GENERAL DESCRIPTION

OB2305 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.

In CC control, the current and output power setting can be adjusted externally by the sense resistor Rs at CS pin. In CV control, multi-mode operations are utilized to achieve high performance and high efficiency. In addition, good load regulation is achieved by the built-in cable drop compensation. Device operates in PFM in CC mode at large load condition and it operates in PWM with frequency reduction at light/medium load. The chip consumes very low operation current. It achieves less than 30mW standby power to meet strict standby power standard.

OB2305 offers comprehensive protection coverage with auto-recovery feature 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), OTP etc.

OB2305 is offered in SOT23-6 package (for up to 10W application) and SOP8 package (for up to 15W application).
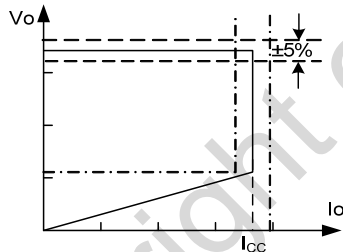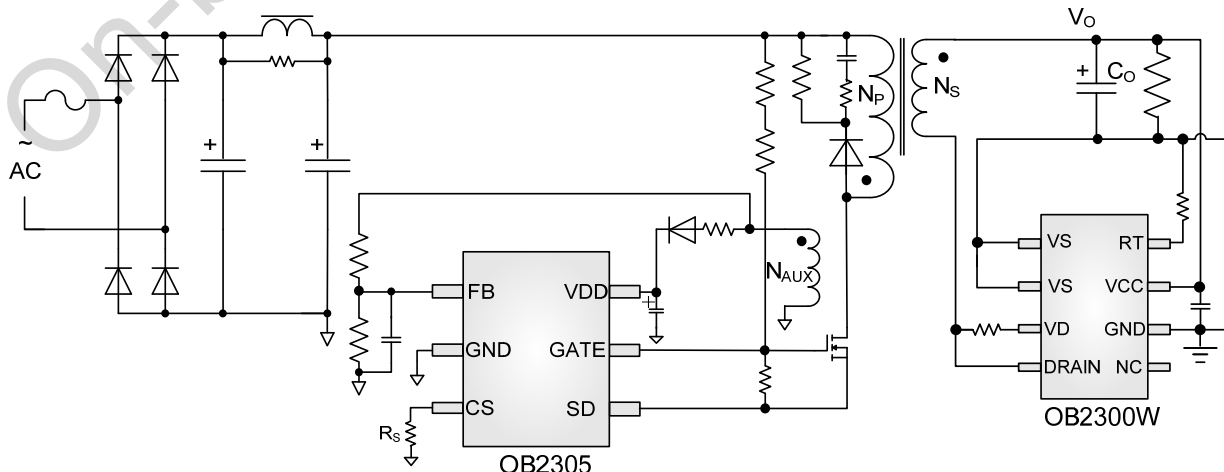

Figure.1. Typical CC/CV Curve

FEATURES

- Primary-side sensing and regulation without TL431 and opto-coupler
- High precision constant voltage and current regulation at universal AC input
- Multi-mode PWM/PFM operation for efficiency improving
- Less than 30mW standby power consumption at 230V with typical application circuit
- Programmable CV and CC regulation
- Built-in dynamic signal detection from 2nd-side synchronous rectification
- Built-in line voltage and primary winding inductance compensation
- Programmable cable drop compensation
- No need for control loop compensation
- Precise internal over temperature protection
- Audio noise free operation
- Built-in leading edge blanking (LEB)
- Ultra low start-up current and low operating current
- Comprehensive protection coverage with auto-recovery
  - VDD over voltage protection
  - VDD under voltage lockout with hysteresis (UVLO)
  - Cycle-by-cycle current limiting
  - Feedback loop open protection
  - Output short circuit protection
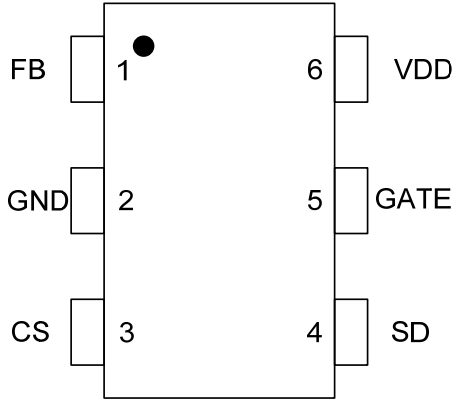 - Over temperature protection (OTP)

APPLICATIONS

Low Power AC/DC offline SMPS for
- Cell Phone Charger
- Digital Cameras Charger
- Small Power Adapter
- Auxiliary Power for PC, TV etc.
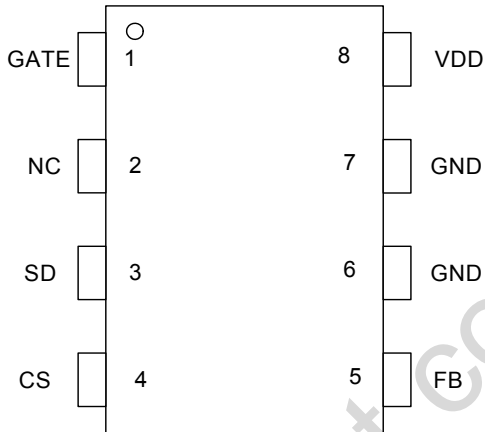- Linear Regulator/RCC Replacement

TYPICAL APPLICATION

GENERAL INFORMATION

Pin Configuration

The pin map is shown as below:
SOT23-6

SOP8

Ordering Information

Part Number	Description
OB2305MP	SOT23-6, Pb-free, T&R
OB2305CP	SOP8, Pb-free in Tube
OB2305CPA	SOP8, Pb-free in T&R

Package Dissipation Rating

Package	RθJA (℃/W)
SOT23-6	200
SOP8	150

Absolute Maximum Ratings

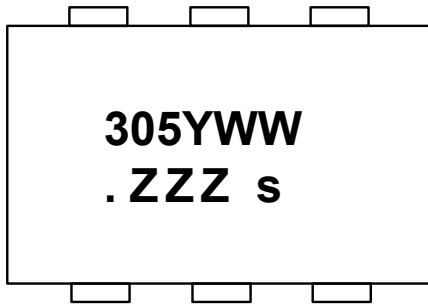| Parameter	Value
VDD Voltage	-0.3 to 30V
FB Input Voltage	-0.3 to 7V
CS Input Voltage	-0.3 to 7V
SD Input Voltage	-0.3 to 24V
GATE Input Voltage	-0.3 to 24V
Min/Max Operating Junction Temperature T_J	-40 to 150 ℃
Operating Ambient Temperature T_A	-40 to 150 ℃
Min/Max Storage Temperature T_{stg}	-55 to 150 ℃
Lead Temperature (Soldering, 10secs)	260 ℃

Note: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

Recommended operating condition

Symbol	Parameter	Range
VDD	VDD Supply Voltage	9 to24V

OB2305 X X X

High Precision CC/CV Primary-Side PWM Controller	Package	Package Pb-free	Packing
	M:SOT23-6 C:SOP8	P:Pb-free	Blank:Tube A: Tape/Reel

Confidential
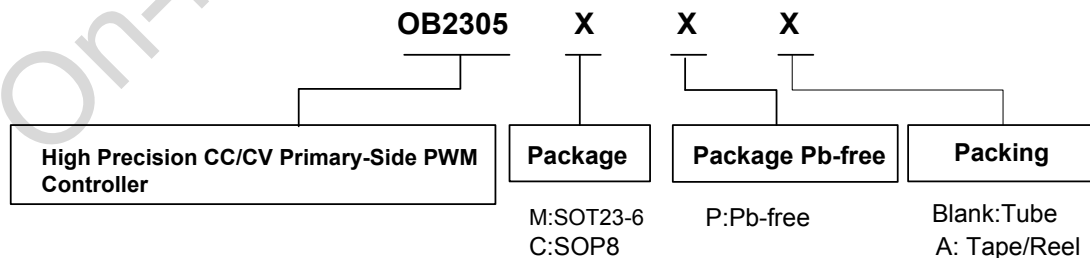
Marking Information

```
┌─────────────────────┐
│                     │
│    305YWW           │
│    .ZZZ s           │
│                     │
└─────────────────────┘
```

Y:Year Code
WW:Week Code(01-52)
ZZZ: Lot code
s: Internal code

```
┌─────────────────────┐
│  YWWZZZ             │
│  OB2305CP          │
│  ○            s     │
└─────────────────────┘
```
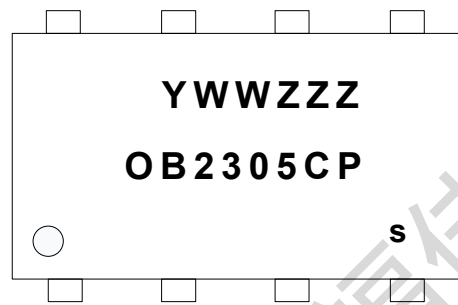
Y: Year Code

WW: Week Code (01-52)

ZZZ:Lot Code

C: SOP8

P:Pb-free Package

S: Internal Code(Optional)

TERMINAL ASSIGNMENTS

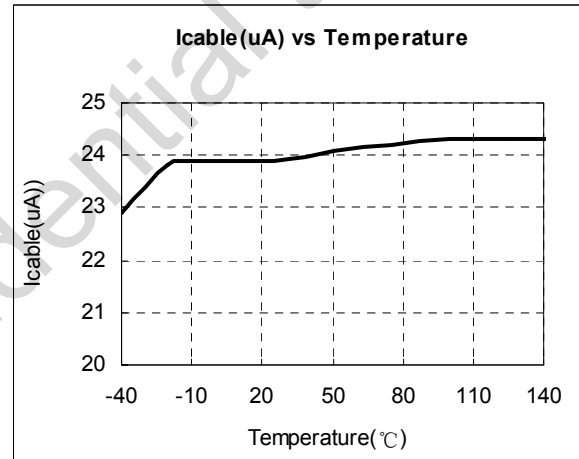| Pin Num	Pin Name	I/O	Description
1	FB	I	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
2	GND	P	Ground
3	CS	I	Power MOSFET source
4	SD	O	Source driver of power MOSFET
5	GATE	O	Gate driver of power MOSFET.
6	VDD	P	Power Supply

BLOCK DIAGRAM
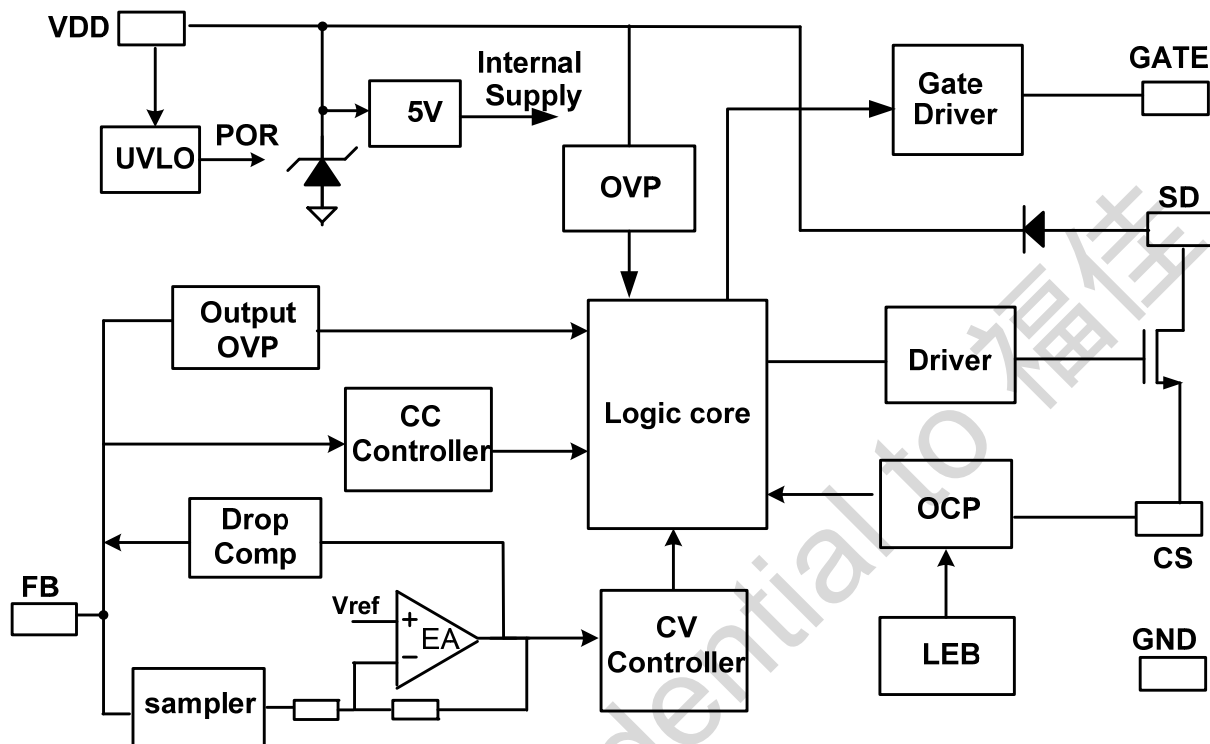
ELECTRICAL CHARACTERISTICS

(TA = 25℃, VDD=15V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
I start-up	Start up current	VDD=UVLO_OFF-1V		5	15	uA
I static	Static current			0.65	1.0	mA
UVLO(OFF)	VDD under voltage lockout exit		13.8	14.8	15.8	V
UVLO(ON)	VDD under voltage lockout enter		7.0	7.6	8.2	V
VDD_OVP	VDD over voltage protection		26	27	28	V
Max. Operating Voltage					24	V
Current Sense Input Section						
TLEB	LEB time			330		ns
TD_OC	OCP propagation delay			100		ns
Vth_ocp_min	Minimum over current threshold		485	500	515	mV
Vth_ocp_max	Maximum over current threshold			550		mV
Vcs_mini	Minimum CS threshold			100		mV
Ton_max	Maximum Ton			50		us
Td_oc	OCP propagation delay			100		ns
FB Input Section						
Vref_fb	Reference voltage for feedback threshold		2.475	2.50	2.525	V
Tpause_min	Minimum Toff			2.0		us
F_min	Minimum frequency			200		Hz
Vth_cc_shutdown	CC mode shut down threshold			1.55		V
Icomp_cable	Maximum cable compensation current		22	24	26	uA
Gate Drive Section						
V_clamp	Output clamp voltage level		12	13.5	15	V
Tr	Output rising time	CL=0.22nF		180		ns
Tf	Output falling time	CL=0.22nF		30		ns
Rdson_l	Internal switch on resistor			1.0	2	Ω
Isw_leak	Before startup, SD pin leakage current	Vsw=VDD-1V			1	uA
Output Over Voltage Protection						
V_OVP	Output Over voltage threshold		2.9	3.0	3.1	V
On chip Over temperature Section						
T_otp	Over temperature trigger point		150	165	180	℃
T_otp_rec	Over temperature recovery point		115	130	145	℃

CHARACTERIZATION PLOTS

VDD vs Istatic

Ivdd_startup(uA) vs Temperature

Vref(V) vs Temperature

Icable(uA) vs Temperature

UVLO_ON(V) vs Temperature


UVLO_OFF(V) vs Temperature
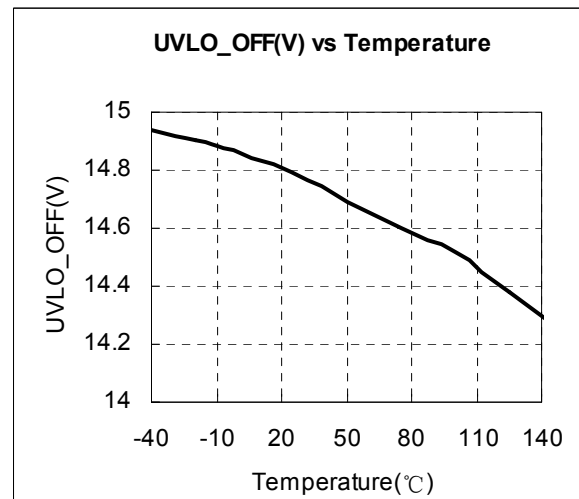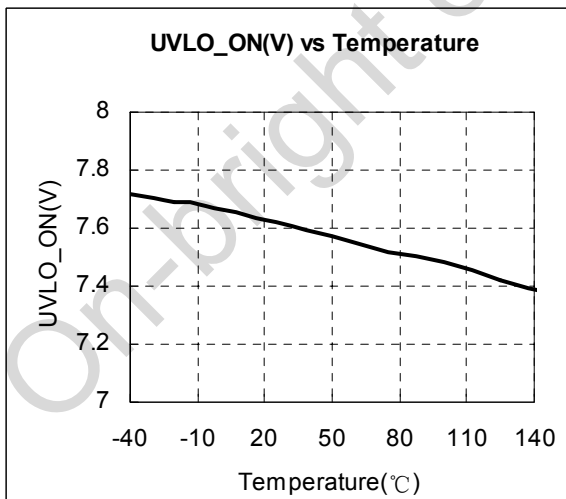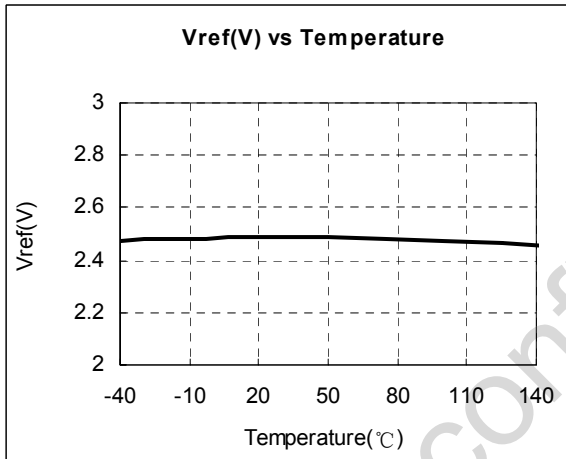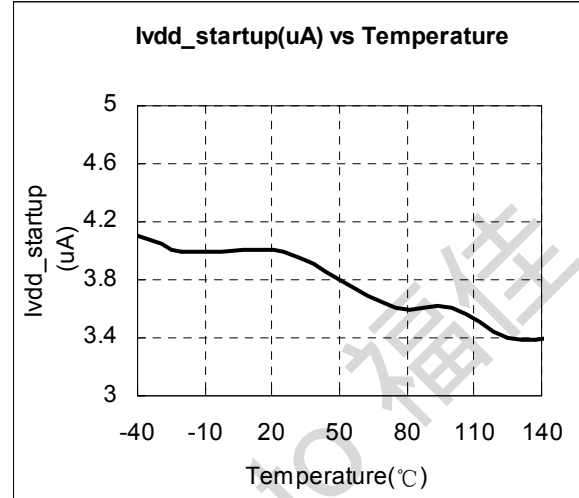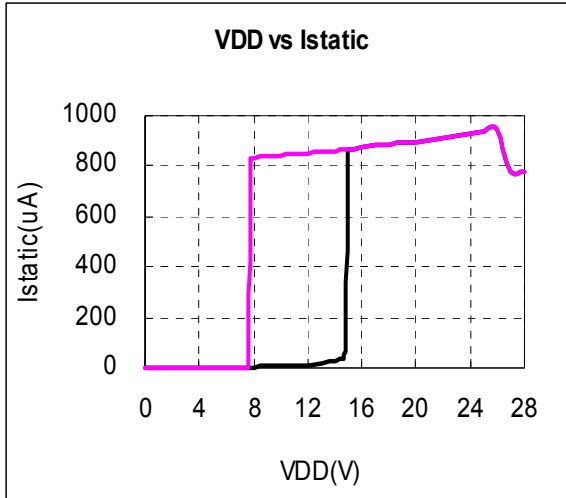
OPERATION DESCRIPTION

OB2305 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.

● **Fast Start up Control**
Startup current of OB2305 is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly.
The startup resister is connected between the rectified high voltage DC rail and the gate of the power MOSFET. The power MOSFET current charges VDD capacitor through internal diode from SD pin to VDD pin. Thus, a large value startup resistor can therefore be used to minimize the power loss in application.
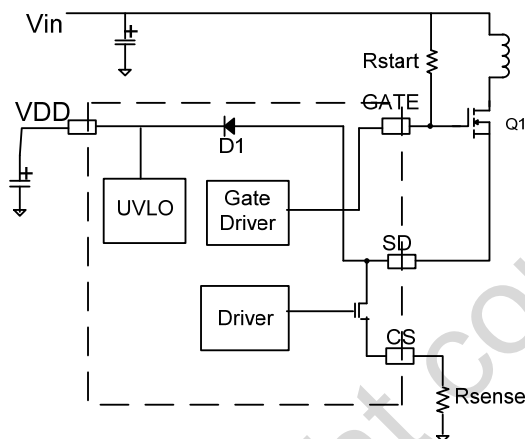
● **Operating Current**
The Operating current of OB2305 is as low as 650uA (typical). Good efficiency and les than 30mW standby power is achieved with the low operating current.

● **CC/CV Operation**
OB2305 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, OB2305 will regulate the output current constant regardless of the output voltage drop.

● **Principle of Operation**
To support OB2305 proprietary CC/CV control, system needs to be designed in DCM mode for flyback system (Refer to Typical Application Diagram in 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, and 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 and 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

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

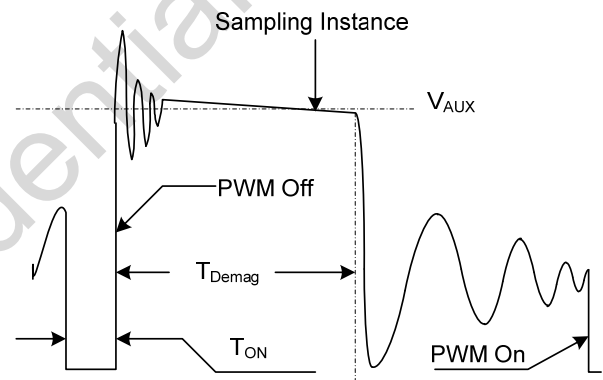Where ΔV indicates the voltage drop of the output Diode.

Figure.2. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB (pin 1), 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 reference voltage Vref (typical 2.5V) and the difference 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 OB2305, the CC point and maximum output power can be externally adjusted by external current sense resistor Rs at CS pin as illustrated in the typical application diagram. The larger Rs, the smaller CC point is, and the smaller output power
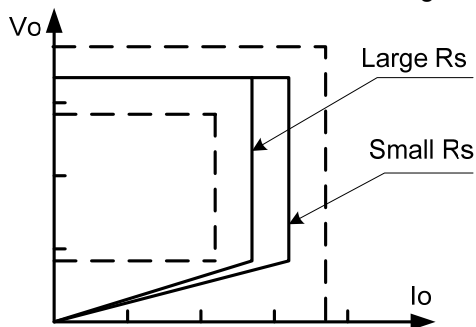
becomes, and vice versa as shown in Figure.3.

Figure.3. Adjustable output power by changing Rs

● **On time OCP compensation**

The variation of max output current in CC mode can be rather large if no compensation is provided. The OCP threshold value is self adjusted higher at higher AC voltage. This OCP threshold slope adjustment helps to compensate the increased output current limit at higher AC voltage. In OB2305, a proprietary OCP compensation block is integrated and no external components are needed. The OCP threshold in OB2305 is a function of the switching ON time. For the ON time between 2.0us to 4.0us (typical), the OCP threshold changes linearly from 500mV to 550mV. For the ON time larger than 4.0us, the OCP threshold is clamped to 550mV, as shown in Figure 4.
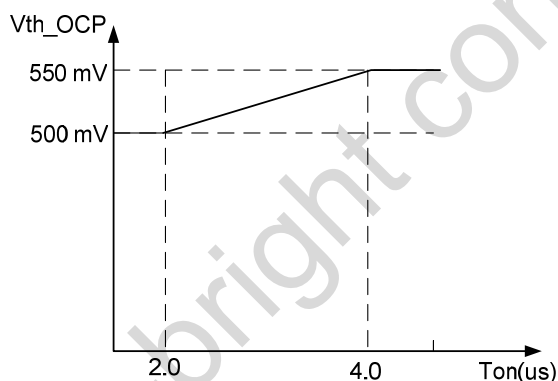

Figure.4. On time OCP compensation

● **Operation Switching Frequency**

The switching frequency of OB2305 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 and the switching frequency is

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

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 $\pm 7\%$ variation of the primary winding inductance can be compensated.

● **Programmable Cable Drop Compensation**

In OB2305, 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 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.
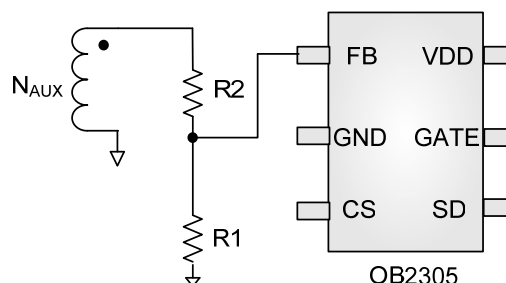
The percentage of maximum compensation is

$$\frac{\Delta V}{Vout} = \frac{Icomp\_cable \times R1//R2 \times 10^{-6}}{2.5} \times 100\%$$

ΔV is load compensation voltage and Vout is output voltage;

For example: R1//R2=6.2Kohm, the percentage of maximum compensation is

$$\frac{\Delta V}{Vout} = \frac{47 \times 6200 \times 10^{-6}}{2.5} \times 100\% = 11.6\%$$

● **Current Sensing and Leading Edge Blanking**

Cycle-by-Cycle current limiting is offered in OB2305. 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.

● **Gate Driver**

The GATE pin is connected to the gate of an external power switch. An internal 13.5V (typical) clamp is added for MOSFET gate protection at high VCC voltage. When VCC voltage drops below UVLO(ON), the GATE pin is internally pull low to maintain the off state.

● **CC mode shutdown function**

In OB2305, to prevent the controller operating under abnormal conditions, the minimum output voltage of CC mode is limited to predetermined voltage. The CC output voltage is sampled through FB pin from auxiliary winding at the middle of the de-magnetization. When the FB sampled voltage is below 1.55V and last 1024-2048 cycle, the controller will shut down.

● **Protection Control**

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

VDD is supplied by transformer auxiliary winding output. The output of OB2305 is shut down when VDD drops below UVLO (ON) and the power converter enters power on start-up sequence thereafter.

To prevent the circuit being damaged under abnormal conditions, OB2305 provides over thermal protection function. When the die temperature rises above over temperature threshold T_otp, the OB2305 will shut down the gate output and then latch the power supply off. The controller will remains latched until the die temperature drops below the recovery threshold T_otp_rec and the OB2305 will reset at the same time.

PACKAGE MECHANICAL DATA

SOT-23-6L PACKAGE OUTLINE DIMENSIONS
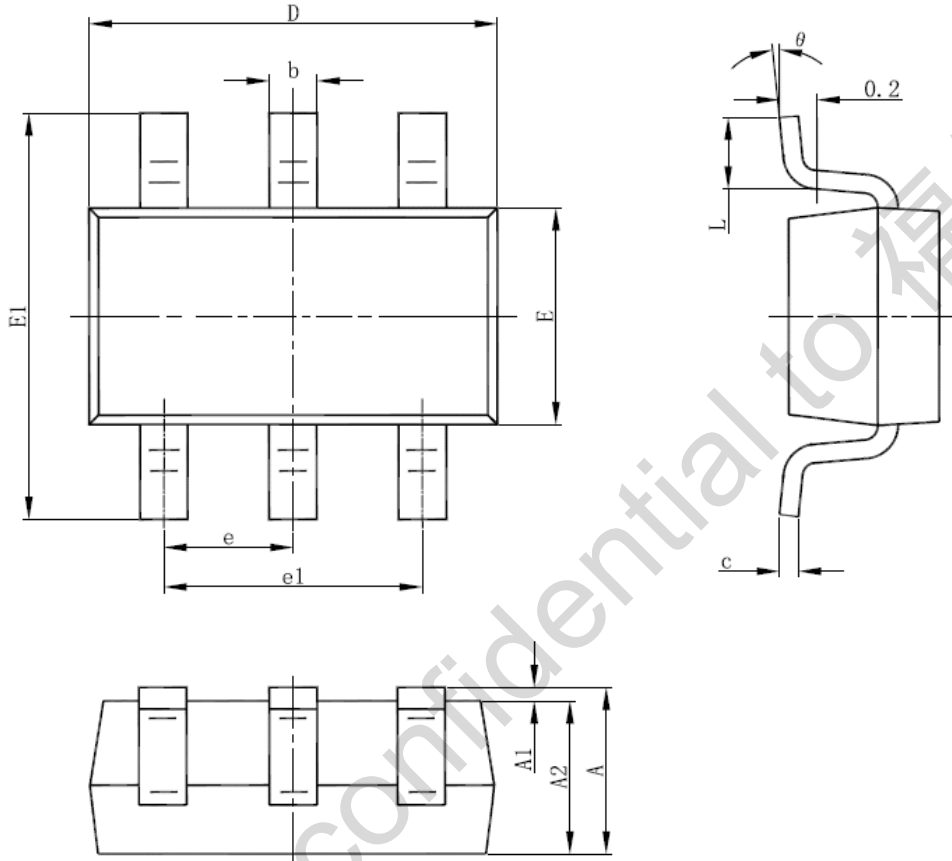
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.000	1.450	0.039	0.057
A1	0.000	0.150	0.000	0.006
A2	0.900	1.300	0.035	0.051
b	0.300	0.500	0.012	0.020
c	0.080	0.220	0.003	0.009
D	2.800	3.020	0.110	0.119
E	1.500	1.726	0.059	0.068
E1	2.600	3.000	0.102	0.118
e	0.950 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0º	8º	0º	8º

PACKAGE MECHANICAL DATA

SOP8 PACKAGE OUTLINE DIMENSIONS
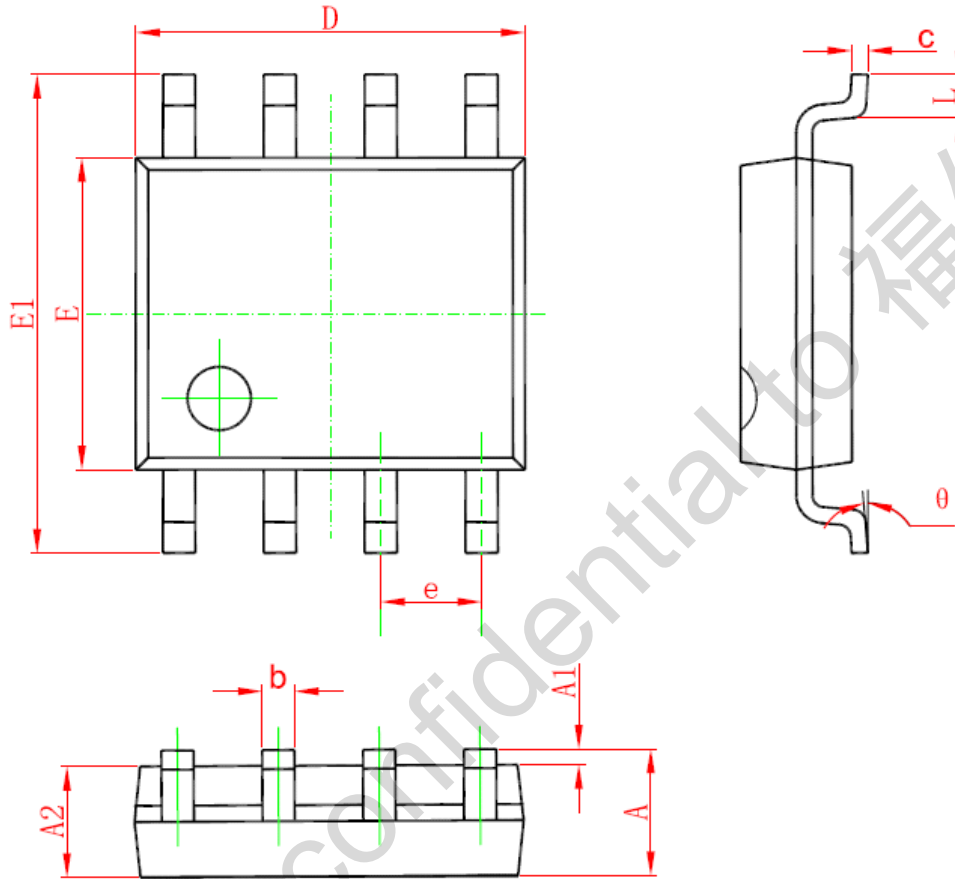
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	4.700	5.150	0.185	0.203
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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