Non-Isolated LED Power Switch with Active PFC

Features

- Inversed-Buck Topology
- Transition Mode Control
- High Power Factor Performance
- Cycle-by-Cycle Current Limit
- Accurate constant current
- High/Low Line Compensation
- Soft Driving for good EMI performance
- VCC Over Voltage Protection
- LED Open-circuit Protection
- LED Short-circuit Protection
- CS Short-circuit Protection
- Inductor Saturation Protection
- Internal Over Temperature Protection
- SOP-8 Package

Description

The GL26014 is a highly integrated, transition mode power switch with 600V internal power MOSFET for LED lighting application.

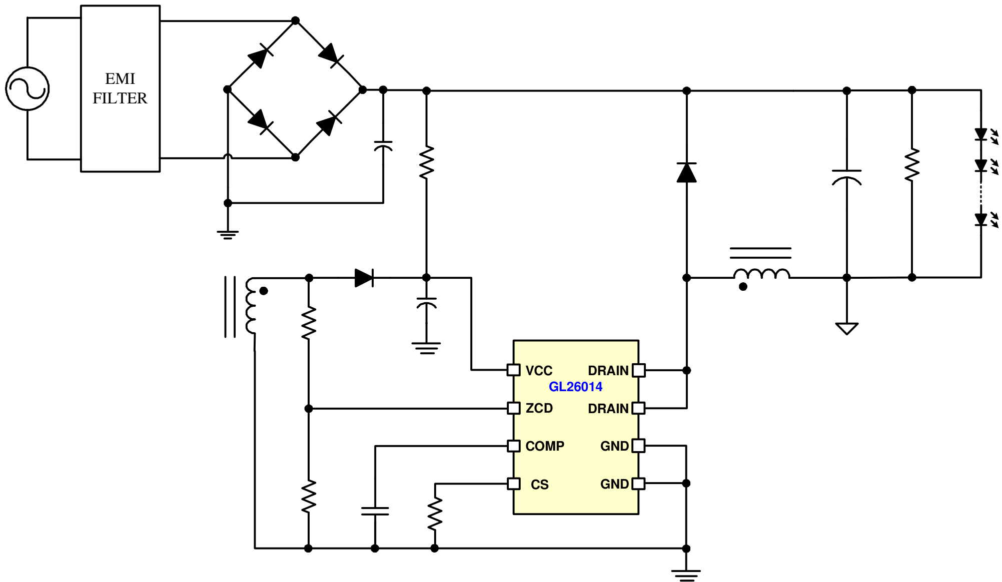
The integrated functions of VCC Over Voltage Protection, LED Open-Circuit Protection, LED short-circuit Protection, CS short-circuit protection, inductor Saturation Protection and internal Over Temperature Protection prevent the system from being damaged at abnormal conditions.

It minimizes the components counts and is available in the SOP-8 Package. Those make it an ideal solution for low cost LED lighting application.

Application

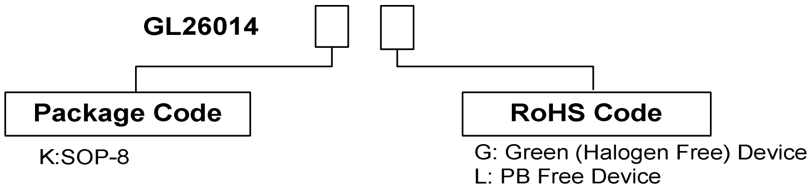
- E26/E27, T5/T8 LED lamp
- Other LED Lighting Application

Application Information

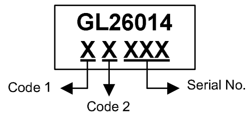


GL26014 Typical Application

Ordering and Marking Information



SOP- 8



Code 1	8	9	A	B	…	G	H	I	J
Year	2008	2009	2010	2011		2016	2017	2018	2019
Code 2	1	2	3	4		9	A	B	C
Month	Jan.	Feb.	Mar.	Apr.		Sep.	Oct.	Nov.	Dec.

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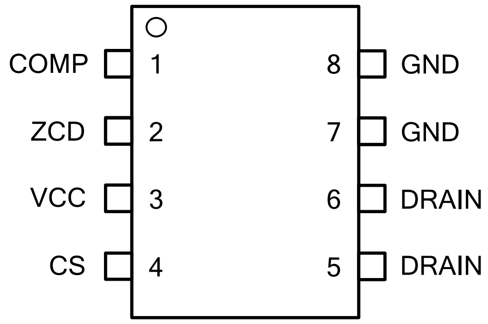
Pin Configuration



Pin Description

Pin No.	Name	Function
1	COMP	Voltage Feedback pin.
2	ZCD	Zero Current Detection pin.
3	VCC	Power supply pin.
4	CS	Current sense pin, connect to sense the power MOSFET current.
5,6	DRAIN	The DRAIN pin of the internal power MOSFET.
7,8	GND	Ground.

Absolute Maximum Ratings

Supply Voltage VCC -- -0.3 ~ 30V

COMP, CS, ZCD --- -0.3 ~ 7V

DRAIN Voltage --- -0.3~600V

Junction Temperature -- 150°C

Operating Ambient Temperature --- -20°C to 85°C

Storage Temperature Range --- -65°C to 150°C

Lead Temperature (Soldering, 10sec) -- 260°C

ESD Voltage Protection, Human Body Model --- 2.0 KV

ESD Voltage Protection, Machine Model --- 200 V

Recommended Operating Conditions

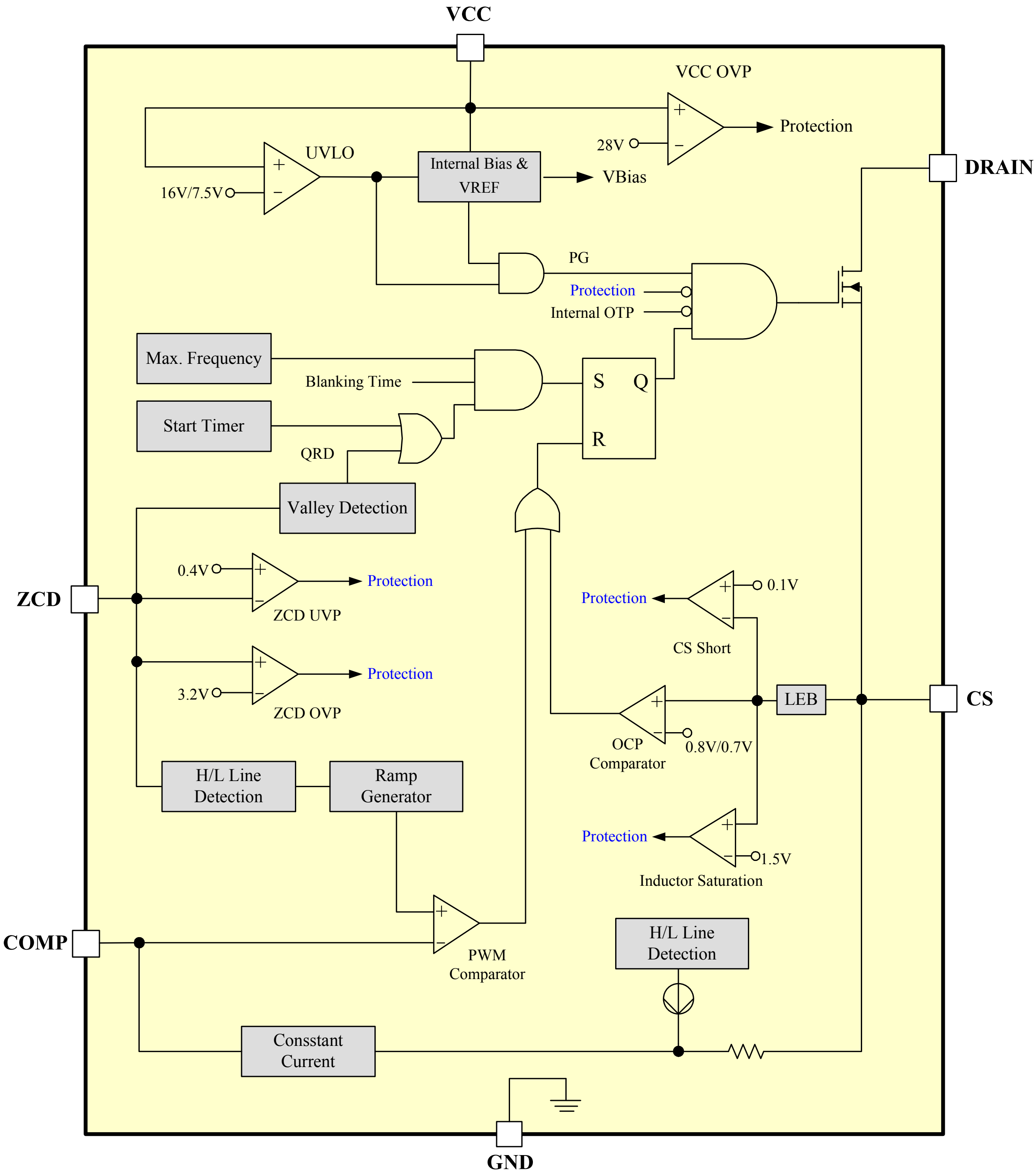
Item	Min	Max	Unit
Supply Voltage VCC	10	25	V
VCC capacitor	10	22	μF
COMP pin capacitor	0.47	1	μF
Operating Junction temperature	-20	125	℃
Operating ambient temperature	-20	85	℃

Note:

1. Grenergy does not recommended that the device operate under conditions beyond those specified in this table for extended period of time.
2. It's recommended that connecting VCC pin with a SMD type ceramic capacitor (0.1μF~0.47μF) to filter out the switching noise for stable operation.

3.The capacitors above should be located near the pin of IC as possible.

Block Diagram



Electrical Characteristics (VCC = 15V & TA = 25℃, unless otherwise specified.)

Parameter		Min	Typ	Max	Unit
VCC SECTION					
Start-Up Current	VCC=UVLO(on) - 0.1V		10	15	μA
Operating Current	Vcomp=0V, Fsw=20k @ Cload=1nF		1.20		mA
	Protection		1.00		mA
UVLO (on)		15.5	16.0	16.5	V
UVLO (off)		7.0	7.5	8.0	V
VCC OVP	Trigger Level	27	28	29	V
ZERO CURRENT DETECTION SECTION					
Upper Clamp Voltage	I_{DET}=100μA	4.90	5.20	5.50	V
Lower Clamp Voltage	$I_{DET=}$-1mA	0		-0.5	V
OVP trigger high level			3.20		V
OVP blanking time			2.50		μs
OVP de-bounce time	Continuous		4		cycle
Input Voltage Threshold	Arming (falling edge)		0.1		V
	Reset (rising edge)		0.3		V
Start Timer Period(Fst)	After start-up		150		μs
	At start-up		50		μs
	Duration		10		ms
Maximum Frequency			125		kHz
Line Compensation	Trigger current I_{ZCD}		240		μA
	Hysteresis		30		μA
	De-bounce		16		cycle
ZCD short protection	Threshold		0.40		V
	Blanking after Gate off		2.50		μs
	Blanking time after UVLO(on)		60		ms
	De-bounce time		20		ms
CURRENT-SENSE SECTION					
Input Impedance		1			MΩ
Peak Current Limitation	Low line		0.80		V
	High line		0.70		V
Inductor saturation protection	Peak current level		1.50		V
	De-bounce		4		cycles
Leading Edge Blanking			250		ns
H/L line compensation current	I_{ZCD}=540μA		135		μA

(Linear)	I_{ZCD}=0μA		5		μA
CS short protection	Trigger Level		100		mV
	Blanking time after UVLO(on)		60		ms
	De-bounce time		30		ms

ERROR AMPLIFIER (COMP pin)

Reference Voltage		-2.5%	200	+2.5%	mV
Trans-conductance	I_{source}		30		μA
	I_{sink}		30		μA
Open Loop Voltage		5.0	5.3	5.6	V
On Time	Vcomp=4V(Low line)		21.83		μs
	Vcomp=1V(Low line)		3.08		μs
	Vcomp=4 V(High line)		10.92		μs
	Vcomp=1V(High line)		1.54		μs
Min. On Time	Vcomp=0.5V		400		ns

MOSFET SECTION

BVdss	Vgs=0V	600			V
Rds(on)	4A MOSFET		1.9		Ω

ON-CHIP OVER TEMPERATURE PROTECTION

OTP Triple level(*)	Shutdown		140		℃
			20		℃

*：Design guarantee

Application Information

■ Overview

The GL26014 is a highly integrated, transition mode non-isolated buck controller with high power factor and good THD performance for LED lighting application.

The integrated functions of VCC Over Voltage Protection, LED Open-Circuit Protection, LED short-circuit Protection, CS short-circuit protection, inductor Saturation Protection and internal Over Temperature Protection prevent the system from being damaged at abnormal conditions. The following are the major features of GL26014.

■ UVLO (Under Voltage Lockout)

An UVLO comparator with hysteresis is implemented in GL26014. Once VCC rise up to UVLO(on), the internal blocks start to work. And they stop to work as VCC drops down to be lower than UVLO(off). The level of UVLO(on) and UVLO(off) are designed as 16.0V and 7.5V respectively as shown in Fig.1.

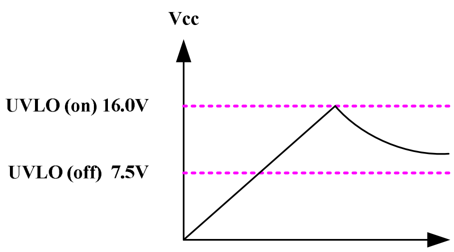


Fig.1

■ Zero Current Detection (ZCD)

To be operated at transition mode, the current flows through the transformer should be detected exactly. A typical ramp generator and ZCD block shown in Fig.2 are adopted to implement the function.

The current flows though the transformer starts to decrease at the instant when the output driver is turned off and decreases to zero gradually for the duration of the energy transference to output.

The Zero Current Detection block detects the current above to drive the MOSFET through the auxiliary winding signal which is the reflection of main winding signal.

As the level of ZCD pin dropped to be less than 0.1V, the current flows through the transformer will be also less than zero. At the same time, the ZCD comparator will be active high to set the SR flip-flop in ZCD block. After a short delay time, the output driver will be turned on to drive the MOSFET. After the turn-off of the MOSET, the level of ZCD start to rise. And the comparator will be reset as the level of ZCD is higher than 0.3V. It accomplishes the turn-on state of transition mode operation.

Furthermore, there is a 150μs timer generating the set signal for start-up and the robustness of the operation. Fig.2 shows the ZCD waveform at normal operation.

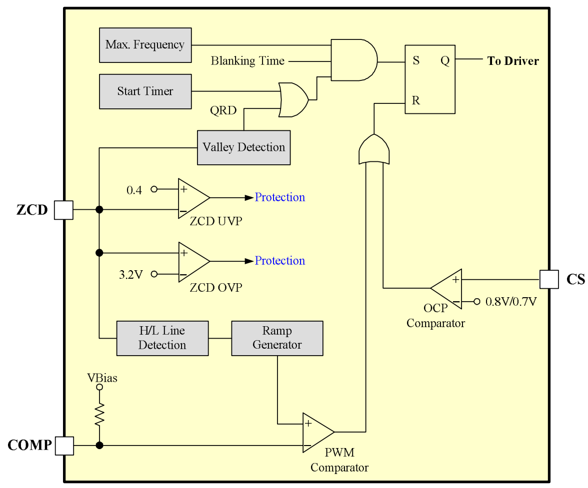


Fig.2

■ High/Low (H/L) Line Detection

The GL26014 features H/L line detection to adjust the compensation on current sense and the slope of ramp generator. Fig.3 is the auxiliary winding circuitry that shows how the H/L line detection function works.

There is a current sinking from ZCD pin to GND pin through the resistor R_{up} at the turn-on state of the MOSFET. The current, I_{ZCD} , determined by input voltage and R_{up} is the criterion to distinguish the input condition between low line and high line. If I_{ZCD} is larger than the trigger point $I_{ZCD,trigger}$, the input status will be regard as high line condition. And the following are the setting of Rup and Rdn.

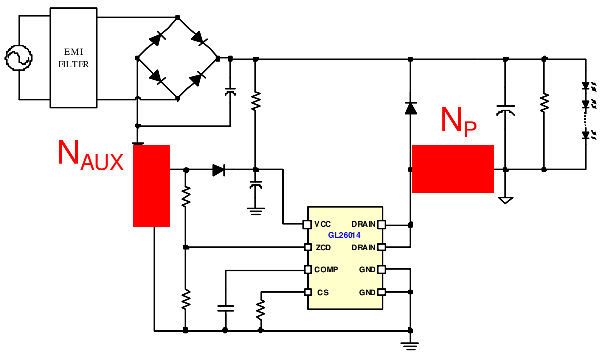


Fig.3-1

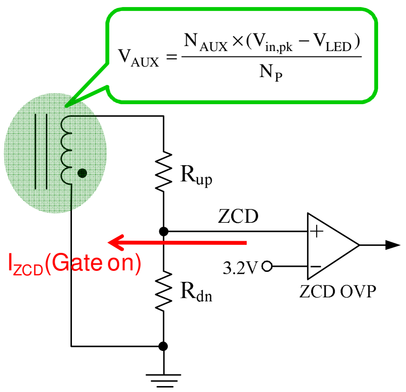


Fig.3-2

(1)H/L Line Setting

$$I_{ZCD} = \frac{V_{AUX}}{R_{up}} = \frac{N_{AUX} \times (V_{in,pk} - V_{LED})}{N_P \times R_{up}}$$

$$\Rightarrow R_{up} = \frac{N_{AUX} \times (V_{in,pk} - V_{LED})}{N_P \times I_{ZCD}}$$

For GL2001, the trigger point of High line is $240\mu A$

$$\Rightarrow R_{up} = \frac{N_{AUX} \times (V_{in,trigger}\sqrt{2} - V_{LED})}{N_P \times 240\mu A} (V_{in} > V_{in,trigger} \Rightarrow \text{High line})$$

(2)LED Open Setting

$$\frac{(V_{LED} + V_F)}{V_{AUX}} = \frac{N_S}{N_{AUX}} \Rightarrow V_{AUX} = \frac{(V_{LED} + V_F) \times N_{AUX}}{N_S}$$

For GL2001, the OVP setting level is 3.2V

$$\Rightarrow \frac{(V_{OVP} + V_F) \times N_{AUX}}{N_S} \times \frac{R_{dn}}{R_{up} + R_{dn}} = 3.2V (V_{LED} > V_{OVP} \Rightarrow OVP)$$

■ H/L line Compensation

According to the H/L line information above, the slope of ramp generator for low line is different from the one at high line condition. There are two reasons for using a higher slope of ramp at high line condition. One reason is that a higher slope of ramp will lead to a higher level of comp pin on account of the energy conservation. And the higher the comp pin level, the lower the risk of abnormal condition. The other reason is that it will reduce the level difference between low line and high line condition which leads to a better performance for input transient response.

The compensation current on current sense pin, $I_{CS,COMP}$, sinks from CS pin to GND thru a 125Ω resistor and sense resistor at the turn-on state of the MOSFET. Therefore, there is a tiny compensation on current sense pin which is a good compensation on output current accuracy. The following table is the relationship between I_{ZCD} and $I_{CS,COMP}$.

I_{ZCD}(μA)	$I_{CS,COMP}$(μA)
<240	5
>240	¼ I_{ZCD}

Table 1

■ **LED Open-circuit Protection**

For primary-side regulation topology, the output voltage is reflected by the auxiliary winding. By detecting the status of ZCD pin, we can easily monitor the abnormal condition and protect the system from being damaged. Once the LED open-circuit condition occurs, the level of output will rise up rapidly and so does ZCD pin. As shown in Fig.4, if the level of ZCD pin is higher than 3.2V for several switching cycles, the LED open-circuit protection will be triggered and VCC will be discharged by internal current source. As VCC drops down to the level of UVLO(off), the controller will shut down and VCC will be charged again.

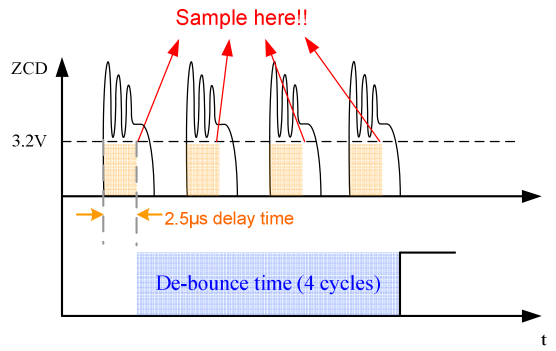


Fig.4

■ **LED Short-circuit Protection**

Once the LED short-circuit condition occurs, the voltage of auxiliary winding will be clamped to zero as the output voltage. The auxiliary winding can't provide enough energy and VCC starts to drop. As VCC drops down to the level of UVLO(off), the controller will shut down and VCC will be charged again. In GL26014, the LED short-circuit duration is detected. With the ZCD level being lower than 0.4V for 20ms as shown in Fig.5, the controller will stops to switch for reducing the input current stress and temperature rising at LED short-circuit condition.

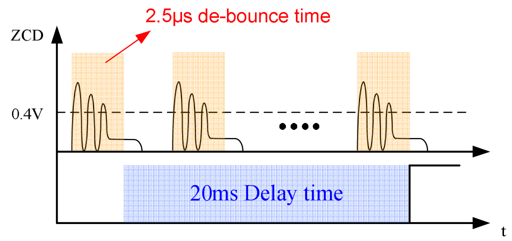


Fig.5

■ **CS Short-circuit Protection**

The CS short-circuit protection is another mechanism to prevent the system from being damaged as CS pin is short. If the level of CS is lower than 0.1V for 30ms as shown in Fig.6, the controller will stops to switch and VCC will be discharged by internal current source. As VCC drops down to the level of UVLO(off), the controller will shut down and VCC will be charged again.

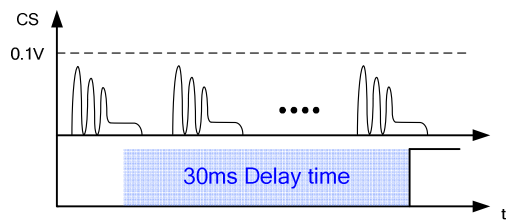


Fig.6

■ **Inductor Saturation Protection**

When the transformer is saturated, the inductance will drop down to zero rapidly causing huge current spikes on CS pin. Not only damage the controller but also the system peripheral.

In addition to the normal voltage reference of OCP comparator are 0.8V and 0.7V for low line and high line separately, there is a higher 1.5V comparator to protect the system from being damaged at abnormal condition above. If the CS level rise up to 1.5V for several cycles as shown in Fig.7, the inductor saturation protection will be triggered and VCC will be discharged by internal current source. As VCC drops down to the level of UVLO(off), the controller will shut down and VCC will be charged again.

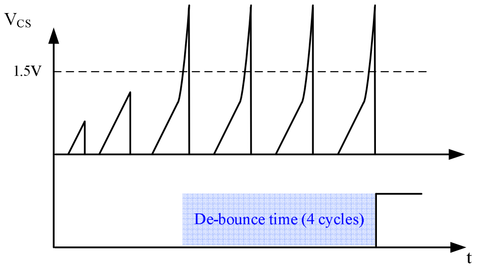


Fig.7

■ VCC Over Voltage Protection(OVP)

To prevent system from being damaged, the VCC OVP function is implemented in GL26014. As the VCC rises up to a higher level than the VCC OVP trigger level, the output driver will be turned off immediately to stop the switching of the MOSFET. The operation mode of OVP is auto recovery mode. That is, the output driver will continue being turned off till the coming of next UVLO(on) state as shown in Fig. 8.

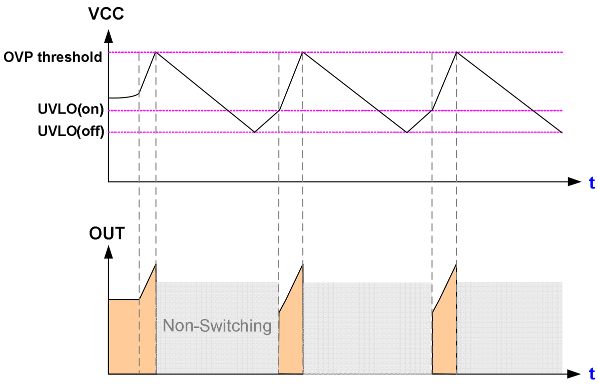


Fig.8

■ Current Sense & Leading-Edge Blanking

In GL26014, the current of the MOSFET is detected through the current sense (CS) pin. If the level of CS pin is higher than the OCP level, the protection will be triggered to turn off the output driver. This cycle-by-cycle current limit function protects the system from being overload. And the OCP level is 0.8V and 0.7V for low line and high line separately.

A 250ns leading-edge-blanking (LEB) time is built-in to avoid the false triggering of turn-on current spike caused by the turn-on of the MOSFET. During this blanking period, the gate driver will continue its turned-on state but can't be turned-off. It could be a substitute for traditional RC filter on CS pin.

■ Protection Mode

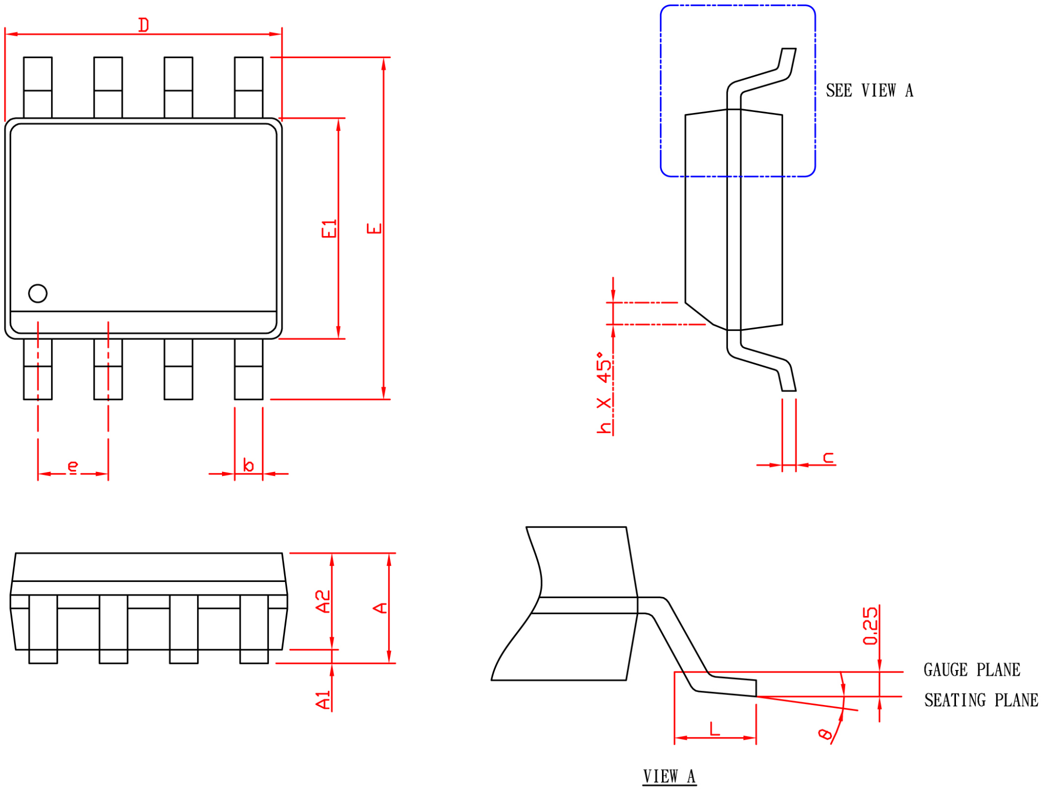
The modes for all the protections in GL26014 are described in table 2 as below.

Function	Protection Mode
VCC OVP	Auto recovery
LED Open-circuit	Auto recovery
LED Short-circuit	Auto recovery
CS Short-circuit	Auto recovery
Inductor Saturation	Auto recovery
Internal OTP	Auto recovery

Table 2

Package Information

SOP-8



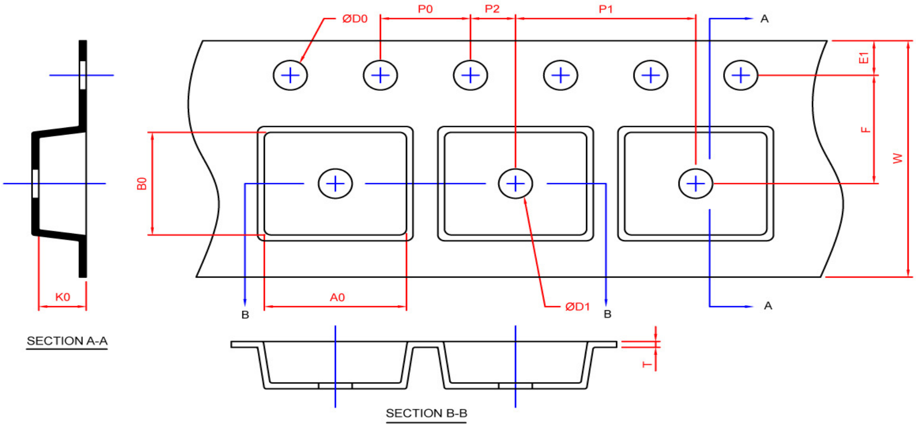
SYMBOL	SOP-8			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.75		0.069
A1	0.10	0.25	0.004	0.010
A2	1.25		0.049	
b	0.31	0.51	0.012	0.020
c	0.17	0.25	0.007	0.010
D	4.80	5.00	0.189	0.197
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
h	0.25	0.50	0.010	0.020
L	0.40	1.27	0.016	0.050
θ	0°	8°	0°	8°

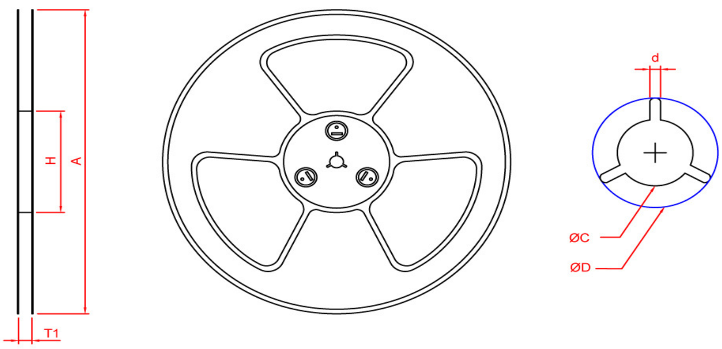
Note: 1. Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.

2. Dimension “E” does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 10 mil per side.

Carrier Tape & Reel Dimensions

SOP-8





Application	A	H	T1	C	d	D	W	E1	F
SOP-8	330.0±2.0	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.0±0.10	8.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.40±0.20	5.20±0.20	2.10±0.20

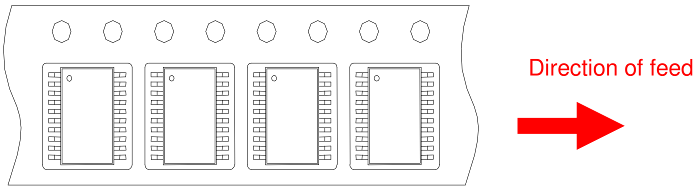
(mm)

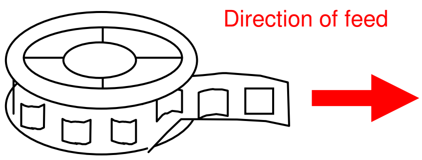
Devices Per Unit

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP-8	12	-	2500

Tape and Specification Reel

SOP-8





Revision History

Ver.	Date	Change Notice