APFC Buck LED Power Switch

Features

- Active Power Factor Correction
- PF>0.9, THD<15% with high line input
- Built-in HV Power Supply Circuit
- Internal 650V Power MOSFET
- No VDD, COMP Capacitor Design
- Programmable OVP
- QR Operation Mode for High Efficiency
- High Output Current Accuracy<±3%
- Ultra-low Operation Current
- Good Line and Load Regulation
- Built-in Protections
 - Output Over Voltage Protection (OVP)
 - Cycle by Cycle Current Limit (OCP)
 - Leading Edge Blanking (LEB)
 - LED Open and Short Protection
 - Line OVP
 - Thermal Fold-back (OTP)
- Package Available with SOP-7

Applications

• LED Driver

Typical application(non-isolated circuit)



Description

XT420X is a family of highly integrated Consta Current LED power switch. The IC utilizes Quasi-Re onant (QR) Buck topology with active PFC control f high PF, low THD, and high efficiency.

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XT420X integrates internal demagnetization dete tion circuit and 650V power MOSFET with hic voltage startup, which eliminates auxiliary windir for power supply and demagnetization and simp fies the design and production cost of the syster The IC adopts accurate current sensing, close loc constant current control to achieve high precisio

XT420X integrates functions and protections of Cycle-by-cycle Current Limiting (OCP), Thermal Fold-back (OTP), Line OVP, Output Over Voltage Protection (OVP), LED Open/Short Protection, etc.



Pin Configuration



Output Power Table

Part Number	Package .	Maximum Output Current (176-265 Vac)			
		36V output	72V output		
XT4201A2	SOP-7	200mA	130mA		
XT4202A2	SOP-7	300mA	240mA		

Note: Maximum output power is constrained by IC maximum Junction Temperature and determined by ambient temperature and PCB. The system actual maximum output power is determined by the test.



Pin Description

Pin Number	Pin Name	I/O	Description	
1	ROVP	Ι	Output OVP adjustment pin. Connecting a resistor to GND can continuously adjust the OVP point.	
2	GND	Ρ	IC Ground Reference Pin	
3	NC		Left floating in use	
4	HVDD	Ρ	IC HV Supply Pin	
5, 6	Drain	0	Internal power MOSFET Drain pin	
7	CS	I	Internal power MOSFET Source and current sampling pin	

Ordering Information

Part Number	Description		
XT4201A2	SOP-7, Pb free in T&R, 4000Pcs/Reel		
XT4202A2	SOP-7, Pb free in T&R, 4000Pcs/Reel		





Absolute Maximum Ratings (Note 1)

Parameter	Value	Unit	
HVDD Voltage	-0.3 to 650	V	
Drain Voltage	-0.3 to 650	V	
CS, ROVP Voltage	-0.3 to 7	V	
PDmax, Power dissipation @TA=50°C (SOP-7) (Note2)	0.6	W	
$ heta_{JA}$, Thermal ResistanceJunction to Ambient (SOP-7)	165	°C/W	
Maximum Junction Temperature	150	°C	
Storage Temperature Range	-65 to 150	°C	
Lead Temperature (Soldering, 10sec.)	260	°C	
ESD Capability, HBM (Human Body Model)	3	kV	

Recommended Operation Conditions

Parameter	Value	Unit
Operating Junction Temperature	-40 to 125	°C

Electrical Characteristics (Ta = 25°C, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit.	
Supply Vol	Supply Voltage Section (HVDD Pin)						
HVDD_on	HVDD Startup Voltage			50		V	
Power Sup	ply Current						
lq	Quiescent Current	No Switching Action		0.32		mA	
Control Loo	Control Loop						
Vref	Voltage Reference For Feedback	Close The Feedback Loop		200		mV	
Ton_max	Maximum ON Time			6.5		μs	
Toff_max	Maximum OFF Time			250		μs	
	Minimum ON Time			0.8		μs	



	Minimum OFF Time			0.3		μs
TMin	Maximum Switching Period			10		μs
Current Se	nse Input Section (CS Pin)					
ОСР	Current Limiting Threshold			1.4		V
Tleb	Leading Edge Blanking Time			300		ns
Input Over	Voltage Protection					
Vovp	Input Over Voltage Protection Threshold			370		V
Vovp_r	Input OVP Recovery Threshold	0		325		\vee
Over Temp	erature Protection					
Tsd	Thermal Foldback Trigger Point			155		°C
Power MOSFET Section (Drain						
Vbr	Power MOSFET Drain Source Breakdown Voltage			650		V
Pdrop	Static Drain-Source On Resistance	XT4201A2		8.5		Ω
, cuson		XT4202A2		4.5		Ω
Id	MOS Saturation Current	XT4201A2		1		А
		XT4202A2		2		А

Characterization Plots







Characterization Plots





XT420X is a highly integrated power switch with constant current (CC) control for LED lighting applications. The IC utilizes Quasi-Resonant (QR) Buck topology with active PFC control for high PF, low THD, and high efficiency. XT420X integrates internal loop compensation capacitance (COMP capacitance) and VDD capacitance and supports for non auxiliary winding design. Output OVP voltage is continuously adjustable. The system cost can be minimized.

System Start-Up Operation

After system power up, a digital counter is enabled. When 60ms had been counted, IC starts to switch at the lowest frequency, and then the output current slowly rises to the design value.

Constant Current (CC) Control

XT420X samples the peak inductor current in each switching cycle to be as the CC loop feedback, and the high accurate output current can be realized with a high accurate current reference. The output current is determined by:





In the equation above,

R_{cs}--- the sensing resistor connected between CS and GND.

When AC input voltage drops, Ton will increase. When Ton reaches Ton_max, the output current will drop to limit IC temperature. The inductor can be set to adjust Ton and the curve. At the same time, in order to ensure the reliability of the system under high Vac, when Vac exceeds 370Vac, the Input Over Voltage Protection is triggered & PWM Pulse Stops.





Leading Edge Blanking (LEB)

Each time the power MOSFET is switched on, a turn-on spike occurs across the sensing resistor. The spike is caused by MOSFET parasitic capacitance and freewheeling rectifier reverse recovery. To avoid premature termination of the switching pulse, an internal leading-edge blanking circuit is built in. During this blanking period (typically 300ns), the PWM comparator is disabled and cannot switch off the gate driver.

Demagnetization Detection

XT420X integrates internal demagnetization detection circuit which eliminates the auxiliary winding and simplifies the design cost of the system.

Timing Control

In XT420X, a minimum blanking time is implemented to suppress ringing when the power MOSFET is off. Meanwhile the maximum OFF time in XT420X is typically 250us. The chip also integrates maximum frequency clamping function to achieve good EMI performance.

Output Over Voltage Protection (OVP)

XT420X is integrated proprietary OVP control scheme, and the output over voltage can be programmed by the Rovp. The output over voltage is determined by:

R1 (KΩ)	VOVP (V)
<10 (can be shorted to GND)	8
10~30	60
30~56	200
>56 (can be floating)	100

Auto-Restart LED Open Protect

In the event of LED open circuit condition/output OVP protection, the IC enters auto-restart mode, wherein the power MOSFET is disabled and a digital counter is enabled. When 250ms had been counted, the IC will reset and start up the system again. However, if the fault still exists, the system will experience the above-mentioned process.

On Chip Thermal Fold-back (OTP)

XT420X integrates thermal fold-back function. When the IC temperature is over 155°C, the system output regulation current is gradually reduced, as shown in Fig.2. Thus, the output power and thermal dissipation are also reduced. In this way, the system temperature is limited and system reliability is also improved.



Soft Totem-Pole Gate Driver

XT420X has a soft totem-pole gate driver with optimized EMI performance.

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XT420X

PCB Layout Guidelines

PCB layout is very important for reliable operation. Please follow guideline to optimize performance.

1. The area of main power switching loop should be as small as possible to reduce the EMI radiation, such as the inductor charging loop consisted of the EMI filter capacitor, output capacitor, inductor and IC; the inductor discharging loop consisted of the inductor, freewheeling diode and output capacitor.

2. Use single-point grounding. IC ground and other small signals ground should be connected to terminal ground point, the current sampling resistor ground. And the trace should be as short as possible.

3. Increase the copper area of the Drain pin to improve thermal performance. But too much copper area will worsen EMI performance.



Top layout





Package Dimension



Symbol	Dimensions in Millimeters		Dimensions in Inches		
Symbol	Min	Max	Min	Max	
А	1.350	1.750	0.053	0.069	
Al	0.100	0.250	0.004	0.010	
A2	1.350	1.550	0.053	0.061	
b	0.330	0.510	0.013	0.020	
С	0.170	0.250	0.006	0.006	
D	4.700	5.100	0.185	0.006	
E	3.800	4.000	0.150	0.244	
El	5.800	6.200	0.228	0.244	
е	1.270	(BSC)	0.050 (BSC)		
L	0.400	1.270	0.016	0.050	
е	O°	8°	O°	8°	