

LED Backlight Controller

Features

- 7V to 27V input voltage range
- High power current mode DC/DC boost controller
- 100Hz to 1kHz Dimming Frequency
- Internal 5V/12V Voltage Regulator
- Programmable LED current
- Programmable Slope compensation
- Protections:
 - Open LED Protection (OLP)
 - Short LED Protection (SLP)
 - Switch Over Current Protection (OCP)
 - Output Over Voltage Protection (OVP)
 - Over Temperature Protection (OTP)
- SOP-10 Package
- RoHS Compliant

Applications

- LCD TV LED Backlighting
- LCD Monitor LED Backlighting

Ordering Information

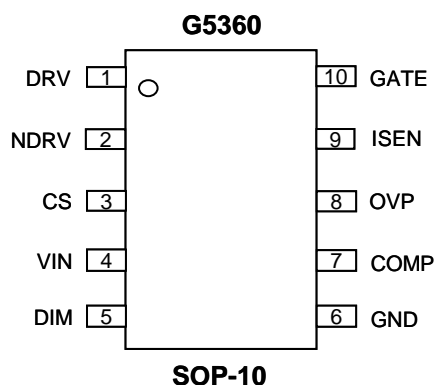
ORDER NUMBER	MARKING	TEMP. RANGE	PACKAGE (Green)
G5360PA1U	G5360	-40°C to +85°C	SOP-10

Note: PA: SOP-10

1: Bonding Code

U: Tube & Reel

Pin Configuration



General Description

The G5360 is a current mode LED driver and boost controller. The PWM DIM input not only drives the load PWM switch, but also enables NDRV switching and error amplifier operation. This feature provides extremely fast, true PWM load switching. External current sense resistor and slope compensation resistor make it flexible for various applications.

An ISEN pin is used for programming LED current. A high contrast ratio true PWM dimming can be achieved by driving DIM pin with a PWM signal. LED current is proportional to the DIM pin duty.

The G5360 features extensive protection functions that include OLP, SLP, OCP, OVP and OTP. It is available in a SOP-10 package.

Absolute Maximum Ratings

V_{IN}, DRV to GND -0.3V to +30V
 NDRV to GND -0.3V to V_{DRV}+0.3V
 GATE to GND -0.3V to V_{DRV}+0.3V
 DIM, CS, ISEN, COMP, OVP to GND . . . -0.3V to +6V
 Thermal Resistance Junction to Ambient, (θ_{JA})
 SOP-10 TBD

Thermal Resistance Junction to Case, (θ_{JC})
 SOP-10 TBD
 Operating Temperature Range -40°C to 85°C
 Junction Temperature 150°C
 Storage Temperature Range -65°C to 150°C
 Reflow Temperature (soldering, 10s) 260°C

Electrical Characteristics

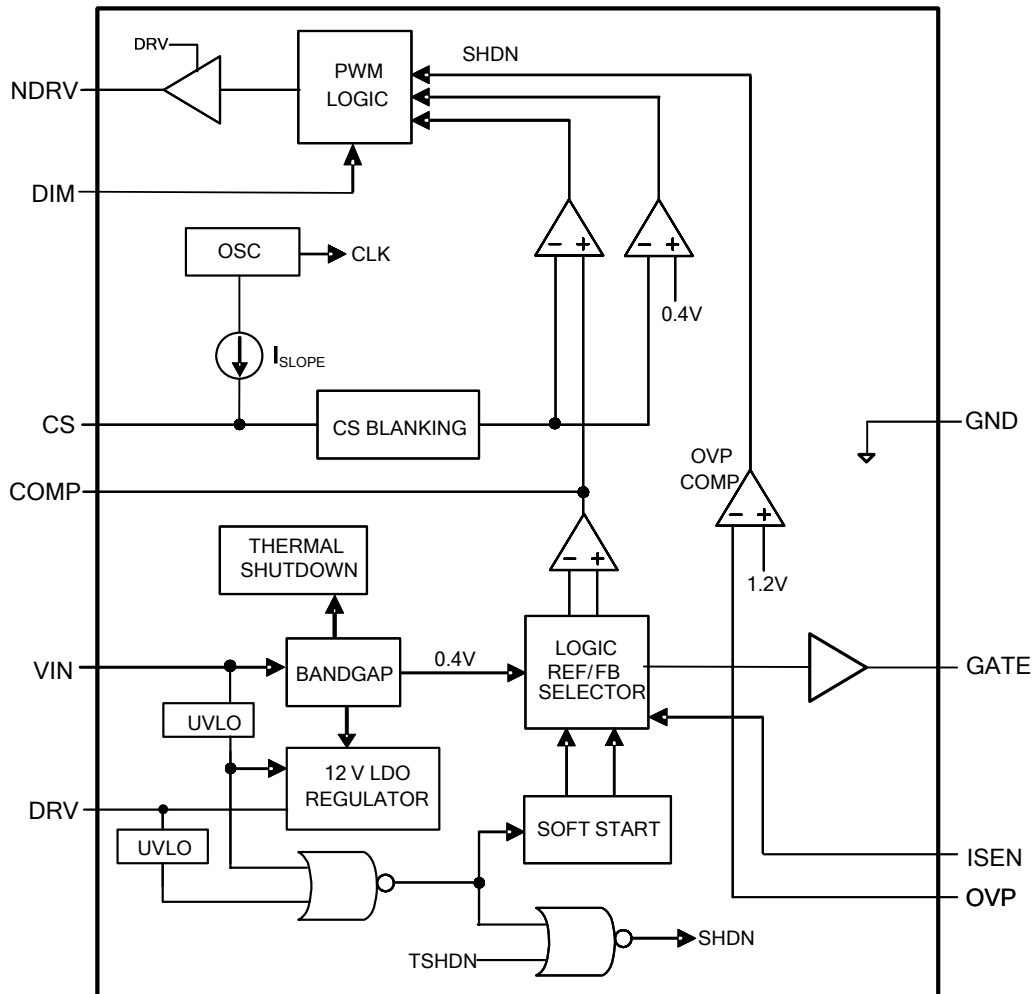
V_{IN}=12V, V_{DIM}=5V, T_A = 25°C

The device is not guaranteed to function outside its operating conditions. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified.

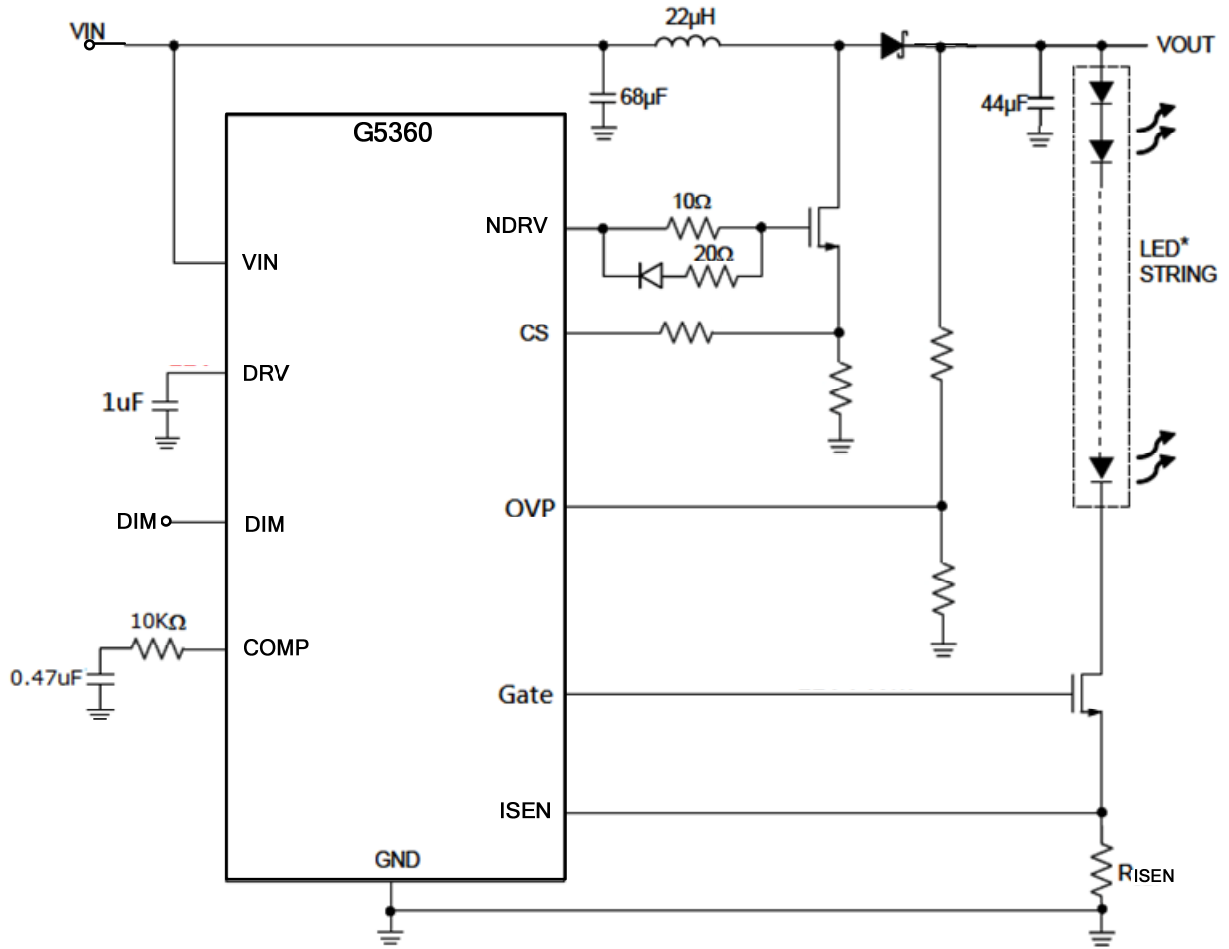
PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
IN Supply Voltage		7	---	27	V
IN Standby Supply Current	V _{DIM} =0V	---	---	160	μA
VIN UVLO Threshold		---	6	7	V
Internal Regulator Output DRV		---	12	---	V
OSCILLATOR					
Switching Frequency		-20%	200	+20%	kHz
Maximum Duty		85	90		%
Current Sense & Slope Compensation					
Current Sense Leading Edge Blanking		100	---	375	ns
PWM Duty Comparator Delay Time		---	50	---	ns
CS slope compensation	R _{SC} = 1kΩ	---	0.12	---	V
Current Limit Threshold		350	400	450	mV
ERROR AMPLIFIER					
ISEN Reference Voltage		388	400	412	mV
Transconductance		260	360	460	μA/V
MOSFET DRIVER					
NDRV Source Current	V _{IN} = 12V	---	300	---	mA
NDRV Sink Current	V _{IN} = 12V	---	500	---	mA
GATE Source Current	V _{IN} = 12V	---	15	---	mA
GATE Sink Current	V _{IN} = 12V	---	25	---	mA
Dimming					
DIM Input High Voltage		2	---	---	V
DIM Input Low Voltage		---	---	0.8	V
DIM Input Pull Low Current		---	2	---	μA
Protections					
OVP Threshold	V _{OVP} rising	-3%	1.2	+3%	V
SCP Threshold	V _{OVP} falling	---	100	---	mV
SLP Threshold	V _{ISEN} rising	550	600	650	mV
OTP Threshold		---	150	---	°C
OTP Hysteresis		---	20	---	°C

Pin Descriptions

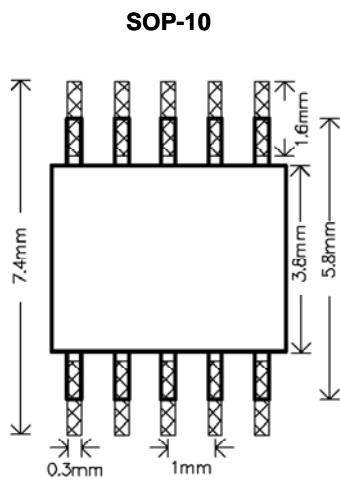
NAME	PIN	FUNCTION
DRV	1	Internal Controller 12V Power Pin. It must be bypassed with a low ESR capacitor to ground.
NDRV	2	Switching Gate Driver Output Pin. Controls the main n-channel MOSFET switch.
CS	3	Current Sense Pin. It is used to sense drain current of the main n-channel MOSFET switch
VIN	4	12V/24V Input Power Supply Pin.
DIM	5	PWM Dimming Pin. Default pulled low while floating
GND	6	IC ground
COMP	7	Loop Compensation Pin.
OVP	8	Over Voltage Sense Pin. When this pin reaches 1.2V, the NDRV and GATE output will be pulled down to ground.
ISEN	9	LED current Adjust Input. Connect a resistor(R_{ISEN}) from ISEN to GND to set the current through LED string (I_{LED}) according to the formula $I_{LED}=0.4/R_{ISEN}$ Connect ISEN pin to GND for unused.
GATE	10	Gate control pin of the n-channel load PWM switch.

Block Diagram


Typical Application Circuit



Minimum Footprint PCB Layout Section



Function Description

Power Sequence

As V_{IN} powered up to its UVLO threshold, the G5360 will enter standby mode. In standby mode, the G5360 receives DIM signal. The first DIM rising edge triggers G5360 to power on, and then the boost converter will follow internal soft start ramp to charge the output capacitor with minimized inrush current.

The G5360 start to normal operation by receiving the last appeared signal between VIN and DIM. Any sequence of VIN and DIM is acceptable.

DRV Regulator

DRV voltage regulator generates 12V voltage for NDRV driver circuit. It must bypassed using a low ESR MLCC to ground.

Boost Converter

The current mode PWM boost converter produces one output voltage needed to enable the LED stack to run at the programmed current. The feedback to the boost loop controller is taken from ISEN pin, which is regulated at 0.4V when normal operation.

Error Amplifier

The error amplifier regulates inductor current by comparing internal reference and the feedback of the boost converter. A 0.4V internal reference voltage is used to minimize the output voltage for better efficiency.

Once the dimming control stop LED current sinks, the error amplifier is also stop to control output voltage. Keep the output capacitors charge for the fast response of next dimming command.

Feedback Compensation

To make G5360 stable, loop compensation circuit must be considered. Control loop bandwidth in the boost converter is often determined by RHP (right-half plane) zero. It is calculated as:

$$f_{RHPZ} = \frac{(1-D_{MAX})^2 \times (V_{OUT}/I_{OUT})}{2\pi \times L}$$

A RHP zero increases the gain and also increase phase shift. To avoid this RHP zero, a loop bandwidth frequency (F_C) often choose to 1/5~1/10 below RHP zero.

When the F_C is determined, the R_{COMP} can be calculated as:

$$R_{COMP} = \frac{2\pi \times F_C \times C_{OUT} \times R_{CS}}{G_{M(EA)}}$$

R_{COMP} determines the high frequency gain and C_{COMP} determines the response time. R_{COMP} and C_{COMP} zero is often designed to cancel the output pole:

$$C_{COMP} = \frac{(V_{OUT}/I_{OUT}) \times C_{OUT}}{R_{COMP}}$$

Slope Compensation

Choosing a slope compensation which is at least one half of the down slope of the inductor current ensures that the converter will be stable for all duty cycles.

Slope compensation can be programmed by the resistor R_{SC} . Assuming a down slope (DS, unit: A/s) for the inductor current, the slope compensation resistor can be calculated as:

$$R_{SC}(\Omega) = \frac{0.5 \times DS \times T_S \times R_{CS}}{I_{SLOPE}}$$

Where $DS=(V_O-V_{IN})/L$, $I_{SLOPE}=120\mu A$ (typ.)

Program LED Current

The brightness should be set by choosing a R_{ISEN} resistor that sets the LED maximum current as:

$$I_{LED} = (0.4) / R_{ISEN}$$

LED Dimming Control

The G5360 features a DIM pin for the use of PWM dimming control. It accepts the PWM frequency range from 100Hz to 20kHz. But the minimum LED turn on time is determined by inductor current ramp speed, the reasonable limit is around 10 switching cycle time. Recommend using low frequency (100Hz~1kHz) PWM dimming control to obtain good linearity.

FAULT protection

The G5360 has built-in various protections: output over voltage protection (OVP), output short circuit protection (SCP), over current protection (OCP), short LED protection (SLP), open LED protection (OLP), and Over Temperature protection (OTP).

A. Open LED Protection (OLP)

When the LED string is open, the output will reach OVP threshold, then the G5360 turn off switching and the LED string. This LED string with fault condition is latched off until the re-start of G5360 by VIN or DIM.

B. Short LED Protection (SLP)

Short the LED string anode and cathode makes ISEN

pin feedback higher voltage than ISEN over voltage threshold, 0.6V in G5360. SLP will be activates to turn off the LED string with fault condition and it will be latched off until the re-start of G5360 by VIN or DIM.

C. Over Current Protection (OCP)

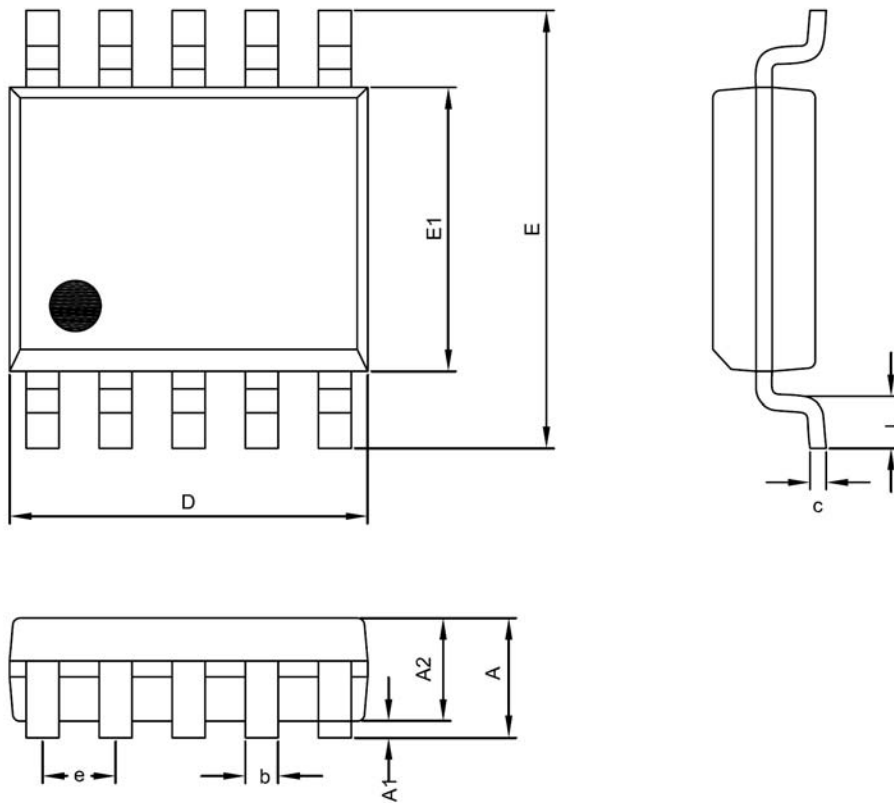
The boost converter features an OCP to protect external n-channel MOSFET from too much power and damage. The CS pin voltage is sensed and compare to 400mV when the turn on period of MOSFET. If V_{CS} exceed the threshold, the controller immediately turns off the MOSFET. It is operate every switching cycle.

D. Output Over Voltage Protection (OVP)

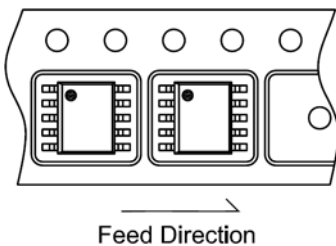
At the output reaches OVP threshold, the boost converter stop switching and turns off the LED string. It needs to re-start G5360 by VIN or DIM to remove this protection.

E. Over Temperature Protection (OTP)

An on chip thermal sensor is embedded to limit the device from thermal over load (temperature>150°C). When this condition is occurred, the G5360 stop switching and stop current sink until cooled down.

Package Information

SOP-10 Package

Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.35	1.55	1.75	0.053	0.061	0.069
A1	0.00	---	0.25	0.000	---	0.010
A2	1.15	1.35	1.50	0.045	0.053	0.059
D	4.80	4.90	5.00	0.189	0.192	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.153	0.157
c	0.19	0.23	0.27	0.007	0.009	0.011
b	0.30	0.38	0.45	0.012	0.015	0.018
e	1.00 BSC			0.039 BSC		
L	0.40	0.84	1.27	0.016	0.033	0.050

Taping Specification


PACKAGE	Q'TY/REEL
SOP-10	2,500 ea

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