



## PSR Single-Stage APFC AC-DC LED Driver

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### DESCRIPTION

M1870A is a single-stage primary side control AC- DC LED driver with active power factor correction, specially designed for universal input offline Flyback or buck-boost constant current LED lighting. The controller with on-chip PFC circuit achieves high power factor and low THD. Operating in critical conduction mode, the power MOSFET switching loss is reduced and the inductor is fully utilized.

The M1870A offers rich protection functions to improve the system reliability, including LED open circuit protection, LED short circuit protection, VCC under voltage protection, CS resistor open circuit protection and cycle by cycle current limit. All the protection functions are auto-recovery. The system reliability is further improved by the thermal regulation function. The output current is reduced when the driver is over temperature.

### FEATURE

- Active PFC for High Power Factor and Low THD
- Primary side control eliminates the opto-coupler
- High Resistance Feedback Resistor for Improved Efficiency
- Ultra Low (30uA) Start Up Current
- $\pm 3\%$  LED Output Current Accuracy
- Excellent Line and Load Regulation
- Critical Conduction Mode Operation
- Ultra Low Start Up Current
- LED Short/Open Protection
- Current Sensing Resistor Open Protection
- Cycle by Cycle Current Limit
- VCC Under Voltage Protection
- Auto Fault Recovery
- Thermal Regulation Function
- SOP-8 Package

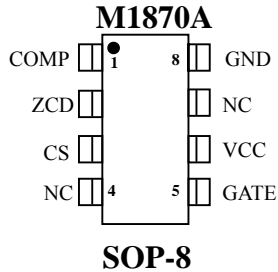
### APPLICATIONS

- LED Bulb
- LED String



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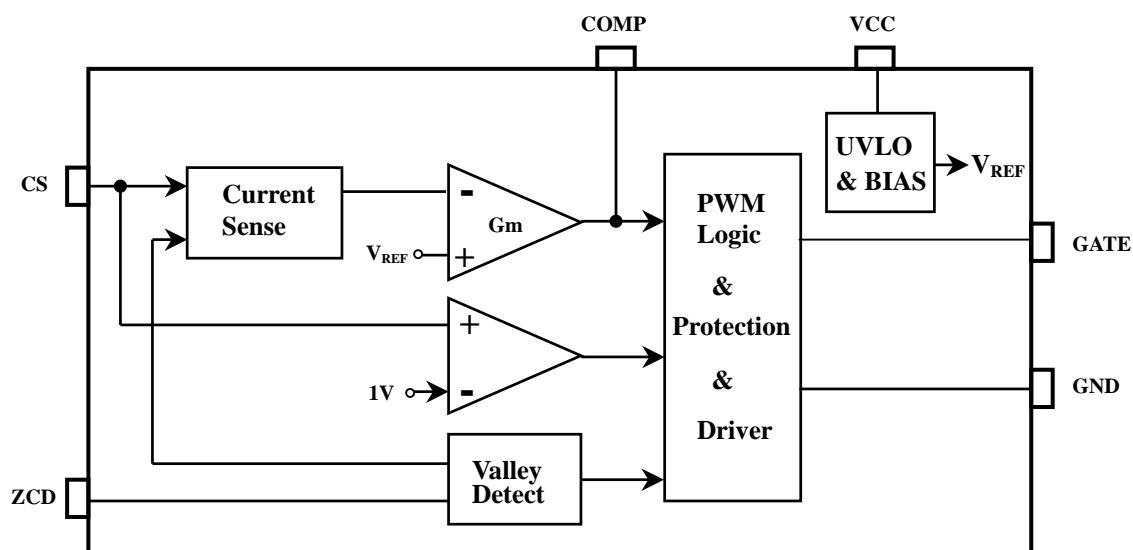
PIN ASSIGNMENT



PIN DEFINITION

Pin No.	Pin name	I/O	Description
1	COMP	I	Loop Compensation Node. This pin connects a capacitor to GND for stabilization of the control loop, achieving accurate
2	ZCD	I	Inductor current zero-crossing detection pin, This pin detects the transformer demagnetization signal and the output voltage.
3	CS	I	Current Sense Pin. Connect a resistor to GND
4,7	NC	—	No connection.
5	GATE	O	Connect this pin to the gate of external power MOSFET
6	VCC	—	Power Supply Pin
8	GND	—	Ground

FUNCTION DIAGRAM





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**ABSOLUTE MAXIMUM RATINGS**

(TA=25°C)

Parameters	Symbol	Range	Units
Internal HV MOSFET Drain to Source voltage	V <sub>DS</sub>	-0.3 ~ 600	V
VCC pin maximum sink current	I <sub>CC_MAX</sub>	10	mA
Compensation pin voltage	COMP	-0.3 ~ 6	V
Feedback pin input voltage	FB	-0.3 ~ 6	V
Current sense pin input voltage	CS	-0.3 ~ 6	V
Power dissipation	P <sub>DMAX</sub>	0.45	W
Operating junction temperature	T <sub>J</sub>	-40 to 150	°C
Storage temperature range	T <sub>STG</sub>	-55 to 150	°C

**ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, V<sub>CC</sub>=19V, TA=25°C)

Parameter	Symbol	Min	Typ	Max	Units	Conditions
<b>Supply Voltage Section</b>						
V <sub>CC</sub> Turn On Threshold	V <sub>CC_ON</sub>		16.5		V	V <sub>CC</sub> Rising
V <sub>CC</sub> Turn Off Threshold	V <sub>CC_UVLO</sub>		7.5		V	V <sub>CC</sub> Falling
V <sub>CC</sub> Clamp Voltage	V <sub>CC_OVP</sub>		20		V	
V <sub>CC</sub> Startup Current	I <sub>CC_UVLO</sub>		30	50	uA	V <sub>CC</sub> Rising, V <sub>CC</sub> = V <sub>CC_ON</sub> - 1V
V <sub>CC</sub> Operating Current	I <sub>CC</sub>		680		uA	F <sub>OP</sub> =10KHz
<b>ZCD Section</b>						
ZCD Falling Edge Threshold Voltage	V <sub>ZCD_FALL</sub>		0.2		V	ZCD Falling
ZCD Hysteresis Voltage	V <sub>ZCD_HYS</sub>		0.15		V	ZCD Rising
ZCD Over Voltage Protection Threshold	V <sub>ZCD_OVP</sub>		1.6		V	
Maximum On Time	T <sub>ON_MAX</sub>		20		μS	
Minimum Off Time	T <sub>OFF_MIN</sub>		3		μS	
Maximum Off Time	T <sub>OFF_MAX</sub>		100		μS	
<b>Current Sense Section</b>						
CS Peak Voltage Limitation	V <sub>CS_LIMIT</sub>		1.0		V	
Leading Edge Blanking Time for Current Sense	T <sub>LEB_CS</sub>		350		ns	
Switch off Delay Time	T <sub>DELAY</sub>		200		ns	
<b>Compensation Section</b>						
Internal Reference Voltage	V <sub>REF</sub>	0.194	0.2	0.206	V	
COMP Low Clamp Voltage	V <sub>COMP_LO</sub>		1.5		V	
COMP Linear Operating Voltage Range	V <sub>COMP</sub>	1.5		3.9	V	
COMP High Clamp Voltage	V <sub>COMP_HI</sub>		4.0		V	
<b>Thermal Regulation Section</b>						
Thermal Regulation Temperature	T <sub>REG</sub>		150		°C	



## PSR Single-Stage APFC AC-DC LED Driver

### FUNCTION DESCRIPTION

M1870A 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. M1870A integrates power factor correction function to eliminate pollution to the AC line and works in BCM (Critical Conduction Mode).

#### 1. Start Up

After system powered up, the VCC pin capacitor is charged up by the startup resistor. When the VCC pin voltage reaches the turn on threshold, the internal circuits start working. The COMP pin voltage is pulled up to 1.5V quickly, and then the M1870A starts switching. The system works at 10 KHz frequency at the beginning, the COMP voltage rises up gradually, and the inductor peak current also rises up. The LED current hence achieves a soft start without overshoot. After the output voltage is built up, the VCC power is supplied by the output voltage through a diode.

#### 2. Constant Current Controls

The M1870A adopts proprietary primary-side current sensing scheme. It can precisely control the LED current without secondary side sense and feedback circuit. The current in LED can be calculated by the equation:

$$I_{out} = \frac{V_{ref}}{2 \times R_{cs}} \times \frac{N_p}{N_s}$$

Where,

$V_{ref}$  : Internal reference voltage

$N_p$  : Primary winding turns of transformer

$N_s$  : Secondary winding turns of transformer

$R_{cs}$  : The current sensing resistor value

#### 3. Feedback Network

The M1870A senses the output current zero crossing information through the feedback network, the ZCD falling threshold voltage is set to 0.1V with 0.08V hysteresis. The ZCD pin is also used to detect output OVP, the threshold voltage is 1.6V. The ratio of ZCD upper resistor to lower resistor can be set as:

$$\frac{R_{zcdl}}{R_{zcdl} + R_{zcdh}} = \frac{1.6V}{V_{ovp\_zcd}} \times \frac{N_s}{N_A}$$

Where,

$R_{zcdl}$  : The lower resistor of the feedback network

$R_{zcdh}$  : The upper resistor of the feedback network

$V_{ovp\_zcd}$  : Output over voltage setting point

$N_s$  : Secondary winding turns of transformer

$N_A$  : Auxiliary winding turns of transformer

The ZCD upper resistor can be set to around 300KΩ to improve the system efficiency. It is also used for fine tuning the LED current line compensation.



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4. Thermal Regulations

The M1870A integrates thermal regulation function. When the system is over temperature, the output current is gradually reduced; the output power and thermal dissipation are also reduced. The system temperature is regulated and the system reliability is improved. The thermal regulation temperature is set to 150°C internally.

5. Protection Functions

The M1870A offers rich protection functions to improve the system reliability. When the LED is open circuit, the output voltage will gradually rise up. The output voltage is sensed by the ZCD pin when power MOSFET is turned off. When ZCD voltage reaches the OVP threshold, it will trigger fault logic and the system stops switching. When the LED is shorted circuit, the system will work under 10KHz switching frequency. Meanwhile, the output voltage is low and the VCC pin cannot be charged up by the output voltage, so the VCC pin voltage will gradually decrease and finally reaches the UVLO threshold. After the system enters into fault condition, the VCC voltage will decrease until it reaches UVLO threshold. Then the system will re-start again. If the fault condition is removed, the system will resume normal operation. When the output is short circuit or the inductor is saturated, the CS peak voltage will be relatively high. When CS voltage reaches the internal limitation (1V), the power MOSFET will be turned off instantaneously. This cycle by cycle current limitation can help protecting the power MOSFET, the inductor and the output diode.

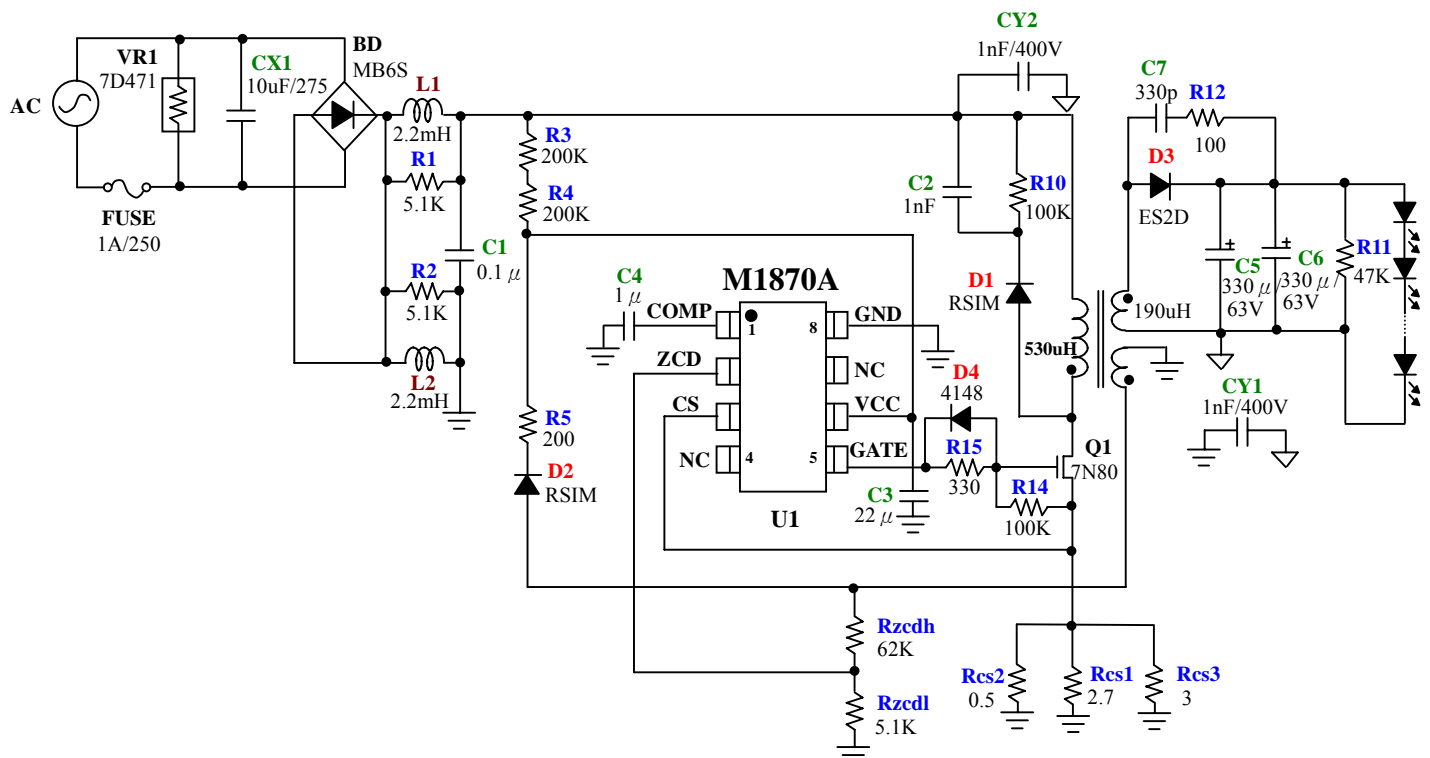
TYPICAL APPLICATION

18W LED EXTERNAL POWER SUPPLY

Input Voltage : 90Vac ~ 265Vac ; 47Hz ~ 63Hz

Output Voltage : 25V ~ 48V

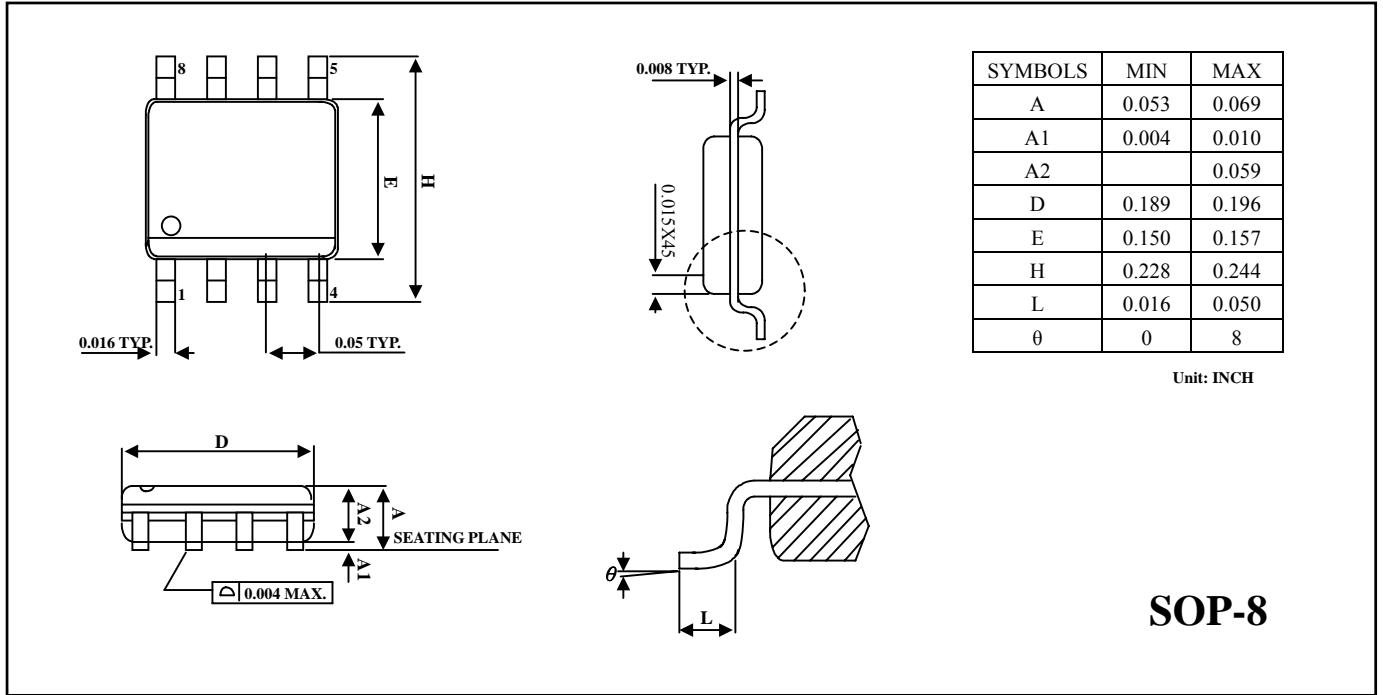
Output Current : 440mA





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PACKAGE OUTLINE



\* All specs and applications shown above subject to change without prior notice.  
(以上電路及規格僅供參考,本公司得逕行修正)