

WS2597N High Efficiency Charger Control IC

Features

- Standby power < 75mW
- Low start-up current, < 1uA
- High efficiency (Meet Energy Star 6.0)
- Internal random Frequency jitter to Reduce System EMI
- Internal leading edge blanking
- Cycle by cycle current limit
- VCC UVLO and Over Voltage Protection
- ±5% CC、CV accuracy
- Good dynamic transient (10%--any load)
- CS pin and CS resistor Open/Short protection
- FB Upper/Lower resistor Open/Short protection
- IC GND open protection
- Output over voltage protection
- Output under voltage protection
- Over temperature protection
- Intelligent temperature regulation (When the temperature over 133°C, the output power will be reduced.)
- Secondary SBD short protection
- Transformer saturation protection
- CS double peak threshold, suppress audio noise
- Patented adaptive soft-driven features
- External proprietary adjustable cable voltage drop Compensation
- Internal proprietary adjustable line compensation for CC Variation
- Internal MOS
- SOP7 package

Typical Application

- Adapters/Chargers for Cell/cordless Phones, PDAs, MP3 and Other Portable Devices
- LED driver

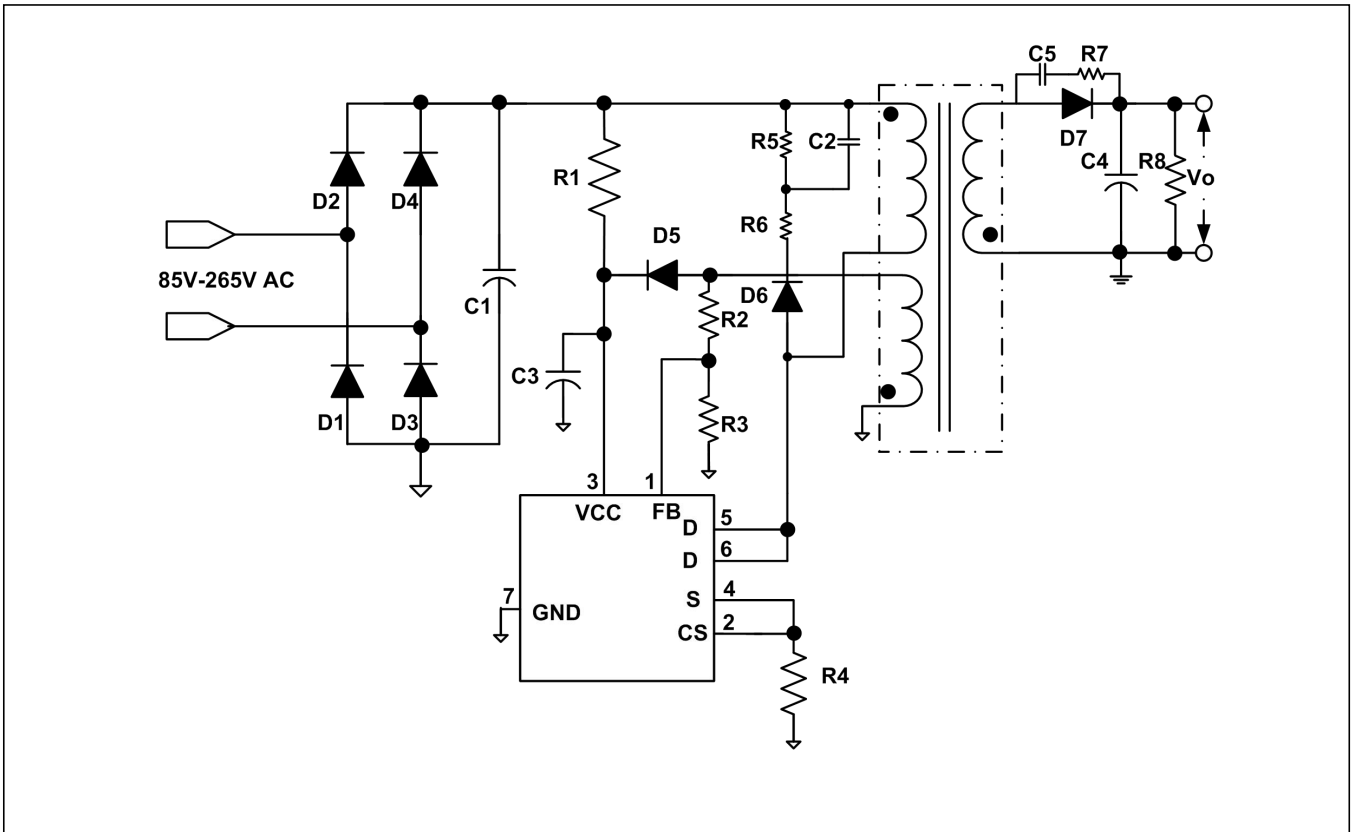
Description

WS2597N is a high performance AC/DC power supply controller for battery charger and adapter applications. The device uses Pulse Frequency Modulation (PFM) method to build discontinuous conduction mode (DCM) flyback power supplies.

WS2597N provides accurate constant voltage, constant current (CV/CC) regulation without requiring an opto-coupler and the secondary control circuitry. It also eliminates the need of loop compensation circuitry while maintaining good stability. WS2597N can achieve excellent regulation and high average efficiency (meet Energy star 6.0), yet meets standby power less than 75mW.

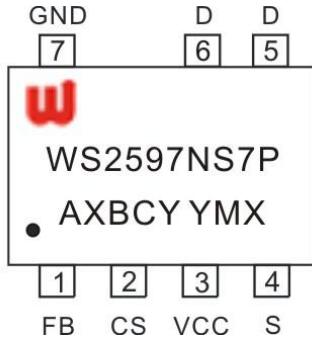
WS2597N has a proprietary cable voltage drop compensation function. Internal random frequency modulation and patented adaptive soft-driven features reduce system EMI.

Typical Application Circuit



Pin Definition and Device Marking

WS2597N is available in SOP-7 package:

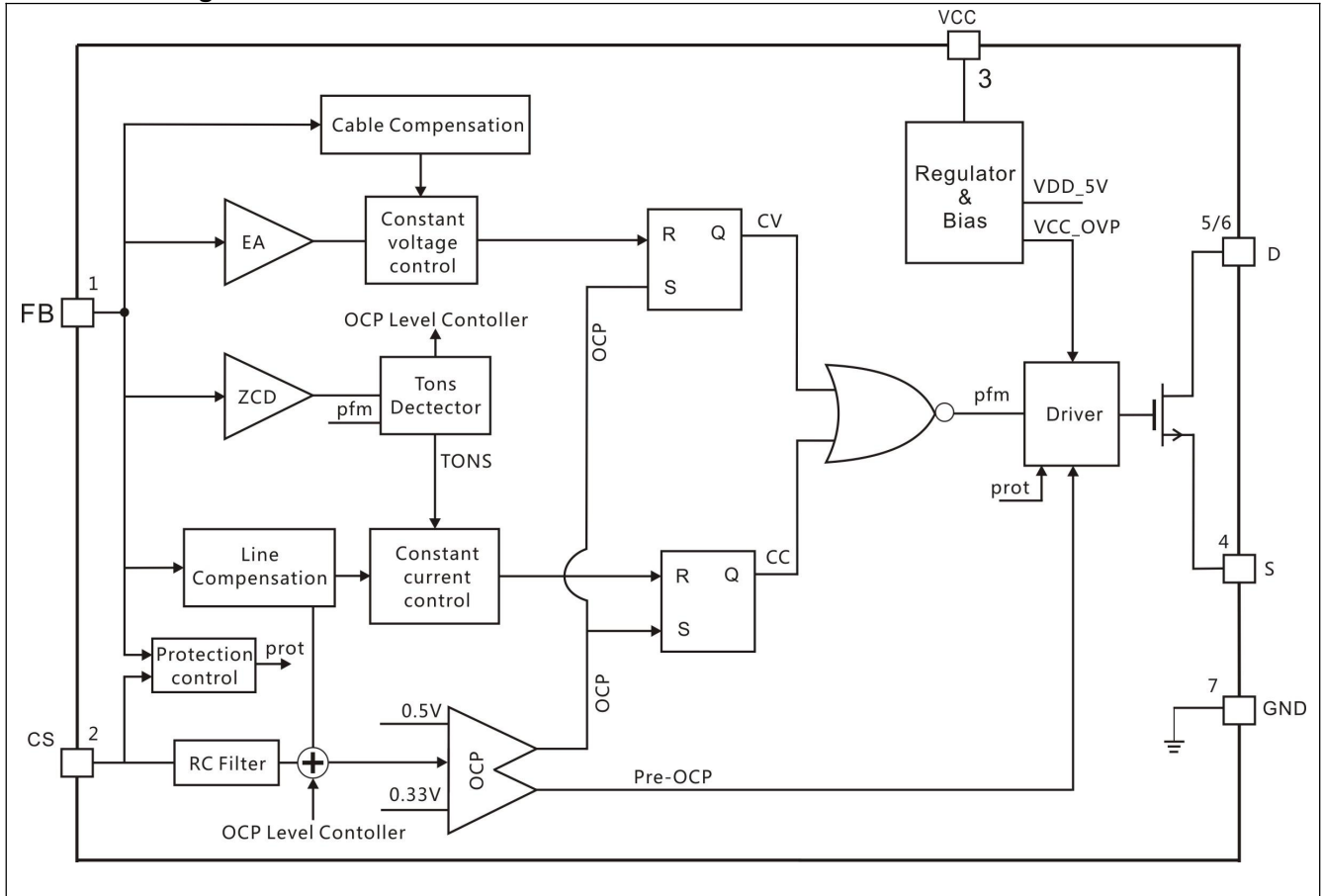


WS2597NS7P: Product Code
 A: Product Code
 X: Internal Code
 BCY: Internal QC Code
 YMX: D/C

SOP7 Package Pin Definition

Pin name	Pin No.	Description
FB	1	Feedback input
CS	2	Current sense input
VCC	3	IC Supply Voltage input
S	4	Source of internal MOS
D	5/6	Drain of internal MOS
GND	7	IC Ground

SOP7 Block Diagram



Ordering Information

Package	Marking	Part Number
7-Pin SOIP-7,Pb-free	WS2597NS7P	WS2597NS7P

Recommended Operating Condition

Parameter	Value	Unit
Supply Voltage (VCC)	10~18	V
Operating temperature	-40~85	°C

Absolute Maximum Ratings

Parameter	Limit	Unit
Supply Voltage (VCC)	30	V
FB pin voltage (FB)	-40~10	V
Other pins voltage (CS, E, OUT)	-0.3~7	V
OUT pin output current	Internal limited	A
Maximum junction temperature	-40~150	°C
Storage temperature range	-55~150	°C
Thermal resistance junction to ambient	250	°C/W

Note 1: Stresses beyond those listed under “ absolute maximum ratings” may cause permanent damage to the device. Under “ recommended operating conditions” the device operation is assured, but some particular parameter may not be achieved.

ESD Parameter

Symbol	Parameter	Value	Unit
V _{ESD_HBM}	Human Body Model	2000	V
V _{ESD_MM}	Machine Model	200	V

Electrical Characteristics

Conditions: VCC=15V,T=25°C.(Unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Start-up section						
Start-up voltage threshold	UVLO_on		14.1	16.3	18	V
UVLO threshold	UVLO_off		7.9	8.7	9.5	V
VCCOVP threshold	VCC_OVP		24	26	29	V
VCC Clamp	VCC_clamp		22	24	27	V
VCC Clamp current	I_clamp		2.5	5	8.5	mA
Start-up current	Istart	VCC=Vstu-0.5V	0	0.2	3	uA
Operating current	I _{vcc}	Static	240	450	660	uA
Current Sense section						
CS comparator threshold	Vocp	Load >40%	480	500	520	mV
CS comparator threshold	Vocp	Load <30%		330		mV
Schottky barrier diode short protection threshold	FOCP			1.5		V
Leading Edge Blanking time	T _{leb}			800		ns
Maximum Off time	Toff_max			6		ms
Feedback Section						
Feedback threshold voltage	Vs&href		3.94	4	4.06	V
Output OVP	FB_OVP			6		V
Output OVP delay time	TD_OVP	Remain 6 cycles		6		CLK
Output UVP	FB_UVP			2.4		V
Output UVP delay time	TD_UVP			64		ms
Abnormal protection	FB_abnor	Vfb@switch on		-1.2		V
FB input resistance	Z_FB			1.5		MΩ
Power switch section						
Drain to Source Breakdown Voltage	Vds-BV		650	-		V
Static Drain-source On-resistance	Rds_on		-	2.9	-	Ω
Thermal section						
Intelligent thermal control threshold	Tz	Output power start to reduce		133		℃
OTP threshold	Totp	Restart		150		℃

Function Description

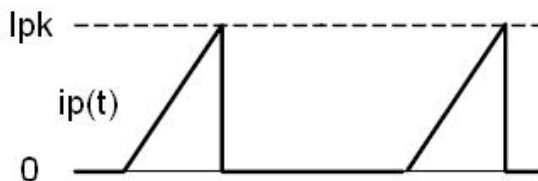
Start-up and UVLO

At the phase of power-on, the rectified high voltage DC charges the capacitor of VCC through the start-up resistor. When VCC rises to 16.3V, the IC enters normal operation, then switching begins and the output voltage begins to rise. The VCC bypass capacitor must supply the IC until the output voltage builds up enough to provide power from the auxiliary winding to sustain the VCC. The under-voltage threshold of VCC is 8.7V, the control circuit will turn off the output, and then the Vcc capacitor will be charged again.

Constant primary peak current

The primary current ip(t) is sensed by a current sense resistor Rcs, the current rises up linearly at a rate of:

$$\frac{dip(t)}{dt} = \frac{Vg(t)}{Lm} \quad Lm \text{ is primary inductance} \quad (1)$$



Primary current waveform

As illustrated in top figure, when the current ip(t) rises up to Ipk, the switch turns off. The constant peak current is given by:

$$Ipk = \frac{Vcs}{Rcs} \quad , \quad Vcs \text{ is internal limited to } 0.5V \quad (2)$$

The energy stored in the magnetizing inductance Lm each cycle is :

$$Eg = \frac{1}{2} \times Lm \times Ipk^2 \quad (3)$$

So the power transferring from the input to the output is given by:

$$P = \frac{1}{2} \times Lm \times Ipk^2 \times f_{sw} \quad (4)$$

Where fsw is the switching frequency. When the peak current Ipk is constant, the output power depends on the switching frequency fsw.

Constant Voltage Operation

The WS2597N captures the auxiliary winding feedback voltage at FB pin and operates in constant-voltage (CV) mode to regulate the output voltage. Assuming the secondary winding is master, the auxiliary winding is slave during the D1 on-time. The auxiliary voltage is given by:

$$\frac{Vaux}{Naux} = \frac{Vs}{Ns}$$

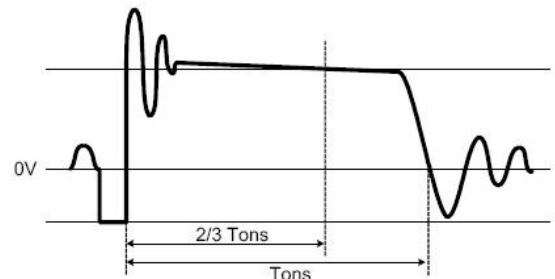
And $Vs = Vo + Vd$

$$\text{So } Vaux = \frac{Naux}{Ns} \cdot (Vo + Vd) ,$$

$$Vaux = V_{FB} * (1 + \frac{R2}{R3})$$

Where Vd is the diode forward drop voltage.

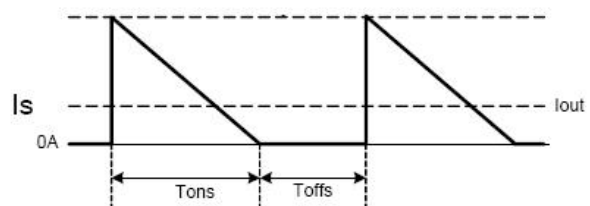
So the output will be constant when the VFB is constant to 4V.



Auxiliary voltage waveform

The output voltage is different from the secondary voltage in a diode forward drop voltage that depends on the current. If the secondary voltage is always detected at a fixed secondary current, the difference between the output voltage and the secondary voltage will be a fixed Vd. The voltage detection point is at two-thirds of the D1 on-time. The CV loop control function of WS2597N then generates a D1 off-time to regulate the output voltage.

Constant Current Operation



Secondary current waveform

In CC operation, the CC loop control function of WS2597N will keep a fixed proportion between D1 on-time

Tons and D1 off-time Toffs by discharging or charging the capacitance. The fixed proportion is:

$$\frac{Tons}{Toffs} = \frac{1}{1}$$

The relationship between the output constant-current Iout and secondary peak current Ipks is given by:

$$Iout = \frac{1}{2} \times Ipks \times \frac{Tons}{Tons + Toffs}$$

$$Ipks = \frac{Np}{Ns} \times Ipk$$

Thus the output constant-current is given by:

$$Iout = \frac{1}{2} \times \frac{Np}{Ns} \times Ipk \times \frac{Tons}{Tons + Toffs} = \frac{1}{4} \times \frac{Np}{Ns} \times Ipk$$

Cable Compensation

WS2597N detects the duty cycle (Tons/T) of the secondary side using internal RC filter. The larger the Tons/T, which means the greater the load, the IC draws more current from FB pin, thus through the feedback loop, the output voltage would be higher.

Line Compensation

For a better CC Variation of the system in 90-264VAC, WS2597N built in line compensation which makes that the higher the line voltage is, the lower the threshold value of actual OCP is. The effect of line compensation can be finely tuned by changing the resistance value of R3 and R2. The smaller the resistance of R3, the bigger the line compensation will be.

Leading Edge Blanking

When the power switch is turned on, a turn-on spike will occur on the sense-resistor. To avoid false-termination of the switching pulse, a 800ns leading-edge blanking is built in. During this blanking period, the current sense comparator is disabled and the gate driver cannot be switched off.

CCM Protection

WS2597N is designed to operate in discontinuous conduction mode (DCM) in both CV and CC modes. To avoid operating in continuous conduction mode (CCM), the

WS2597N detects the falling edge of the FB input voltage on each cycle. If a 0.1V falling edge of FB is not detected, the WS2597N will stop switching.

VCC Over Voltage Protection and Clamp

When the VCC voltage reaches 24V, WS2597N will start a 5mA clamp current inside, make the VCC voltage is not up, avoid error VCC_OVP when VCC is changed by load changing which caused by large leakage inductance and other factors. When the output voltage is too high, the auxiliary winding current is greater than 5mA, resulting in VCC 26V, the chip will stop the output pulse, enter the auto-restart mode until the error is removed. Reasonable set of VCC voltage, VCC_OVP can be used to accurately set the output over-voltage protection.

Output Over Voltage Protection

When VFB>6V (continues for 6 cycles) since the Vout is too high, or VCC>26V, WS2597N will enter Over Voltage Protection status. The switching pulses will be stopped, and IC auto-restart.

Output Under Voltage Protection

When Vout is less than 60% of the value of designing, and remains more than 64mS, WS2597N will enter Under Voltage Protection status. The switching pulses will be stopped, and IC auto-restart.

Intelligent Thermal Control and OTP

When Tj rises to 133°C, internal intelligent thermal control will make the output power reduced.

When Tj is 150 °C , IC will enter OTP, then begin to auto-restart.

Pin Open / Short Protection

WS2597N has built-in pin open/short protections, such as GND open protection, CS open/short protection, Rcs open/short protection, FB resistor open/short protection. Each kind of bugs like above happened, IC will stop operating in order to avoid any damage to the system and load.

Secondary SBD Short and Transformer Saturation Protection

The Vcs will rise up rapidly when the secondary SBD is shorted or the transformer is saturated. When $V_{cs} > 1.5V$, the switching pulses will be stopped, and IC auto-restart.

If $V_{FB} > -1.2V$ during primary ON, IC will auto-restart, too.

CS Threshold

When the load is high, the CS threshold is 500mV. To improve the audio noise suppression, the CS threshold will be reduced to 330mV when the system operates with light

load or no load.

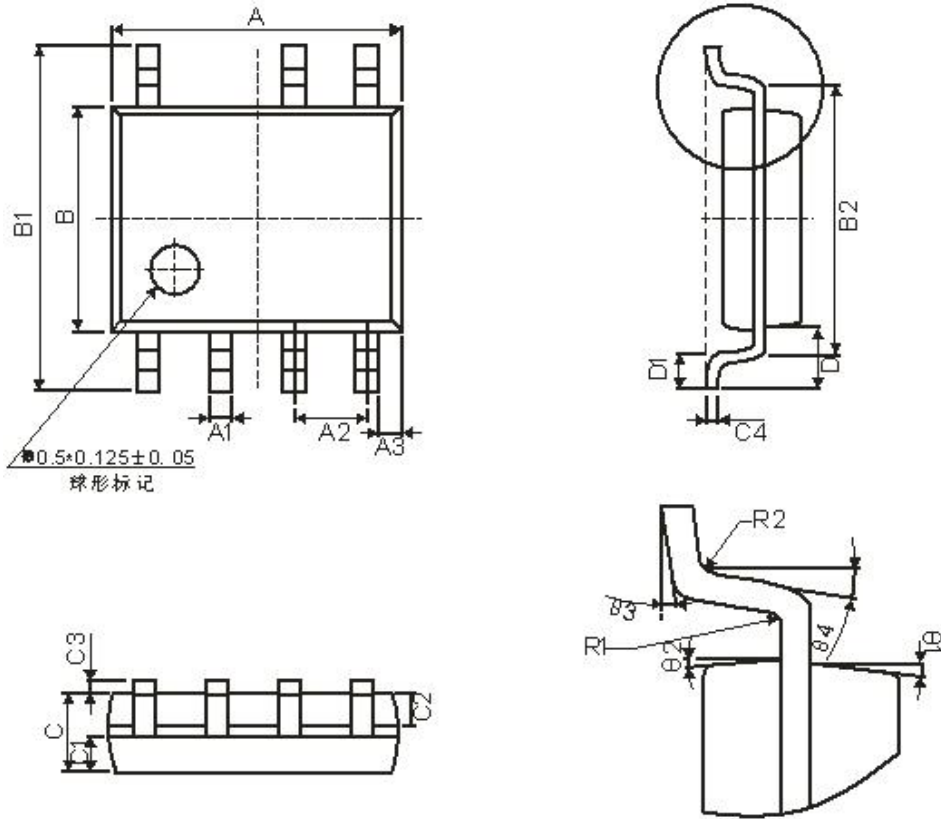
Adaptive Soft-driven Features

WS2597N employs patented adaptive soft-driven technology and it can automatically adjust the drive capability in accordance with MOS. Therefore, the startup speed of MOS won't change obviously with the size of MOS to reduce system EMI.

Random Frequency jitter

WS2597N has built-in random frequency jitter to reduce system EMI.

SOP7 Package Dimension



Symbol	Winsemi			
	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	4.70	5.10	0.185	0.201
B	3.70	4.10	0.146	0.161
C	1.30	1.50	0.051	0.059
A1	0.35	0.48	0.014	0.019
A2	1.27TYP		0.05TYP	
A3	0.345TYP		0.014TYP	
B1	5.80	6.20	0.228	0.244
B2	5.00TYP		0.197TYP	
C1	0.55	0.70	0.022	0.028
C2	0.55	0.70	0.022	0.028
C3	0.05	0.225	0.002	0.009
C4	0.203TYP		0.008TYP	
D	1.05TYP		0.041TYP	
D1	0.40	0.80	0.016	0.031

NOTE:

- 1.We strongly recommend customers check carefully on the trademark when buying our product, if there is any question, please don't be hesitate to contact us.
- 2.Please do not exceed the absolute maximum ratings of the device when circuit designing.
- 3.Winsemi Microelectronics Co., Ltd reserved the right to make changes in this specification sheet and is subject to change without prior notice.

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