

# LZC8720

## Single Stage buck PFC for LED lighting



### General Description

LZC8720 is a voltage mode Buck PFC controller operating at transition mode. It keeps the Buck 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.

### Ordering Information

Part Number	Package	Remark
LZC8720	SOP-23-6	

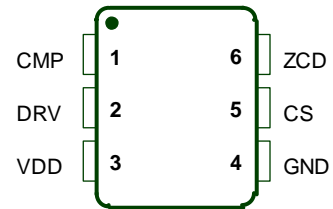
### Applications

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

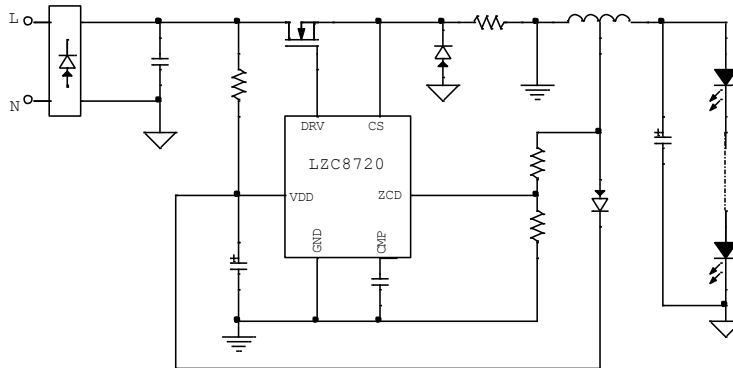
### Features

- Single stage Buck PFC controller
- Regulator with Internal Temperature Compensation
- Voltage Mode Control
- Valley turn on of the MOSFET to achieve lower switching loss
- Low Start Up Current : 5uA typical
- Maximum gate drive voltage at 16V
- Over Voltage Protection for IC bias voltage
- LED Open/Short Protection
- Internal over-thermal Shutdown

### Pin Configuration



### Application Circuit



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### Pin Assignment

Pin Name	Pin No.	Pin Function
CMP	1	Output of the error amplifier. Connect a RC network across this pin and ground to stabilize the control loop.
DRV	2	Connect this pin to the gate of MOSFET. Maximum gate voltage is clamping at 16V.
VDD	3	Power supply. Provide 27V typical over voltage protection.
GND	4	Ground pin.
CS	5	Connect this pin to the source of the MOSFET. Connect the sense resistor across the source of the MOSFET and the GND pin.
ZCD	6	Inductor current zero crossing detection pin. The pin receives the auxiliary winding voltage or output voltage by a resistor divider and detects the inductor current zero crossing point.

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### Absolute Maximum Ratings (Note 1)

- Supply Input Voltage, VDD ----- 30V
- Gate pin----- 30V
- other Pins ----- - 0.3V to 6.5V
- Power Dissipation, PD @ TA = 25C
  - SOP-23-6 ----- 0.4W
- Package Thermal Resistance,  $\Theta_{JA}$ 
  - SOP-23-6 (Note 2), ----- 200°C /W
- Junction Temperature ----- 160°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, VDD ----- 11V to 23V
- VDD capacitor ----- 10uF to 22uF

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### Electrical Characteristics

V<sub>DD</sub>=15V, T<sub>A</sub>=25°C, unless otherwise specified

Symbol	Parameter	Test Conditions	Limits			Unit
			Min.	Typ.	Max.	
<b>VDD Supply Voltage</b>						
V <sub>DD_ON</sub>	VDD Turn on threshold		18.1	19.8	21.5	V
V <sub>DD_OFF</sub>	VDD Turn off threshold		7.0	8.0	9.0	V
V <sub>DD_OVP</sub>	Over voltage threshold			27		V
I <sub>ST</sub>	Startup current	V <sub>DD</sub> =V <sub>DD_ON</sub> -0.3V		5	10	μA
I <sub>OP</sub>	Operating current of VDD	C <sub>DRV</sub> =1.5nF		1.5		mA
<b>Oscillator</b>						
F <sub>MAX</sub>	Maximal Frequency			90		KHz
T <sub>MAX_ON</sub>	Maximal on time			30		μS
T <sub>MAX_OFF</sub>	Maximal off time			40		μS
T <sub>MIN_OFF</sub>	Minimal off time			1.5		μS
<b>ZCD</b>						
V <sub>ZCD_SINK</sub>	ZCD High clamp voltage	I <sub>ZCD_SINK_Max</sub> =2mA		6		V
V <sub>ZCD_SOURCE</sub>	ZCD Low clamp voltage	I <sub>ZCD_SOURCE_Max</sub> =4mA		0		V
V <sub>ZCD_SCP</sub>	Output SCP voltage			0.7		V
V <sub>ZCD_OVP</sub>	Output OVP voltage			3.6		V
T <sub>ZCD-LEB1</sub>	ZCD pin leading edge blanking time for PRO			1.5		μS
V <sub>ZCD_DET</sub>	ZCD detection voltage			0.5		V
<b>COMP Compensation</b>						
V <sub>REF</sub>			247.5	253.0	258.5	mV
I <sub>COMP_H</sub>	Max source current			32		μA
I <sub>COMP_L</sub>	Max sink current			106		μA

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Current Sense (CS)						
$T_{CS-LEB}$	CS pin Leading edge blanking time			400		nS
$V_{CS-PEAK3}$	Maximum peak voltage	ZCD>1.6V		1.3		V
DRV						
$T_R$	Rise time of driver	$C_{DRV}=1.0nF$		200		nS
$T_F$	Fall time of driver	$C_{DRV}=1.0nF$		100		nS
$V_{DRV-MAX}$	DRV clamped voltage			16		V
OTP						
$T_{OTPP}$	OTP protection temp.			160		°C
$T_{OTPR}$	OTP Release temp.			125		°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.**  $\theta_{JA}$  SOP23 packages is 110 °C /W on JEDEC 51-7 (4 layers,2S2P) thermal test board with 50mm<sup>2</sup> 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.

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### Functional Description

LZC8720 is a constant current Buck PFC controller targeting at LED lighting applications.

The device is designed to operate in transition mode and is suitable for single stage Buck PFC converters in constant on time operation to achieve high power factor.

LZC8720 provides reliable protections such as LED Short Circuit Protection, LED Open Protection, Over Temperature Protection (OTP), etc..

### 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 5uA 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.1 and Fig.2.  $t_{STC}$  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.

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

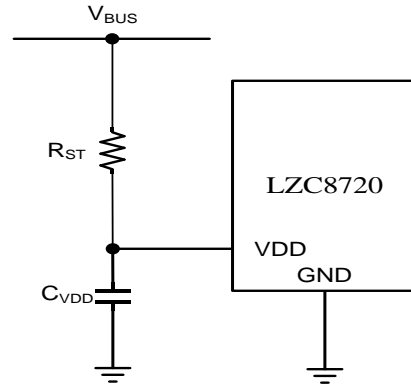


Fig. 1

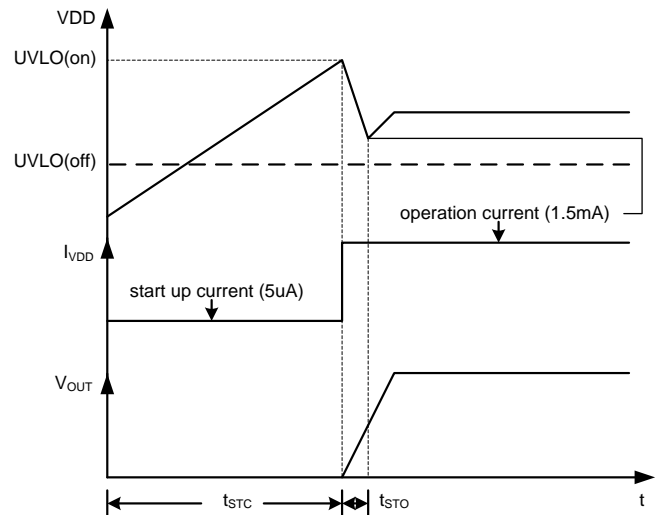


Fig. 2

### 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 1.6V that its action is ready to aim, the ZCD comparator waits until the voltage goes below 0.7V. And when the voltage goes below 0.5V, the internal logic turns on the MOSFET. That is shown in Fig.3.

The ZCD pin is protected internally by two clamps, 6V high voltage clamp and zero low

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voltage clamp.

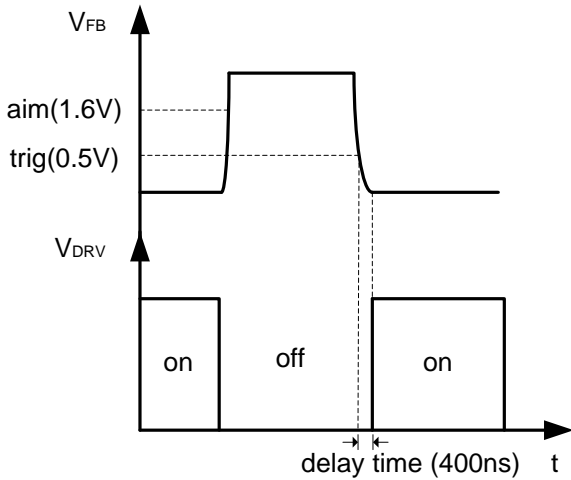


Fig. 3

### Switch Driver

The LZC8720 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(19.8V), the IC's internal blocks are enabled and start operation. If the VCC voltage drops below 8.0V, most of the internal blocks are disabled to reduce the operating current. VDD voltage should reach UVLO(8.0V) again to do restart up operation.

### Constant current control

The output current I<sub>OUT</sub> can be represented by,

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

$$V_{REF} : 253mV$$

The figure.4 show the R<sub>CS</sub> location in Buck PFC converter.

### 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<sub>BUS</sub>. At the same time, the output capacitor will be damage because of high voltage

LZC8720 VDD pin has over voltage protection and that voltage is 27V typical. When VDD reach 27V, 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) 8.0V and the IC will cease operation.

Once LZC8720 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 160 degree C. It resumes normal operation when the junction temperature drops to or below approximately 125 degree C.

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### Typical Application Circuit

- Single stage Buck PFC application circuit

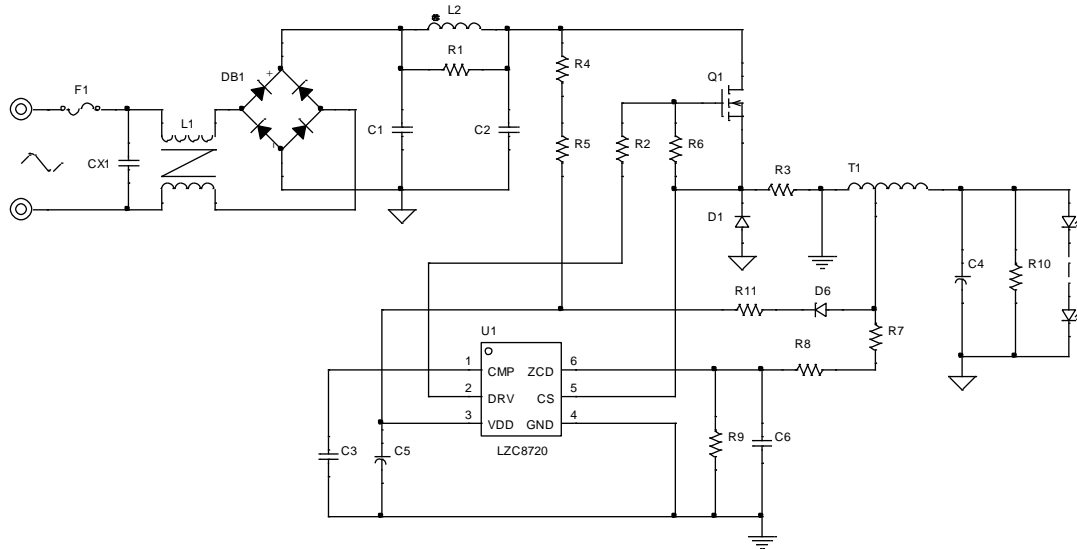
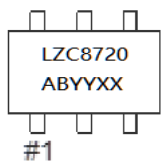


Fig. 4

### Ordering & Marking Information

Device Name: LZC8720 for SOT-23-6



LZC8720  
ABYYXX: AB for Assembly house, YYXX for Date code

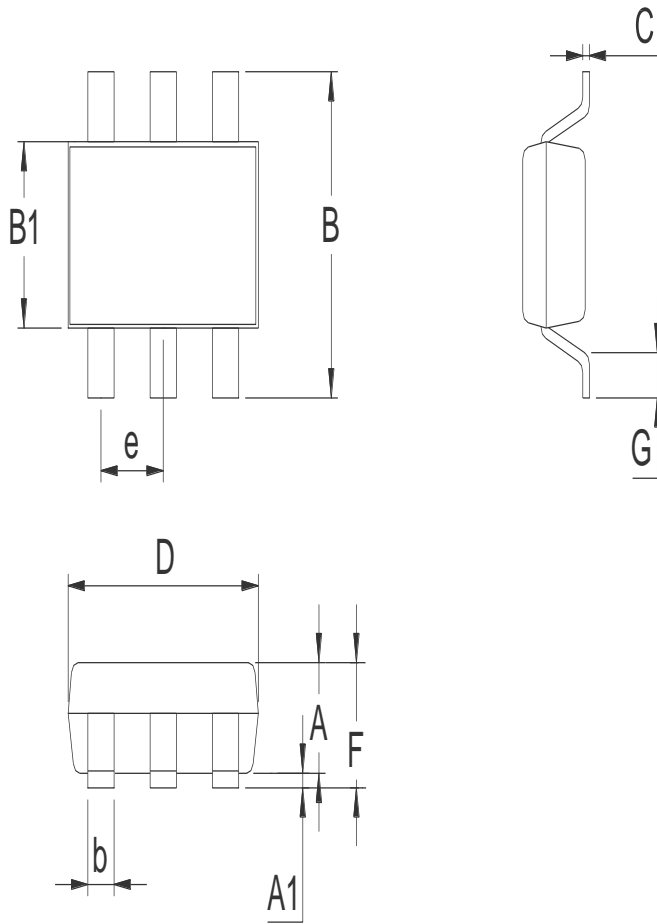


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### Outline Drawing



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