High PF, Low THD Flyback PFC Constant Voltage Controller

FEATURES

- **Quasi-Resonant for High Efficiency**
- **PF>0.95 and THD<10% within Universal Input**
- **Harmonics Meets IEC61000-3-2 Class C**
- **Startup Time < 500ms**
- **±3% CV Regulation**
- **Built-in HV Power Supply Circuit**
- **Less Than 50mW Standby Power**
- **Built-in Adaptive Output voltage limiting mechanism**
- **Built-in Protections:**
  - **VDD OVP and UVLO**
  - **Output Over Voltage Protection (OVP)**
  - **Brownout Protection (BOP)**
  - **Over Load Protection (OLP)**
  - **Short Circuit Protection (SCP)**
  - **Cycle by Cycle Current Limit (OCP/AOCP)**
  - **Over Temperature Protection (OTP)**
- **Available in SOP-8 Package**

APPLICATIONS

- **LED Lighting**
- **AC/DC Adapters**

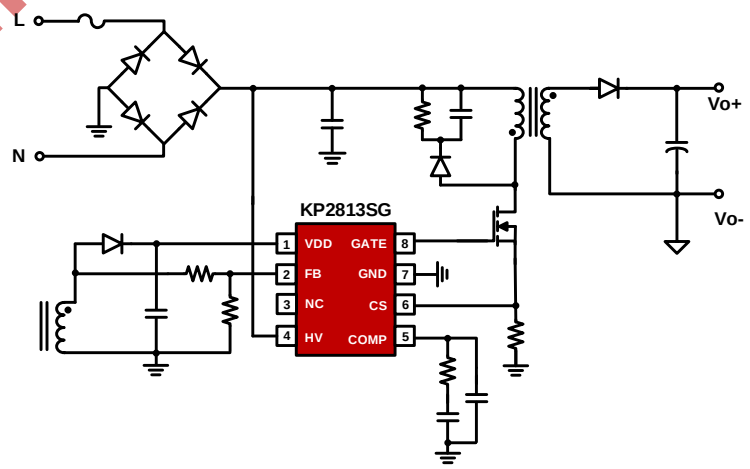
GENERAL DESCRIPTION

KP2813SG is a quasi-resonant constant voltage controller with high power factor, low THD and primary side control. The IC has built-in high-voltage start-up circuit to meet the requirements of fast start-up and ultra-low standby consumption.

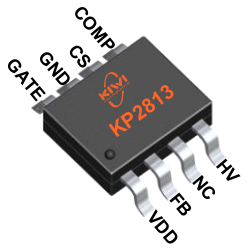
KP2813SG operates in quasi-resonant mode, which has high efficiency. The minimum operating frequency of IC can be set, which can ensure the system to work normally under the condition of ultra-light dummy load and meet the requirements of ultra-low standby consumption. The built-in output voltage sampling method can ensure the output voltage accuracy within ± 3%, even under light load conditions.

KP2813SG integrates protection functions, including VDD Under Voltage Lock Out (UVLO) and VDD Over-Voltage Protection (VDD OVP), Line Brownout (BOP), Output Over Voltage Protection (OVP), Over Load Protection (OLP), Short Circuit Protection (SCP), Cycle-by-Cycle Current Limit (OCP), Over Temperature Protection (OTP), Leading Edge Blanking (LEB), etc.

TYPICAL APPLICATION CIRCUIT



Pin Configuration



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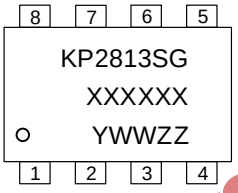
Marking Information

XXXXXX : Wafer for Code
Y : Year Code
WW : Week Code，01-52
ZZ : Serial Number，01-99 or A0-ZZ



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Pin Description

Pin Number	Pin Name	I/O	Description
1	VDD	P	Power supply pin which is connected to the auxiliary winding of the transformer via a diode.
2	FB	I	Output voltage feedback pin and inductor current zero crossing detection pin. The voltage of auxiliary winding is connected to this pin through voltage divider. The pin also has the function of setting the minimum operation frequency and fast dynamic response threshold.
3	NC		No Function Pin, Left Floating in Use.
4	HV	I	High voltage power supply pin, which is connected to input voltage after rectifier bridge. At the same time, it has LBOP detection function.
5	COMP	I	Control Loop Compensation Pin.
6	CS	I	The MOSFET current feedback pin. Which is connected to the MOSFET current sampling resistor.
7	GND	P	IC Ground.
8	GATE	O	Gate driver pin, connected to the gate of MOSFET

Ordering Information

Part Number	Description
KP2813SGA	SOP-8, Halogen free in T&R, 4000 Pcs/Reel

Absolute Maximum Ratings (Note 1)

Parameter	Value	Unit
HV Pin Voltage Range	-0.3 to 650	V
VDD DC Supply Voltage	-0.3 to 31	V
Gate Voltage Range	-0.3 to 20	V
CS, FB, COMP Voltage Range	-0.3 to 7	V
P_{Dmax}, Power dissipation @T_A=50°C (SOP-8), (Note 2)	0.6	W
θ_{JA}, Thermal Resistance---Junction to Ambient (SOP-8), (Note 2)	165	°C/W
IC Junction Temperature	150	°C
Storage Temperature Range	-65 to 150	°C
Lead Temperature (Soldering, 10sec.)	260	°C
ESD Capability, HBM (Human Body Model)	2.5	kV

Recommended Operation Conditions

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

Electrical Characteristics (Ta = 25°C, VDD=10V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage Section (VDD Pin)						
I_{VDD_st}	VDD pin Start-up Current	VDD<V_{DD_Op}		300	400	μA
I_{VDD_Op}	Operation Current	Fsw=50kHz，Gate=1nF		1	2	mA
V_{DD_On}	VDD Turn On Voltage		11	12	13	V
V_{DD_OFF}	VDD Under Voltage Lock Out Enter		6.5	6.8	7.1	V
V_{DD_OVP}	VDD OVP threshold		26.5	28	31	V
V_{DD_Clamp}	VDD Clamp Voltage	I(V_{DD}) = 7 mA		32		V
Driver Section						
T_{on_max}	Maximum ON Time	HV=155V,Duty=40%		9		μs
T_{on_min}	Minimum ON Time			0.4		μs
T_{st}	Period Time at Startup		110	125	140	μs
T_{off_max}	Maximum OFF Time 1 at Steady State	Z_{VFB_IN}=3k	0.87	1	1.13	ms
	Maximum OFF Time 2 at Steady State	Z_{VFB_IN}=6.8k	4.4	5	5.6	ms
F_{max}	Maximum Switching Frequency			100		kHz
Current Sense Section (CS Pin)						
V_{cs_OCP}	Current Limiting Threshold		0.65	0.75	0.85	V

V_{cs_AOCP}	Abnormal Over Current Protection		0.9	1	1.1	V
Output Voltage Sense Section (FB PIN)						
V_{FBref}	Reference Voltage		1.58	1.6	1.62	V
$V_{FB\_OVP\_EN}$	OVP Voltage Threshold	130% V_{FBref}		2.08		V
V_{FB_H}	VFB High Threshold	Z_{VFB_IN}=15k ,120% V_{FBref}		1.92		V
		Z_{VFB_IN}=6.8k ,110% V_{FBref}		1.76		V
V_{FB_L}	VFB Low Threshold	Z_{VFB_IN}=15k ,80% V_{FBref}		1.28		V
		Z_{VFB_IN}=6.8k ,90% V_{FBref}		1.44		V
Gate Driver Section (GATE Pin)						
V_{GATE_H}	Gate High Voltage			12		V
V_{GATE_L}	Gate Low Voltage				0.1	V
I_{GATE_sink}	Maximum Source Current	Gate=1nF		500		mA
I_{GATE_source}	Maximum Sink Current	Gate=1nF		150		mA
CC Loop Compensation Section (COMP Pin)						
V_{comp_H}	COMP High Clamp Voltage			2.5		V
Over Temperature Protection						
T_{OTP_EN}	OTP Trigger Point	(Note 3)		150		°C
T_{OTP_EX}	OTP Recovery Threshold			130		°C
HV Startup and IC Supply Section (HV Pin)						
V_{BR}	HV Pin Breakdown Voltage		650			V
I_{HV}	HV Charging Current	HV=20V		10		mA
I_{HV_leak}	Leakage Current of HV Charging Circuit	VDD=15V,HV=500V		20	30	μA

Note 1. Stresses listed as the above "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 maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. Maximum Power dissipation P_{Dmax}= (T_{Jmax}-T_A)/θ_{JA}. As ambient temperature rises, P_{Dmax} will decrease.

Note 3. Guaranteed by the Design.

Operation Description

KP2813SG is a quasi-resonant constant voltage controller with high power factor, low THD and primary side control. The IC has built-in high-voltage start-up circuit to meet the requirements of fast start-up and ultra-low standby consumption.

• System Start-Up Operation

When the system is powered on, the IC extracts current to charge the VDD capacitor through the high voltage charging circuit inside the HV pin. When the output voltage of VDD is higher than VDD_on, it starts operation and enters the closed-loop soft start stage. With the rise of Comp voltage, the output voltage and switching frequency also rise. In this way, the system realizes the soft start and avoids the output overshoot when starting.

• Constant Voltage (CV) Control

KP2813SG detects the output voltage through FB pin, and maintains the constant output voltage compared with the internal high-precision reference. The output voltage under closed-loop control is determined by the following formula:

$$V_o = \frac{V_{ref}}{R_{FB1}} \times (R_{FB1} + R_{FB2}) \times \frac{N_{sec}}{N_{aux}} - V_{DF}$$

In the equation above,

Vref---Voltage Reference

R_{FB1}---the Resistor between FB pin and GND

R_{FB2}--- the Upper Voltage Divider Resistor

N_{SEC}---Secondary Winding Turns

N_{AUX}---Auxiliary Winding Turns.

V_{DF}---Forward Voltage Of the Secondary Diode.

• Leading Edge Blanking (LEB)

Each time the power MOSFET is turned on, the voltage spike of parasitic capacitor of MOSFET will produce. In order to avoid premature termination of the switching pulse, the leading edge blanking time is designed in the IC. During this blanking period, the PWM comparator is disabled and cannot switch off the gate driver.

• Time control

When the power MOSFET is turned off, a blanking time is implemented in KP2813SG to avoid interference and avoid false detection of demagnetization. KP2813SG also integrates the operation frequency clamping function. The system operation frequency will be limited to less than 100kHz.

• Fast Dynamic Response

When the output load jumps from heavy load to light load (or other similar situation), the output voltage will rise. When detecting that VFB voltage is higher than VFB_H, the system is forced to work in Max-off-time state to respond quickly.

When the output load jumps from light load to heavy load (or other similar situation), the output voltage drops. When detecting that the VFB voltage is lower than VFB_L, the system enters the constant CS peak operation mode to ensure fast energy supply to maintain output voltage. The dynamic response threshold can be graded by the RFB resistor.

T_{off_max} and fast dynamic response threshold VFB_H and VFB_L can be set according to the following table:

R_{FB1}/kΩ	T_{off_max} /ms	VFB_H/V	VFB_L/V
3	1	1.76	1.44
6.8	5	1.76	1.44
15	5	1.92	1.28

- **VDD Over Voltage Protection (VDD OVP)**

When the transformer design is unreasonable or other faults occur, if VDD is greater than VDD_ OVP, the IC will stop switching and enter the automatic restart mode.

- **Output Over Voltage Protection (OVP)**

The output voltage can be detected by the FB pin. When the FB voltage is higher than FB OVP threshold (VFB_OVP), the IC stops switching immediately. The output over voltage is determined by：

$$V_{OVP} = \frac{V_{FB\_OVP}}{R_{FB1}} \times (R_{FB1} + R_{FB2}) \times \frac{N_{sec}}{N_{aux}} - V_{DF}$$

where：

V_{FB_OVP}---FB Over Voltage Threshold

- **Cycle-by-cycle Current Limit (OCP)**

The KP2813SG limits the maximum inductor current through the MOSFET each time the power MOSFET is turned on. When the CS voltage exceeds the peak current reference Vcs_OCP, the power MOSFET is immediately turned off.

- **Abnormal Over Current Protection (AOCP)**

The KP2813SG is integrated with abnormal over-current protection function in case of transformer short-circuit or secondary diode short-circuit and other faults to prevent IC, MOSFET and other devices from damage and further protect the system. After the protection is triggered, the system enters automatic restart protection.

- **Over Load Protection (OLP)**

When the load increases, Vcomp increases. When Vcomp > 2.5V, the drive stops and the system enters the automatic restart mode.

- **Short Circuit Protection (SCP)**

When the output is short circuited, the output voltage and secondary winding voltage are clamped to be low, the auxiliary winding voltage and VFB voltage are also low. Demagnetization detection fails, and the IC will work in Max-off-time state.

After this state lasts for a certain time, the IC stops switching and starts to restart automatically. If the output is short circuited during startup, the VDD voltage will drop below 7.5V. If this state lasts for some time, it will enter the automatic restart protection.

- **Line Brownout Protection (LBOP)**

When the HV voltage is lower than the threshold voltage for a certain period of time, the IC stops switching and enters the automatic restart mode.

- **Automatic Restart**

When the system fails (Line Brownout protection, overload protection, output short-circuit protection, abnormal over current protection, VDD over voltage protection, etc.), the IC stops switching, and at the same time, the internal counter starts counting. When the time exceeds 1.3s, the IC will enter the restart mode. However, if the fault does not disappear after restart, the IC will repeat the above protection action; otherwise, the system will resume normal operation.

- **Over Temperature Protection (OTP)**

KP2813SG integrates over temperature protection function. When the IC temperature is over 150ºC, the IC stops switching. When the IC temperature is under 130 ºC, the system restart. In this way, the system temperature is limited and system reliability is also improved.

PCB Layout Guide

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 primary power loop, secondary power loop and auxiliary power loop.
2. The peripheral device should be as close to the chip pin as possible. For example, FB partial voltage resistance, CS sampling resistance, etc.
3. The power ground of the current sampling resistor is as thick as possible and should be as close as the IC GND as possible.

Package Dimension

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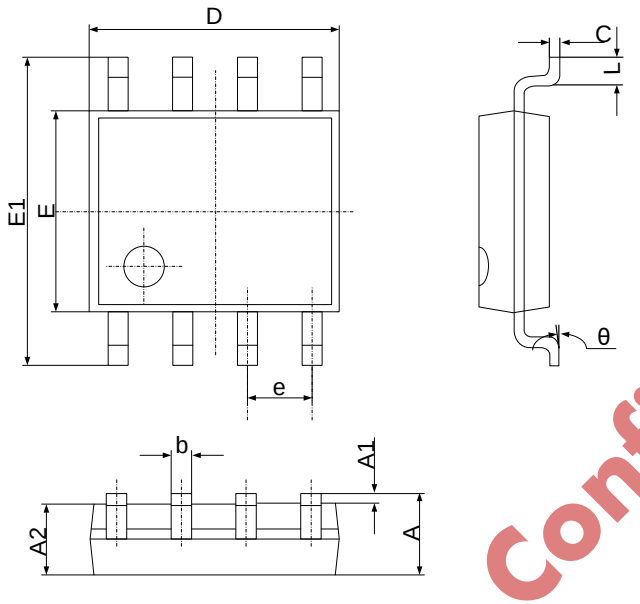

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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