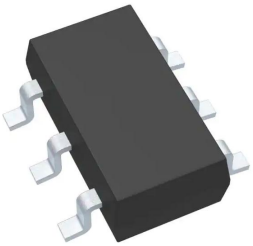
D3820

High Precision CC/CV Primary-Side Controller

Description

D3820 is a high performance offline PSR controller for low power AC/DC charger and adapter applications. It operates in primary-side sensing and regulation. Consequently, opto-coupler and TL431 could be eliminated. Proprietary Constant Voltage (CV) and Constant Current (CC) control is integrated as shown in the figure below.



SOT23-6

In CC control, the current and output power setting can be adjusted externally by the sense resistor Rs at CS pin. In CV control, PFM operations are utilized to achieve high performance and high efficiency. In addition, good load regulation is achieved by the built-in cable drop compensation. The chip consumes very low operation current (typical 300uA), it can achieve less than 30mW standby power to meet strict standby power standard.

D3820 offers comprehensive protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD over voltage protection, feedback loop open protection, short circuit protection, built-in leading edge blanking, VDD under voltage lockout (UVLO), etc.

D3820 is offered in SOT23-6 package.

Features

- ±5% Constant Voltage Regulation at
- Universal AC input
- High precision Constant Current Regulation at
- Primary-side Sensing and Regulation Without
- TL431 and Opto-coupler
- Programmable CV and CC Regulation
- Built-in Primary winding inductance compensation
- Programmable Cable Drop Compensation
- Driver BJT Switch
- Ultra Low Start-up Current (Typ. 1uA)
- VDD Over Voltage Protection
- Built-in Feedback Loop Open Protection
- Built-in Short Circuit Protection
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis(UVLO)

Package Information

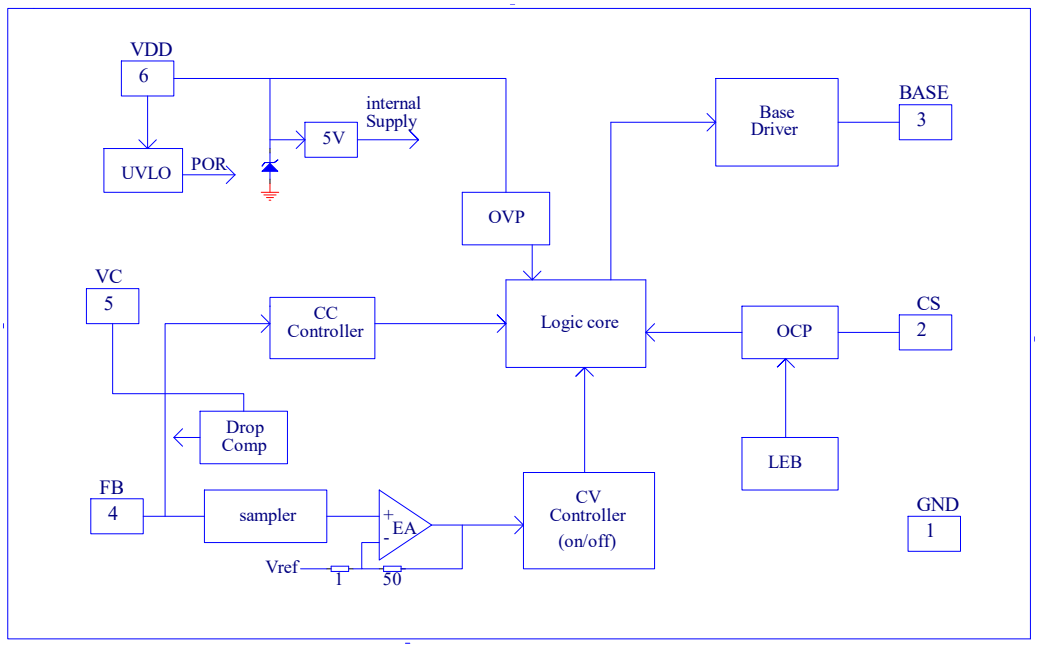
Part NO.	Order NO.	Package Description	Package Marking	Package Option
D3820	D3820	SOT23-6	P20XY	3000/Reel

P20:D3820 X:Year Code Y：Date Code

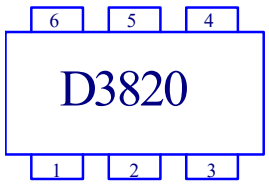
Applications

- Cell Phone Charge
- Small Power Adapter
- Digital Cameras Charge
- Linear Regulator/RCC Replacement

Block Diagram



Pin Configuration



Pin Description

Name	No.	Function
GND	1	Ground
CS	2	Current sense input.
BASE	3	Base drive with current limit for power BJT.
FB	4	The voltage feedback from auxiliary winding. Connected to resistordivider from auxiliary winding reflecting output voltage.
VC	5	Low pass filter capacitor for cable compensation
VDD	6	Power Supply

Absolute Maximum Ratings

Characteristic	Limit	Unit
VDD Voltage	-0.3~30	V
VC Voltage	-0.3~7	V
BASE Voltage	-0.3~7	V
CS Input Voltage	-0.3~7	V
FB Input Voltage	-0.3~7	V
Operating Junction Temperature	-40 ~ +150	℃
Storage Temperature	-55 ~ +150	℃
Lead Temperature (Soldering, 10secs)	260	℃

Electrical Characteristics (Ta=25℃,Vcc=15.0V, unless otherwise noted)

characteristic	Symbol	Test condition	limit			Unit
			Min.	Typ.	Max.	
Supply Voltage section						
Start up current	I start_up	VDD=11V		1	3	uA
Static current	I static	VDD=15V		300	400	uA
VDD under voltage lockout exit	ULVO（OFF）		11.5	12.5	13.5	V
VDD under voltage lockout enter	ULVO（ON）		6.0	6.8	7.6	V
VDD over voltage protection	VDD_OVP		25	27	29	V
Max. operating voltage					25	V
Current Sense Input Section						
LEB Time	TLEB			0.5		us
Over current threshold	Vth_ocp		485	500	515	mV
OCP propagation	Td_oc			100		ns
FB Input Section						
Reference voltage for feedback threshold	Vref_fb		1.98	2.00	2.02	V
Minimum pause	Tpause_min			2.0		uS
Maximum pause	Tpause_max		8	10	12	mS
Maximum cable compensation current	Icomp_cable		42	45	48	uA
BASE Driver Section						
Base sourcing maximum current	Is_max		20	30	40	mA
Base sourcing current after pre-off	Is_preoff		0.5	1.0	1.5	mA
Base drive low side on resistor	Rdson_I			1		ohm

Application Summary

D3820 is a cost effective PSR controller optimized for off-line low power AC/DC applications including battery chargers. It operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. Proprietary built-in CV and CC control can achieve high precision CC/CV control meeting most charger application requirements.

Startup Current and Start up Control

Startup current of D3820 is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

Operating Current

The Operating current of D3820 is as low as 300uA. Good efficiency and very low standby power(less than 30mW) is achieved with the low operating current.

CC/CV Operation

D3820 is designed to produce good CC/CV control characteristic as shown in the Figure. 1. In charger applications, a discharged battery charging starts in the CC portion of the curve until it is nearly full charged and smoothly switches to operate in CV portion of the curve.

The CC portion provides output current limiting. In CV operation, the output voltage is regulated through the primary side control. In CC operation mode, D3820 will regulate the output current constant regardless of the output voltage drop.

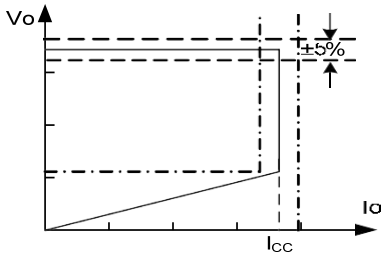


Figure.1. Typical CC/CV Curve

Principle of Operation

To support D3820 proprietary CC/CV control, system needs to be designed in DCM mode for flyback system (Refer to Typical Application Diagram on page1).

In the DCM flyback converter, the output voltage can be sensed via the auxiliary winding.

During MOSFET turn-on time, the load current is supplied from the output filter capacitor, Co. The current in the primary winding ramps up. When MOSFET turns off, the energy stored in the primary winding is transfered to the secondary side such that the current in the secondary winding is

$$I_S = \frac{N_P}{N_S} \cdot I_P \qquad (1)$$

The auxiliary voltage reflects the output voltage as shown in Figure.2 and it is given by

$$V_{AUX} = \frac{N_{AUX}}{N_S} \cdot (V_O + \Delta V) \qquad (2)$$

Where ΔV indicates the drop voltage of the output Diode.

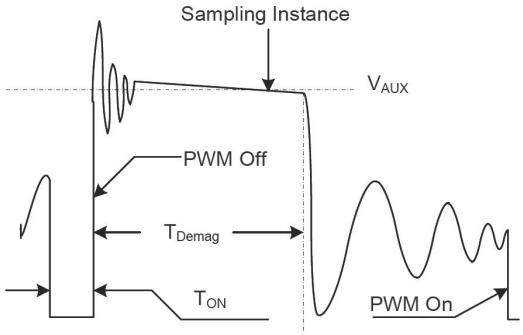


Figure.2. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB (pin 4), the auxiliary voltage is sampled at the middle of the de-magnetization and it is hold until the next sampling. The sampled voltage is compared with Vref (2.0V) and the error is amplified. The error amplifier output reflects the load condition and controls the switching off time to regulate the output voltage, thus constant output voltage can be achieved.

When the sampled voltage is below Vref and the error amplifier output reaches its minimum, the switching frequency is controlled by the sampled voltage to regulate the output current, thus the constant output current can be achieved.

Adjustable CC point and Output Power

In D3820, the CC point and maximum output power can be externally adjusted by external current sense resistor Rs at CS pin as illustrated in typical application diagram. The larger Rs, the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Figure.3.

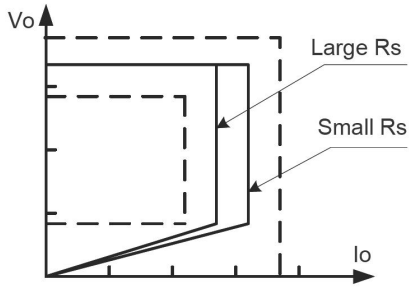


Figure.3. Adjustable output power by changing Rs

Operation switching frequency

The switching frequency of D3820 is adaptively controlled according to the load conditions and the operation modes. For flyback operating in DCM, The maximum output power is given by

$$Po_{MAX} = \frac{1}{2} L_P F_{SW} I_p^2 \qquad (3)$$

Where Lp indicate the inductance of primary winding and Ip is the peak current of primary

winding.

Refer to the equation 3, the change of the primary winding inductance results in the change of the maximum output power and the constant output current in CC mode. To compensate the change from variations of primary winding inductance, the switching frequency is locked by an internal loop such that the switching frequency is

$$F_{SW} = \frac{1}{2T_{Demag}} \quad (4)$$

Since T_{Demag} is inversely proportional to the inductance, as a result, the product *Lp* and *fsw* is constant, thus the maximum output power and constant current in CC mode will not change as primary winding inductance changes. Up to ±10% variation of the primary winding inductance can be compensated.

Programmable Cable drop Compensation

In D3820, cable drop compensation is implemented to achieve good load regulation. An offset voltage is generated at FB pin by an internal current flowing into the resister divider.

The current is proportional to the switching off time, as a result, it is inversely proportional to the output load current, thus the drop due to the cable loss can be compensated. As the load current decreases from full-load to no-load, the offset voltage at FB will increase. It can also be programmed by adjusting the resistance of the divider to compensate the drop for various cable lines used.

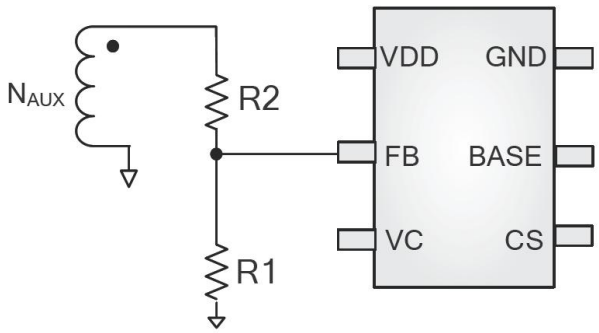
The percentage of maximum compesation is

$$\frac{\Delta V}{Vout} = \frac{Icomp\_cable \times (R1 // R2) \times 10^{-6}}{2} \times 100\%$$

ΔV is load compensation voltage and Vout is output voltage;

For example: R1 // R2=3Kohm, the percentage of maximum compensation is

$$\frac{\Delta V}{Vout} = \frac{45 \times 3000 \times 10^{-6}}{2} \times 100\% = 6.75\%$$



Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in D3820. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial power BJT on state so

that the external RC filtering on sense input is no longer needed.

Base Drive

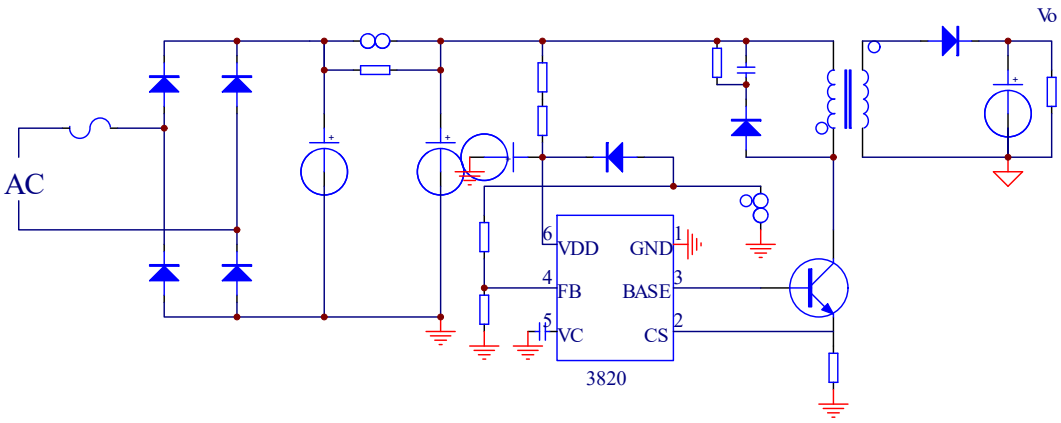
The drive is a push pull stage with supply voltage VDD. It provides the driving current for the external power bipolar transistor. The output signal is current limit to Is_max (typical 30mA).

Protection Control

Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD over voltage protection, feedback loop open protection, short circuit protection and Under Voltage Lockout on VDD (UVLO).

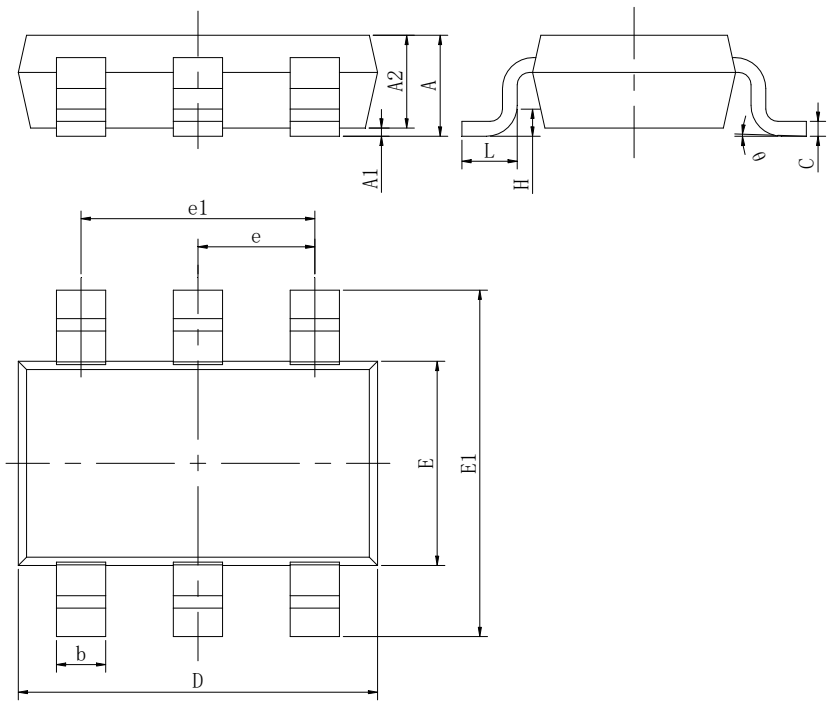
VDD is supplied by transformer auxiliary winding output. The output of D3820 is shut down when VDD drops below UVLO (ON) and the power converter enters power on start-up sequence thereafter.

Application Circuit



Outline Drawing

SOT23-6 Unit: mm



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.050	1.250	0.041	0.049
A1	0.000	0.130	0.000	0.005
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.95（BSC）		0.037(BSC)	
e1	1.90（BSC）		0.075(BSC)	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Statements

- Silicore Technology reserves the right to make changes without further notice to any products or specifications herein. Before customers place an order, customers need to confirm whether datasheet obtained is the latest version, and to verify the integrity of the relevant information.

- Failure or malfunction of any semiconductor products may occur under particular conditions, customers shall have obligation to comply with safety standards when customers use Silicore Technology products to do their system design and machine manufacturing, and take corresponding safety measures in order to avoid potential risk of failure that may cause personal injury or property damage.

- The product upgrades without end, Silicore Technology will wholeheartedly provide customers integrated circuits that have better performance and better quality.