHz with a swing voltage of 0V to a level greater than 2.6V.

A internal square wave whose duty cycle is the same as the duty cycle of the external PWM signal to PWM pin is filtered to provide reference voltage of EA input which determines the FB reference.

Slope Compensation

The OB33510 uses a current mode control scheme. The main advantages of current mode control are inherent cycle-by-cycle current limit for the switch and simpler control loop characteristics. However, current mode control has an inherent instability for duty cycles greater than 50%, which is also called sub-harmonic oscillation. The OB33510 has a build-in slope compensation to avoid sub-harmonic oscillation.

LED open Protection

OB33510 shuts down the output if the output voltage is higher than the predetermined threshold level. In case of LED failing, the current of LED and the resulted voltage drop on sensing resistor is nearly zero; the converter will run at maximum duty cycle that boosts the output voltage to a very

high level. To prevent this happen, the output voltage is monitored through Pin OVP and converter is shut down if the output voltage exceeds the predetermined level. This protection is latched and OB33510 can be reset from VIN or PWM.

LED cathode short to GND Protection

When LED cathode is shorted to GND, the boost converter will continuously increase the output to OVP to shut down output. But in some condition, if the output is power limited by OCP protection before the output reach the OVP voltage, the OB33510 can never be turned off, in this case large current will go through both Schottky diode and build-in MOSFET, and cause permanent damage. OB33510 will monitor the voltage on COMP pin, if the voltage on COMP pin is continuously greater than 3.2V (typical) for 37ms (typical). The OB33510 will latch shut down for the safe propose.

Diode & Inductor Short Protection

When the Schottky diode or the inductor shorts, the current of the build-in MOSFET increasing significantly, which will cause the MOSFET permanent damage if the IC is continuously working. OB33510 will monitor the voltage on CS pin voltage cycle by cycle, if the voltage on CS pin is greater than 0.9V (typical) for continuous 17 cycles(typical 141.67us).The OB33510 will latch shutdown to prevent the MOSFET from permanent damage.

VOUT Short Protection

VOUT short condition is monitored by the voltage at pins OVP. During normal operation, when the voltage at OVP pin drops below a threshold of approximately 0.25V (typical), the VOUT-short protection function is activated and the build-in MOSFET is turned off.
This state is latched and can be reset from VIN or PWM.

Thermal Shut down

The OB33510 includes a thermal protection circuit. When the junction temperature exceeds 160℃ (typical), the OB33510 latch shut down.

Reference Application

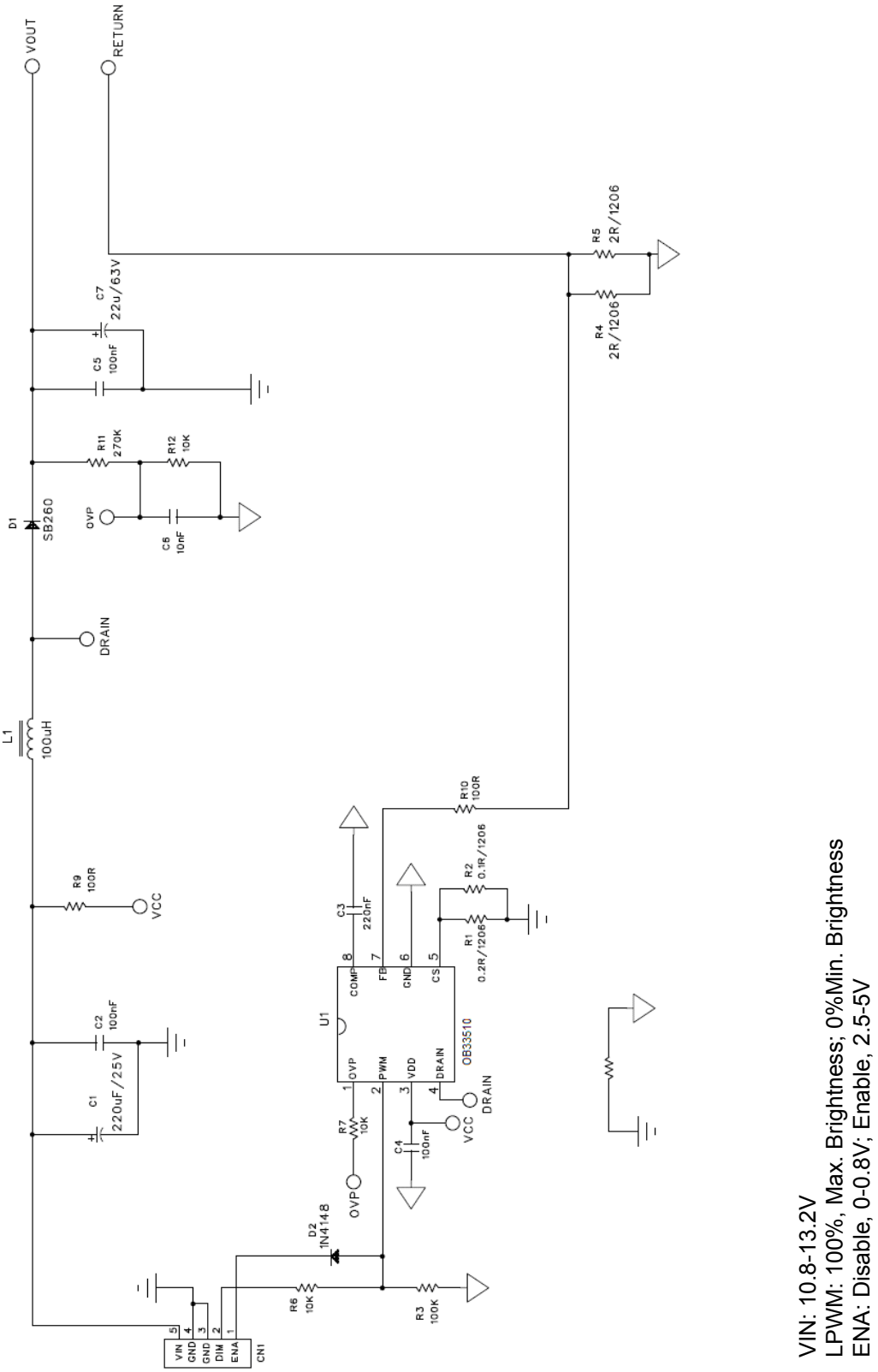
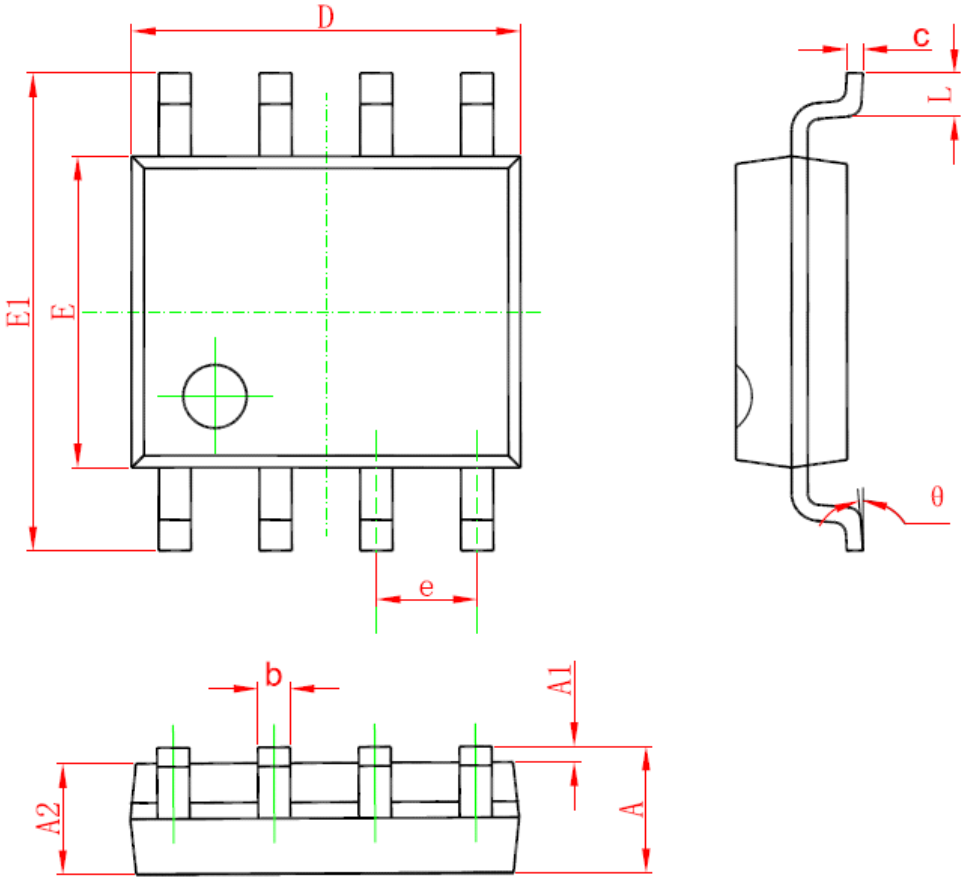


Figure3. OB33510 for PWM to analog dimming Reference Application Schematic

PACKAGE MECHANICAL DATA

SOP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	4.700	5.150	0.185	0.203
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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