GENERAL DESCRIPTION

OB2576x is an excellent primary side regulation controller with CC/CV operation for medium level power AC/DC charger and adapter applications. The device operates in 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 load condition. At full loading, the controller operates in quasi-resonant (QR) mode in the universal line voltage. The primary side regulation power supplies up to high power without the efficiency limitation of DCM or audible noise.

In CC control, OB2576x samples the Vcs peak current and the demagnetization pulse to regulation the output current. The current and output power setting can be adjusted externally by the sense resistor Rs at CS pin.

OB2576x offers comprehensive protection coverage with auto-recovery feature including Cycle-by-Cycle current limiting, VDD OVP, OLP, SCP, OTP etc.

OB2576x consumes less than 75mW input power at no- load condition with high line voltage.

OB2576x is offered in SOT23-6 package.

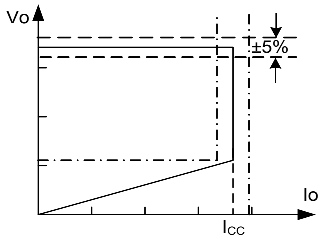


Figure.1. Typical CC/CV Curve

FEATURES

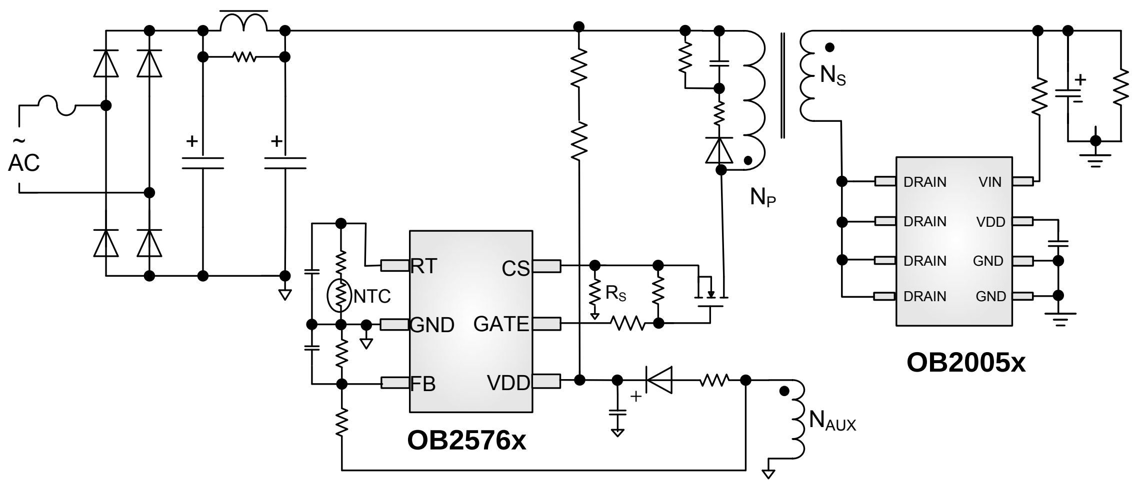
- Primary-side sensing and regulation operates in QR mode without TL431 and opto-coupler
- High precision constant voltage and current regulation at universal AC input
- Programmable CV and CC regulation
- Good dynamic response
- Built-in line compensation for tight CC regulation
- Built-in fixed cable compensation
- Built-in primary winding inductance compensation
- Built-in control loop compensation
- 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 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

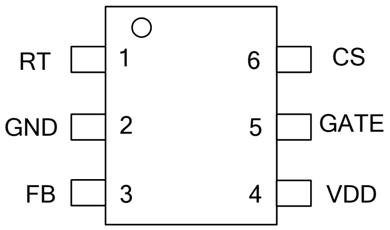
TYPICAL APPLICATION



GENERAL INFORMATION

Pin Configuration

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



Ordering Information

Part Number	Description
OB2576MP	SOT23-6, Halogen-free in T&R
OB2576AMP	SOT23-6, Halogen-free in T&R
OB2576BMP	SOT23-6, Halogen-free in T&R
OB2576CMP	SOT23-6, Halogen-free in T&R

Package Dissipation Rating

Package	RθJA (℃/W)
SOT23-6	200

Recommended Operating Condition

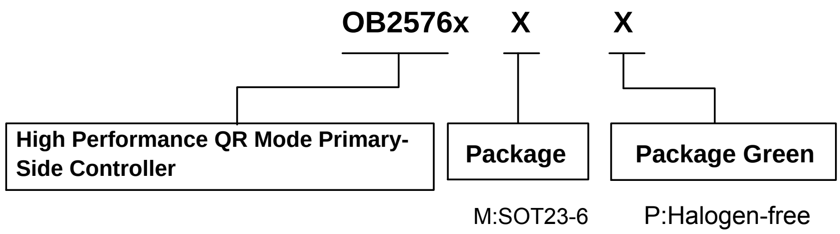
Symbol	Parameter	Range
VDD	VDD Supply Voltage	9 to 31V

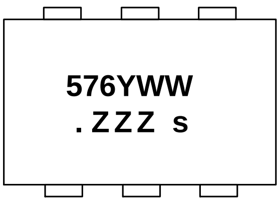
Absolute Maximum Ratings

Parameter	Value
VDD Voltage	-0.3 to 35V
FB Input Voltage	-0.3 to 7V
RT Input Voltage	-0.3 to 7V
CS Input Voltage	-0.3 to 7V
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 ℃

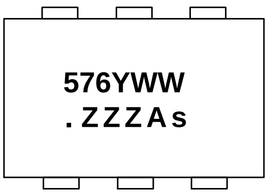
Note: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to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

Marking Information

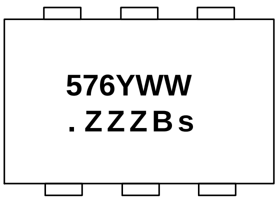




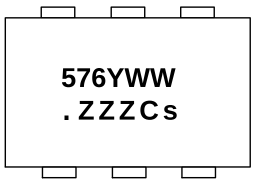
Y:Year Code
WW:Week Code(01-52)
ZZZ: Lot code
s: Internal code



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



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

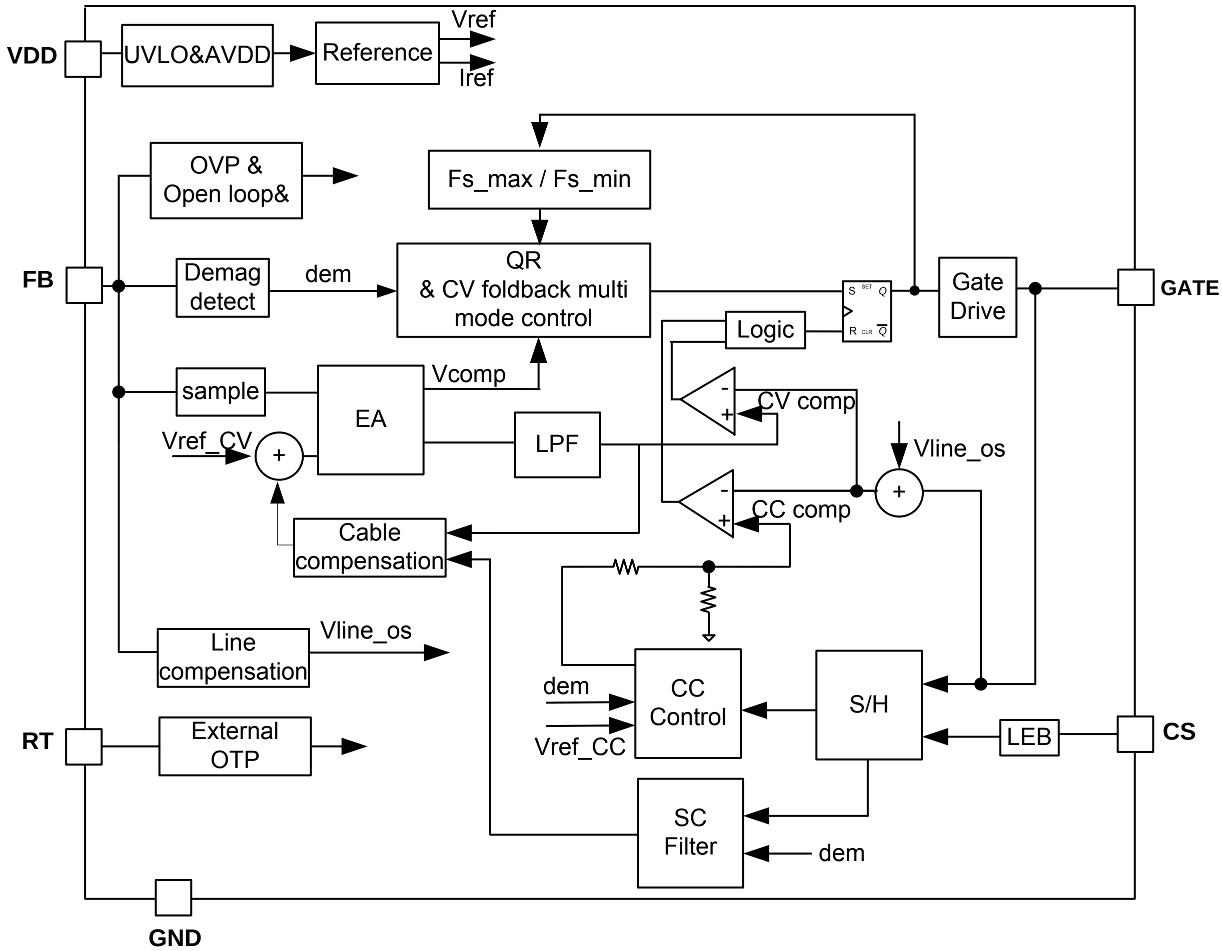


Y:Year Code
WW:Week Code(01-52)
ZZZ: Lot code
C:Character Code
s: Internal code

TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	RT	I	External OTP PIN, an NTC resistor should connected from this PIN to GND
2	GND	P	Ground
3	FB	I	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
4	VDD	P	Power Supply
5	GATE	O	Totem-pole gate drive output for power MOSFET
6	CS	I	Current sense input. Connect a sense resistor from this pin to ground.

BLOCK DIAGRAM



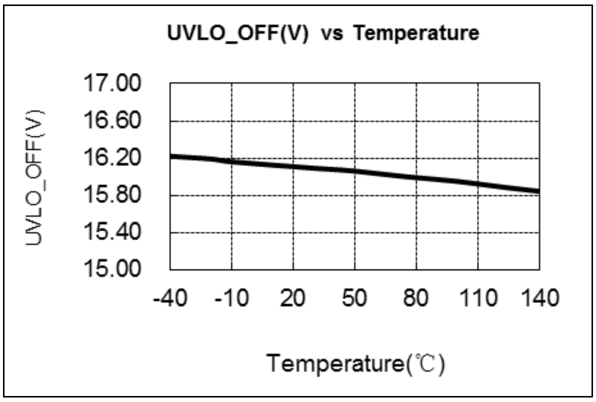
ELECTRICAL CHARACTERISTICS

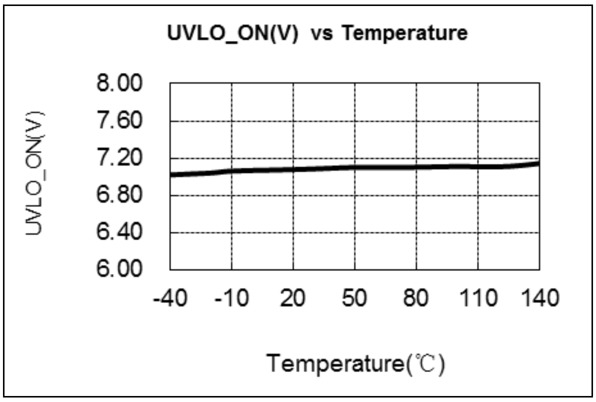
(TA = 25℃, VDD=18V, if not otherwise noted)

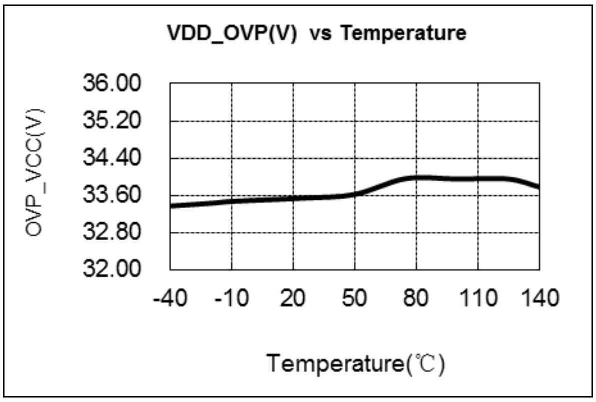
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
I start-up	Start up current	VDD=UVLO_OFF-1V		5	15	uA
I standy	Standby current			0.8	1.0	mA
Iop_s	Operating current	FB=1V, GATE pin floating		1.5	2.5	mA
UVLO(OFF)	VDD under voltage lockout exit		14.5	16	17.5	V
UVLO(ON)	VDD under voltage lockout enter		6.5	7	7.5	V
VDD_OVP	VDD over voltage protection		31	33	35	V
Current Sense Input Section						
TLEB	LEB time			425		ns
TD_OC	OCP propagation delay			100		ns
Vth_ocp_max	Maximum over current threshold@ Low AC voltage			700		mV
Vth_ocp_max	Maximum over current threshold@ High AC voltage			600		mV
FB Input Section						
Vref_fb	Reference voltage for feedback threshold		2.475	2.5	2.525	V
V_OVP	Output Over voltage threshold			3.25		V
Vth_cc_shutdown	CC mode shut down threshold			1.55		V
Tdbs_cc_shutdown	CC mode shut down debounce time		55	60	65	ms
Δcable_max/Vout	Maximum cable compensation to Vout ratio	OB2576MP		7		%
		OB2576AMP		5		%
		OB2576BMP		3		%
		OB2576CMP		1		%
RT Input Section						
Vth_otp	OTP trigger voltage		1.15	1.2	1.25	V
Vth_otp_exit	OTP exit voltage		1.3	1.35	1.4	V
Iotp	Sourcing current to RT pin		45	50	55	uA
Tdbs_otp	OTP debounce time			1		ms
CC Loop Section						
Vref_cc	CC loop reference		290	300	310	mV
Gm	CC loop integrator transconductance			1		uS
Timer Section						
Fs_max	CV QR maximum frequency		74	80	86	kHz
Fmin	Minimum switch frequency		0.27	0.3	0.33	kHz
Internal OTP Section						
OTP_int_enter	internal OTP enter temperature			150		℃
OTP_int_exit	internal OTP exit temperature			120		℃
GATE PIN Section						

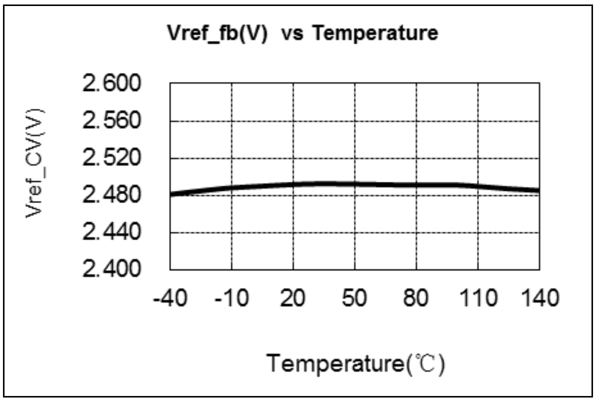
Tr	Gate rising time	CL=1nF		500		ns
Tf	Gate falling time	CL=1nF		60		ns
V_clamp	Gate output clamping voltage			13		V

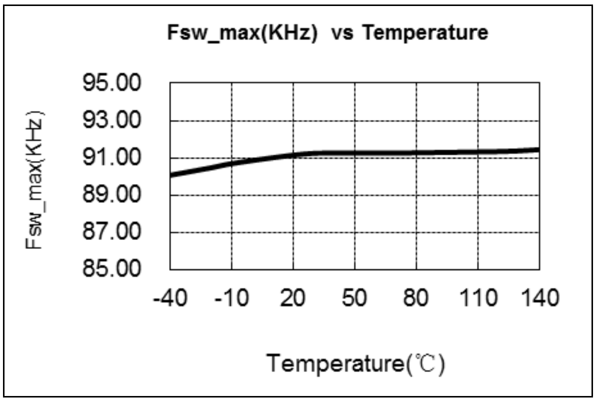
CHARACTERIZATION PLOTS

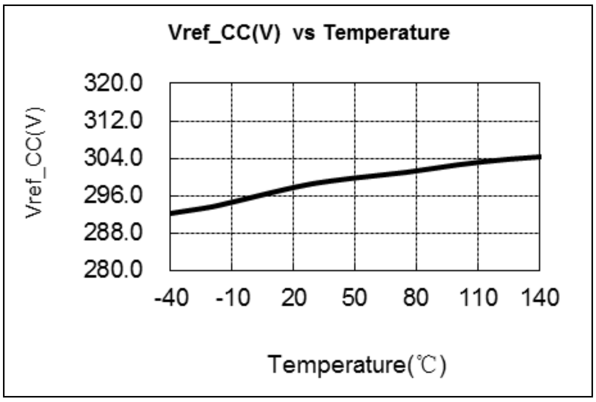












OPERATION DESCRIPTION

OB2576x is an excellent integrated multi-mode (see Figure 2) PWM controller optimized for off-line middle power AC/DC applications. It operates in quasi-resonant mode (QR) to provide high efficiency with primary side sensing and regulation thus provides cost effective solution for energy efficient power supplies.
At full loading, the IC operates in QR mode in the universal 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 0.3kHz to minimize the standby power loss. As a result, high conversion efficiency can be achieved in the whole loading range.

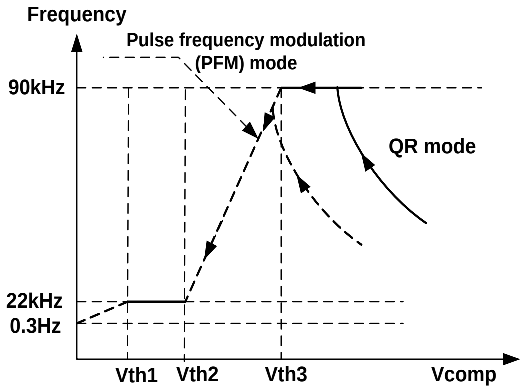


Figure 2 Multi-mode operation diagram

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 OB2576x 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 OB2576x is as low as around 800uA @ no load mode. Good efficiency and less than 75mW standby power is achieved with the low operating current.

CV Mode Operation

OB2576x 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, OB2576x will regulate the output current constant regardless of the output voltage drop.

Principle of Operation

With OB2576x proprietary CC/CV control, system can be designed in QR/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.

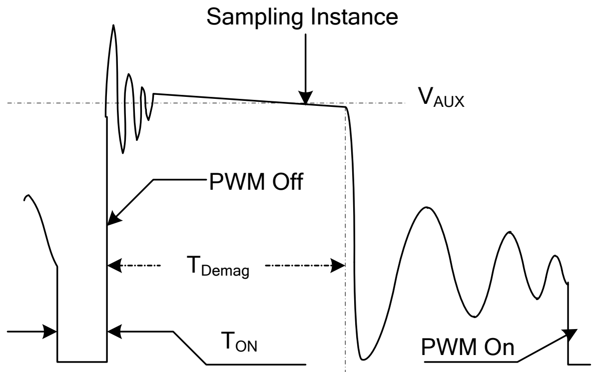


Figure.3. Auxiliary winding voltage waveform

Via a resistor divider connected between the auxiliary winding and FB PIN, the auxiliary voltage is sampled and hold during the demagnetization cycle.The sampling instance is variable according to the demagnetization width. The output voltage can be monitored when the secondary current is small. Thus ΔV can be ignored. 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

OB2576x samples the CS peak and the transformer core demagnetization period to regulate the output current. The primary CS peak is adaptively controlled according to vref_cc and the internal CC comp voltage.

$$I_o = \frac{1}{2} \cdot N \cdot I_{pk} \cdot \frac{T_{demag}}{T_s} = \frac{1}{2} \cdot N \cdot \frac{1}{R_{cs}} \cdot \frac{V_{cs} T_{demag}}{T_s} \quad (3)$$

Where Ipk is the peak current of primary winding, Tdemag is the transformer core demagnetization period, and Ts, the switch period.

Refer to the equation 3, Regulating the Ipk can achieve the constant output current. The constant output current is independent of the primary winding inductance. The ratio of $\frac{V_{cs} T_{demag}}{T_s}$ will be modulated equal to vref_cc which is 0.3V. Then

Io can be determined by

$$I_o = \frac{1}{2} \cdot N \cdot \frac{1}{R_{cs}} \cdot \frac{V_{cs} T_{demag}}{T_s} = \frac{1}{2} \cdot N \cdot \frac{vref\_cc}{R_{cs}} \quad (4)$$

Adjustable CC Point and Output Power

In OB2576x, 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 the Rs is, the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Figure.4.

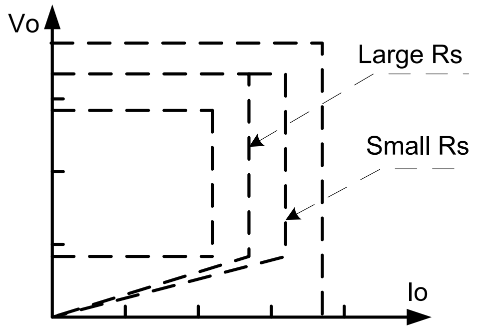


Figure.4. Adjustable output power by changing Rs

CC Line Voltage Compensation

The variation of maximum output current in CC mode can be rather large at high input voltage (such as 264Vac) if no compensation is provided. The CC threshold value is self adjusted higher at higher AC voltage due to CC propagation delay. In OB2576x, the AC line voltage information is sampled through detecting FB sourcing current when gate turns on, and the AC line voltage information is added to the CS pin voltage. So the maximum CS threshold voltage Vcs_max in OB2576x is a function of the CC threshold and AC line voltage information as shown in Figure5.

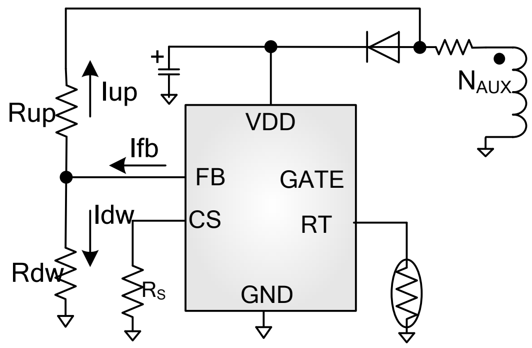


Figure.5. CC line voltage compensation

The CS threshold voltage Vcs is given by

$$Vcs = Vth\_cc - \frac{1}{M} \cdot \frac{Naux}{Np} \cdot \sqrt{2} \cdot Vac \cdot \frac{Ros}{Rup} \quad (5)$$

Where Vth_cc a threshold determined by internal CC comp voltage, M is the FB current mirror ratio(M=55), Naux/Np is the auxiliary winding to primary winding turns ratio, Vac is the effective voltage of input voltage, Ros is the internal line compensation offset resistor(Ros=1.5kohm) , Rup is the external FB PIN up side resistor.

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in OB2576x. 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.

External Over Temperature Protection with GATE Shutdown

OB2576x provides external over temperature protection function from RT PIN through souring out a current of Iotp. When external temperature rises above such a point that make RT voltage fall below Vth_otp and last long for Tdbs_otp, OB2576x will shut down the gate, until the external temperature drops below such a point that make RT voltage rise above Vth_otp_exit, the OB2576x resume work state.

Internal Over Temperature Protection with GATE Shutdown

The internal OTP circuit of OB2576x is triggered and only shuts down the internal MOSFET when the chip temperature rises above 150℃, and the internal MOSFET will resume switching after the chip temperature falls below 120℃.

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 OB2576x is shut down when VDD drops below UVLO (ON) and the power converter enters power on start-up sequence thereafter.

CC mode shutdown function

In OB2576x, 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 60ms, the controller will shut down.

Gate Driver

The GATE pin is connected to the gate of an external power switch. An internal 13V (typical) clamp is added for MOSFET gate protection at high VDD voltage. When protections happens or VDD voltage drops below UVLO(ON), the GATE pin is internally pull low to maintain the off state.

PCB Layout Consideration

The following rules should be followed in OB2576x PCB Layout:

The Area of Power Loop: The area of the main current loop should be as small as possible to reduce EMI radiation, such as the primary current loop, the snubber circuit and the secondary rectifying loop (Red wire as shows in Fig.6).

Bypass Capacitor and FB Divider Resistor: The bypass capacitor on VDD and the FB divider resistor should be placed as close as possible to pin out. And the negative node of VDD capacitor and the FB down resistor should be connected directly to the IC GND pin before single point connected to the negative node of the output capacitor. (Blue wire as shows in Fig.6)

Ground Path: The GND path of the input power loop and IC controller path should be separated and connected at the negative terminal of input capacitor by single point, such as power sense resistor, the negative of the auxiliary winding and the IC GND.

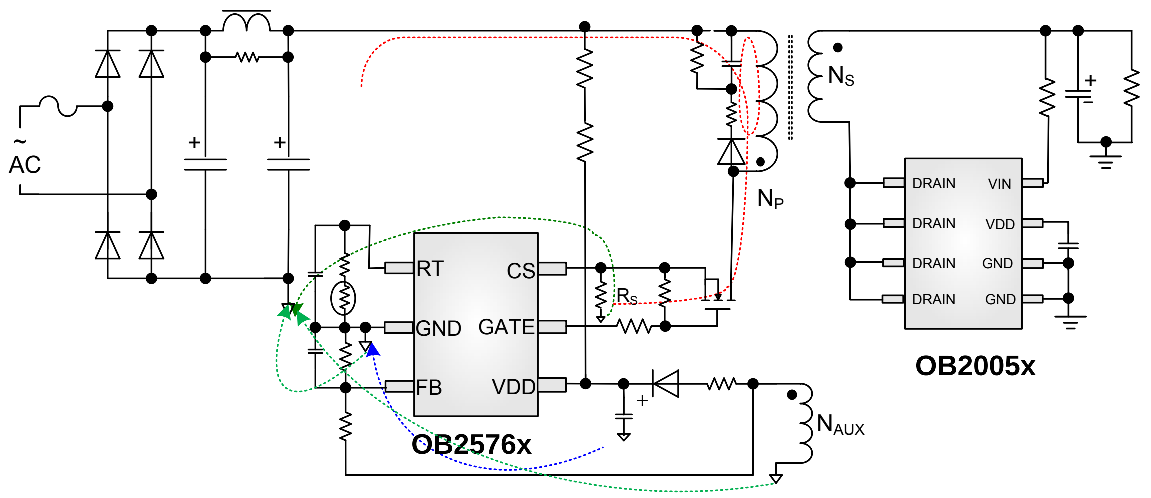
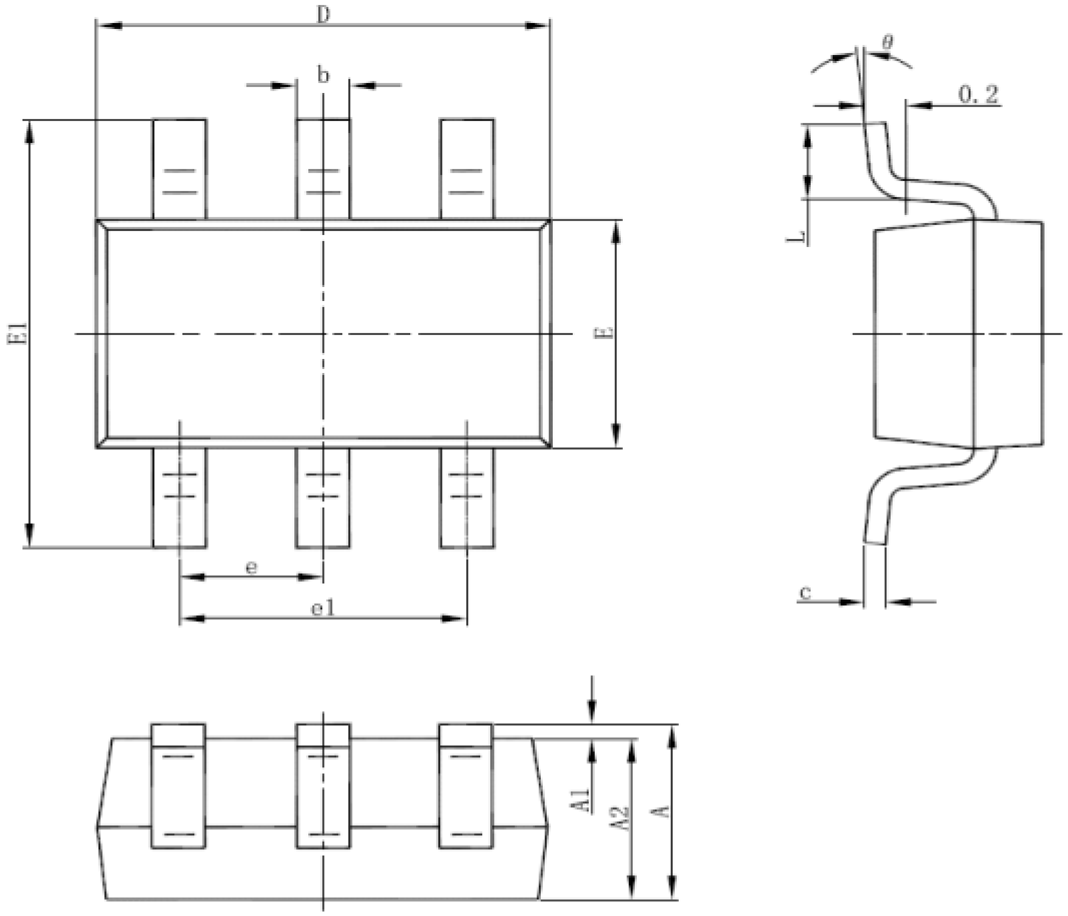


Fig.6 Flyback Schematic with OB2576x

PACKAGE MECHANICAL DATA

SOT23-6 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

IMPORTANT NOTICE

RIGHT TO MAKE CHANGES
On-Bright Electronics Corp. reserves the right to make corrections, modifications, enhancements, improvements and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

WARRANTY INFORMATION
On-Bright Electronics Corp. warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with its standard warranty. Testing and other quality control techniques are used to the extent it deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.
On-Bright Electronics Corp. assumes no liability for application assistance or customer product design. Customers are responsible for their products and applications using On-Bright's components, data sheet and application notes. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

LIFE SUPPORT
On-Bright Electronics Corp.'s products are not designed to be used as components in devices intended to support or sustain human life. On-bright Electronics Corp. will not be held liable for any damages or claims resulting from the use of its products in medical applications.

MILITARY
On-Bright Electronics Corp.'s products are not designed for use in military applications. On-Bright Electronics Corp. will not be held liable for any damages or claims resulting from the use of its products in military applications.