

# Primary Side Regulation for LED Controller with Active PFC

## ADT6031

### GENERAL DESCRIPTION

The ADT6031 is a high accuracy constant current mode primary side regulation controller for dimmable LED lighting system. The control signal comes from primary side without optical coupler to simplify application design and cost. The controller operates in BCM (Boundary conduction mode) and in a quasi-resonant mode to provides high efficiency and to ease system EMI design. The device has robust protection function such as LED open/short protection, over voltage protection, over temperature protection and Under voltage lock-out. The ADT6031 is available in SOP8 Package.

### FEATURES

- Operating range up to 30V
- $PF \geq 0.9$
- LED Current accuracy  $\leq \pm 5\%$
- 20 $\mu$ A Start-Up current
- Over voltage / LED open protection
- Over temperature protection
- Secondary catch diode open/short protection
- 0V~10V Dimming / PWM dimming input
- Line feed-forward for accuracy regulation
- 5V LDO Output ( $\leq 10mA$ )
- SOP8 package

### APPLICATIONS

- Dimmable LED lighting
- LED Bulb, PAR, TUBE
- LED Down light, Flood-light
- External LED driving module

### TYPICAL APPLICATION CIRCUIT

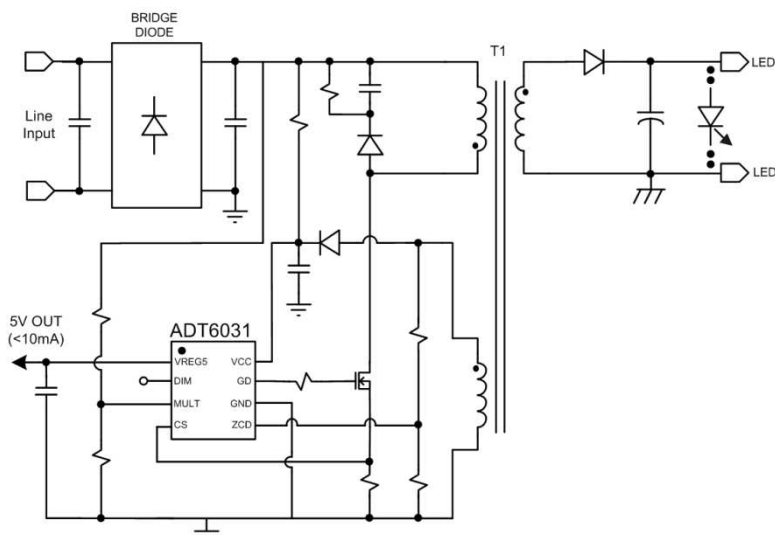
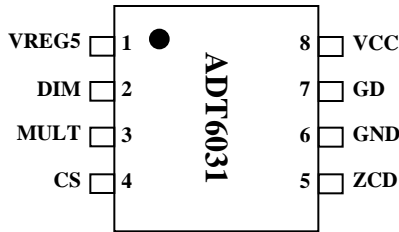


Figure 1. Typical Application Circuit

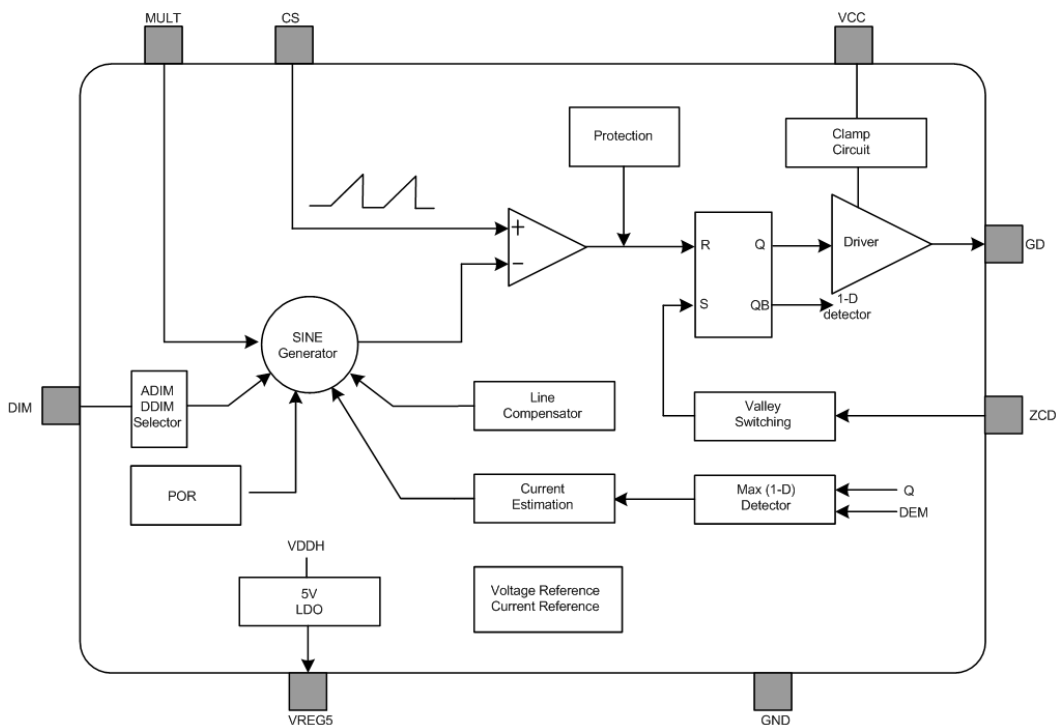
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## PIN CONFIGURATION



Pin No.	Pin Name	Description
1	VREG5	5V power supply output. A capacitor (typical 1 $\mu$ F) should be connected to GND.
2	DIM	0V~10V Dimming / PWM Dimming input
3	MULT	Main input of the multiplier. Connected to the rectified main voltage via a resistor divider and provides the sinusoidal reference to the current loop.
4	CS	Current sense input and one input of internal PWM comparator.
5	ZCD	Zero Current Detection input. A negative edge triggers MOSFET' turn on.
6	GND	Ground.
7	GD	Gate driver output.
8	VCC	Supply voltage input.

## SIMPLIFIED BLOCK DIAGRAM



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**ABSOLUTE MAXIMUM RATINGS** (Note1)

PARAMETER	SYMBOL	RATING	UNIT
Ground Voltage	GND	-0.3	V
Power Voltage	VCC	-0.3 ~ 40	V
Gate Driver Output	OUT	-0.3 ~ 18	V
ZCD	ZCD	-0.7 ~ 6	V
All other pins	VREG5,DIM,MULT,CS	-0.3 ~ 6	V
Power Dissipation(Note2)	$P_D$	-	W
Junction Temperature	$T_J$	-40 ~ 150	°C
Storage Temperature	$T_{STG}$	-65 ~ 150	°C
Thermal Resistance (Note3)	$\theta_{JA}$	150	°C/W

Note1. Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device.

Note2. Junction to ambient temperature is highly dependent upon the application and board layout .

The maximum allowable power dissipation can be calculated by  $P_D(\text{Max}) = (T_J(\text{Max}) - T_A)/\theta_{JA}$ .

If exceeding the maximum allowable power dissipation, the device goes to the shutdown conditions by over temperature protection.

Note3. Measured on JESD51-7, 4-layer PCB

**Recommended Operating Conditions** (Note4)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	VCC	-	20	-	V
Operating temperature	$T_{OPR}$	-40	-	+85	°C
Junction temperature	$T_J$	-40	-	+125	°C

Note4. The device is not guaranteed to function outside of its operating conditions

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## ELECTRICAL CHARACTERISTICS

(VCC = 20V, Ta=25°C, unless otherwise specified)

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Units
<b>Supply Voltage</b>						
Operating Range		V <sub>CC</sub>	-	20	-	V
Turn-On Threshold	UVLO Enable	V <sub>CC-ON</sub>		16		V
Turn-Off Threshold	UVLO Disable	V <sub>CC-OFF</sub>		10		V
Hysteretic Voltage		V <sub>CC-HYS</sub>		6		V
Clamp Voltage		V <sub>CC-CLAMP</sub>		35		V
<b>Supply Current</b>						
Start Up Current		I <sub>START</sub>		20		μA
Quiescent Current		I <sub>Q</sub>		2.5		mA
Operating Current		I <sub>CC</sub>			5	mA
<b>Current Sensing</b>						
Start Up Time		T <sub>START</sub>		100		μsec
Max On time		T <sub>MAX</sub>		50		μsec
Min off time		T <sub>MIN1</sub>		3.5		μsec
Min off time (Protection)		T <sub>MIN2</sub>		170		μsec
Propagation delay	ZCD to GD	T <sub>PD</sub>		50		nsec
Leding Edge Banking Time		T <sub>LEB</sub>		300		nsec
<b>Gate Driver</b>						
Rising Time	C <sub>L</sub> =1nF	T <sub>R</sub>		150		nsec
Falling Time	C <sub>L</sub> =1nF	T <sub>F</sub>		60		nsec
Output Clamp Voltage	V <sub>CC</sub> =28V	V <sub>GD-CLAMP</sub>			12	V
Max Source Current		I <sub>SOURCE</sub>		50		mA
Max Sink Current		I <sub>SINK</sub>		50		mA
<b>Zero Cross Detection (ZCD)</b>						
Enable Voltage		V <sub>ZCD_EN</sub>		0.3		V
Disable Voltage		V <sub>ZCD_DIS</sub>		1		V
Hysteretic Voltage		V <sub>ZCD-HYS</sub>		700		mV
Quasi-Resonant Delay Time		T <sub>QUASI</sub>		200		nsec
<b>Protection</b>						
Over Current Protection		V <sub>OCP</sub>		1.5		V
Over Voltage Protection (VCC)		V <sub>OVP_VCC</sub>		30		V
Over Voltage Protection (Secondary Side)		V <sub>OVP_ZCD</sub>		4		V
Over Temperature Protection		T <sub>OTP</sub>		150		°C
<b>LDO</b>						
Output Voltage	C=1uF, Iload=1mA	V <sub>LDO</sub>		5		V
<b>DIMMING</b>						
0V~10V Dimming	-	V <sub>LDO</sub>	10		100	%
PWM Dimming	-	V <sub>LDO</sub>	10		100	KHz

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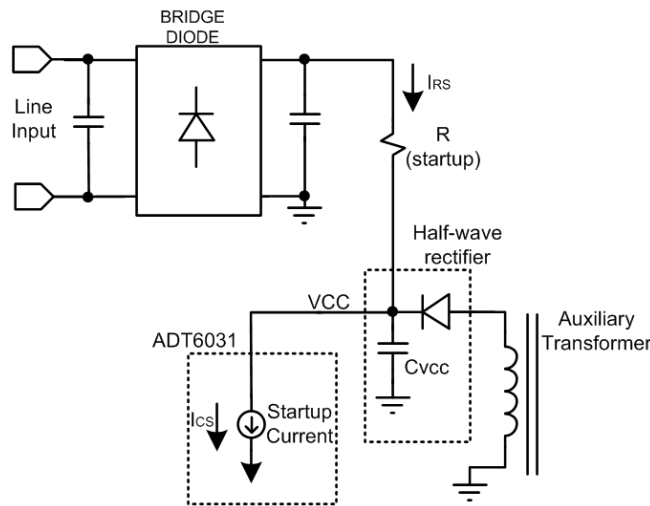
## Functional Description

### General Operations

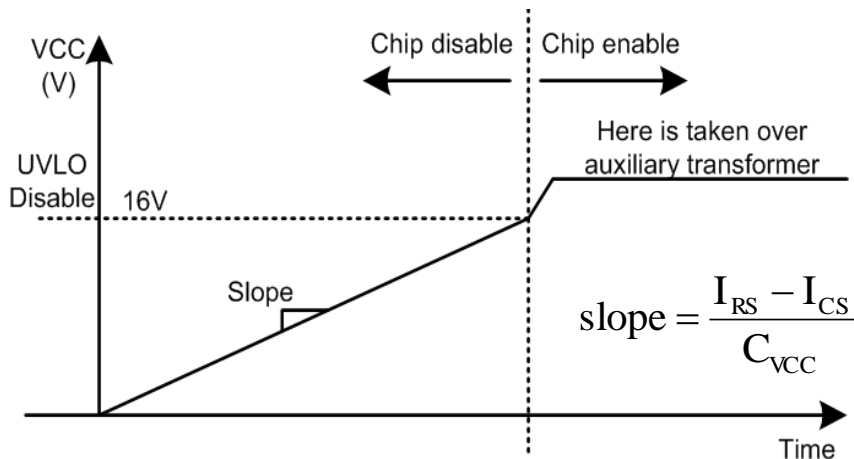
The ADT6031 is a primary side offline LED driver with inherent Power Factor Correction(PFC). The LED current can be well controlled by the primary current sensing technology without secondary current sensing using opto-coupler. It provides cycle by cycle over current protection, VCC (Chip power supply) over voltage protection, LED over voltage protection and over temperature protection. In order to decrease EMI, the ADT6031 has Quasi-Resonant turn-on MOSFET technique.

### Startup and UVLO

The VCC voltage is charged through sensing resistor from the AC line. The startup current of ADT6031 is approximately 20uA until VCC voltage is less than UVLO disable voltage ( Typical 16V). The startup time can be designed by the selection of sensing resistor and half wave rectifier which is connected to auxiliary transformer to make VCC voltage. When VCC voltage exceeds the UVLO disable level, the VCC is taken over by the auxiliary winding.



<Fig.1 Operation of Startup and UVLO>



<Fig.2 Waveform of startup and UVLO>

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**Constant-Current Regulation**

In order to drive LED load, the constant-current mode is better choice to decrease LED brightness variation. The ADT6031 estimates the LED current at the primary side by ADTech constant current estimation method called TrueCurrent-I.

※ TrueCurrent-I will be described end of this document.

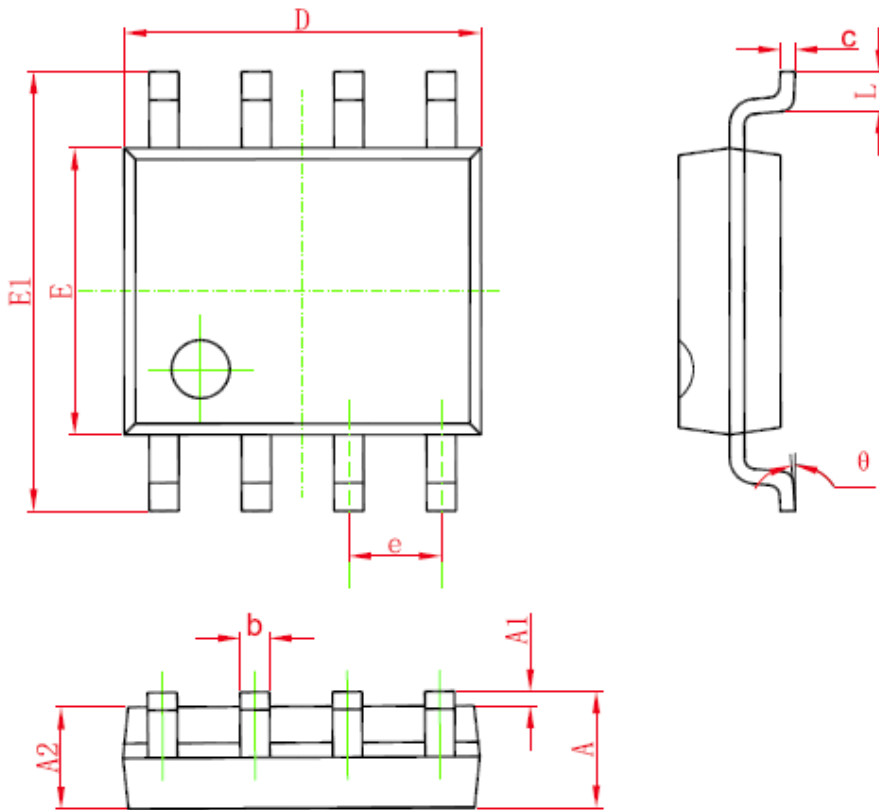
**Zero Crossing Detection (Quasi –Resonant)**

The hard switching technique is notorious for EMI source in the SMPS applications.

The ADT6031 provides Quasi-Resonant switching by zero crossing detection block(ZCD).

## PACKAGE DIMENSION

### 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	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
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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