
Single Stage, High PFC, AC-DC LED Driver LY6316

General Description

The LY 6316 is a single-stage, primary side control AC-DC LED driver with high power factor. The LED current can be regulated accurately through sensing the primary side information with few external components without the need of an opto-coupler.

The LY 6316 integrates power factor correction function and works in DCM and constant OFF time mode. A small harmonic current emission (THD) is achieved.

The LY 6316 is also implemented with various protections, such as over-current protection (OCP), over-voltage protection (OVP), short-circuit protection (SCP) and over-temperature protection (OTP), etc, to ensure a reliable system.

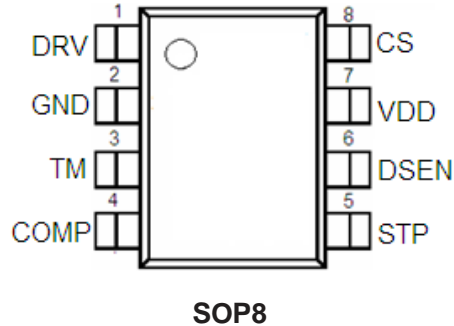
Features

- Wide input voltage range from AC85V to AC265V
- Highly accurate constant LED current ($\pm 5\%$)
- Supply Voltage Range: 7.5V~18V
- Up to 50W power drivability.
- Primary-side current sensing and regulation without an opto-coupler
- Leading edge blanking (LEB) technique
- Cycle-by-cycle current limiting
- Under-voltage lockout (UVLO) protection
- VDD and output over voltage protection
- Adjustable constant current and output power setting
- Power on soft-start
- Available in SOP8 package

Applications

- AC/DC LED driver applications
- General purpose constant current source
- Signal and decorative LED lighting
- E14/E27/PAR30/PAR38/GU10 LED lamp

Pin Configuration



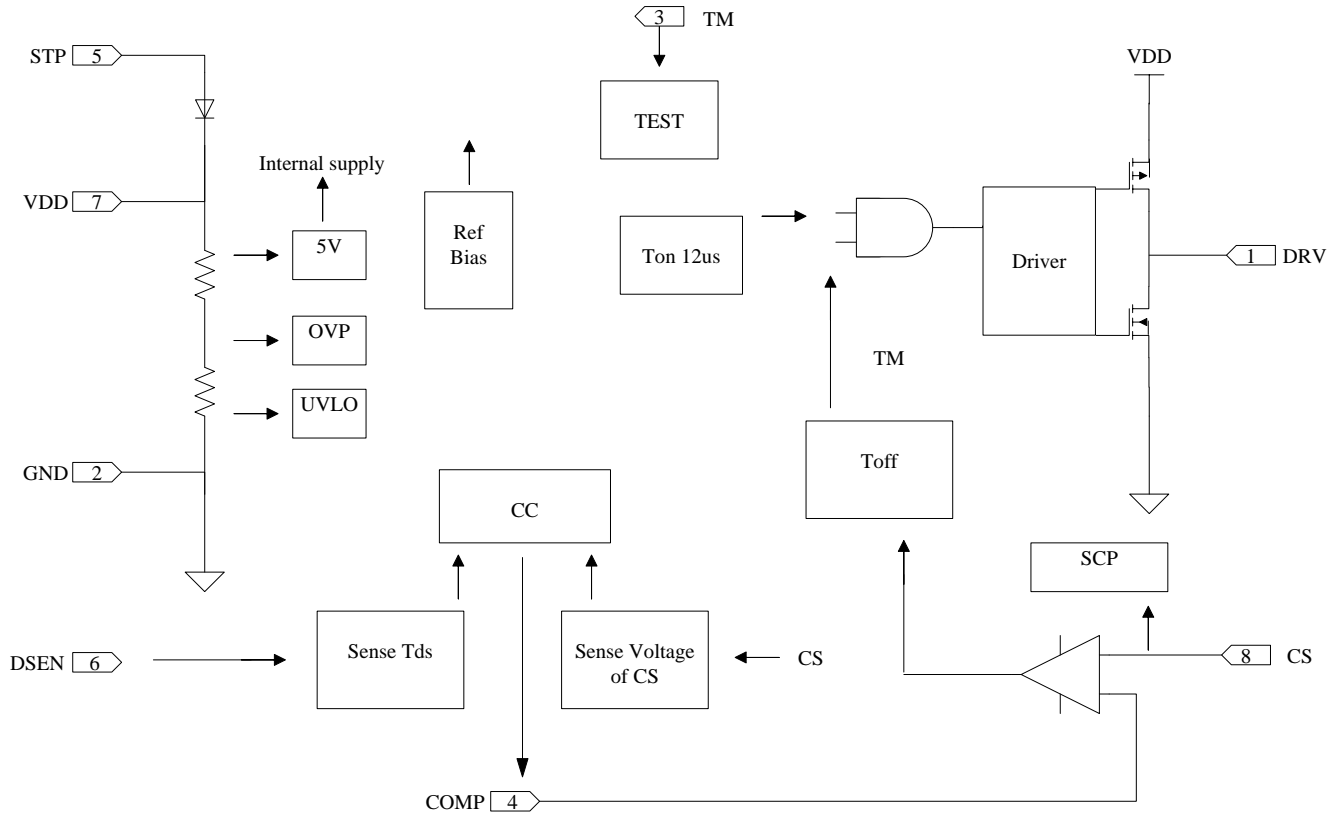
Pin Assignment

Pin Num.	Symbol	Function
1	DRV	Gate drive output for power N-MOSFET.
2	GND	Ground.
3	TM	Test pin. Always tie to ground.
4	COMP	Internal EA's output. Connect a capacitor to ground for frequency compensation.
5	STP	Start-up Pin. The LY 6316 is softly started through STP Pin.
6	DSEN	The voltage feedback from auxiliary winding. Connected to a resistor divider from auxiliary winding reflecting output voltage.
7	VDD	Power Supply.
8	CS	Current Sense pin.

Absolute Maximum Ratings

Parameter	Rating	Unit
Voltage at STP, VDD, DRV to GND	-0.3~25	V
All Other Pins Voltage	-0.3~6	V
Power Dissipation	800	mW
Operating temperature	-40~105	°C
Storage Temperature	-55~+150	°C
Junction Temperature	150	°C
Thermal resistance junction-to-ambient	128	°C/W
Soldering temperature and time	+300 (Recommended 10S)	°C

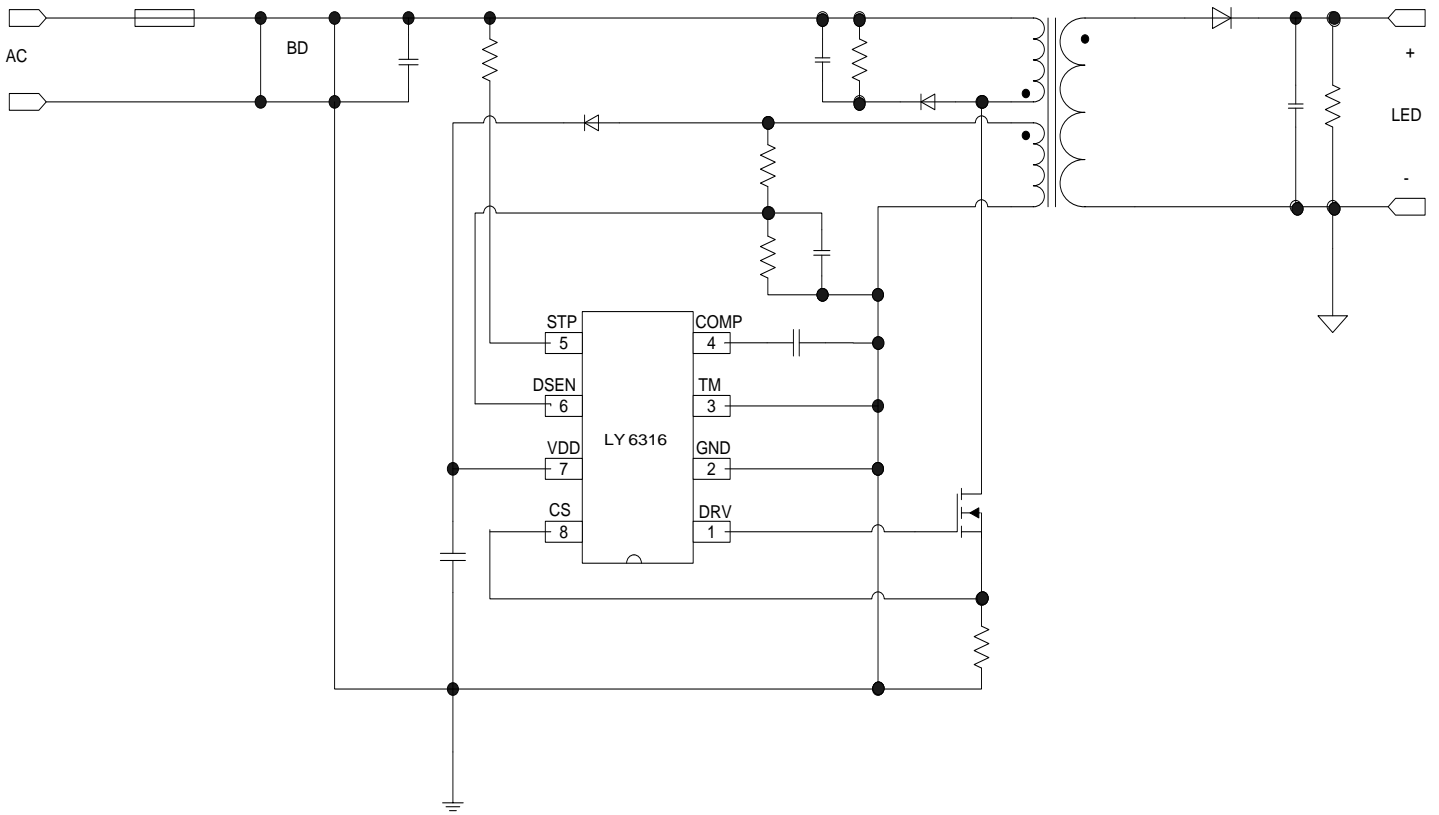
Block Diagram



Electrical Characteristics(T_A =25 °C, VDD =12V, unless otherwise noted.)

Item	Symbol	Test condition	Min	Typ.	Max	Unit
Start-up(STP pin, VDD pin)						
Start up Current	I _{START}		-	30	50	μA
Lower Threshold Voltage of VDD	ULVO	VDD Pin ramp down	6.0	7.5	8.5	V
Start-up Voltage	V _{START}	VDD Pin ramp up	15.5	17.5	20	V
Supply Current						
Quiescent Current	I _q	No switching		1		mA
Operating Current	I _{cc}	F _s =70KHZ		2		mA
Control Loop						
Primary Current Sense Voltage	VFB		400	410	420	mV
Upper Limit of COMP	V _{COMPH}		2.26	2.3	2.34	V
Off Time of DRV	T _{OFF}		11	12	13	μS
Short Circuit Protection Threshold at DSEN pin	SCP		190	200	210	mV
Over Voltage Protection Threshold at DSEN	OVP1		3.04	3.2	3.36	V
Over Voltage Protection Threshold at VDD pin	OVP2		18.2	19.2	23.5	V
Current Sense (CS pin)						
Leading Edge Blanking of CS	LEB			300		nS
Over Current Protection at CS pin	OCP			2.2	2.4	V
Thermal Protection						
Over temperature protection	OTP		-	150	-	°C
Over temperature release hysteresis			-	15	-	°C
Drive Stage(DRV pin)						
Rising Time	T _R	CL=1nF, DRV Pin Falls from VDD to 0V		50		nS
Falling Time	T _F	CL=1nF, DRV Pin Rises from 0V to VDD		30		nS

Typical Application Circuit



Application Information

The LY 6316 is a primary-side controller for AC-DC LED driver. The LED current can be accurately regulated through sensing the primary side information to realize real current control. LY 6316 integrates power factor correction function to eliminate pollution to the AC line and works in DCM and constant OFF time mode.

Real Current Control

LY 6316 accurately regulate LED current through sensing the primary side information. The LED current can be easily set as following (refer to the application circuit in page 2):

$$I_{LED} = \frac{1}{2} \times \frac{N_P}{N_S} \frac{V_{FB}}{R_S}$$

Where N_P is primary winding, N_S is secondary winding; V_{FB} (=400mV) is the internal voltage reference and R_S is an external current sensing resistor (R_S is R_4 in page2 application circuit).

Start Up

During start-up process, VDD is charged through a start-up resistor. As VDD reaches 17.5V, the control logic starts to work, and the gate drive begins to switch. A soft-start function is implemented to prevent the transformer from entering into CCM (continuous current mode) as show in Fig.1.

The power supply is taken over by the auxiliary winding once the voltage of this winding is high enough.

After LY 6316 control logic starts to work, STP pin is clamped to lower than VDD voltage about 0.2V.

The LY 6316 will shut down if VDD goes below 7.5V (UVLO threshold voltage).

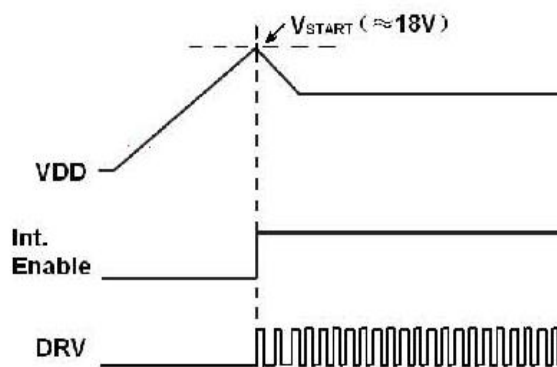


Fig.1 Start up sequence

Power Factor Correction

The primary side current increases linearly from zero to peak value, as sensed by the current sensing pin CS, during the external MOSFET on-time. When the primary current reaches the threshold, LY 6316 turns off the power

MOSFET immediately. After a constant OFF time, TOFF, LY 6316 turns on the power MOSFET again. The peak current threshold follows the rectified sinusoidal-shape of main line voltage. As a result, the envelope of the inductor current is sinusoidal-shaped, high power factor is therefore achieved in this way.

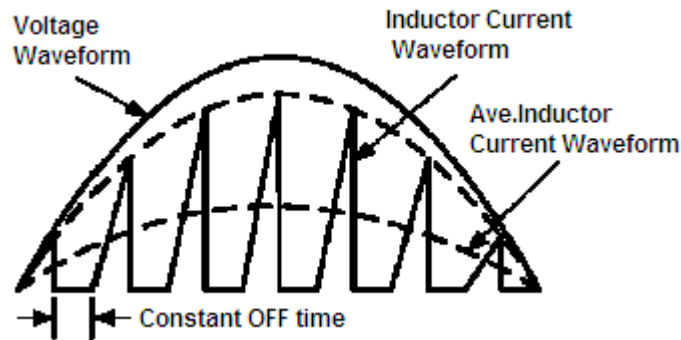


Fig.2 Power Factor Correction

Auxiliary Sensing

The LY 6316 features over-voltage protection (OVP), short-circuit protection (SCP), and over-current protection (OCP) functions. Those protections are triggered by sensing the auxiliary winding waveform information, as the auxiliary winding voltage is proportional to the output voltage (secondary winding voltage) during the OFF time period. The auxiliary winding voltage is sampled by DSEN pin, one LEB (Leading Edge Blanking) time right after DRV signal is turned off.

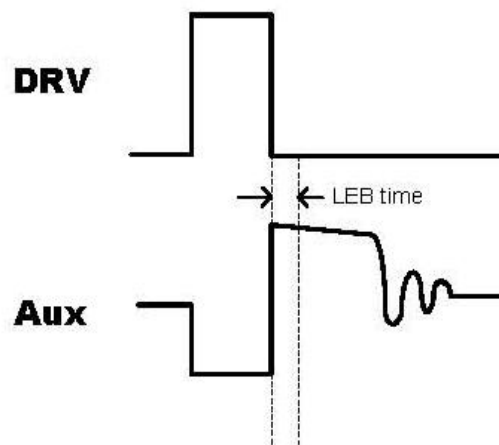


Fig.3 Auxiliary Single Sensing

Over-voltage Protection

The LY 6316 is implemented with two over-voltage protection schemes: (1) If DSEN pin's voltage is detected above 3.2V for three times (refer to **Auxiliary Sensing** section), LY 6316 turns off the PWM switching signal, and VDD

voltage gradually drops to UVLO threshold, and the system will be re-started. The threshold voltage of over-voltage protection VOUT_OV, can be easily defined as (refer to the application circuit in page 2):

$$V_{OUT-OV} = 3.2 \times \left(1 + \frac{R5}{R6}\right) \times \frac{N_s}{N_a} - V_{D8}$$

Where N_s is the secondary winding, N_a is auxiliary winding, V_{D8} is the forward bias of the secondary side rectifier diode.

(2) If VDD pin's voltage exceeds 19.2V three times, LY 6316 turns off the PWM switching signal, and VDD gradually drops to UVLO threshold, and then the system will be re-started. It is highly recommended to set up the VDD voltage between 12V and 16V by designed a proper N_a to N_s ratio of the transformer.

Short-circuit Protection

The short-circuit protection is triggered if the DSEN pin voltage is detected below 200mV for a continuous time of 640us. The gate drive switching will be turned off, and a restart process will be kicked off when the VDD voltage drops below the UVLO threshold.

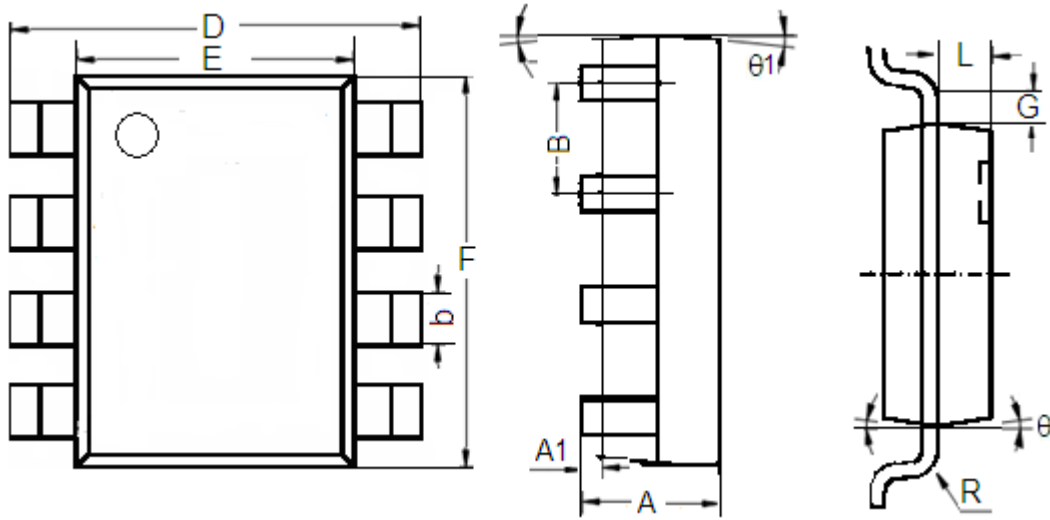
This re-start process will repeat if the short-circuit condition continues to exist.

Over-current Protection

The LY 6316 immediately turns off the power MOSFET once the voltage at CS pin exceeds 2.2V. This cycle by cycle current limitation scheme prevents the relevant components, such as power MOSFET, transformer, etc. from damage.

Package Information

Package type:SOP8 Unit: mm (inch)



Character	Dimension (mm)		Dimension (Inches)	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.1	0.3	0.004	0.012
B	1.27(Typ.)		0.05(Typ.)	
b	0.330	0.510	0.013	0.020
D	5.8	6.2	0.228	0.244
E	3.800	4.000	0.150	0.157
F	4.7	5.1	0.185	0.201
L	0.675	0.725	0.027	0.029
G	0.32(Typ.)		0.013(Typ.)	
R	0.15(Typ.)		0.006(Typ.)	
θ_1	7°		7°	
θ	8°		8°	