WS2596B High Efficiency Charger Control IC

Features

- Standby power<75mw
- Low stat-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℃，the output power will be reduced.)
- Secondary SBD short protection
- Transformer saturation protection
- CS double peak threshold，suppress audio noise
- Slope drive technology，reduce driving loss
- External proprietary adjustable cable voltage drop Compensation
- Internal proprietary adjustable line compensation for CC Variation
- Internal BJT
- SOP-7 package

Typical Appliction

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

Description

WS2596B 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.

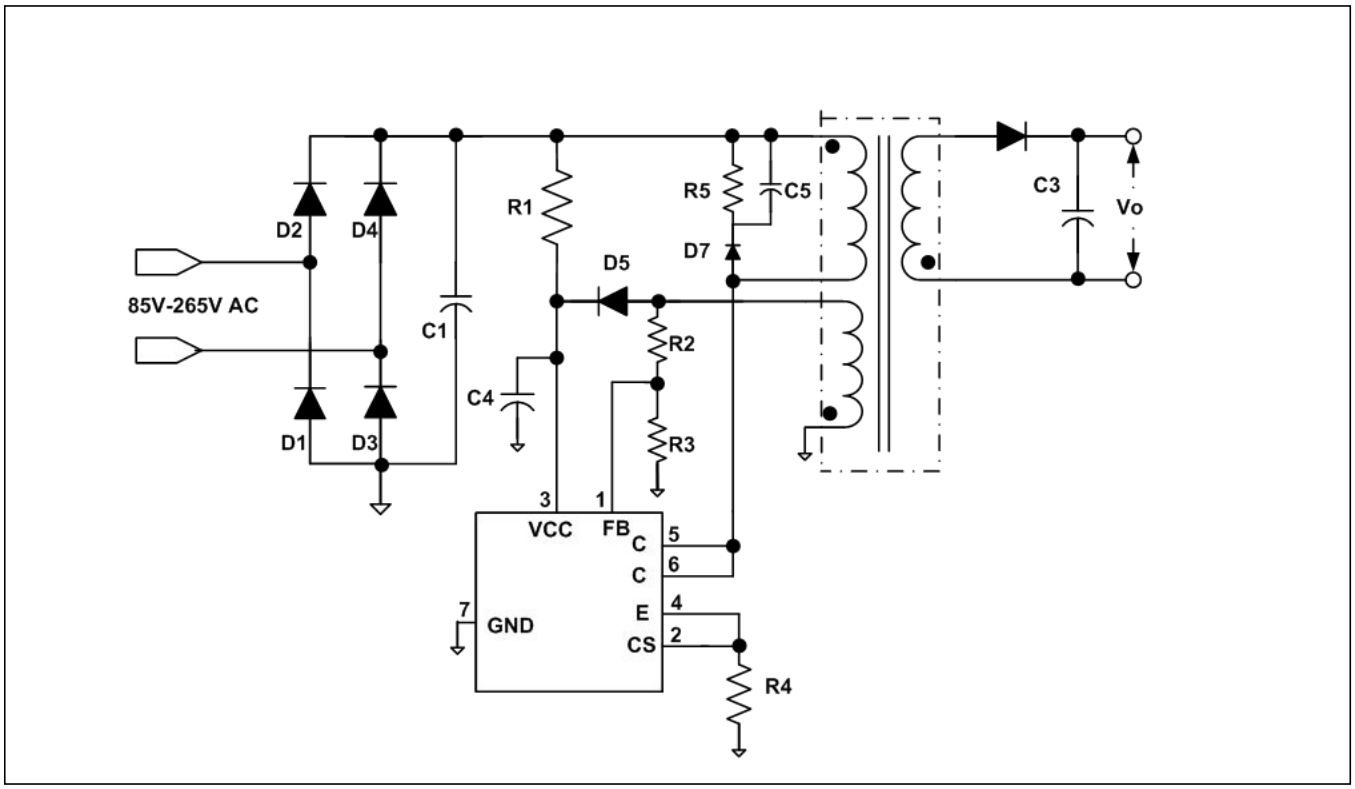
WS2596B provides accurate constant voltage, constant current (CV/CC) regulation without requiring an opto-coupler and the secondary control circuitry. It also eliminates the need of loop compensation circuitry while maintaining good stability. WS2596B can achieve excellent regulation and high average efficiency(meet Energy star 6.0), yet meets standby power less than 75mW.

WS2596B has a proprietary cable voltage drop compensation function. Internal random frequency modulation to reduce system EMI.

WS2596B is available in SOP-7 package.

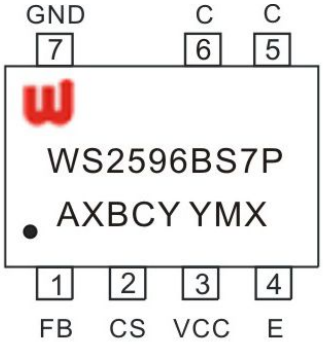
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Typical Application Circuit



Pin Definition and Device Marking

WS2596B is available in SOP-7 package：

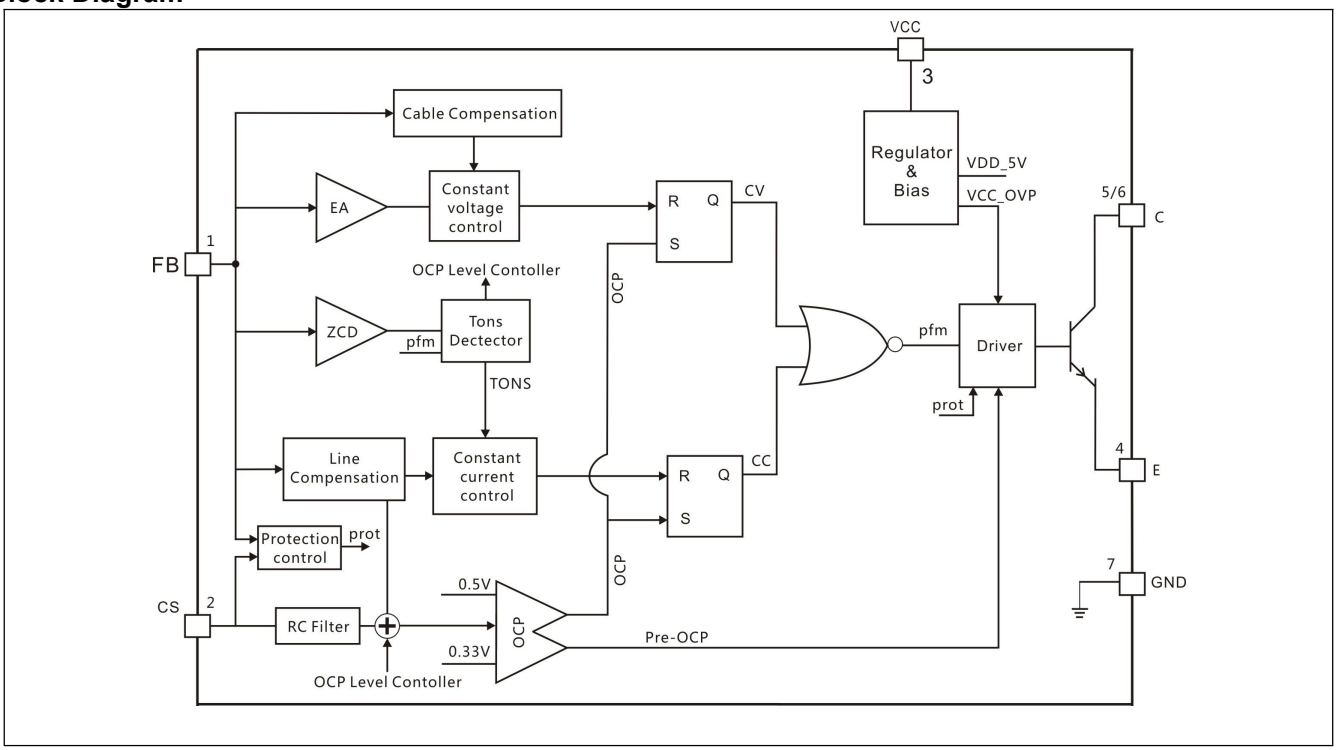


WS2596BS7P：Product Code
A：Product Code
X：Internal Code
BCY：Internal QC Code
YMX：D/C

SOP7 Package Pin Definition

Pin name	Pin No.	Description
FB	1	Feedback input
CS	2	Current sense input
VCC	3	IC Supply Voltage input
E	4	Emitter of internal BJT
C	5/6	Collector of internal BJT
GND	7	IC Ground

Block Diagram



Ordering Information

Package	Marking	Part Number
7-Pin SOP-7,Pb-free	WS2596BS7P	WS2596BS7P

Recommended Operating Condition

Parameter	Value	Unit
Supply Voltage （VCC）	7~18	V
Operating temperature	-20~85	℃

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	150	℃
Storage temperature range	-65~150	℃
Thermal resistance junction to ambient	250	℃/W
V_{CBO}	700	V
V_{CEO}	450	V
I_{CM}	400	mA

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℃.(unless otherwise specified)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Start-up section						
Start-up voltage threshold	UVLO_on		14	16.3	18	V
UVLO threshold	UVLO_off		3.4	4.2	5	V
VCCOVP threshold	VCC_OVP			18.7		V
VCC Clamp	VCC_clamp			18.1		V
VCC Clamp current	I_clamp			5		mA
Start-up current	Istart	VCC=Vstu-0.5V		0.2	3	uA
Operating current	I_{VCC}	Static		500		uA
Driver section						
Output source current	Isourceh	CS=0.4V	34	40	46	mA
Output source current	Isourceh	CS=0V		10		mA
Output source current，Vcs>Vocp80%	Isourcel	Vout=2V		2.1		mA
Sink current	Isink	VCC=15V OUT=1V		250		mA
Current Sense section						
CS comparator threshold	Vocp	Load>40%	480	500	520	mV
80%CS comparator threshold	Vocp80%			430		mV
CS comparator threshold	Vocp	Load<30%		330		mV
80%CS comparator threshold	Vocp80%			280		mV
Schottky barrier diode short protection threshold	FOCP			1.5		V
Leading Edge Blanking time	T_{leb}			800		ns
Maximum Off time	Toff_max			18		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						
BJT Breakdown voltage	I_{OC}=1mA	I_{OC}=1mA	700	-		V
BJT saturation voltage	Ioc=300mA	Ioc=300mA	-		1	V
Maximum collector current				350	400	mA

Thermal section						
Intelligent thermal control threshold	Tz	Output power start to reduce		133		℃
OTP threshold	Totp	Restart		150		℃

Function Description

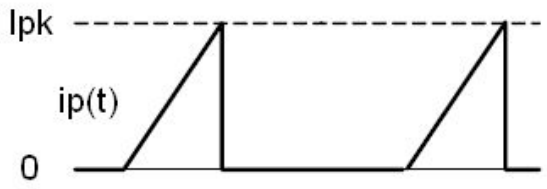
Start-up and UVLO

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 4.2V, the control circuit will turn off the output, 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:

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

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

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

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

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

$$P=\frac{1}{2}\times Lm\times Ipk^2\times f_{sw}$$ （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 WS2596B 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:

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

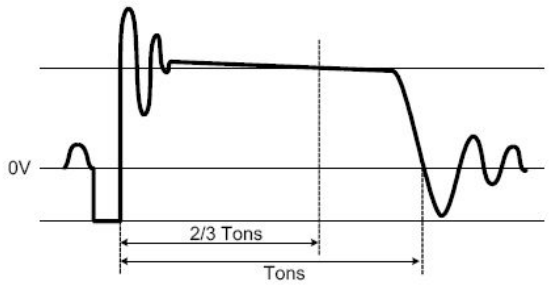
And $Vs=Vo+Vd$

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

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

Where Vd is the diode forward drop voltage.

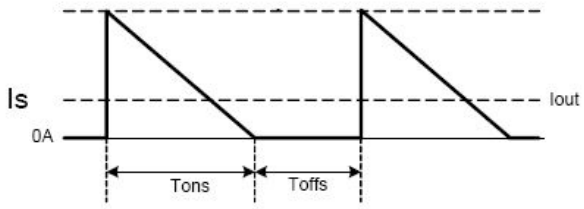
So the output will be constant when the V_{FB} is constant to 4V.



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 WS2596B 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 WS2596B 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:

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

At the instant of D1 turn-on, the primary current transfers to the secondary at an amplitude of:

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

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

WS2596B 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 drags more current from FB pin, thus through the feedback loop, the output voltage would be higher.

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 can not be switched off.

CCM Protection

The WS2596B is designed to operate in discontinuous conduction mode (DCM) in both CV and CC modes. To avoid operating in continuous conduction mode (CCM), the WS2596B detects the falling edge of the FB input voltage on each cycle. If a 0.1V falling edge of FB is not detected, the WS2596B will stop switching.

VCC Over Voltage Protection and Clamp

When the VCC voltage reaches 17.9V, WS2596B 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 18.7V, 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 V_{FB}>6V (continues for 6 cycles) since the Vout is too high, or VCC>18.7V, WS2596B 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, WS2596B 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℃, internal intelligent thermal control will make the output power reduced.

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

Pin Open / Short Protection

WS2596B has built-in pin open/short protections, such as GND open protection, CS open/short protection, Rcs open/short protection, FB resister 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 of the transformer is saturation. When Vcs >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.

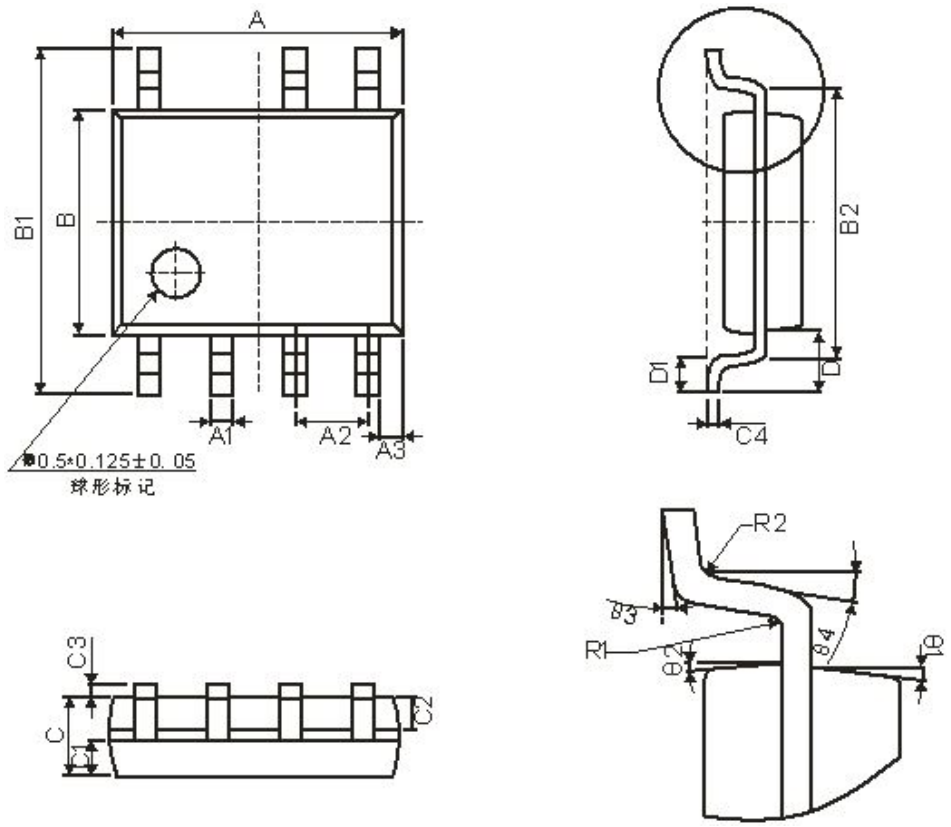
Slope Drive Technology

Because the transistor is a current amplifier, its collector current and base current has a certain ratio. WS2596B works in discontinuous mode. When the internal BJT is ON, the collector current will rise from 0, in order to reduce the driving loss, the base current will start from 12mA, and then with the CS voltage rise, base current ratio increased, when the CS voltage reached 430mV, the base current will rise to 40mA.

Random Frequency jitter

WS2596B 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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