DIO8301
High Precision CC/CV PSR PWM Switch

Features

- No-load consumption power < 75mW
- Primary-side Sensing and Regulation Without TL431 and Opto-couple
- High precision constant voltage and current regulation at Universal AC input
- Programmable CV and CC Regulation
- Multi-mode PWM/PFM operation for efficiency improving
- Audio noise free operation
- Programmable Cable Drop Compensation
- Built-in line voltage and primary winding inductance compensation
- No need for control loop compensation
- Built-in Feedback Loop Open Protection
- VDD Over Voltage Protection
- VOUT Over Voltage Protection
- Reliable Short Circuit Protection
- Over temperature protection (OTP)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout (UVLO)
- Package: SOP7

Applications

- Switching power supply
- Battery Charger
- AC-DC Adaptor
- Auxiliary Power for White Goods, PC
- Linear Regulator

Descriptions

DIO8301 is a high performance offline PSR controller for low power AC/DC charger and adapter applications, less than 75mW standby power consumption with typical application. It operates in primary-side sensing and regulation. Opto-coupler and TL431 could be eliminated. In CC control, the current and output power can be adjusted externally by the sense resistor R_S at CS pin. In CV control, PFM operation is utilized to achieve high performance and high efficiency. In addition, good load regulation is achieved by the built-in cable drop compensation.

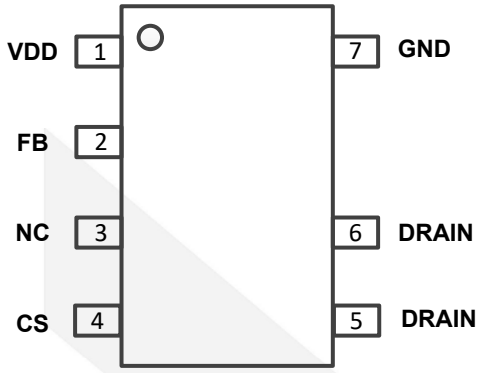
DIO8301 offers comprehensive protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD over voltage protection, VOUT over voltage protection, feedback loop open protection, short circuit protection, built-in leading edge blanking, VDD under voltage lockout (UVLO).

DIO8301 provides an advanced platform well suited for ENERGY STAR level VI criterion.

Ordering Information

Order Part Number	Top Marking		T_A	Package	
DIO8301SO7	DIO8301	Green	-40 to +85°C	SOP7	Tape & Reel, 3000

Pin Assignments



SOP7

Figure 1 Pin Assignment (Top View)

Pin Definitions

Pin Name	Description
VDD	Power Supply
FB	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
NC	No Connection
CS	Current sense input
DRAIN	Drain of internal power MOSFET
GND	GND Pin

Block Diagram

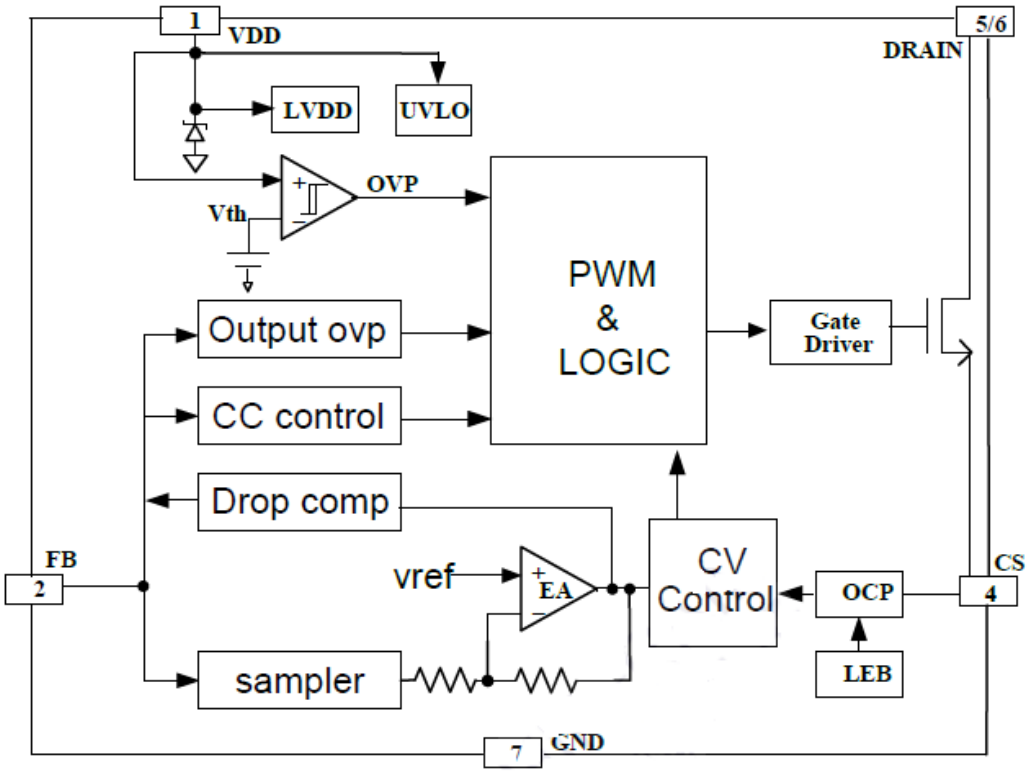


Figure 2. Simplified Internal Circuit Architecture

Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Rating” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maxim rating conditions for extended periods may affect device reliability.

Parameter	Rating	Unit
DRAIN Pin	-0.3 to BVdss	V
VDD Pin	-0.3 to 23	V
FB/CS Pin	-0.3 to 6	V
Min/Max Operation Junction Temperature Range	-40 to 150	°C
Min/Max Storage Temperature Range	-40 to 150	°C
Lead Temperature (Soldering, 10sec SOP-7L)	260	°C

Electrical Characteristics

T_A = 25°C, VDD = 16V, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Power Voltage Section (V_{DD} Pin)						
I_{ST}	Startup Current	VDD=15V		5	15	μA
I_{OP}	Operating Current	V_{FB}=2.5V		0.8		mA
V_{VDD_ON}	UVLO Turn-on Threshold Voltage		6.8	7.5	8.2	V
V_{VDD_OFF}	UVLO Turn-off Threshold Voltage		15.5	16.5	17.5	V
V_{VDD_OVP}	VDD OVP Voltage	V_{CS}=0V, V_{FB}=2.5V	23	25	27	V
Current Sense Input Section (CS Pin)						
T_{LEB}	Leading edge blanking time			280		ns
T_{D_OC}	OCP propagation delay			120		ns
$V_{TH\_OC\_MIN}$	Minimum over current threshold		485	500	515	mV
$V_{TH\_OC\_MAX}$	Maximum over current threshold			580		mV
T_{ON_MAX}	Maximum Ton			55		μs
FB Iput section (FB Pin)						
V_{REF_FB}	Reference voltage for feedback		2.475	2.5	2.525	V
T_{PAUSE_MIN}	Minimum cut off time			2		μs
$F_{\_MIN}$	Minimum frequency		300	400	500	Hz
I_{COMP_MAX}	Maximum cable compensation current		40	45	50	μA
V_{OUT_OVP}	Output Over voltage threshold		2.95	3.05	3.15	V
Drive Output (DRAIN Pin)						
BV_{dss}	MOSFET Drain-Source Breakdown Voltage	V_{GS}=0V, I_{DS}=250μA	600			V
R_{DS_ON}	Static drain to source on resistance	V_{GS}=10V, I_{DS}=1.0A		4.5	5.0	ohm
On chip Over temperature Section						
$OTP_{\_TH}$	Over temperature trigger point			160		°C
$OTP_{\_REC}$	Over temperature recovery point			130		°C

Specifications subject to change without notice.

Application Reference

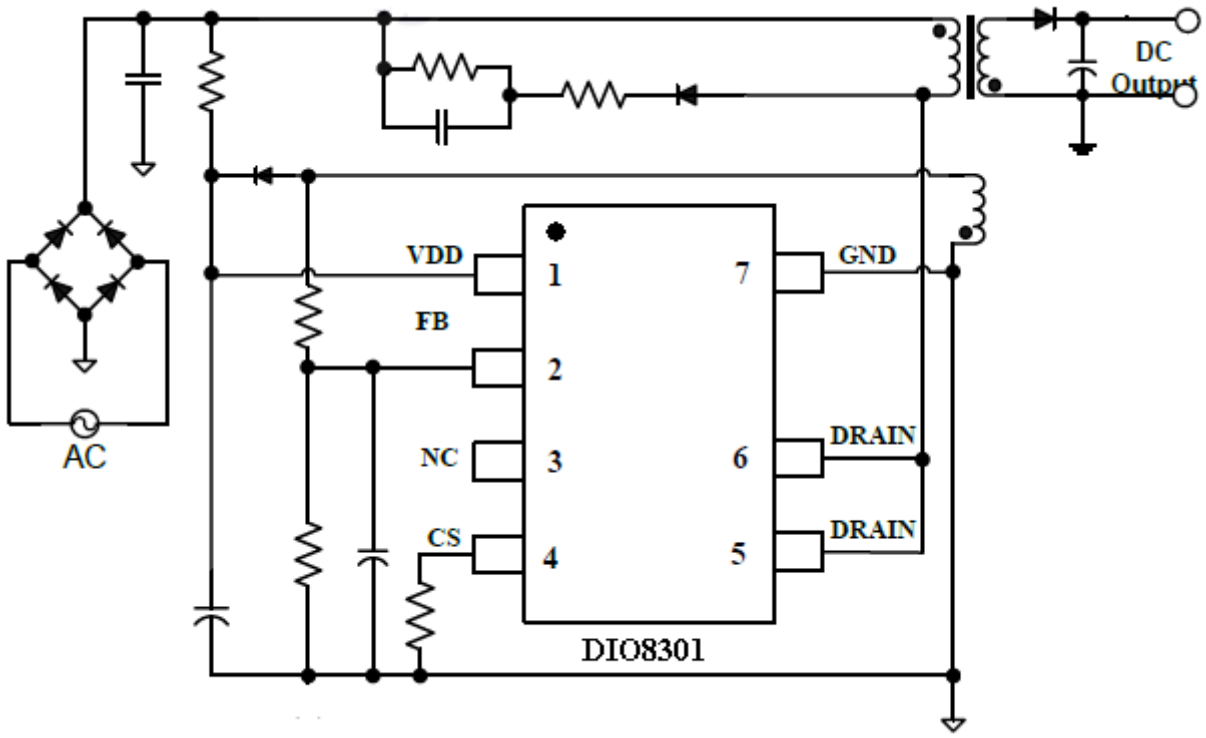


Figure 3. Typical application

Application Information

DIO8301 is cost effective PSR power switch 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 CC/CV control can achieve high precision CC/CV control to meet most charger application requirements.

CC/CV Operation

DIO8301 is designed to produce good CC/CV operation. In charger applications, a discharged battery charger 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, DIO8301 will regulate the output current constant regardless of the output voltage drop.

Principle of Operation

To support DIO8301 CC/CV control, system needs to be designed in DCM mode for flyback system. 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. The current in the primary winding ramps up. When MOSFET turns off, the energy stored in the primary winding is transferred to the secondary side. The current in the secondary winding is

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

The auxiliary voltage reflects the output voltage and it is given by

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

Where ΔV indicates the drop voltage of the output Diode.

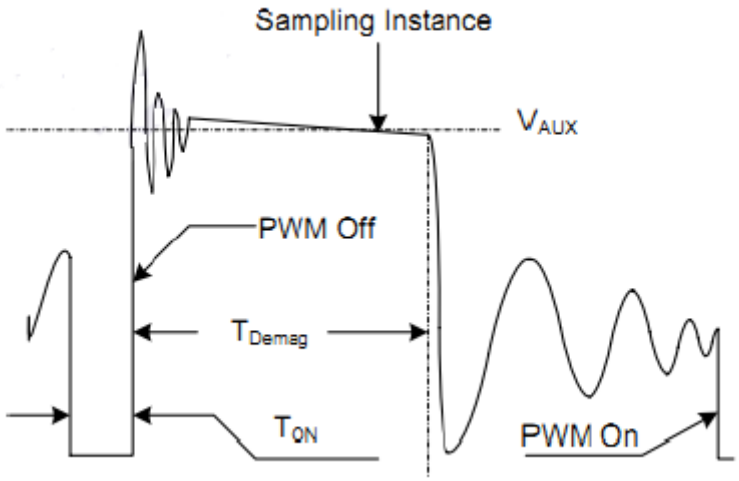


Figure 4. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB, 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_FB 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_FB 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 DIO8301, the CC point and maximum output power can be externally adjusted by external current sense resistor R_S at CS pin as illustrated in typical application diagram. The larger R_S, the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Figure 5.

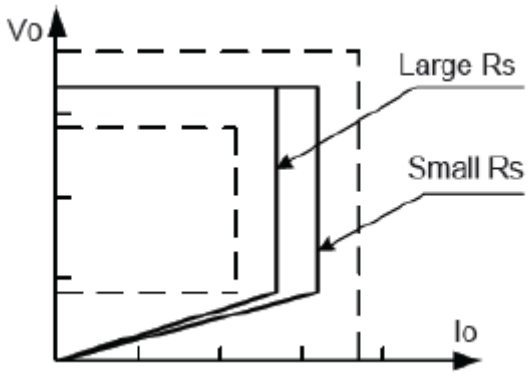


Figure 5. Adjustable output power by changing R_S

Operation switching frequency

The switching frequency of DIO8301 is an adaptively controlled according to the load conditions and the operation modes. For flyback operating in DCM, The maximum output power is given by

$$P_{O\_MAX} = \frac{1}{2} L_P F_{SW} I_P^2 \qquad (3)$$

Where LP indicates the inductance of primary winding and IP is the peak current of primary winding. Refer to the equation 3, the charge 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 variations of primary winding inductance, the switching frequency is locked by an internal loop such that the switching frequency is

$$F_{SW} = \frac{1}{2T_{DEMAG}} \qquad (4)$$

Since TDEMAG is inversely proportional to the inductance, 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 DIO8301, 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, and 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 use. The percentage of maximum compensation is

$$\frac{\Delta V}{V_{OUT}} = \frac{I_{comp\_cable} \times (R1 // R2) \times 10^{-6}}{2.5} \times 100\% \qquad (5)$$

Where ΔV is load compensation voltage and V_O is the output voltage.

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in DIO8301. 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 MOSFET on state so that the external RC filtering on sense input is no longer needed.

Protection Control

Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting, VDD over voltage protection, VOUT over voltage protection, feedback loop open protection, short circuit protection, built-in leading edge blanking, VDD under voltage lockout (UVLO). VDD is supplied by transformer auxiliary winding output. The output of DIO8301 is shut down when VDD drops below $UVLO_{ON}$ and the power converter enters power on start-up sequence thereafter.

CONTACT US

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