

## GENERAL DESCRIPTION

OB2216 is an offline PWM Power switch for low power AC/DC charger and adaptor 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  $R_s$  at CS pin. In CV control, multi-mode operations are utilized to achieve high performance and high efficiency. Device operates in fixed frequency mode at large load conditions, frequency reduction mode at light/medium load and 'Extended burst mode' at No/light load conditions.

OB2216 offers power on soft start control and protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD clamp and UVLO. Excellent EMI performance is achieved with On-Bright proprietary frequency shuffling technique together with soft switching control at the totem pole gate drive output.

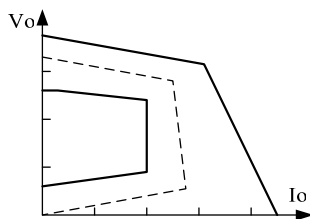


Fig 1. Typical CC/CV Curve

## FEATURES

- Primary-side Sensing and Regulation Without TL431 and Opto-coupler
- Multi-mode Operation for High Efficiency
- Programmable CV and CC Regulation
- Adjustable Constant Current and Output Power setting
- Frequency Shuffling and Adjustable Gate Drive Greatly Improving EMI
- Power on Soft-start Time (4ms)
- "Extended Burst Mode Control" for Improved Efficiency and Minimum Standby Design
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis (UVLO)
- VDD Clamp

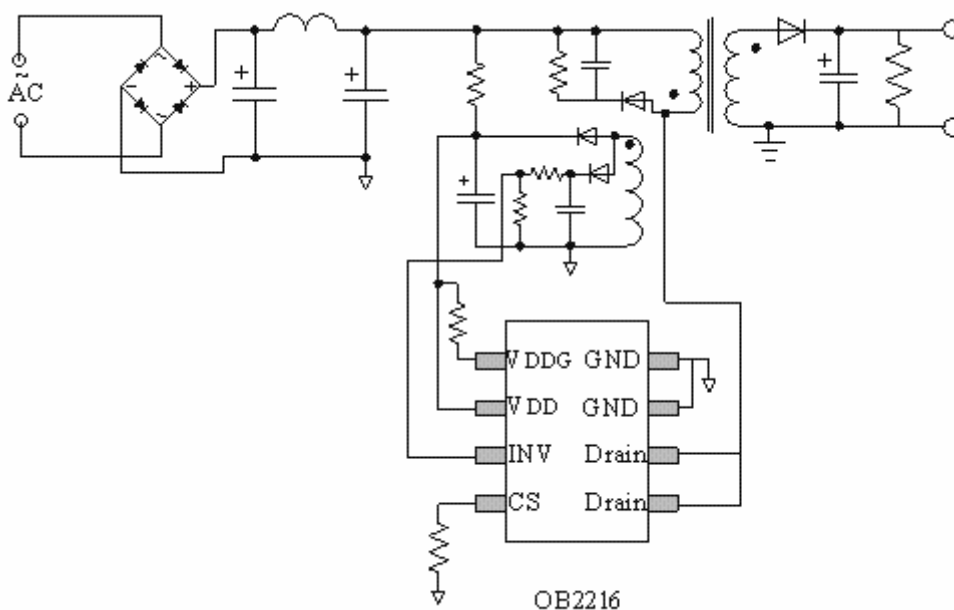
## APPLICATIONS

Low Power AC/DC offline SMPS for

- Cell Phone Charger
- Digital Cameras Charger
- Small Power Adaptor
- Auxiliary Power for PC, TV etc.
- Linear Regulator/RCC Replacement

OB2216 is offered in DIP8 package

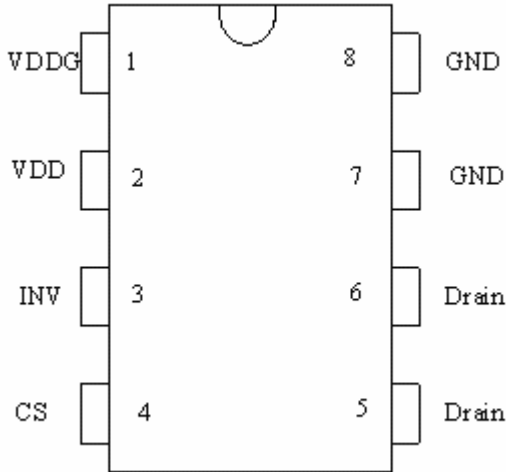
## TYPICAL APPLICATION



**GENERAL INFORMATION**

**Pin Configuration**

The pin map is shown as below for DIP8.



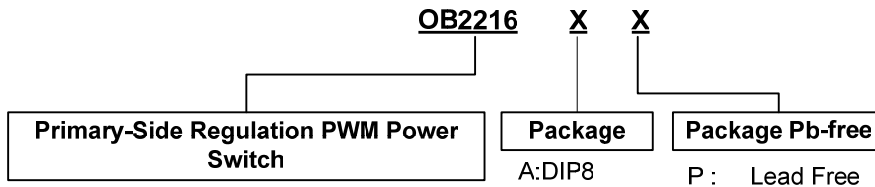
**Ordering Information**

Part Number	Description
OB2216AP	DIP8, Pb-free

**Absolute Maximum Ratings**

Parameter	Value
Drain Voltage (off state)	-0.3V to Bvdss
VDD Voltage	-0.3 to V <sub>DD_clamp</sub>
VDDG Voltage	-0.3 to V <sub>DD_clamp</sub>
VDD Zener Clamp Continuous Current	10 mA
CS Input Voltage	-0.3 to 7V
INV Input Voltage	-0.3 to 7V
Min/Max Operating Junction Temperature T <sub>J</sub>	-20 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.



**Marking Information**



Y: Year Code(0-9)  
 WW: Week Code(01-52)  
 A: DIP8 Package  
 P: Pb-free Package  
 S: Internal Code(Optional)

**TERMINAL ASSIGNMENTS**

Pin Num	Pin Name	I/O	Description
1	VDDG	P	Internal Gate Driver Power Supply
2	VDD	P	IC DC power supply Input
3	INV	I	Inverting input of error amplifier (EA). Connected to resistor divider from primary sensing winding reflecting output voltage. PWM duty cycle is determined by EA output and current sense signal at pin 4.
4	CS	I	Current sense input
5/6	Drain	O	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer
7/8	GND	P	Ground

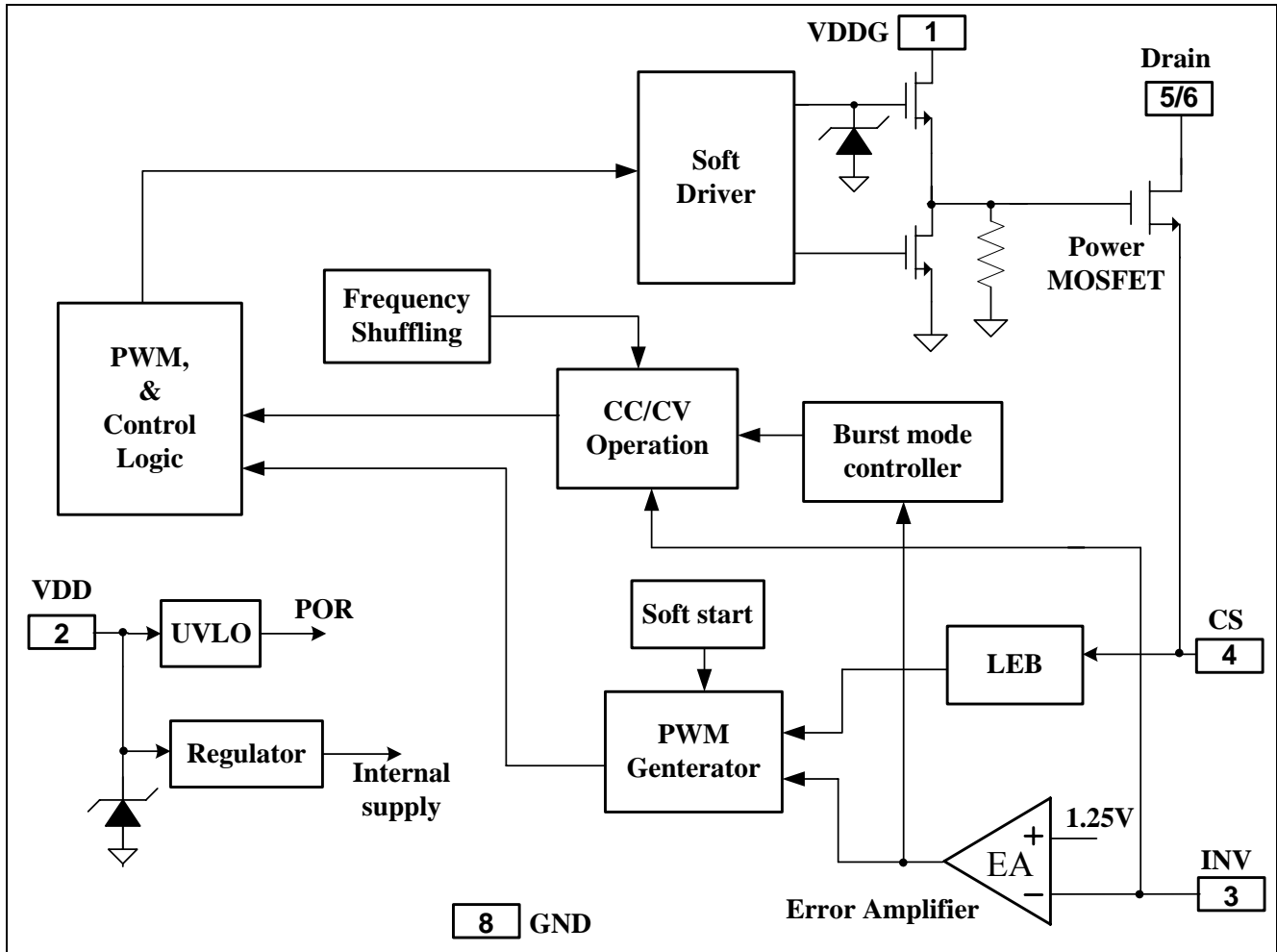
**Output Power Table**

Product	230VAC±15%	85-264VAC
	Open Frame <sup>1</sup>	Open Frame <sup>1</sup>
OB2216	20W	15W

**Notes:**

1. Maximum practical continuous power in an open frame design with sufficient drain pattern as a heat sink, at 50°C ambient.

**BLOCK DIAGRAM**

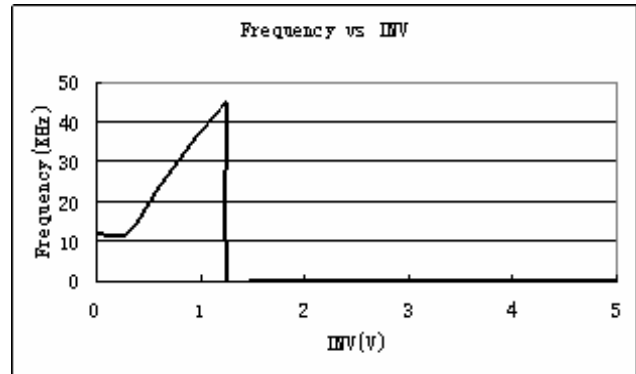
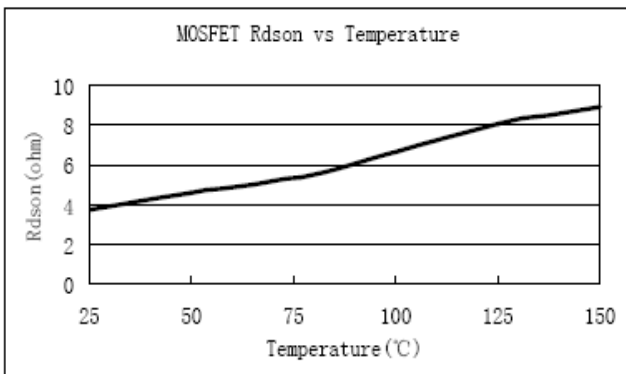
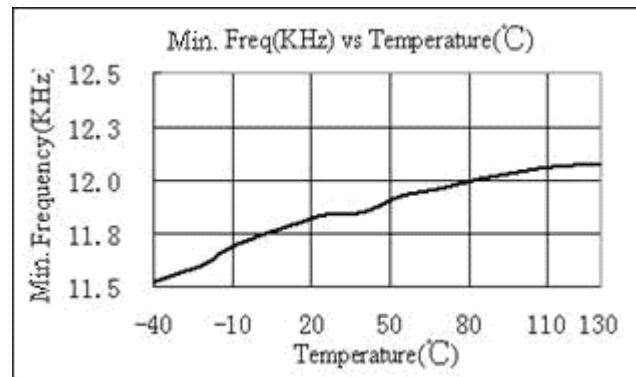
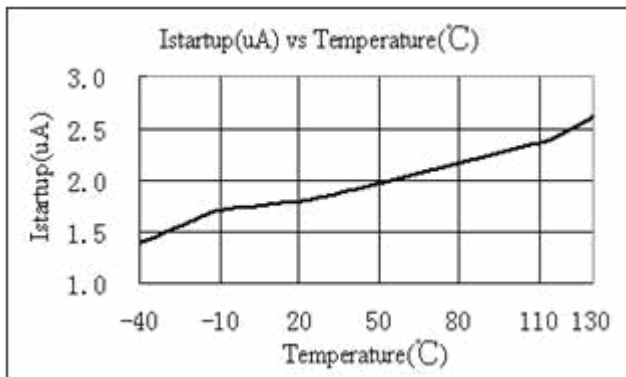
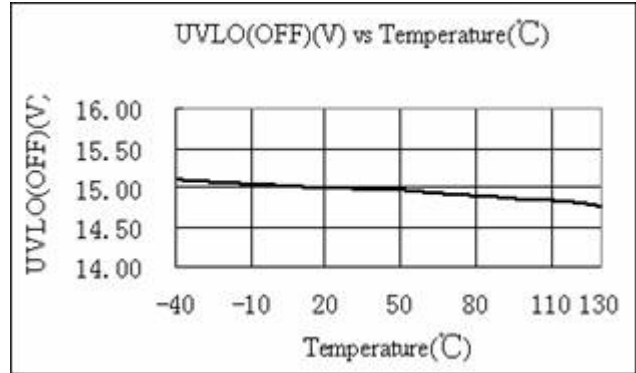
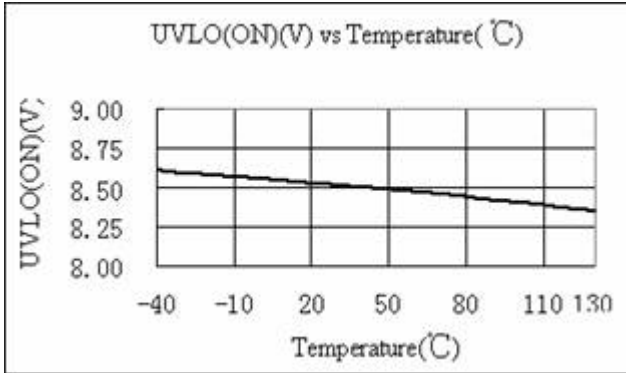


## ELECTRICAL CHARACTERISTICS

(T<sub>A</sub> = 25°C, VDD=VDDG=16V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b>Supply Voltage (VDD) Section</b>						
I <sub>DD ST</sub>	Standby Current	VDD=13.5V		5	10	uA
I <sub>DD op</sub>	Operation Current	Operation supply current INV=1.25V, CS=0V, VDD=VDDG=20V	-	1.0	2.0	mA
UVLO(ON)	VDD Under Voltage Lockout Enter		7.5	8.5	9.5	V
UVLO(OFF)	VDD Under Voltage Lockout Exit		14.0	15	16.0	V
V <sub>DD_clamp</sub>	I <sub>DD</sub> =10mA			38		V
<b>Current Sense Input Section</b>						
T <sub>LEB</sub>	LEB time			540		ns
V <sub>th_oc</sub>	V <sub>th_OC</sub> test		780	820	860	mV
T <sub>d_oc</sub>	Propagation delay			110		ns
Z <sub>SENSE_IN</sub>	Input Impedance			50		Kohm
T <sub>SS</sub>	Soft start time			4		ms
<b>CV Section</b>						
Freq	Normal mode frequency		45	50	55	KHz
Freq_Burst	Burst Mode Base Frequency			22		KHz
Δf/Freq	Frequency shuffling range			+/-4		%
<b>CC Section</b>						
Freq	Oscillation Frequency	Minimum frequency		12		KHz
		Maximum frequency		50		KHz
<b>Error Amplifier section</b>						
V <sub>ref_EA</sub>	Reference voltage for EA		1.21	1.25	1.29	V
G <sub>dc</sub>	DC gain of the EA			50		dB
GBW	Unity gain bandwidth			37.5		kHz
<b>Power MOSFET Section</b>						
BV <sub>dss</sub>	MOSFET Off-state Drain- Source Breakdown		600			V
R <sub>dson</sub>	Static, I <sub>d</sub> =0.9A			4.4	5.5	Ω

**CHARACTERIZATION PLOTS**



## OPERATION DESCRIPTION

OB2216 is cost effective PWM power switch optimized for off-line low power AC/DC applications including battery chargers and adaptors. It operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. Proprietary CC control and built-in error amplifier can achieve a good CC/CV performance.

### ● Startup Current and Start up Control

Startup current of OB2216 is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

### ● Operating Current

The Operating current of OB2216 is as low as 1mA. Good efficiency is achieved with the low operating current together with 'Extended burst mode' control features.

### ● Soft Start

OB2216 features an internal 4ms soft start to minimize the component electrical over-stress during power on startup. As soon as VDD reaches UVLO(OFF), the control algorithm will ramp peak current voltage threshold gradually from nearly zero to normal setting of 0.82V. Every restart is a soft start.

### ● CC/CV Operation

OB2216 is designed to produce good CC/CV control characteristic as shown in the Fig. 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.

In an AC/DC adapter, the normal operation occurs only on the 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.

To support OB2216 proprietary CC/CV control, system needs to be designed in DCM mode for flyback system. Under normal operation, when INV is less than Vref, the system works in CC control, Otherwise, the system works in CV control.

### ● Error Amplifier (EA)

Connected to a resistor divider from the primary side sensing winding, the inverting input of the Error Amplifier (EA) is compared to an internal reference

voltage of 1.25V to regulate the output voltage. The EA output is internally connected to the PWM generator and controls the duty cycle.

### ● Adjustable CC point and Output Power

In OB2216, the CC point and output power can be externally adjusted by external current sense resistor  $R_s$  at CS pin. The output power is adjusted through CC point change. The larger  $R_s$ , the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Fig.2.

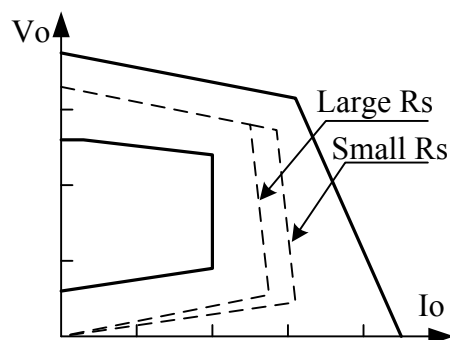


Fig. 2 Adjustable output power by changing  $R_s$

### ● Extended Burst Mode Operation

At light load or zero load condition, most of the power dissipation in a switching mode power supply is from switching loss, the core loss of the transformer and the loss on the snubber circuit. The magnitude of power loss is in proportion to the switching frequency. Lower switching frequency leads to the reduction on the power loss and thus conserves the energy.

OB2216 self adjusts the switching frequency according to the loading condition. The switch frequency is reduced at light/no load condition to improve the conversion efficiency. At light load/no load condition, the output of the Error amplifier (EA) drops below the burst mode threshold level and device enters Burst Mode control. The frequency control also eliminates the audio noise at any loading conditions.

### ● Operation switching frequency

The switching frequency of OB2216 is adaptively controlled according to CC/CV operation. No external frequency setting components are required.

- **Frequency shuffling for EMI improvement**

The frequency Shuffling (switching frequency modulation) is implemented in OB2216. The oscillation frequency is modulated so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore eases the system design.

- **Current Sensing and Leading Edge Blanking**

Cycle-by-Cycle current limiting is offered in OB2216 current mode PWM control. 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 internal power MOSFET on state so that the external RC filtering on sense input is no longer needed. The PWM duty cycle is determined by the current sense input voltage and the EA output voltage.

- **Adjustable Drive Capability**

The internal power MOSFET in OB2216 is driven by a dedicated gate driver for power switch control. Too weak the gate drive strength results in higher conduction and switch loss of MOSFET while too strong gate drive compromises EMI.

A good tradeoff is achieved through the built-in totem pole gate design with right output strength control. The gate drive strength can be adjusted externally by a resistor connected between VDD and VDDG. The low idle loss and good EMI system design is possible with this dedicated control scheme.

- **Protection Control**

Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD protection and clamp, Power on Soft Start, and Under Voltage Lockout on VDD (UVLO).

VDD is supplied by transformer auxiliary winding output. The output of OB2216 is shut down when VDD drops below UVLO(ON) limit and Switcher enters power on start-up sequence thereafter.