CURRENT MODE PWM＋PFM CONTROLLER

DESCRIPTION

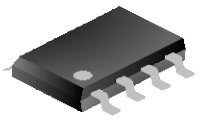
SD4872X is a current mode PWM controller IC for high performance, low standby power offline flyback converter application.

In no load or light load condition, the IC operates in Light Load Mode to reduce switching loss and improve efficiency.

Large startup resistor could be used in the startup circuit to minimize the standby current because of low startup current.

SD4872X offers complete protection functions including cycle-by-cycle over current protection, over load protection, over voltage and under voltage protections for V_{DD} voltage, etc.

Excellent EMI performance is achieved with frequency shuffling technique and soft switching control at the totem pole gate driver output.



SOP-8-225-1.27

FEATURES

* Frequency shuffling to improve EMI performance
* Light Load Mode for minimum standby power
* 65kHz switching frequency
* 10μA low startup current
* Internal LEB circuit
* V_{DD} over-voltage and under-voltage protection
* External programmable over-temperature protection
* Brown-out protection
* External programmable output over-voltage protection
* Over-power compensation
* Gate output voltage clamp
* Cycle-by-cycle current limiting
* Over load protection
* SOP8 package

APPLICATIONS

* Adapters
* Set-Top Box Power Supplies

ORDERING INFORMATION

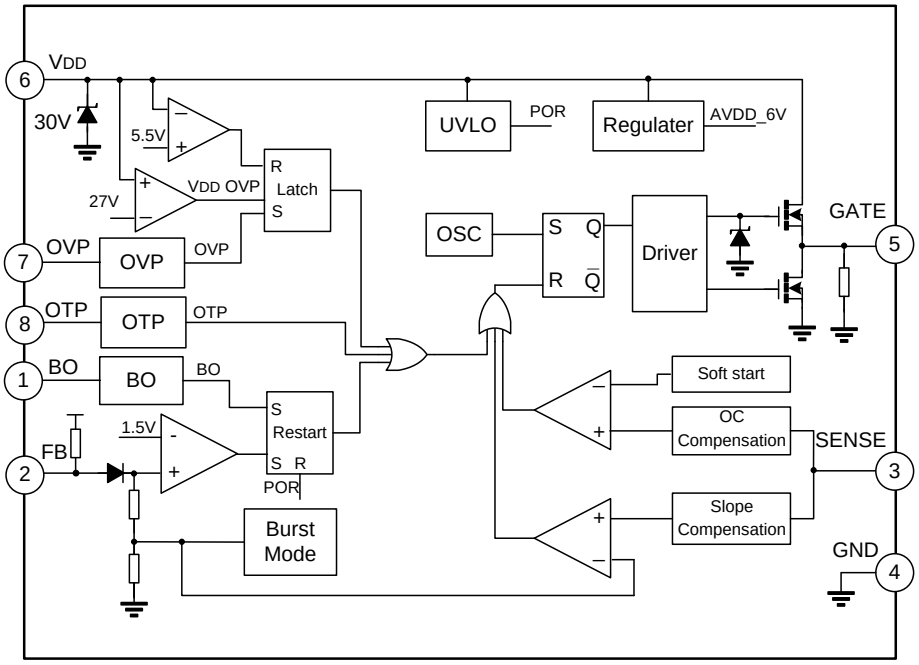
Part No.	Package	Marking	Material	Packing
SD4872	SOP-8-225-1.27	SD4872	Pb free	Tube
SD4872TR	SOP-8-225-1.27	SD4872	Pb free	Tape & Reel
SD4872R	SOP-8-225-1.27	SD4872R	Pb free	Tube
SD4872RTR	SOP-8-225-1.27	SD4872R	Pb free	Tape & Reel

SPECIFICATIONS

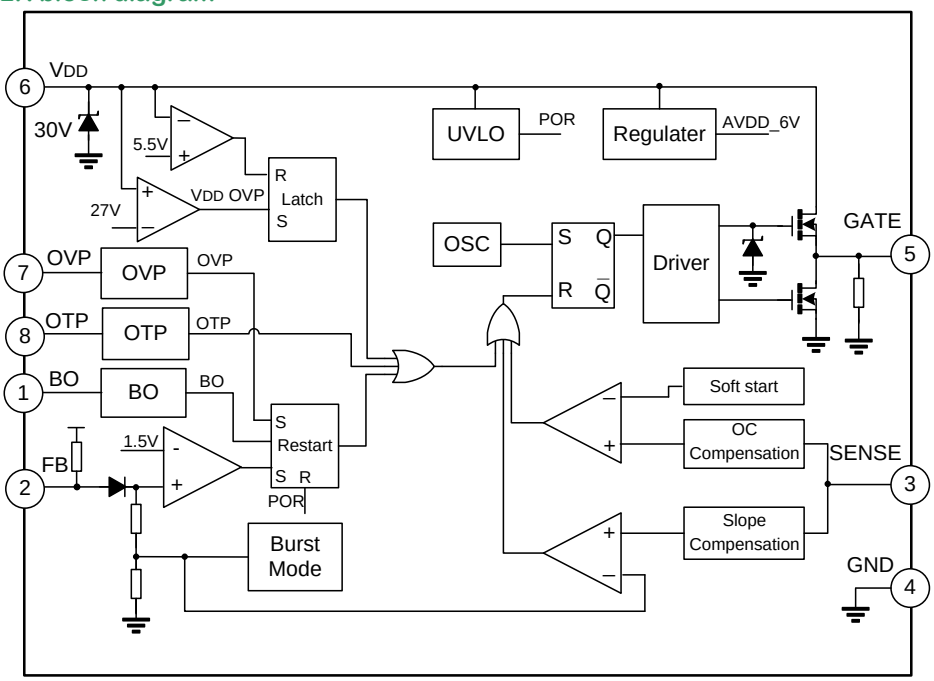
Part No.	Frequency	OLP Mode	OVP Mode
SD4872	65kHz	Auto-restart	AC latch
SD4872R		Auto-restart	Auto-restart

BLOCK DIAGRAM

- SD4872 block diagram



- SD4872R block diagram



ABSOLUTE MAXIMUM RATINGS

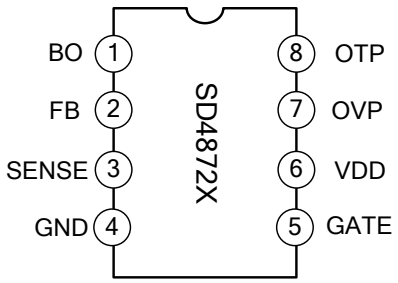
Characteristics	Symbol	Rating	Unit
Supply Voltage	V_{DD}	30	V
Feedback Voltage	V_{FB}	-0.3~6	V
SENSE Voltage	V_{SENSE}	-0.3~6	V
OTP Voltage	V_{OTP}	-0.3~6	V
OVP Voltage	V_{OVP}	-0.7~6	V
BO Voltage	V_{BO}	-0.3~6	V
Junction Temperature Range	T_j	-20~150	°C
Lead Temperature	T_L	260	°C
Storage Temperature Range	T_{stg}	-55~160	°C

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Tamb=25°C)

Characteristics	Symbol	Test Condition	Min.	Typ.	Max.	Unit
V_{DD}						
Startup Current	I_{VDD_ST}	V_{DD}=12 V	--	10	20	μA
Operation Current	I_{VDD}	V_{DD}=16V, V_{FB} =3V	--	1.65	--	mA
Start up Voltage	V_{START}		13.3	14.8	16.0	V
Shut down Voltage	V_{SHUT}		--	7.8	--	V
Reset Voltage (latch status)	V_{RESET}		--	5.5	--	V
V_{DD} OVP Voltage	V_{VDDOVP}		--	27	--	V
V_{DD} Clamp Voltage	V_{VDD_CLP}	I_{VDD} =10mA	--	30	--	V
Feedback						
PWM Gain	A_{VCS}	ΔV_{FB} /ΔV_{SENSE}	--	2	--	V/V
FB Open Loop Voltage	V_{FB_OPEN}		4.6	5	5.4	V
FB Short Circuit Current	I_{FB_SHORT}	FB short connected to ground	0.35	0.4	0.45	mA
FB OL Threshold Voltage	V_{FB_OL}		--	3.8	--	V
OL Debounce Time	T_{D_OL}		--	50	--	ms
FB Input Impedance	Z_{FB_IN}		15	20	--	kΩ
Maximum Duty Cycle	D_{MAX}	V_{DD}=16V V_{FB} =3V,V_{SENSE} =0V	--	80	--	%
Current Sense						
LEB Time	T_{LEB}		--	300	--	ns
SENSE Input Impedance	Z_{SENSE_IN}		--	100	--	kΩ
OC Control Delay	T_{OC}		--	70	--	ns
OC Detection Threshold	V_{SENSE_OC}	V_{BO}=0.7V	0.85	0.9	0.95	V
Switching Frequency						
Oscillation Frequency	f_S		60	65	70	kHz
Frequency Stability With V_{DD}	Δf_{S_VDD}	V_{DD}=8~25V	--	5	--	%
Light Load Mode Frequency	f_{S_LLM}		--	22	--	kHz

Characteristics	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Frequency Shuffling Range	Δf_{S_SHUF}		-3	--	3	%
BO						
Brown-out Turn-off Threshold	V_{BO_OFF}		--	0.7	--	V
Brown-out Debounce Time	T_{D_BO}		--	500	--	ms
Brown-out Turn-on Threshold	V_{BO_ON}		--	0.9	--	V
OTP						
OTP output current	I_{OTP}		--	75	--	uA
OTP Threshold	V_{OTP}		--	1	--	V
OTP Delay	T_{D_OTP}		--	100	--	us
Internal OTP	T_{OTP}		--	150	--	°C
OVP						
OVP Threshold	V_{OVP}		--	1	--	V
Gate Driver						
Output Low Level	V_{OL}	V_{DD}=16V, I_O=-20mA	--	--	0.8	V
Output High Level	V_{OH}	V_{DD}=16V, I_O=20mA	10	--	--	V
Output Clamp Voltage Level	V_{OH_CLAMP}		--	13	--	V
Output Rising Time	T_R	V_{DD}=16V, C_L=1nF	--	200	--	ns
Output Falling Time	T_F	V_{DD}=16V, C_L=1nF	--	90	--	ns

PIN CONFIGURATION



PIN DESCRIPTIONS

Pin No.	Pin Name	I/O	Description
1	BO	I	AC input sense input pin.
2	FB	I	Feedback input pin.
3	SENSE	I	Switch current sense input pin.
4	GND	G	Ground.
5	GATE	O	Gate driver output pin.
6	VDD	P	Power supply pin.
7	OVP	I	Output over-voltage sense input pin.
8	OTP	I/O	Over-temperature sense input pin.

FUNCTION DESCRIPTIONS

SD4872X is a current mode PWM+PFM controller used in applications for offline flyback converter. The description of functions is as follows.

Startup Control

Startup current of SD4872X is very low so that IC could start up quickly. A large startup resistor can be used in startup circuit to minimize standby power loss yet provides reliable startup in application.

Frequency Shuffling Control

Frequency shuffling is used in SD4872X to improve EMI performance.
The oscillation frequency is modulated randomly so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and the system design can be easier. The entire application system design can become simpler.

Light Load Mode

In no load or light load condition, major power loss of total power consumption is from switching loss on the MOSFET transistor switching loss, the core loss of the transformer and the loss on the external snubber circuit, which become the majority in total power loss. The value of those power losses is proportional to switching actions within a fixed period of time. So reducing number of switching actions can reduce the power loss.
SD4872X enters Light Load Mode in no load or light load condition. The gate drive output switches only when output DC voltage drops below a preset level and the switching frequency reduces. Otherwise the gate drive remains at off state.

Current Sense and LEB

At switching leading edge time, the current spike due to snubber diode reverse recovery should be chopped off for it will affect the error of PWM comparator. And this is available through internal LEB (Leading Edge Blanking) circuit. So that the external RC filter circuit on SENSE input is no longer required.
During the blanking period, the PWM comparator and OC comparator are disabled and MOSFET transistor keeps turn-on state. The minimum on time of MOSFET is LEB time.

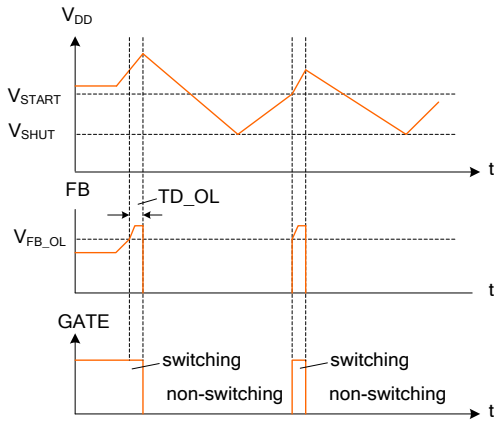
Gate Driver

GATE pin is connected to external MOSFET's gate for switch control. Too weak the gate drive ability results in more switch loss of MOSFET while too strong gate drive compromises the EMI performance.
A good tradeoff is achieved through the totem pole gate drive design with appropriate output ability and dead time control.
The output high voltage of GATE is clamped at 13V to protect the external MOSFET.

Over Load Protection

When FB input voltage is higher than over load threshold voltage 3.8V and lasts for more than 50ms, the circuit enters into over-load protection status. The MOSFET is off and the circuit restarts. The waveform is

shown below.



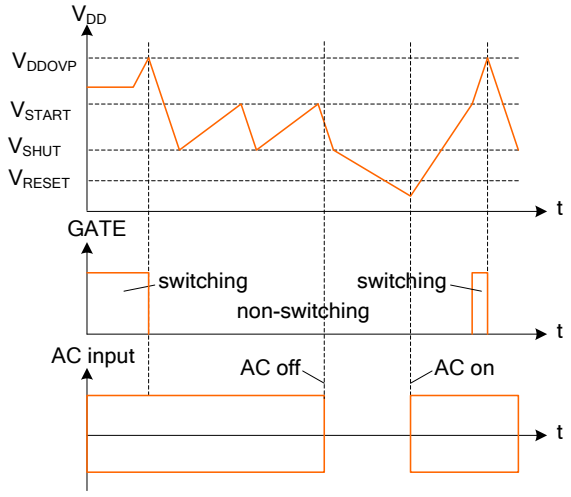
H/L Line Constant output power Compensation

By sensing AC input voltage, it's to compensate the over-current protection threshold, to achieve constant output power.

V_{DD} Over-voltage Protection

When V_{DD} is higher than clamp threshold voltage, the circuit enters into over-voltage protection status. The MOSFET is off and the system enters AC latch status. If the system enters AC latch status, only when the AC input is disconnected and the V_{DD} drops below the reset voltage, the system is unlocked. When the AC input is connected again, the system restarts.

The V_{DD} over-voltage protection waveform is shown below.

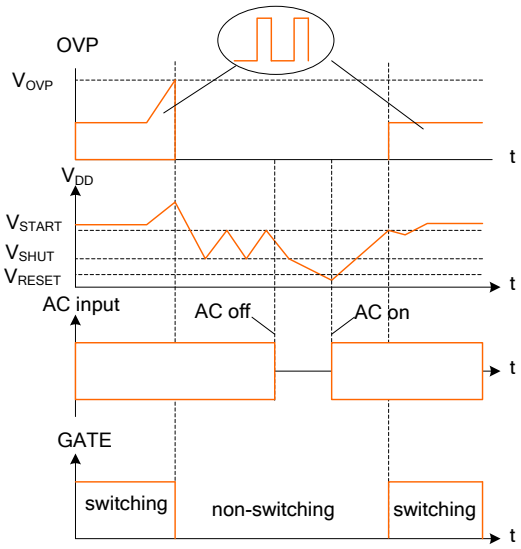


Output Over-voltage Protection

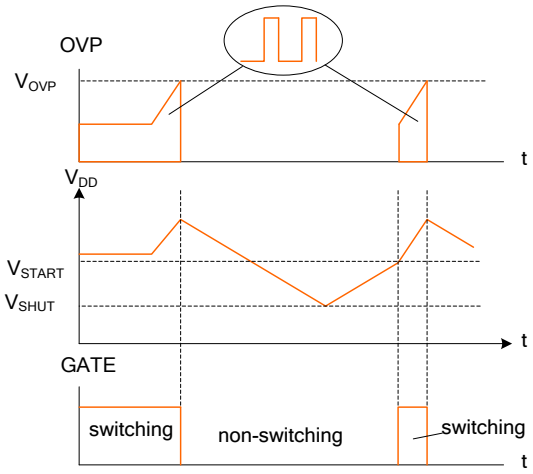
The auxiliary winding port is connected to OVP pin through the resistor divider. The output voltage can be sensing indirectly through the OVP pin. When OVP pin voltage is higher than output over-voltage threshold, the circuit enters into over-voltage protection status. The MOSFET is off and the system enters AC latch

status (SD4872) or restarts (SD4872R). If the system enters AC latch status, only when the AC input is disconnected and the V_{DD} drops below the reset voltage, the system is unlocked. When the AC input is connected again, the system restarts.

The output over-voltage protection waveform (AC latch) of SD4872 is shown below.



The output over-voltage protection waveform (Auto-restart) of SD4872R is shown below.



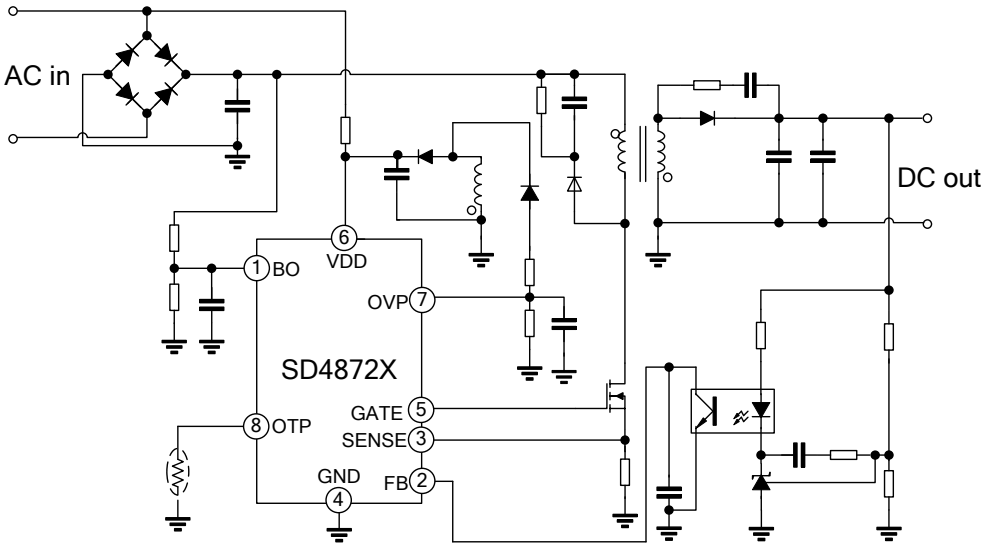
External Over-temperature Protection

The output current (75μA) flows through the NTC resistor connected from OTP pin to ground. When temperature rises, the value of NTC resistor decreases and the voltage across NTC resistor also decreases. When the voltage is smaller than OTP threshold voltage, the circuit enters over-temperature protection. The MOSFET is off and The MOSFET is off and the circuit restarts.

AC Input Under-voltage Protection

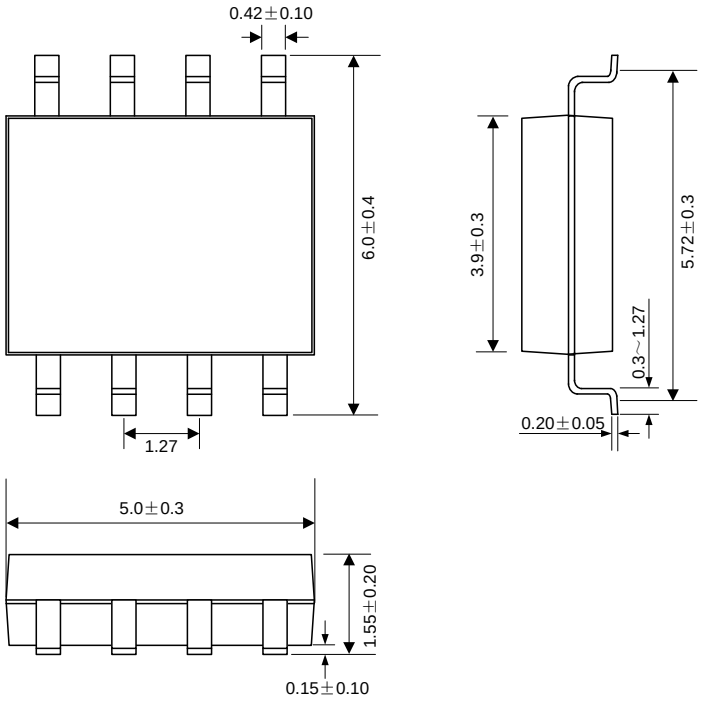
The AC input voltage can be sensed through BO pin. When the voltage of BO is lower than 0.7V, and lasts for more than the Brown-out Debounce Time, the circuit enters into AC input under-voltage protection status. The MOSFET is off and the circuit restarts.

TYPICAL APPLICATION CIRCUIT



PACKAGE OUTLINE

SOP-8-225-1.27 UNIT: mm



MOS DEVICES OPERATE NOTES:

Electrostatic charges may exist in many things. Please take following preventive measures to prevent effectively the MOS electric circuit as a result of the damage which is caused by discharge:

- The operator must put on wrist strap which should be earthed to against electrostatic.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed in antistatic/conductive containers for transportation.

ATTACHMENT

Revision History

Date	REV	Description	Page
2012.05.18	1.0	Initial release	
2012.09.07	1.1	Modify the block diagram of SD4872; Add the block diagram of SD4872R	