GENERAL DESCRIPTION

OB2374 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, OB2374 samples the Vcs 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 Rs at CS pin.

OB2374 offers comprehensive protection coverage with auto-recovery feature including Cycle-by-Cycle current limiting, VDD OVP, OLP, SCP etc.

OB2374 consumes less than 75mW input power at no- load condition with high line voltage.

OB2374 is offered in SOT23-6 package.

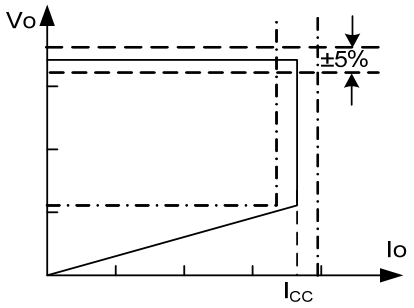


Figure.1. Typical CC/CV Curve

FEATURES

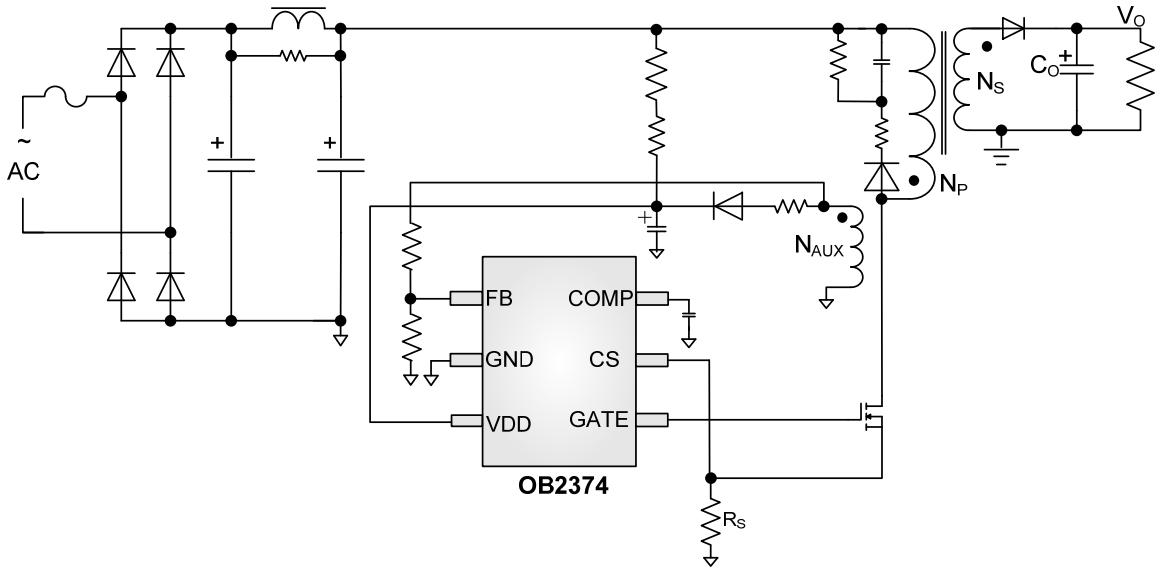
- Primary-side sensing and regulation operates in CCM/QR mode without TL431 and opto-coupler
- High precision constant voltage and current regulation at universal AC input
- Fixed frequency (65kHz) CCM mode operation with low line voltage at full load
- Quasi-resonant operation for high efficiency in 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

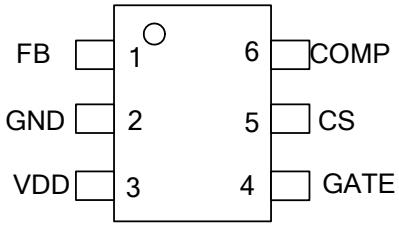
TYPICAL APPLICATION



GENERAL INFORMATION

Pin Configuration

The pin map is shown as below for SOT23-6.



Ordering Information

Part Number	Description
OB2374MP	SOT23-6, Pb-free in T&R

Package Dissipation Rating

Package	RθJA (℃/W)
SOT23-6	200

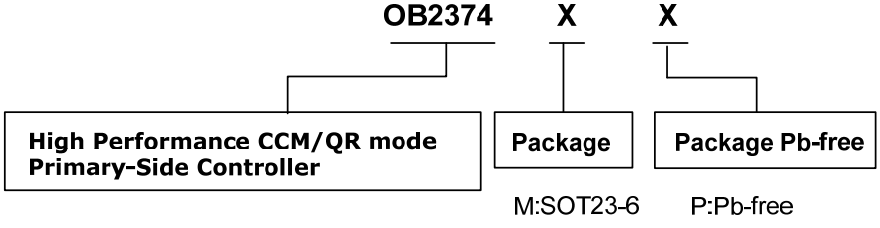
Recommended Operating Condition

Symbol	Parameter	Range
VDD	VDD Supply Voltage	9 to 22V

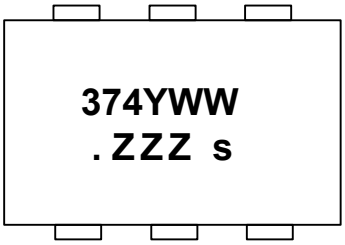
Absolute Maximum Ratings

Parameter	Value
VDD Voltage	-0.3 to 30V
FB Input Voltage	-0.3 to 7V
COMPInput 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_J	-40 to 150 ℃
Operating Ambient Temperature T_A	-20 to 85 ℃
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.



Marking Information

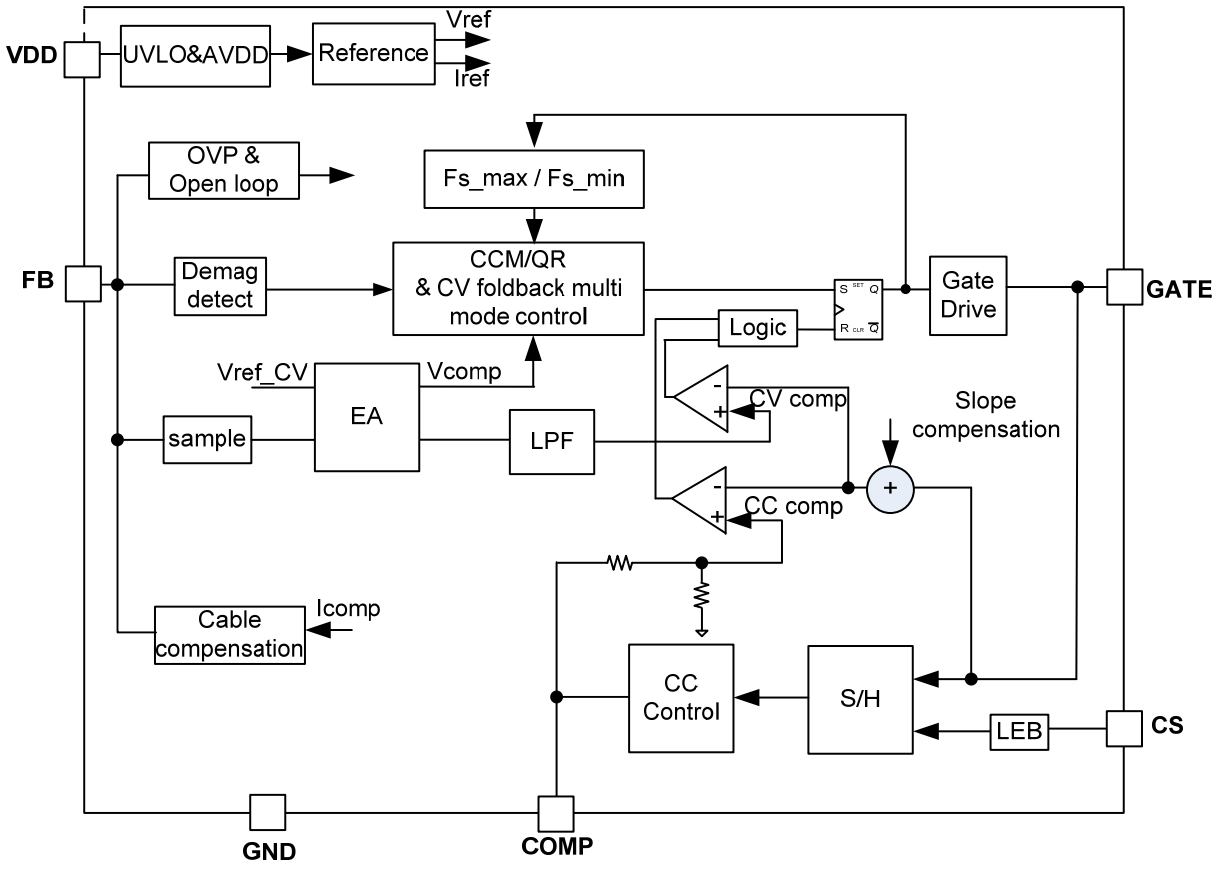


Y:Year Code
WW:Week Code(01-52)
ZZZ: Lot code
s: Internal code

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	VDD	P	Power Supply
4	GATE	O	Gate driver of power MOSFET.
5	CS	I	Current sense input. Connect a sense resistor from this pin to ground.
6	COMP	I/O	Connected through Cap to ground for CC loop compensation.

BLOCK DIAGRAM

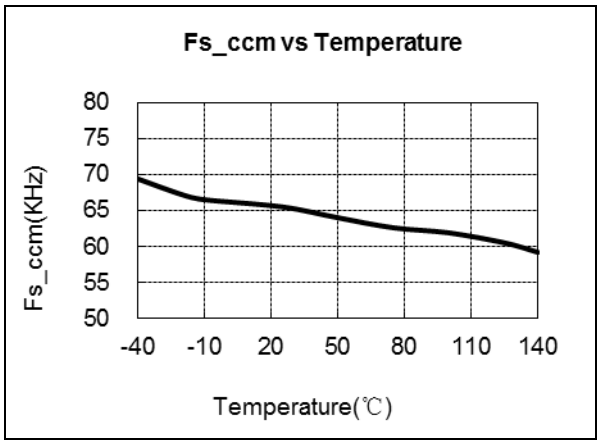


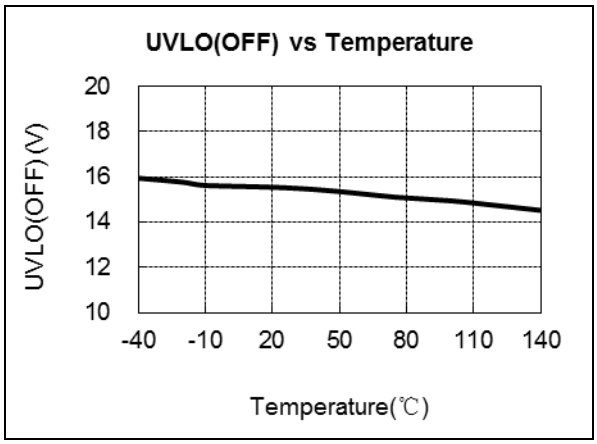
ELECTRICAL CHARACTERISTICS

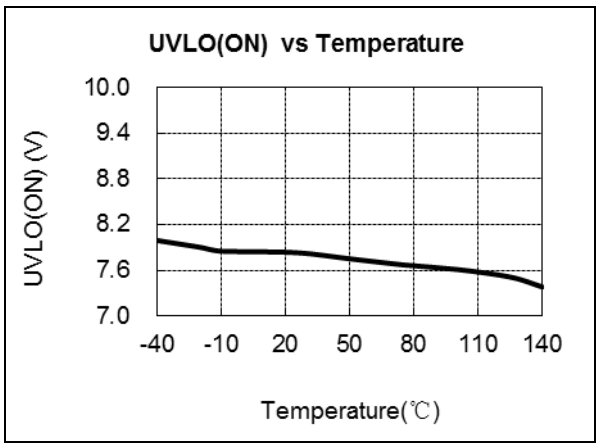
(TA = 25℃, VDD=18V, if not otherwise noted)

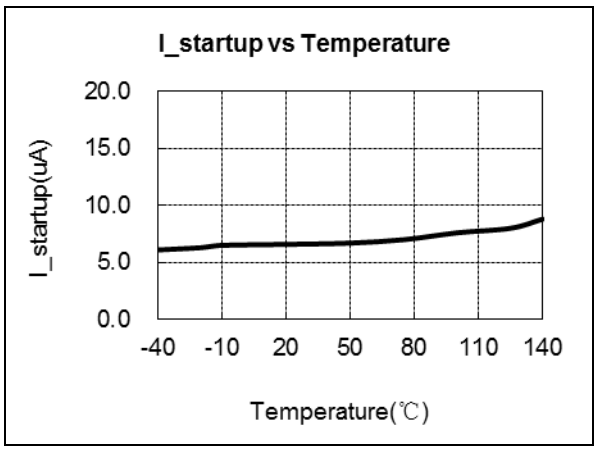
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
I start-up	Start up current	VDD=UVLO_OFF-1V		5	15	uA
I static	Static current			650	975	uA
Iop_s	Operating current	FB=1V, 1nF gate load.		1.8	2.5	mA
UVLO(OFF)	VDD under voltage lockout exit		14.6	15.6	16.6	V
UVLO(ON)	VDD under voltage lockout enter		7.2	7.9	8.6	V
VDD_OVP	VDD over voltage protection		23.5	25	26.6	V
Vlatch_off	Latch release vdd voltage		4.3	5.3	6.3	V
Ilatch_off	Latch release Icc current		30	42	60	uA
Current Sense Input Section						
TLEB	LEB time			300		ns
TD_OC	OCP propagation delay			100		ns
Vth_ocp_max	Maximum over current threshold			675		mV
Vcs_mini	Minimum CS threshold			150		mV
FB Input Section						
Vref_fb	Reference voltage for feedback threshold		2.475	2.500	2.525	V
V_OVP	Output Over voltage threshold		2.95	3.05	3.15	V
Tpause_min	Minimum Toff			2.0		us
Icomp_cable	Maximum cable compensation current			44		uA
CC Loop Section						
Vref_cc	CC loop reference		190	200	210	mV
Gm	CC loop integrator transconductance			16		us
Timer Section						
Fs_ccm	CV CCM switch frequency		60	65	70	KHz
Duty_max	Maximum duty			68		%
Fs_ccm_jitter	65K fixed switch frequency jittering			+/- 4		%
Fs_max	CV QR maximum frequency			90		KHz
Fmin	Minimum switch frequency		250	300	350	Hz
Gate Driver Section						
V_clamp	Output clamp voltage level		10	11.5	13	V
Tr	Output rising time	CL=1nF		150		ns
Tf	Output falling time	CL=1nF		50		ns
Output Over Voltage Protection						
V_OVP	Output Over voltage threshold		2.95	3.05	3.15	V

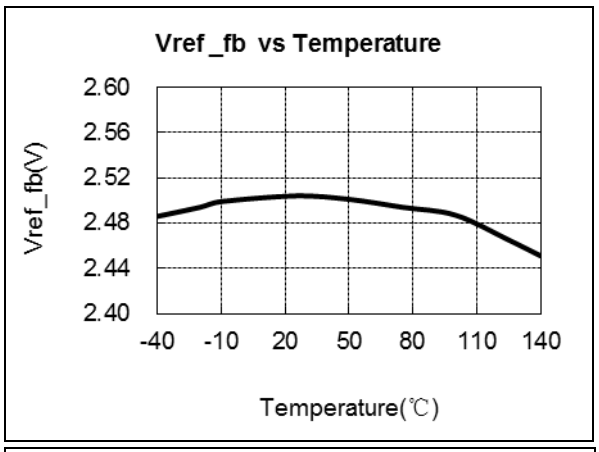
CHARACTERIZATION PLOTS

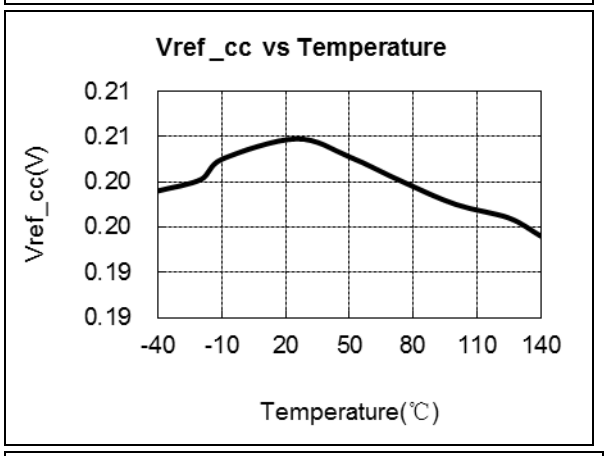


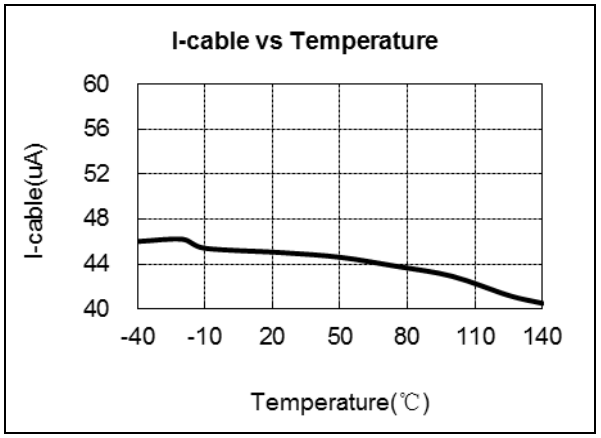


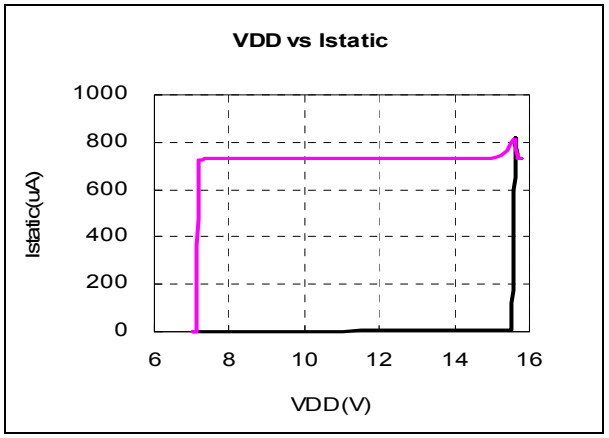












OPERATION DESCRIPTION

OB2374 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.

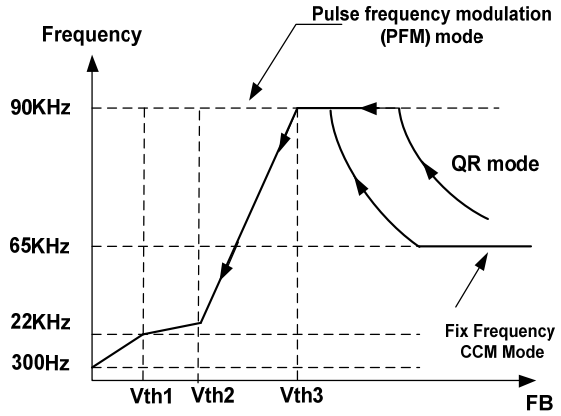


Figure 2 Multi-mode operation diagram

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 OB2374 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 minimum current of OB2374 is as low as 650uA (typical). Good efficiency and less than 75mW standby power is achieved with the low operating current.

CV mode Operation

OB2374 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, OB2374 will regulate the output current constant regardless of the output voltage drop.

Principle of Operation

With OB2374 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

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

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

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

Where ΔV indicates the voltage drop of the output Diode.

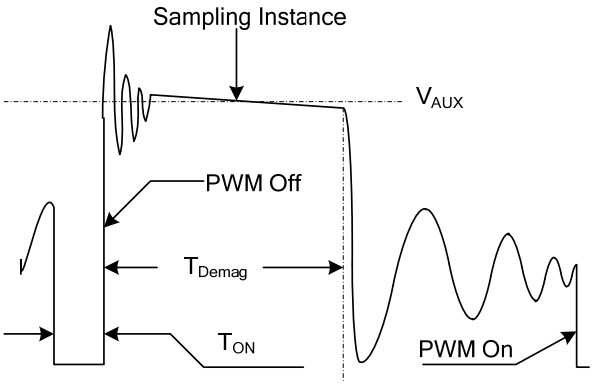


Figure.3. Auxiliary winding voltage waveform

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

OB2374 sample the transform primary side average current and the transformer core demagnetization period to regulate to output current. The primary average CS current is adaptively controlled according to the voltage of COMP pin.

$$I_o = N_{ps} \cdot \frac{V_{CS\_AV}}{Rs} \cdot \frac{T_{demag}}{T_s} = N_{ps} \cdot \frac{V_{ref\_cc}}{Rs} \qquad (3)$$

Where Vcs_av indicates the average voltage of current sense resistor at CS pin(1/2Vcs_peak for DCM mode, 1/2(Vcs_L+Vcs_peak) for CCM mode, Vcs_L is the minimum CS pin voltage when gate driver turn on), Rs is resistance of the current sense resistor, Tdemag is the transformer core demagnetization period, and Ts the switch period. Refer to the equation 3, regulating the primary average CS current 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 OB2374, 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.4.

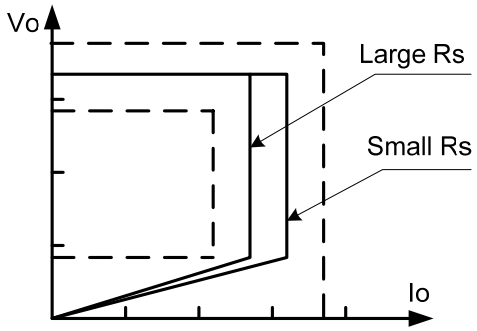


Figure.4. Adjustable output power by changing Rs

Programmable Cable Drop Compensation

In OB2374, 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 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

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

ΔV is load compensation voltage and Vo is output voltage;

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

$$\frac{\Delta V}{V_o} = \frac{44 \times 6200 \times 10^{-6}}{2.5} \times 100\% = 10.9\%$$

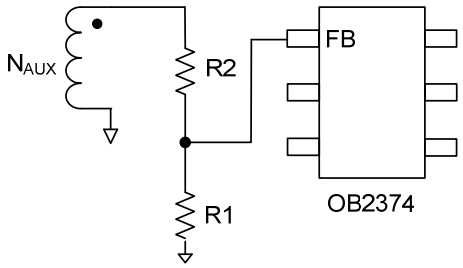


Figure 5 Diagram for cable drop compensation

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in OB2374. 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.

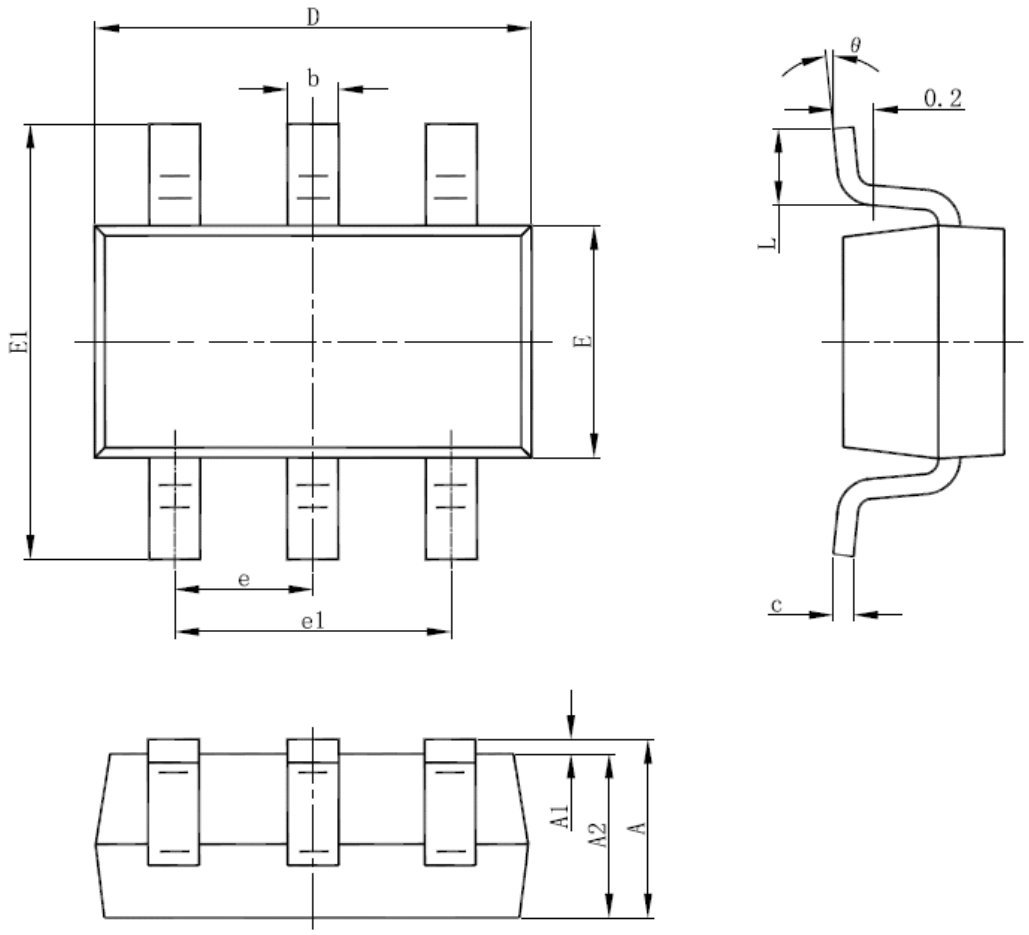
Protection Control

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 OB2374 is shut down when VDD drops below UVLO (ON) and the power converter enters power on start-up sequence thereafter.

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	0°	8°	0°	8°

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