600V / 4A
Non-isolated Buck APFC Offline LED Driver

DESCRIPTION

The M1973A is a high precision non-isolated buck driver with active PFC, specially designed for universal input offline constant current LED lighting. The driver 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 inductor current is sensed during the whole switching cycle. So it achieves high precision output current control, and excellent line regulation and load regulation.

The M1973A 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.
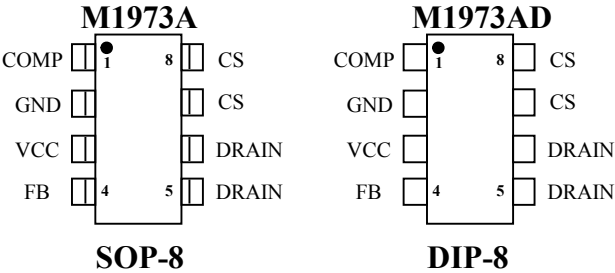
FEATURE

· Active PFC for High Power Factor and Low THD
· MOSFET Internal 600V, 4A Power MOSFET
· System Efficiency up to 95%
· ±3% LED Output Current Accuracy
· Excellent Line and Load Regulation
· Critical Conduction Mode Operation
· Ultra Low (30uA) 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 / DIP8 Package

## APPLICATIONS

· LED Bulb
· LED String

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Tungnan Technology Co., Ltd.

LED DRIVER

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PIN ASSIGNMENT

M1973A

COMP	1	8	CS
GND			CS
VCC			DRAIN
FB	4	5	DRAIN

SOP-8

M1973AD

COMP	1	8	CS
GND			CS
VCC			DRAIN
FB	4	5	DRAIN

DIP-8

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 LED current , high Power Factor and low THD
2	GND		Ground.
3	VCC		Power Supply Pin. Connect a bypass capacitor from this pin to GND
4	FB	I	Feedback Voltage Input Pin. This pin detects the inductor demagnetization signal and the output voltage.
5,6	DRAIN	O	Internal HV Power MOSFET Drain.
7,8	CS	I	Current Sense Pin. Connect a resistor to GND to sense the inductor current.

FUNCTION DIAGRAM

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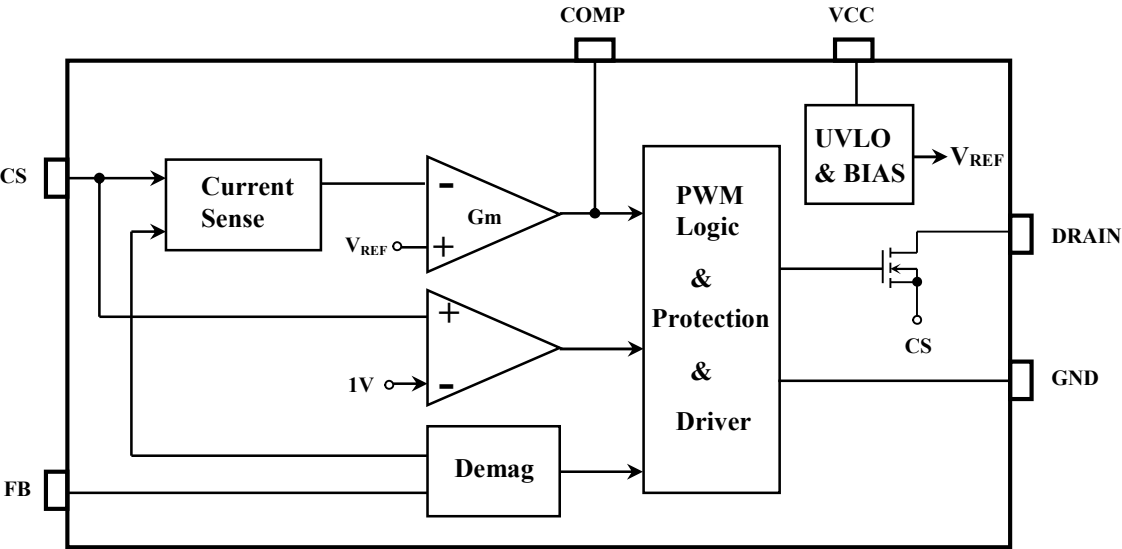
ABSOLUTE MAXIMUM RATINGS

(TA=25℃)

Parameters	Symbol	Range	Units
Internal HV MOSFET Drain to Source voltage	V_{DS}	-0.3 ~ 600	V
VCC pin maximum sink current	I_{CC_MAX}	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_{DMAX}	0.45	W
Operating junction temperature	T_J	-40 to 150	℃
Storage temperature range	T_{STG}	-55 to 150	℃

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified，Vcc =17V, TA =25 ℃)

Parameter	Symbol	Min	Typ	Max	Units	Conditions
Supply Voltage Section						
Vcc Turn On Threshold	V_{CC_ON}		16.5		V	Vcc Rising
Vcc Turn Off Threshold	V_{CC_UVL}		7.6		V	Vcc Falling
Vcc Clamp Voltage	V_{CC_CLA}		19.5		V	
Vcc Startup Current	I_{CC_UVLO}		30	50	uA	Vcc Rising, Vcc = V_{CC_ON} - 1V
Vcc Operating Current	I_{CC}		400	500	uA	F_{OP} =10KHz
Feedback Section						
FB Falling Edge Threshold Voltage	V_{FB_FALL}		0.2		V	FB Falling
FB Hysteresis Voltage	V_{FB_HYS}		0.15		V	FB Rising
FB Over Voltage Protection Threshold	V_{FB_OVP}		1.6		V	
Maximum On Time	T_{ON_MAX}		20		μS	
Minimum Off Time	T_{OFF_MIN}		3		μS	
Maximum Off Time	T_{OFF_MAX}		100		μS	
Current Sense Section						
CS Peak Voltage Limitation	V_{CS_LIMI}		1.0		V	
Leading Edge Blanking Time for Current Sense	T_{LEB_CS}		350		ns	
Switch off Delay Time	T_{DELAY}		200		ns	
Compensation Section						
Internal Reference Voltage	V_{REF}	0.194	0.2	0.206	V	
COMP Low Clamp Voltage	V_{COMP_L}		1.5		V	
COMP Linear Operating Voltage Range	V_{COMP}	1.5		3.9	V	
COMP High Clamp Voltage	V_{COMP_HI}		4.0		V	
Power MOSFET						
Static Drain-source On-resistance	$R_{DS(ON)}$		2.3		Ω	V_{GS} = 10V, ID = 1A
Drain-Source Breakdown Voltage	B_{VDSS}	600			V	V_{GS} = 0V, ID = 250μA
Drain-Source Diode Forward Continuous Current	IS			2	uA	V_{GS} = 0V
Power MOSFET Drain Leakage Current	I_{DSS}			10	uA	V_{DS} = 600V, V_{GS} = 0V
Thermal Regulation Section						
Thermal Regulation Temperature	T_{REG}		150		℃	

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LED DRIVER

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FUNCTION DESCRIPTION

The M1973A is a high precision Active PFC driver integrating 600V power MOSFET, specially designed for non-isolated buck offline constant current LED lighting. Operating in critical conduction mode, the driver achieves high power factor, low THD and high efficiency

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 1.5Vquickly, and then the M1973A 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 M1973A utilizes patent pending floating ground structure. The inductor current is sensed during the whole switching cycle, thus it achieves high precision output current control and also excellent line and load regulation. The current in LED can be calculated by the equation：

$$Iout = \frac{Vref}{Rcs}$$

V_{REF}：Internal reference voltage, typically 0.2V

R_{CS}：The current sensing resistor value

3. Feedback Network

The M1973A senses the output current zero crossing information through the feedback network, the FB falling threshold voltage is set to 0.2V with 0.15V hysteresis. The FB pin is also used to detect output OVP, the threshold voltage is 1.6V. The ratio of FB upper resistor to lower resistor can be set as：

$$\frac{Rfbl}{Rfbl + Rfbh} = \frac{1.6V}{Vovp}$$

R_{FBL}：The lower resistor of the feedback network

R_{FBH}：The upper resistor of the feedback network

V_{OVP}：Output over voltage setting point It is recommended that the FB lower resistor set to 5KΩ--10KΩ.

4. Thermal Regulations

The M1973A 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℃ internally.

5. Protection Functions

The M1973A 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 FB pin when power MOSFET is turned off. When FB 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 10 kHz 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.
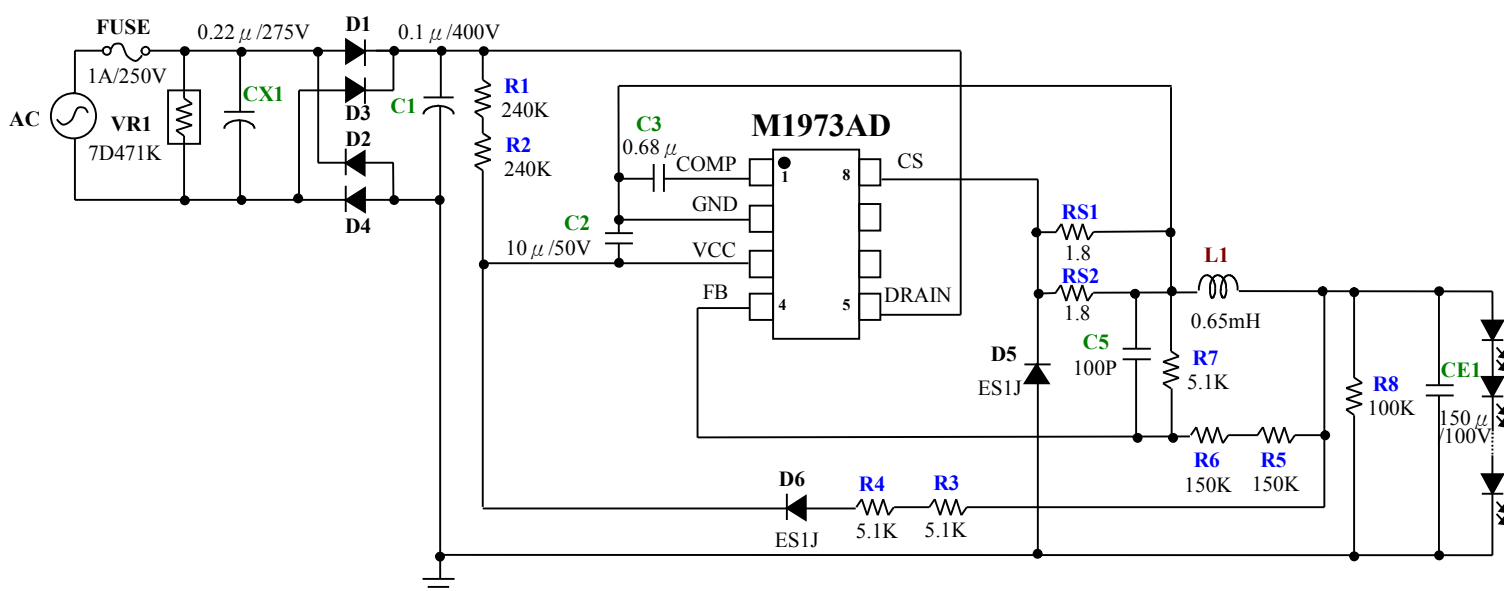
TYPICAL APPLICATION

18W LED Fluorescent

Input Voltage：85Vac ~ 265Vac；47Hz ~ 63Hz

Output Voltage：36 ~ 76V (24 String)

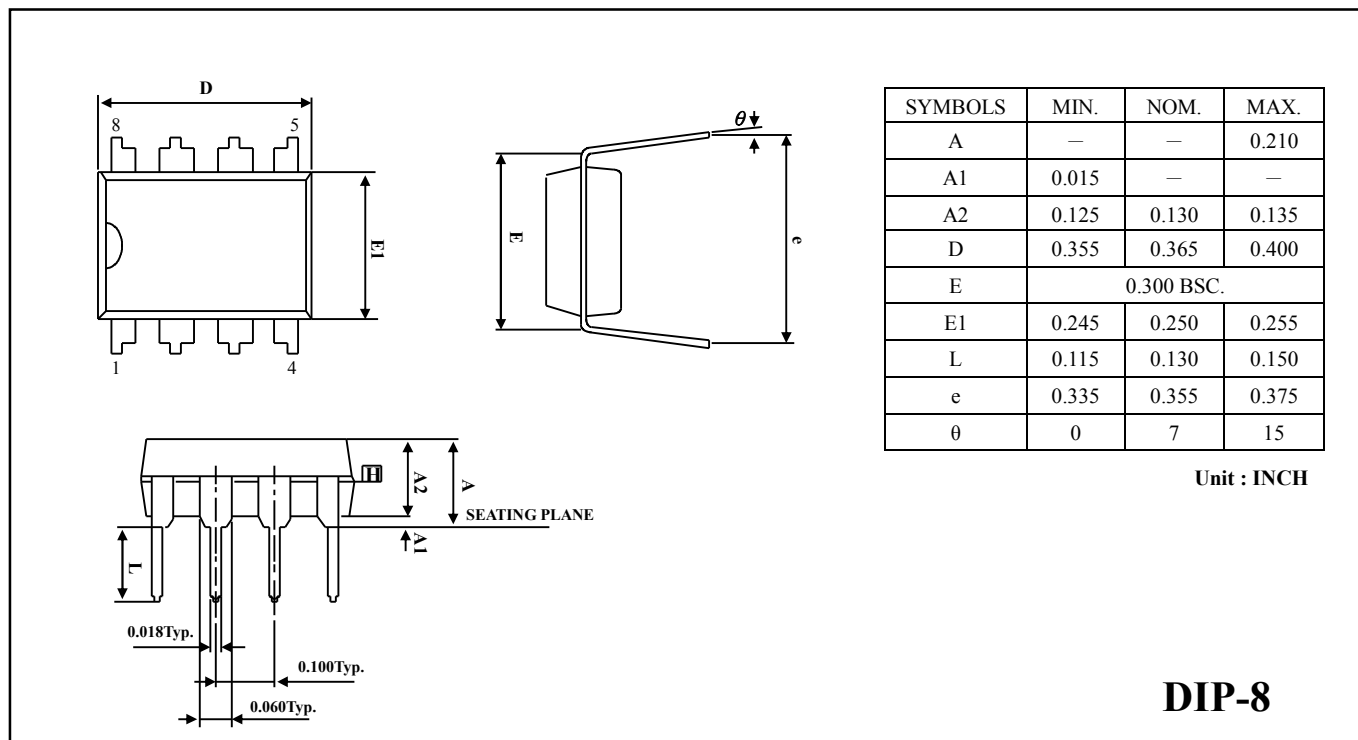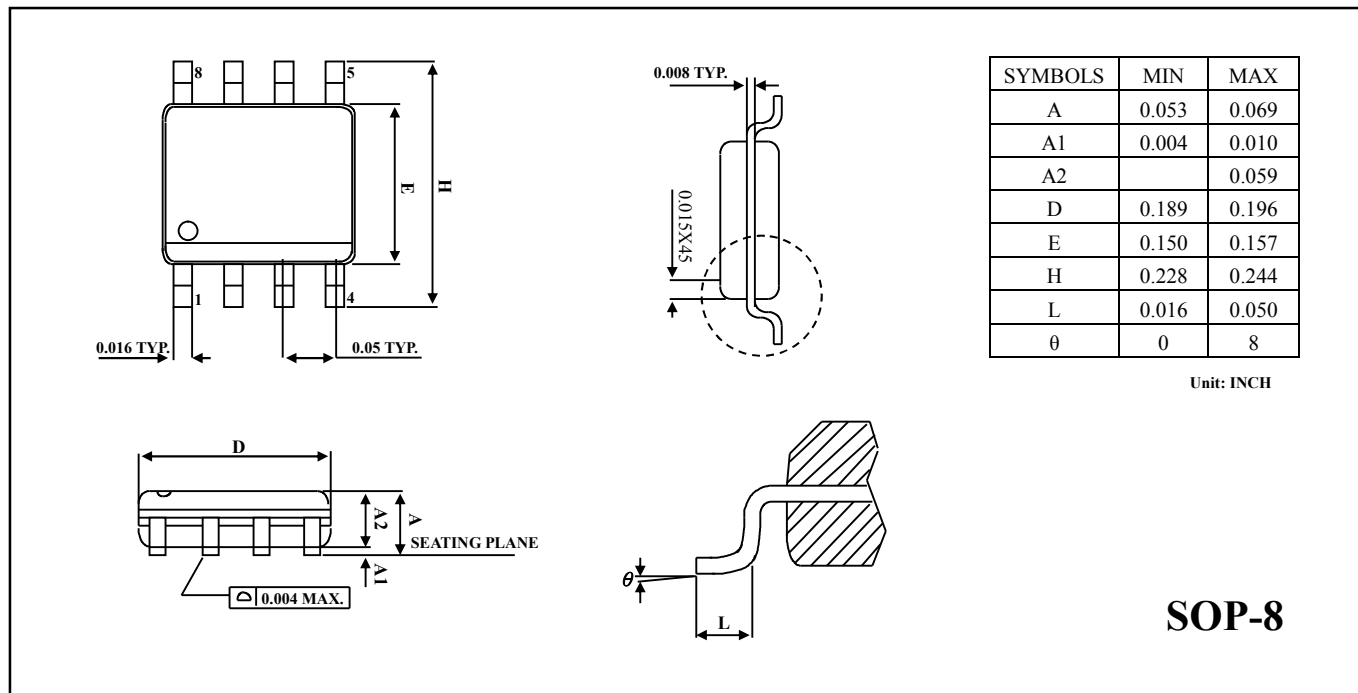Output Current：220mA

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PACKAGE OUTLINE

SYMBOLS	MIN	MAX
A	0.053	0.069
A1	0.004	0.010
A2		0.059
D	0.189	0.196
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
θ	0	8

Unit: INCH

0.008 TYP.

0.015X45

0.016 TYP.   0.05 TYP.

0.004 MAX.   SEATING PLANE

SOP-8

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	0.210
A1	0.015	–	–
A2	0.125	0.130	0.135
D	0.355	0.365	0.400
E	0.300 BSC.		
E1	0.245	0.250	0.255
L	0.115	0.130	0.150
e	0.335	0.355	0.375
θ	0	7	15

Unit : INCH

SEATING PLANE

0.018 Typ.
0.100 Typ.
0.060 Typ.

DIP-8

* 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)