杰力科技股份有限公司
Excelliance MOS Corporation

EM8822A

Single stage Buck/Buck-Boost PFC Controller for LED Lighting

Applications

General Description

EM8822A is a voltage mode Buck/Buck-boost PFC controller operating at transition mode. It keeps the Buck / Buck-boost converter in constant on time operation to achieve high power factor.

This device provides protections of internal soft start, over voltage protection, over current protection and thermal shutdown. It can minimize the external components counts, and makes the design easy.

This part is available in SOP-23-6 package.

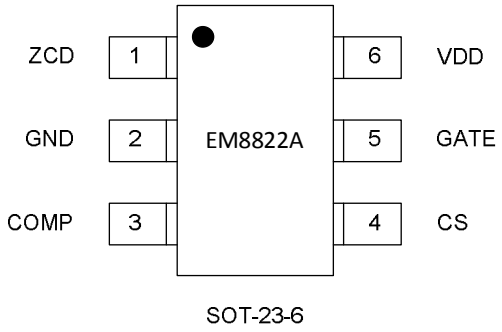
Ordering Information

Part Number	Package	Remark
EM8822AJ	SOP-23-6	

Applications

- General LED lighting applications
- Bulb lamp
- Tube lamp
- PAR lamp

Pin Configuration



SOT-23-6

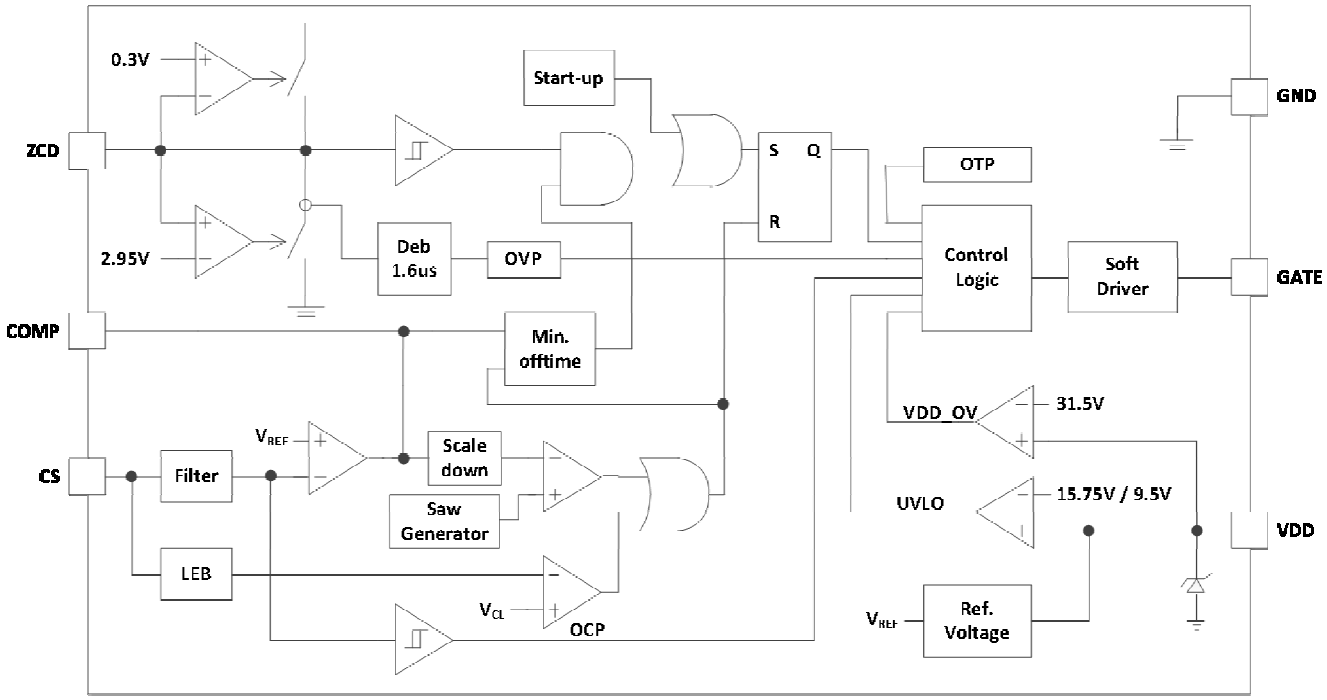
Features

- Single stage Buck/Buck-Boost PFC controller
- Voltage Mode Control
- Valley turn on of the MOSFET to achieve lower switching loss
- Low Start Up Current : 6uA typical
- Maximum gate drive voltage at 19.5V
- Over Voltage Protection for IC bias voltage
- LED Open/Short Protection
- Internal over-thermal Shutdown

Pin Assignment

Pin Name	Pin No.	Pin Function
ZCD	1	**Zero-Current Detection pin.** Inductor current zero crossing detection pin. The pin receives the auxiliary winding voltage or output voltage by a resister divider and detects the inductor current zero crossing point.
GND	2	**Ground pin.**
COMP	3	**Loop Compensation pin.** Output of the error amplifier. Connect a RC network across this pin and ground to stabilize the control loop.
CS	4	**Current Sense pin.** Connect this pin to the source of the MOSFET. Connect the sense resistor across the source of the MOSFET and the GND pin.
GATE	5	**Gate Drive pin**. Connect this pin to the gate of MOSFET. Maximum gate voltage is clamping at 19.5V.
VDD	6	**Power Supply pin.** Provide 29V typical over voltage protection.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage, V_{CC} ---------- 35V
- Gate pin---------- 35V
- other Pins ---------- - 0.3V to 6.5V
- Power Dissipation, PD @ TA = 25C
  SOP-23-6 ---------- 0.4W
- Package Thermal Resistance, Θ_{JA}
  SOP-23-6 (Note 2), ---------- 110°C /W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Storage Temperature Range ---------- -55°C to 150°C
- ESD Susceptibility (Note3)
- HBM (Human Body Mode) ---------- 2kV
- MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note4)

- Junction Temperature ---------- -40°C to 125°C
- Ambient Temperature ---------- -40°C to 85°C
- Supply Input Voltage, V_{CC} ---------- 15V to 20V
- V_{CC} capacitor ---------- 10uF to 22uF

Electrical Characteristics

V_{DD}=18V, T_A=25°C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Supply Input Section						
Startup Current	I_{ST}	VDD=10V, before IC turned-on.		6	12	uA
Operating Current	I_{SS}	@ 70kHz,		1.7	3	mA
Turn-On Threshold	V_{TH_ON}		16	17	18	V
Turn-Off Threshold	V_{TH_OFF}		8.5	9.5	10.5	V
VDD Over Voltage Threshold	V_{DD_OV}	Back to V_{TH_OFF} and restart.	27	29	31	V
Internal OTA						
Reference Voltage	V_{REF}		318	333	348	mV
OCP Threshold Voltage	V_{OC_TH}		810	900	990	mV
OCP Released Threshold Voltage	V_{OC_R}		318	333	348	mV
Output upper clamp voltage		V_{INV}=V_{REF}-0.1V		5.4		V
Zero-Current Detection						
Upper Clamp-Voltage	V_{ZCDU}	$I_{ZCDSINK}$=2.0mA	6.2	6.7	7.2	V
Lower Clamp-Voltage	V_{ZCDL}	$I_{ZCDSORC}$=2.0mA	0.1	0.3	0.5	V
Positive Threshold Voltage	V_{TH_P}		1.3	1.4	1.5	V

Negative Threshold Voltage	V_{TH_N}		0.6	0.7	0.8	V
Minimum Off Time	T_{MIN_OFF}	$V_{COMP} \geq 1V$	3.0	4.0	5.0	us
		$V_{COMP} = 0.4V$	4	5.5	7	us
Gate On Time	Ton	V_{COMP}=3V	10	11	12	us
		V_{COMP}=0.27V	0.3	0.6	0.9	us
Input bias current		VZCD=1V~5V, OUT=OFF	0.005		1	uA
Max. delay from ZCD to OUT				250		ns
AC absent		AC absent detect time		20		ms
Gate Drive Output						
Rise Time	T_R	V_{CC}=16V, C_L = 1nF, Vgs : 1 to 9V		60		ns
Fall Time	T_F	V_{CC}=16V, C_L = 1nF, Vgs : 1 to 9V		60		ns
Gate Clamp Voltage	V_{G_CLAMP}	V_{CC}>=20V		15.5	17.5	V
Output Low Level	V_{OL}	ISINK=1mA	-	-	1.0	V
Output High Level	V_{OH}	ISOURCE=1mA	6.0	-	V_{CC}	V
Start-up						
Startup Period (Max Off Time)			55	75		us
Max. On Time			15		18.5	us
Over Temperature Protection						
Thermal Shutdown Temperature	T_{SD}			140		°C
Thermal Shutdown Resume	T_{SDHYS}			110		°C

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. θ_{JA} SOP-8 packages is 52°C /W on JEDEC 51-7 (4 layers,2S2P) thermal test board with 50mm^2 copper area.

Note 3. Devices are ESD sensitive. Handling precaution is recommended.

Note 4. The device is not guaranteed to function outside its operating conditions.

Functional Description

EM8822A is a constant current Buck/Buck-Boost PFC controller targeting at LED lighting applications.

The device is designed to operate in transition mode (TrM) and is suitable for single stage Buck PFC as well as Buck-Boost PFC converters in constant on time operation to achieve high power factor.

EM8822A provides reliable protections such as LED Short Circuit Protection, LED Open Protection, Over Temperature Protection (OTP)..

Start up

After AC source or DC BUS is powered on, the capacitor C_{VDD} across V_{DD} and GND pin is charged up by V_{BUS} voltage through a start up resistor R_{ST}. The start-up current of IC is 6uA typical. Once VDD rises up to UVLO(on), the internal blocks start to work. VDD will be pulled down by operation current of IC until the bias supply circuit could supply enough energy to maintain VDD above UVLO(off).

The whole start-up procedure is divided to two figures shown in Fig.14 and Fig.15. t_{STC} is the C_{VDD} charged up section, and t_{STO} is the output voltage built-up section. The start-up time t_{ST} composes of t_{STC} and t_{STO}, and usually t_{STO} is smaller than t_{STC}.

Select the C_{VDD} to get an ideal start up time t_{ST} and ensure the output voltage is built up without another startup.

$$C_{VDD} = \frac{(\frac{V_{BUS}}{R_{ST}} - I_{ST})}{UVLO(on)} \quad (1)\ ,\ I_{ST}：\text{start up current.}$$

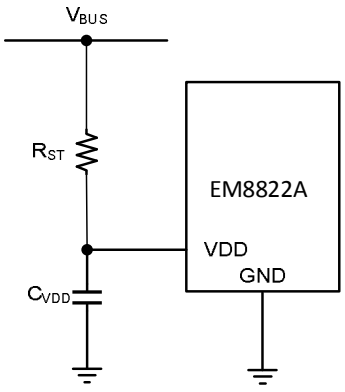


Fig. 14

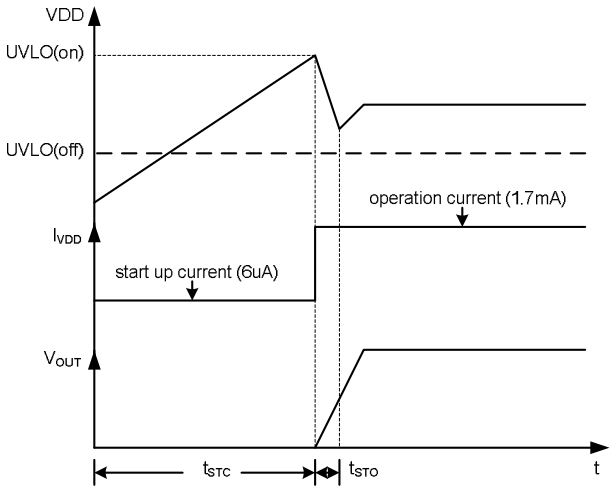


Fig. 15

Zero current detect

The zero current detect (ZCD) generates the turn-on signal of the MOSFET when the inductor current reaches zero current using an auxiliary winding voltage or output voltage that's coupled with the inductor.

If the voltage of the ZCD pin goes higher than 1.4V that its action is ready to aim, the ZCD comparator waits until the voltage goes below 0.7V. And when the voltage goes below 0.7V, the internal logic turns on the MOSFET. That is shown in Fig.3.

The ZCD pin is protected internally by two clamps, 6.7V high voltage clamp and 0.3V low voltage clamp.

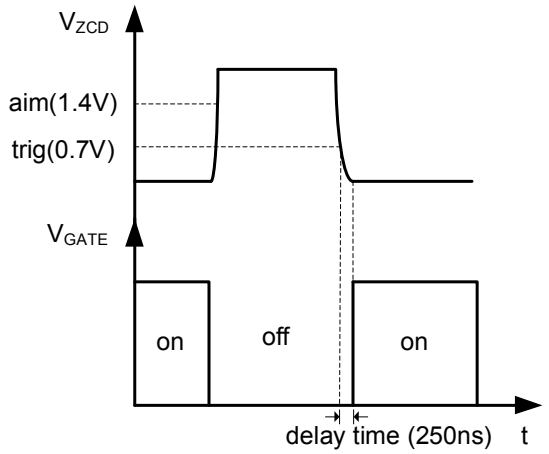


Fig. 15

Switch Driver

The EM8822A contains a single totem-pole output stage designed for direct drive of the power MOSFET. The drive output is capable of typical rise and fall time of 60ns with 1nF load.

Under voltage lockout

If the VDD voltage reaches UVLO(17V), the IC's internal blocks are enabled and start operation. If the VCC voltage drops below 9.5V, most of the internal blocks are disabled to reduce the operating current. VDD voltage should reach UVLO(17V) again to do restart up operation.

Constant current control

The output current IOUT can be represented by,

$$I_{out} = \frac{V_{REF}}{R_{CS}} (2)$$

V_{REF} : 333mV

The pigure.15 show the Rcs location in Buck PFC converter.

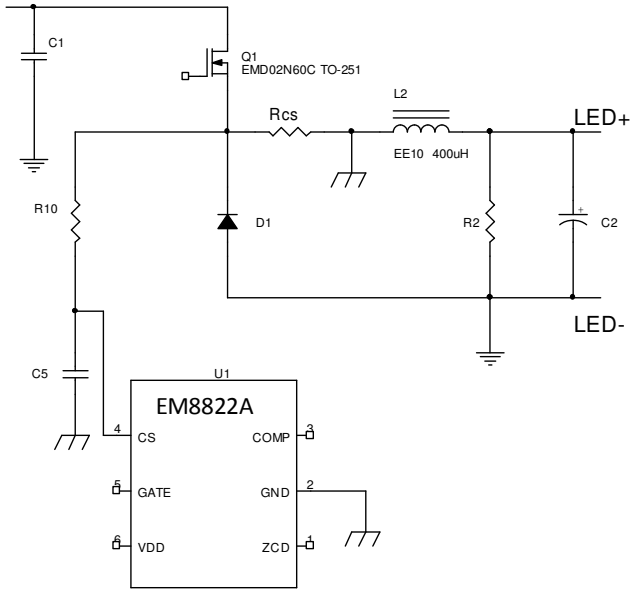


Fig. 15

LED Open Protection

For LED lighting applications, when LEDs are opened, the control loop tends to regulate rated current in the converter. The VDD is connected to output voltage directly. Under this condition, the output voltage will rise to V_{BUS}. At the same time, the output capacitor will be damage because of high voltage.

EM8822A VDD pin has over voltage protection and that voltage is 29V typical. When VDD reach 29V, VDD down to UVLO(off) and restart up again. The auto-recovery function can protect the output capacitor avoid from damage.

LED Short Protection

For LED lighting applications, when a number of LEDs in a string are shorted, the output voltage drops. The VDD is connected to output voltage directly. So VDD drops below UVLO(off) 9.5V and the IC will cease operation.

Once EM8822A is shutdown, the rectified line voltage will charge the VDD hold-up capacitor via start-up resistor. This is same as start-up operation.

Thermal Shutdown

Thermal shutdown occurs when the IC experiences a junction temperature that is exceeds approximately 140 degree C. It resumes normal operation when the junction temperature drops to or below approximately 110 degree C.

Typical Application Circuit

- Buck application circuit

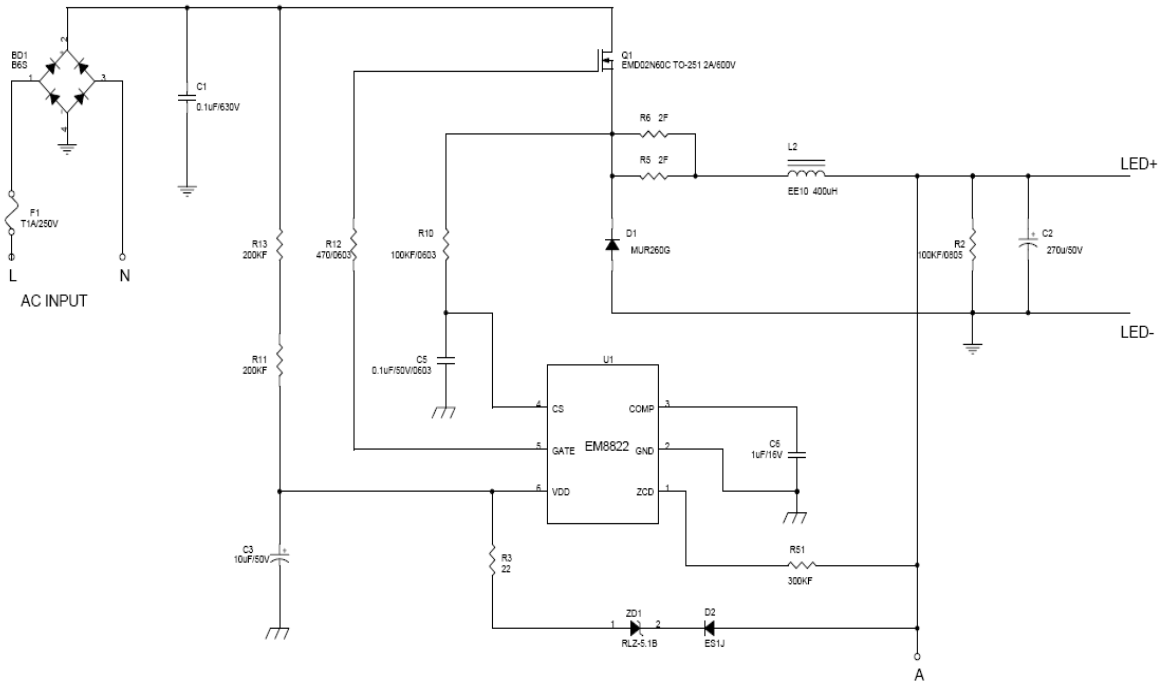


Fig. 15

- Buck –Boost application circuit

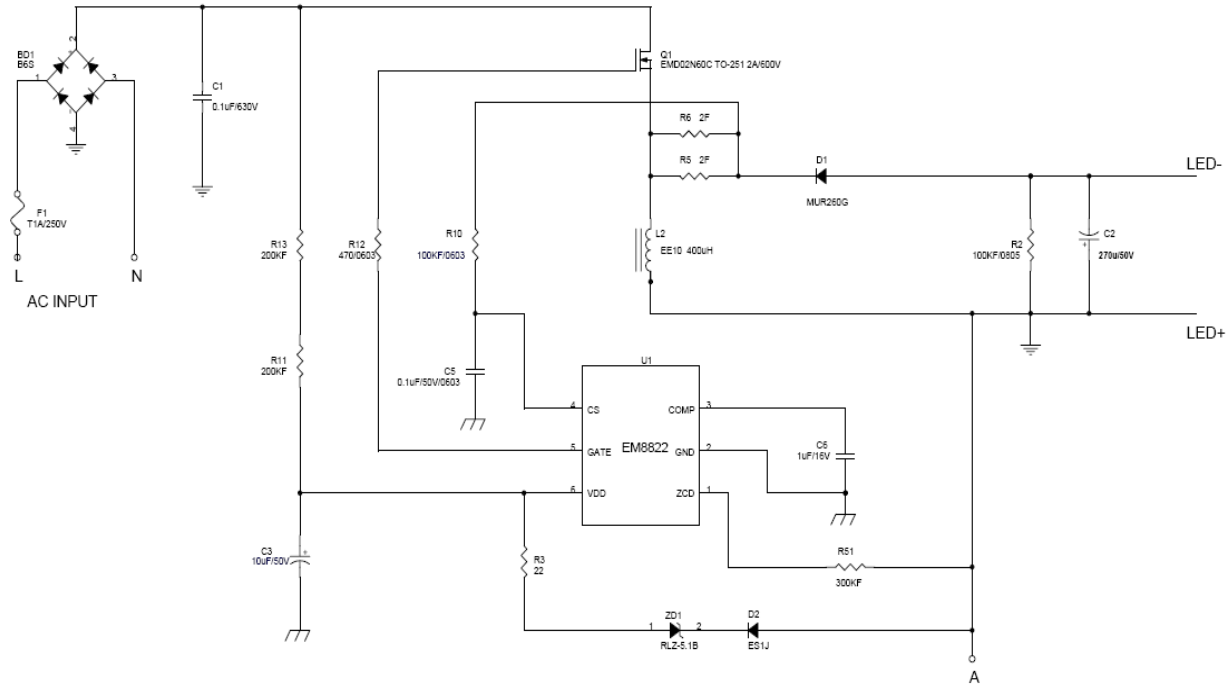
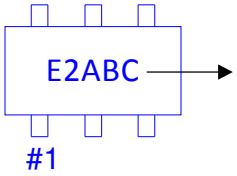


Fig. 15

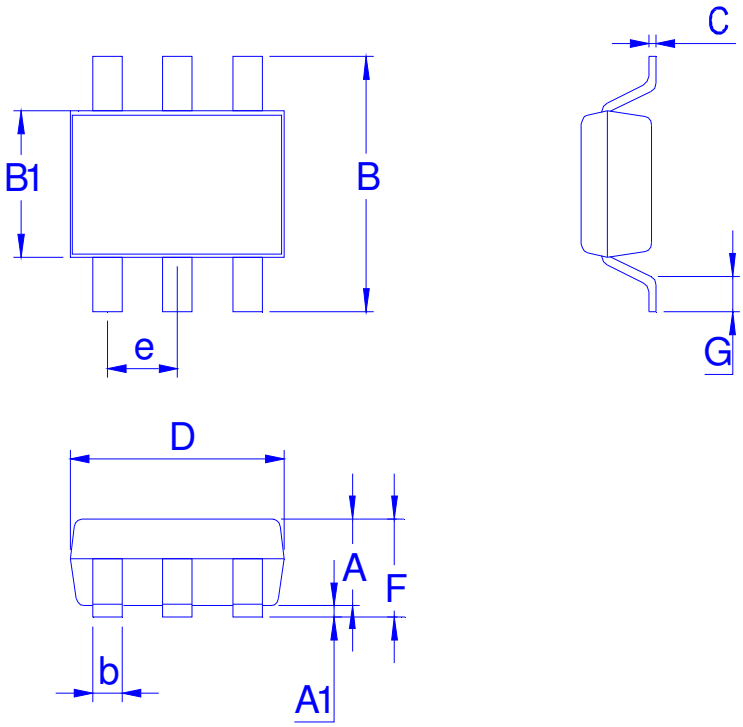
Ordering & Marking Information

Device Name: EM8822AJ for SOT-23-6



E2: Device Code, E1 for EM8822AJ
ABC: Date Code

Outline Drawing



Dimension in mm

Dimension	A	A1	B	B1	b	C	D	e	F	G
Min.	0.90	0.00			0.30	0.08				0.30
Typ.	1.15		2.80	1.60			2.90	0.95		0.45
Max.	1.30	0.15			0.50	0.22			1.45	0.60