FEATURES

- Current Mode PWM Controller with Good Dynamic Response
- 10V to 35V Input Voltage Range
- External PWM Dimming Mode
- Over Voltage Protection
- Over Current Protection
- Under Voltage Lockout (UVLO)
- Thermal Shutdown

APPLICATION

- LCD Monitor
- LCD TV
- Flat panel display

The HM3350 is offered in SOP-8 Package.

GENERAL DESCRIPTION

HM3350 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 HM3350 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 200mV, the error is amplified to control the pulse width of the power switch thus to regulate the current flowing the LED.

The HM3350 offers external low frequency PWM (LPWM) dimming method for a wide range of dimming control.

The HM3350 offers comprehensive protection such as power MOSFET over current protection (OCP), output over voltage protection (OVP), IC power supply under voltage lockout (UVLO), and LED open protection.
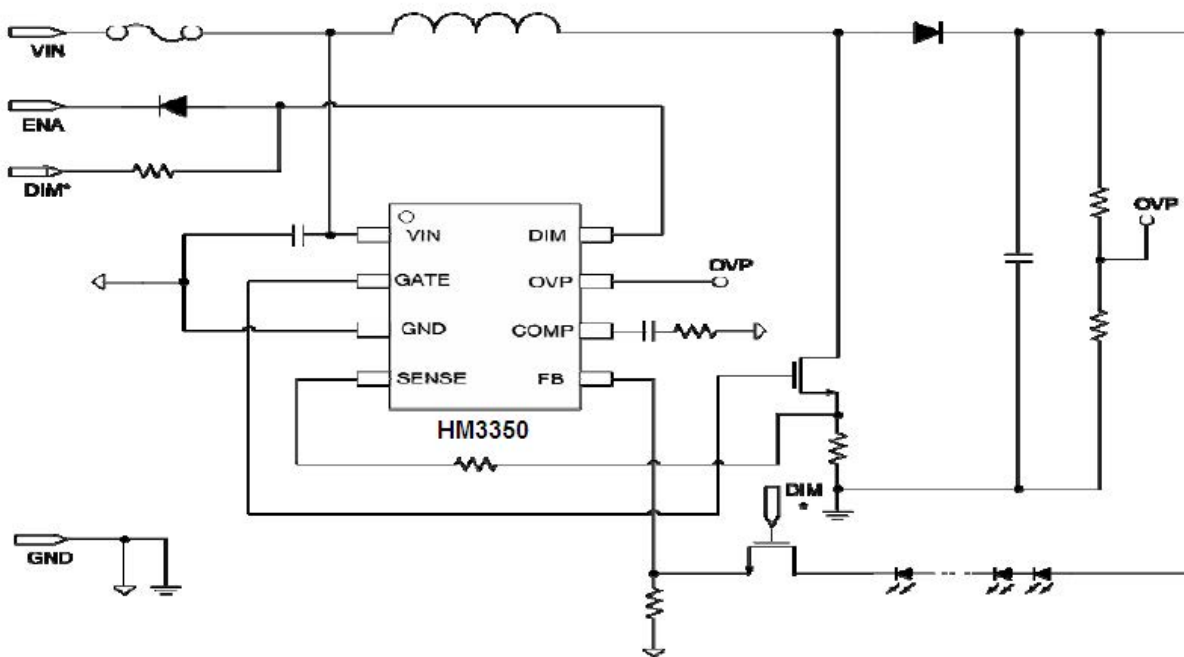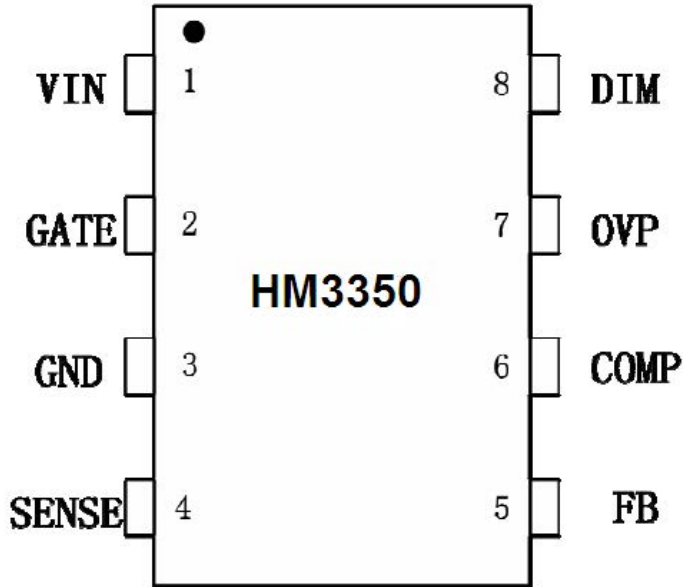
Typical Application

Figure1   HM3350 Typical Application schematic

Pin Configuration

TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	VIN	P	Power Supply
2	GATE	O	Gate Driver Output Pin
3	GND	P	Ground
4	SENSE	I	Current Sense Input
5	FB	I	LED Current Feedback Input
6	COMP	I	Boost Converter Loop Compensation Pin
7	OVP	I	Over Voltage Protection Sense Input
8	DIM	I	External PWM Dimming Control

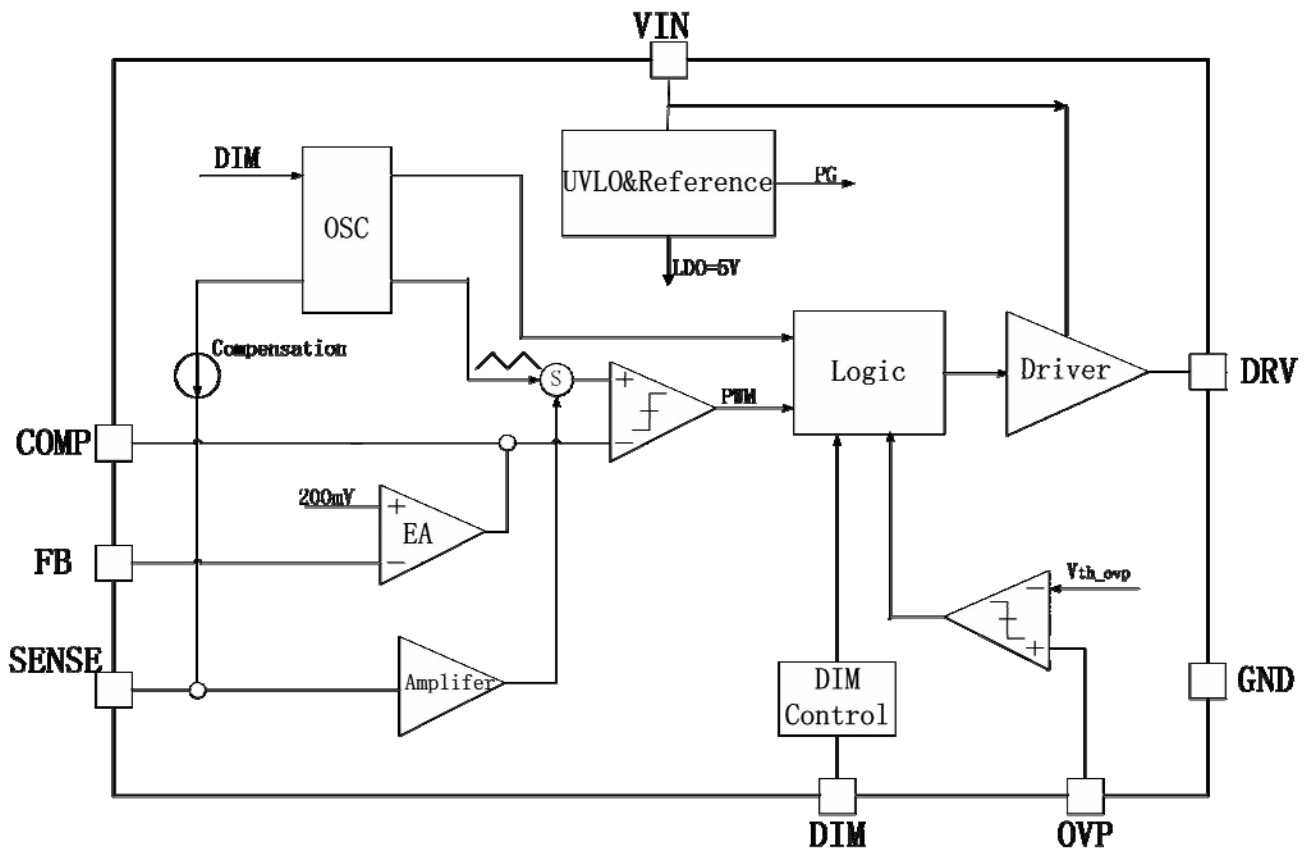# Functional Block Diagram

Figure2   HM3350 Functional Block Diagram

ELECTRICAL CHARACTERISTICS

(VDDH= 12V, PWM= 5V, T_A= 25°C, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Current consumption						
Input voltage			10	-	35	V
UVLO(on)			7.5	8.5	9.5	V
UVLO(off)			9	10	11	V
Istandby	Stand by Current	DIM low >50ms			400	uA
Ioperation	Operation Current	Vin=12V,PWM=5V	-	2.5	3	mA
Soft start						
I_{sst_op}	Soft start slope			400		mV/mS
PWM Control						
F_{OSC}	Operating frequency		175	200	225	KHz
Duty	Maximum duty cycle		93	95	97	%
PWM(high)		High level			2.5	V
PWM(low)		Low level	1.3			V
Error Amplifier section						
V_{REF_EA}	Reference voltage for EA	Reference voltage at non-inverting input	194	0.2	0.206	V
A_m	Open loop voltage gain			80		dB
G_m	Transconductance of EA		80	100	120	uA/V
I_{source}	Output source current		16	20	24	uA
I_{sink}	Output sink current		48	60	72	uA
Protection Threshold						
Vth_ovp	OVP voltage	Threshold of over voltage output	1.8	2	2.2	V
V_{TH_OCP}	OCP	Threshold of over current protection (duty=90%)		330		mV
T_{OTP_ON}	OTP ON		140	160	180	ºC
T_{OTP_OFF}	OTP OFF		120	140	160	ºC
Tdetect	Connect detect time			1		mS
V_{OVP_UVLO}	OVP UVLO threshold	Normal operation		200		mV
		System startup		100		mV
Gate Driver Output						
T_{rise}	Gate rise time	500pf load	-	40	80	nS
T_{fall}	Gate fall time	500pf load		20	40	nS

Function Description

General Operation

The HM3350 is a LED driver designed for boost DC-DC converters in a constant frequency mode. The controller implements a peak current mode control scheme and an internal GM 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%. HM3350 offers comprehensive protection features to protect the system in various fault conditions such as output over voltage protection, boost diode disconnection protection and output short circuit protection. The cycle-by-cycle current limit function limits the maximum current flowing through the external MOSFET. The over temperature protection ensures that the system will not run into condition of thermal runaway and blow up.

UVLO

An under-voltage lockout protection feature with a hysteresis of about 500mv is provided for VIN. When the voltage at this pin exceeds a threshold of approximately 7.5V (typ), the IC starts the normal operation. If the voltage at this pin drops below a Threshold of approximately 7 (typ) V, the IC stops switching operation. The IC resumes switching operation when the voltage at pin VIN increases to a voltage above 7.5V.

Start up

HM3350 is enabled by applying a voltage of greater than approximately 2.5V to PWM pin. An on-chip internal 150k ohm pull down resistor is inserted between PWM pin and ground. When the first rising edge is applied to PWM input, also the pin of PWM is logic high, the HM3350 will power up immediately, and remains power up until the PWM input has been hold low for at least 50ms(typ), at this time the chip will enter sleep mode. At sleep mode, the power of the HM3350 will be lower than 400uA (typ).

Once HM3350 is enabled the internal 5V regulator will be activated to source a current less than 4mA to the whole chip.

When PWM is active high, the HM3350 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 100mV, the output will be disabled. The HM3350 will also check other faults (UVLO, OCP and OTP), if there is no fault, then the boost converter will boost up the output with the internal soft start.

LED Current Regulation

The LED current is sensed by current sense resistors connected between pin FB and GND. he 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 average LED current is approximated by the following equation:

$$I_{LED} \quad \frac{0.2}{R_{FB}}$$

At light loading, the HM3350 automatically skips some pulses to improve efficiency and prevent overcharging the output capacitor. In this pulse-skipping mode, the inductor current ramps up for a minimum on-time (typical 300ns), then deliver the stored energy to the output. The switch remains off until another pulse is needed to boost the output voltage.

Slope Compensation

The HM3350 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 HM3350 has a build-in slope compensation to avoid sub-harmonic oscillation.

When the duty cycle is greater than 50% and the inductance becomes less, the sub-harmonic oscillation increases. And for more flexibility slope compensation amplitude can be increased by adding one external resistor, RSL, in the CS path.

Figure 3 shows the setup. The externally generated slope compensation is then added to the internal slope compensation of the HM3350. A typical value of ICS is 40uA.
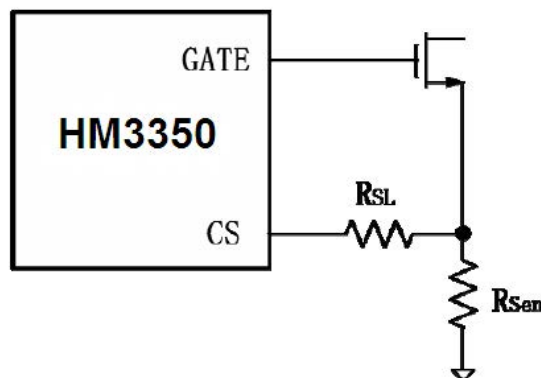

Figure 3

Its good design practice to only add as much slope compensation as needed to avoid sub-harmonic oscillation. Additional slope compensation minimized the influence of the sensed current in the control loop. With very large slope compensation the control loop characteristics are similar to a voltage mode regulator which compares the error voltage to a saw tooth waveform rather than the inductor current.

Dimming Control

The LED brightness is controlled by the PWM signal at DIM pin which has different duty cycle.HM3350 can accept an external PWM signal to PWM pin in the range of 100Hz to 1KHz with a swing voltage of 0V to a level greater than 2.5V. HM3350 provides a high performance dimming current linearly by DIM* driving MOSFET.

Thermal Shutdown

The HM3350 includes a thermal protection circuit.
When the junction temperature exceeds 160°C (typical), the controller and current sources shut down and do not restart until the junction temperature drops below 140°C.

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 0.2V, the VOUT-short protection function is activated and the GATE is turned off. This state is latched and can be reset from VIN or DIM.

OVP Protection

HM3350 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 HM3350 can be reset from VIN or PWM.

Package information

SOP8 PACKAGE OUTLINE DIMENSIONS
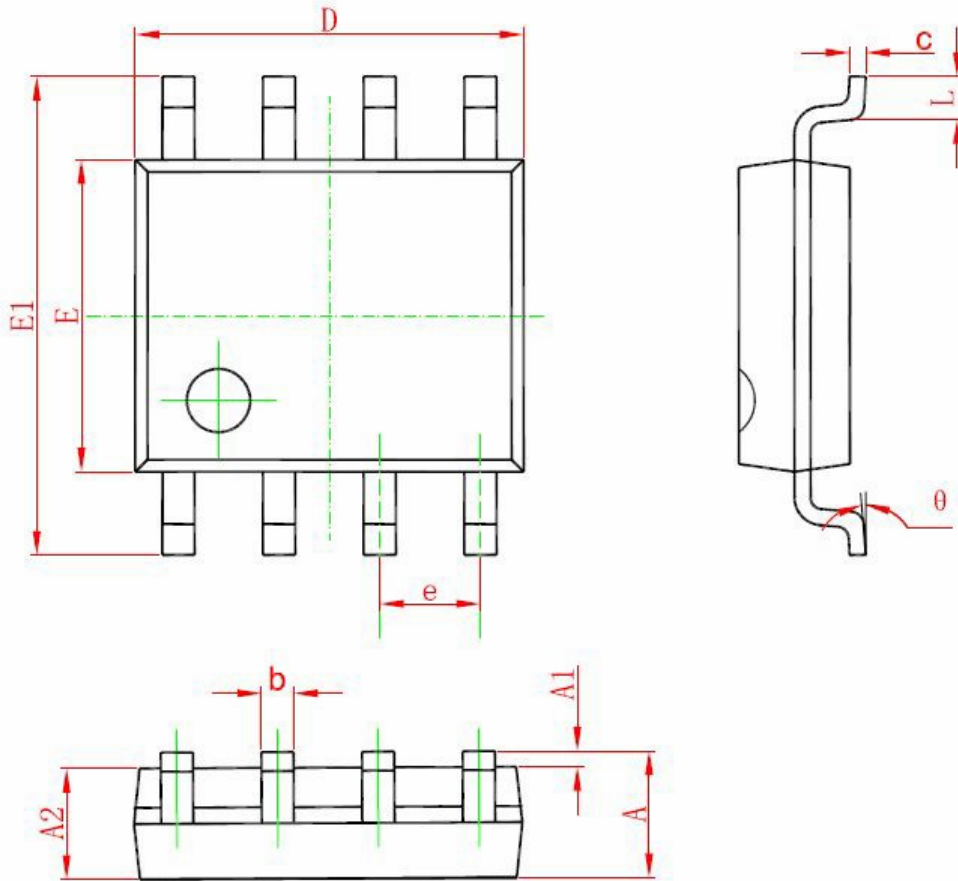
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	4.700	5.150	0.185	0.203
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270		0.050	
L	0.400	1.270	0.016	0.050
θ	0º	8º	0º	8º