

## GENERAL DESCRIPTION

OB2372 is an excellent primary side regulation controller with CC/CV operation for medium level power AC/DC charger and adapter applications. The device directly drives a power MOSFET and operates in CCM/QR mode to provide high efficiency along with several functions of built-in protections. It removes the need for secondary feedback circuitry to lower the total bill of material cost. Proprietary Constant Voltage (CV) and Constant Current (CC) control is integrated as shown in the figure below.

In CV control, the controller changes the mode of operation according to line voltage and load condition. At full loading, the controller operates in fixed frequency CCM in low line voltage and operates quasi-resonant (QR) mode in high line voltage. The primary side regulation power supplies up to high power without the efficiency limitation of DCM or audible noise.

In CC control, OB2372 samples the  $V_{cs}$  peak current and the demagnetization pulse to regulation the output constant current. The current and output power setting can be adjusted externally by the sense resistor  $R_s$  at CS pin.

OB2372 offers comprehensive protection coverage with auto-recovery feature including Cycle-by-Cycle current limiting, VDD OVP, OLP, SCP, OTP etc.

OB2372 consumes less than 75mW input power at no-load condition with high line voltage.

OB2372 is offered in SOP8 package.

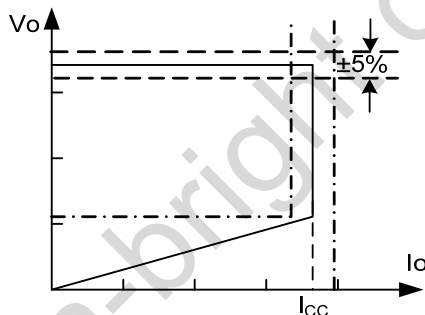


Figure.1. Typical CC/CV Curve

## FEATURES

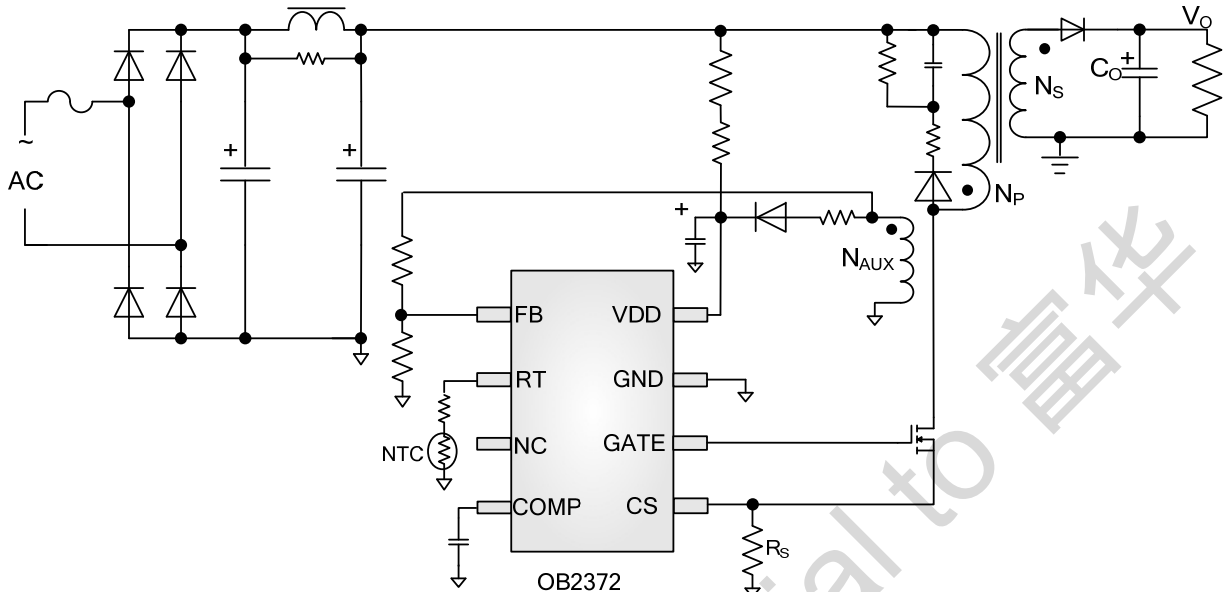
- Primary-side sensing and regulation operates in CCM/QR mode without TL431 and opto-coupler
- High precision constant voltage and current regulation at universal AC input
- Fixed frequency (65kHz) CCM mode operation with low line voltage at full load
- Quasi-resonant operation for high efficiency in high line voltage
- Good dynamic response
- Programmable CV and CC regulation
- Built-in primary winding inductance compensation
- Programmable cable drop compensation
- Built-in control loop compensation
- External over temperature protection with latch shutdown (OTP)
- 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 (OVP)
  - VDD under voltage lockout with hysteresis (UVLO)
  - Cycle-by-cycle current limiting
  - Feedback open loop protection (OLP)
  - Output short circuit protection (SCP)

## APPLICATIONS

Medium level Power AC/DC offline SMPS for

- Cell phone charger
- Tablet PC
- AC/DC adapter
- Set-top box power supplies

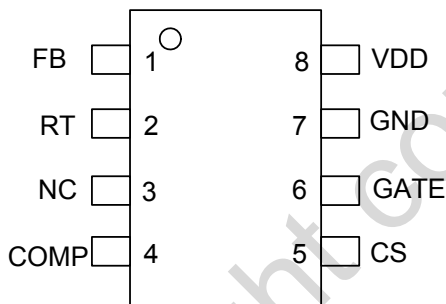
### TYPICAL APPLICATION



### GENERAL INFORMATION

#### Pin Configuration

The pin map is shown as below for SOP8.



#### Ordering Information

Part Number	Description
OB2372CP	SOP8, Pb-free in Tube
OB2372CPA	SOP8, Pb-free in T&R

#### Package Dissipation Rating

Package	R $\theta$ JA (°C/W)
SOP8	150

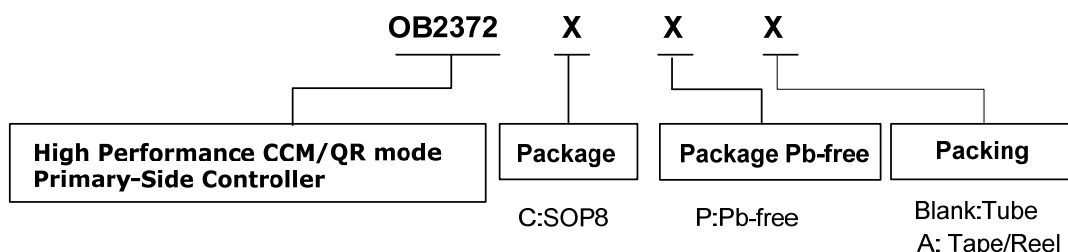
#### Absolute Maximum Ratings

Parameter	Value
VDD Voltage	-0.3 to 30V
FB Input Voltage	-0.3 to 7V
RT Input Voltage	-0.3 to 7V
CS Input Voltage	-0.3 to 7V
GATE Input Voltage	-0.3 to 24V
Min/Max Operating Junction Temperature T <sub>J</sub>	-40 to 150 °C
Min/Max Storage Temperature T <sub>stg</sub>	-55 to 150 °C
Lead Temperature (Soldering, 10secs)	260 °C

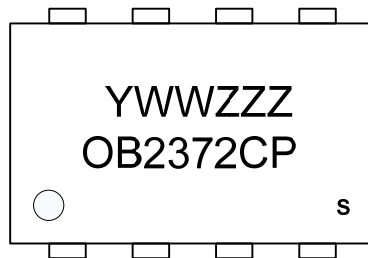
**Note:** Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure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

#### Recommended Operating Condition

Symbol	Parameter	Range
VDD	VDD Supply Voltage	9 to 22V
T <sub>A</sub>	Operating Ambient Temperature	-20 to 85 °C



## Marking Information

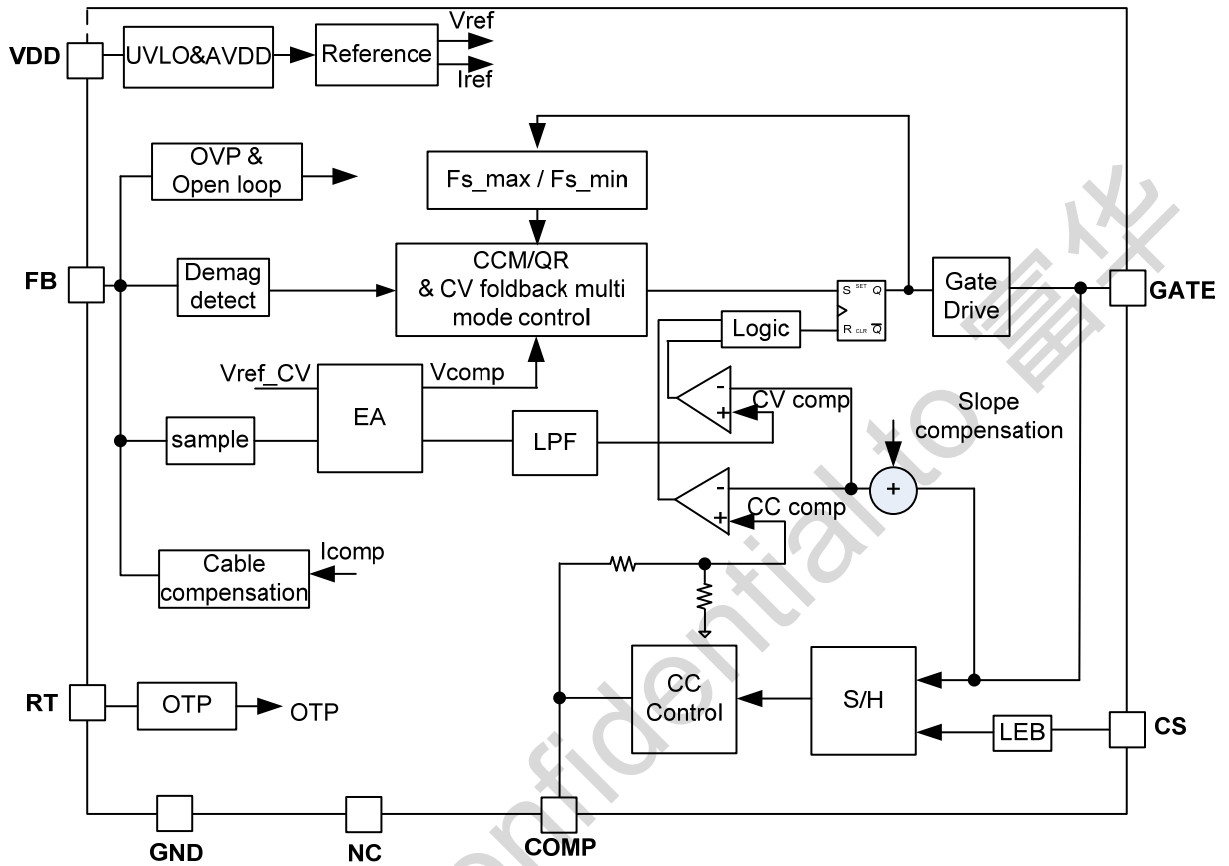


Y:Year Code  
 WW:Week Code(01-52)  
 ZZZ:Lot Code  
 C:SOP8 Package  
 P:Pb-free Package  
 S:Internal Code(Optional)

## 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	RT	I	Connected through a NTC resistor to ground for over temperature protection.
3	NC		
4	COMP	I/O	Connected through Cap to ground for CC loop compensation.
5	CS	I	Current sense input. Connect a sense resistor from this pin to ground.
6	GATE	O	Gate driver of power MOSFET.
7	GND	P	Ground
8	VDD	P	Power Supply

**BLOCK DIAGRAM**

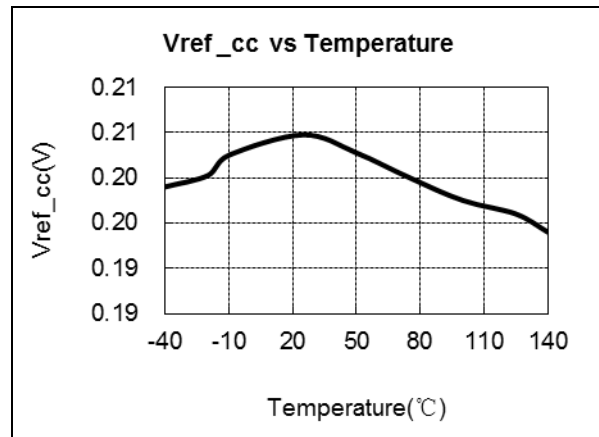
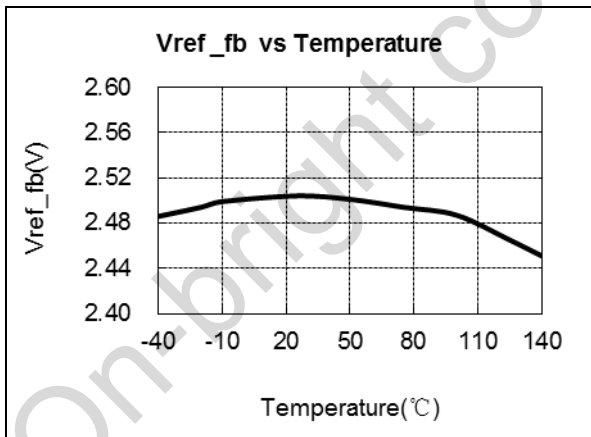
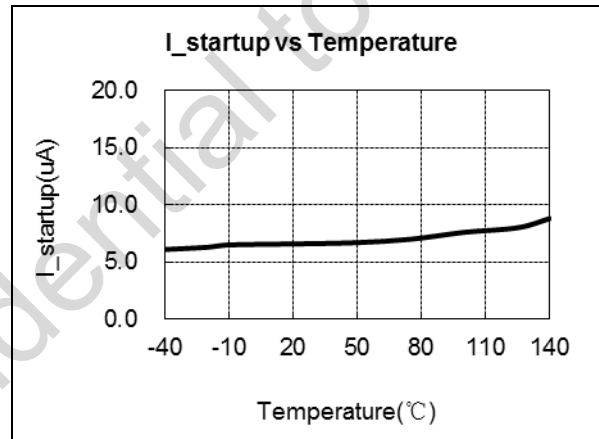
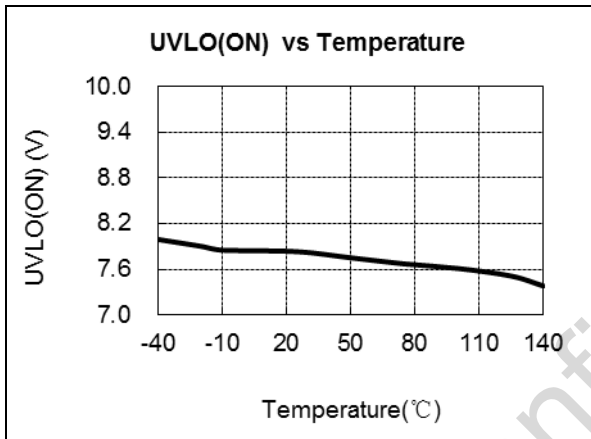
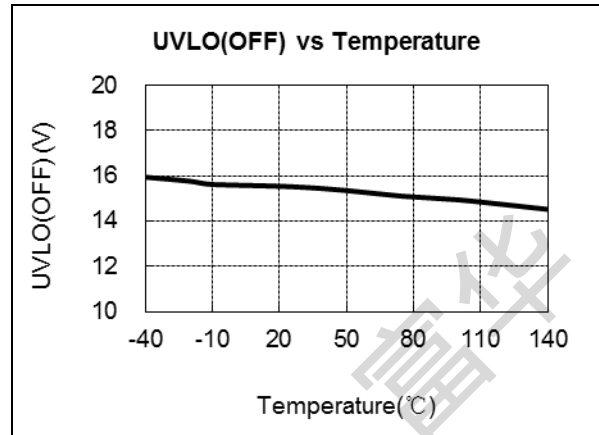
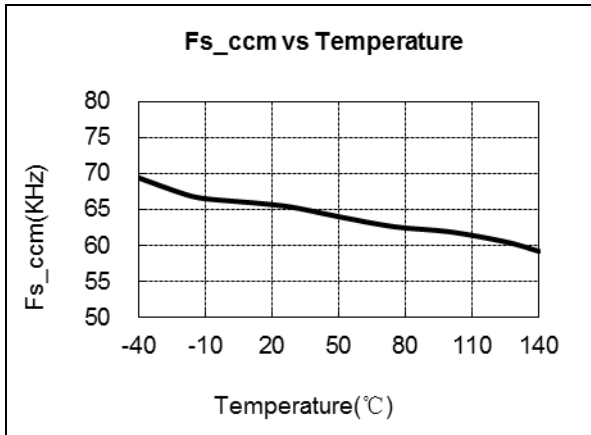


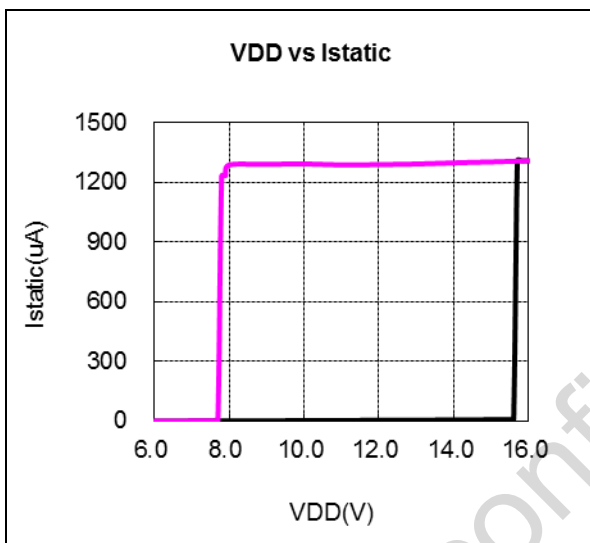
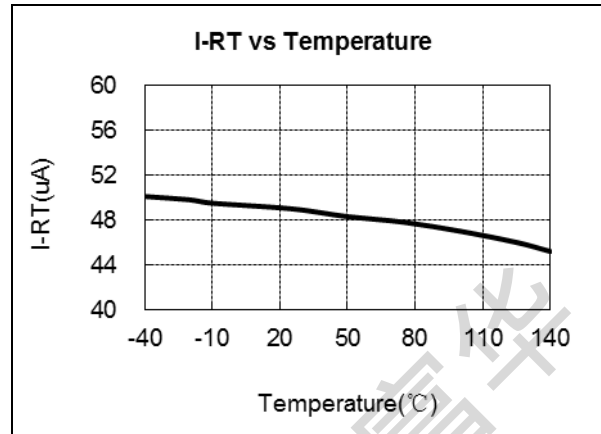
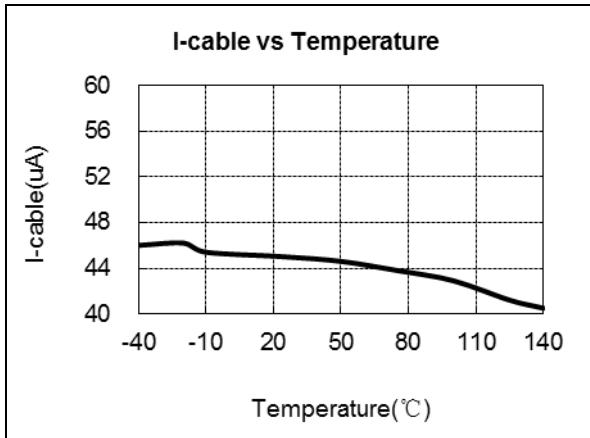
## ELECTRICAL CHARACTERISTICS

(TA = 25°C, VDD=18V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
<b>Supply Voltage (VDD) Section</b>						
I <sub>start-up</sub>	Start up current	VDD=UVLO_OFF-1V		5	15	uA
I <sub>static</sub>	Static current			1.2	1.8	mA
I <sub>op_s</sub>	Operating current	FB=1V, 1nF gate load.		1.8	2.5	mA
UVLO(OFF)	VDD under voltage lockout exit		14.6	15.6	16.6	V
UVLO(ON)	VDD under voltage lockout enter		7.2	7.9	8.6	V
VDD_OVP	VDD over voltage protection		23.5	25	26.6	V
V <sub>latch_off</sub>	Latch release vdd voltage		4.3	5.3	6.3	V
I <sub>latch_off</sub>	Latch release I <sub>cc</sub> current		30	42	60	uA
<b>Current Sense Input Section</b>						
TLEB	LEB time			300		ns
TD_OC	OCP propagation delay			100		ns
V <sub>th_ocp_max</sub>	Maximum over current threshold			750		mV
V <sub>cs_mini</sub>	Minimum CS threshold			150		mV
<b>FB Input Section</b>						
V <sub>ref_fb</sub>	Reference voltage for feedback threshold		2.475	2.500	2.525	V
V <sub>OVP</sub>	Output Over voltage threshold		2.95	3.05	3.15	V
T <sub>pause_min</sub>	Minimum T <sub>off</sub>			2.0		us
I <sub>comp_cable</sub>	Maximum cable compensation current			48		uA
<b>CC Loop Section</b>						
V <sub>ref_cc</sub>	CC loop reference		190	200	210	mV
G <sub>m</sub>	CC loop integrator transconductance			16		us
<b>Timer Section</b>						
F <sub>s_ccm</sub>	CV CCM switch frequency		60	65	70	KHz
Duty <sub>max</sub>	Maximum duty			68		%
F <sub>s_ccm_jitter</sub>	65K fixed switch frequency jittering			+/- 4		%
F <sub>s_max</sub>	CV QR maximum frequency			90		KHz
F <sub>min</sub>	Minimum switch frequency		250	300	350	Hz
<b>Gate Driver Section</b>						
V <sub>clamp</sub>	Output clamp voltage level		10	11.5	13	V
T <sub>r</sub>	Output rising time	CL=1nF		150		ns
T <sub>f</sub>	Output falling time	CL=1nF		50		ns
<b>Output Over Voltage Protection</b>						
V <sub>OVP</sub>	Output Over voltage threshold		2.95	3.05	3.15	V
<b>External OTP Section</b>						
I <sub>otp</sub>	RT pin source current		47.5	50	52.5	uA
V <sub>otp</sub>	Over temperature trigger voltage		1.0	1.05	1.1	V

**CHARACTERIZATION PLOTS**





## OPERATION DESCRIPTION

OB2372 is an excellent integrated multi-mode (see Figure 2) PWM controller optimized for off-line middle power AC/DC applications. It operates in continuous conduction mode (CCM) and quasi-resonant mode (QR) to provide high efficiency with primary side sensing and regulation thus provide cost effective solution for energy efficient power supplies.

At full loading, the IC operates in fixed frequency (65KHz) CCM mode in the low line input voltage and it operates in QR mode in high line input voltage. In this way, high efficiency in the universal input range at full loading can be achieved.

At normal load condition, it operates in QR mode. To minimize switching loss, the maximum switching frequency in QR mode is internally limited to 90 KHz (typical). When the load goes low, it operates in PFM mode with valley switching for high power conversion efficiency. When the load is very small, the IC switch frequency can be reduced to 300Hz to minimize the standby power loss. As a result, high conversion efficiency can be achieved in the whole loading range.

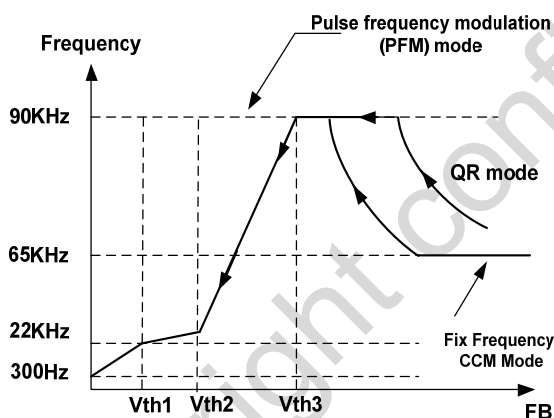


Figure 2 Multi-mode operation diagram  
Proprietary built-in CV and CC control can achieve high precision CC/CV control meeting most charger application requirements.

### Startup Current and Start up Control

Startup current of OB2372 is designed to be very low so that VDD could be charged up above UVLO threshold level and device starts up quickly. A large value startup resistor can therefore be used to minimize the power loss yet achieve a reliable startup in application.

### Operating Current

The Operating current of OB2372 is as low as 1.8mA (typical). Good efficiency and less than 100mW standby power is achieved with the low operating current.

### CV mode Operation

OB2372 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, OB2372 will regulate the output current constant regardless of the output voltage drop.

### Principle of Operation

With OB2372 proprietary CC/CV control, system can be designed in CCM/DCM mode for flyback system (Refer to the Typical Application Diagram in page1).

In the 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 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

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

The auxiliary winding voltage reflects the output voltage as shown in Figure.3 and it is given by

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

Where  $\Delta V$  indicates the voltage drop of the output Diode.

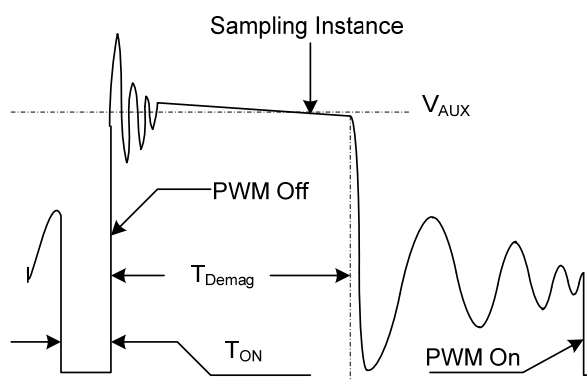


Figure.3. Auxiliary winding voltage waveform  
Via a resistor divider connected between the auxiliary winding and FB (pin 1), the auxiliary winding voltage is sampled at the middle of the de-magnetization and it is hold until the next sampling. The sampled voltage is compared with reference voltage Vref (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.

### CC mode operation

OB2372 sample the CS peak and the transformer core demagnetization period to regulate to output current. The primary CS peak is adaptively controlled according to the voltage of COMP pin.

$$I_o = N \cdot I_{pk} \cdot \frac{T_{demag}}{T_s} \quad (3)$$

Where  $I_{pk}$  indicates the peak current of primary winding,  $T_{demag}$  is the transformer core demagnetization period, and  $T_s$  the switch period. Refer to the equation 3, regulating the  $I_{pk}$  can achieve the constant output current. The constant output current is not related to the primary winding inductance and switch frequency.

### Adjustable CC point and Output Power

In OB2372, the CC point and maximum output power can be externally adjusted by external current sense resistor  $R_s$  at CS pin as illustrated in the 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.4.

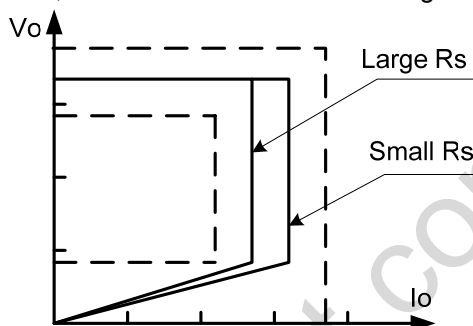


Figure.4. Adjustable output power by changing  $R_s$

### Programmable Cable Drop Compensation

In OB2372, cable drop compensation is implemented to achieve good load regulation (see Figure 5). An offset voltage is generated at FB pin by an internal current flowing into the resistor 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

$$\frac{\Delta V}{V_o} = \frac{I_{comp\_cable} \times R_1 // R_2 \times 10^{-6}}{2.5} \times 100\%$$

$\Delta V$  is load compensation voltage and  $V_o$  is output voltage;

For example:  $R_1 // R_2 = 6.2 \text{Kohm}$ , the percentage of

maximum compensation is

$$\frac{\Delta V}{V_o} = \frac{48 \times 6200 \times 10^{-6}}{2.5} \times 100\% = 11.9\%$$

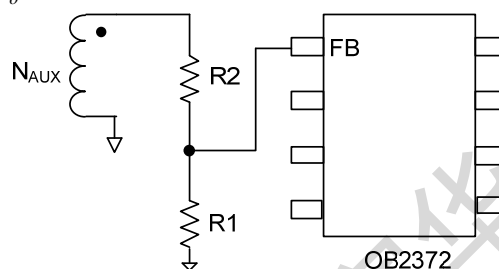


Figure 5 Diagram for cable drop compensation

### Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in OB2372. 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 11.5V (typical) clamp is added for MOSFET gate protection at high VDD voltage. When VDD voltage drops below UVLO(ON), the GATE pin is internally pull low to maintain the off state.

### Over Temperature Protection with latch shutdown

A NTC resistor in series with a regular resistor should be connected between RT and GND for temperature sensing and protection. NTC resistor value becomes lower when the ambient temperature rises. With the fixed internal 50uA current source flowing through the resistors, the voltage at RT pin becomes lower at high temperature. The internal OTP circuit is triggered and shuts down the MOSFET when the sensed input voltage is lower than 1.05V. OTP is a latched shutdown.

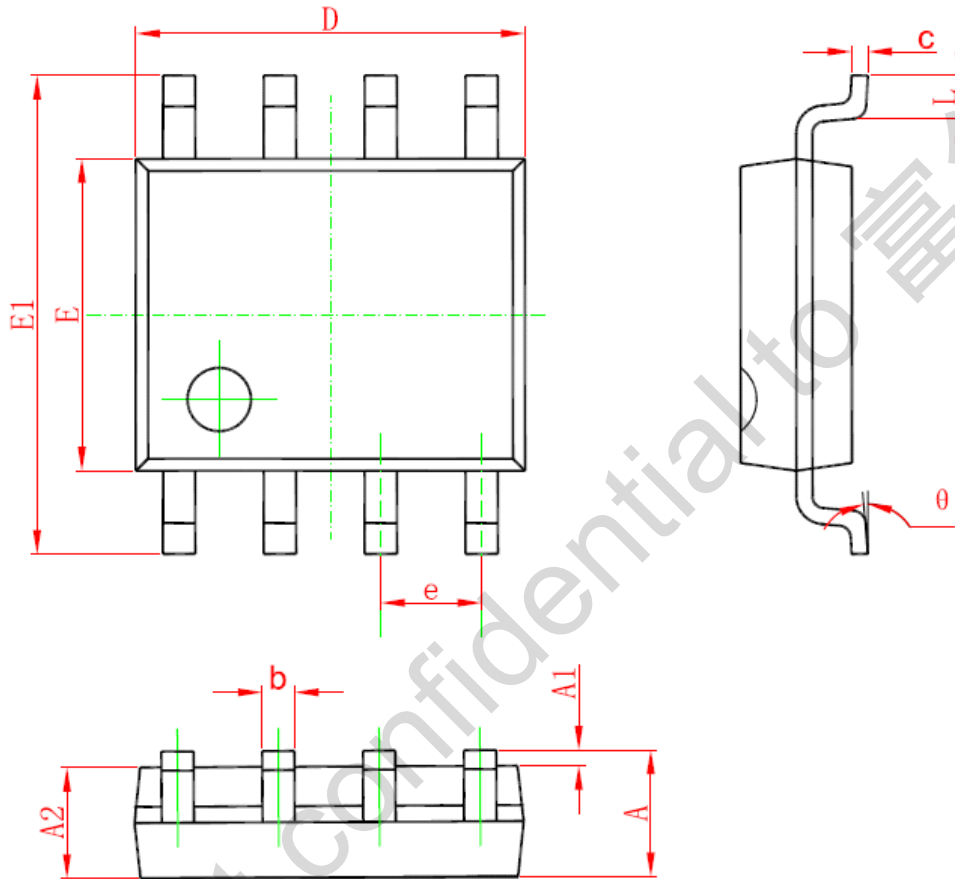
### Protection Control

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

VDD is supplied by transformer auxiliary winding output after startup. The output of OB2372 is shut down when VDD drops below UVLO (ON) and the power converter enters power on start-up sequence thereafter.

**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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