

### GENERAL DESCRIPTION

OB2352 combines a dedicated current mode PWM controller with a high voltage power MOSFET. It is optimized for high performance, low standby power, and cost effective off-line flyback converter applications in sub 15W range.

OB2352 offers complete protection coverage with automatic self-recovery feature including Cycle-by-Cycle current limiting (OCP), over load protection (OLP), VDD over voltage clamp and under voltage lockout (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.

The tone energy at below 20KHZ is minimized in the design and audio noise is eliminated during operation. OB2352 is offered in DIP8 package.

### FEATURES

- Power on Soft Start Reducing MOSFET Vds Stress
- Frequency shuffling for EMI
- Extended Burst Mode Control For Improved Efficiency and Minimum Standby Power Design
- Audio Noise Free Operation

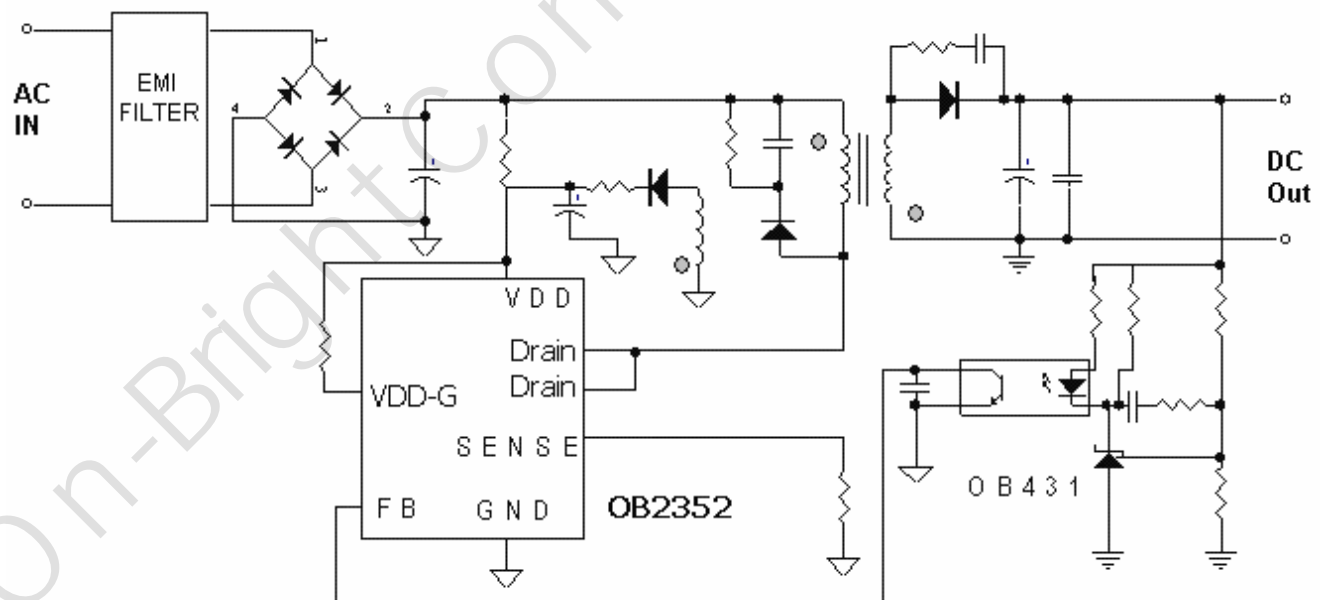
- Fixed 50KHZ Switching Frequency
- Internal Synchronized Slope Compensation
- Low VDD Startup Current and Low Operating Current
- Leading Edge Blanking on Current Sense Input
- Good Protection Coverage With Auto Self-Recovery
  - VDD Over Voltage Clamp and Under Voltage Lockout with Hysteresis (UVLO)
  - On-Bright Proprietary Line Input Compensated Cycle-by-Cycle Over-current Threshold Setting For Constant Output Power Limiting Over Universal Input Voltage Range.
  - Overload Protection (OLP).
  - Over voltage Protection(OVP)

### APPLICATIONS

Offline AC/DC flyback converter for

- Battery Charger
- PDA power supply
- Digital Cameras and Camcorder Adaptor
- VCR, SVR, STB, DVD&DVCD Player SMPS
- Set-Top Box Power
- Auxiliary Power Supply for PC and Server
- Open-frame SMPS

### TYPICAL APPLICATION



### Output Power Table

Product	230VAC±15%	85-265VAC
	Open Frame <sup>1</sup>	Open Frame <sup>1</sup>
OB2352	16W	12W

#### Notes:

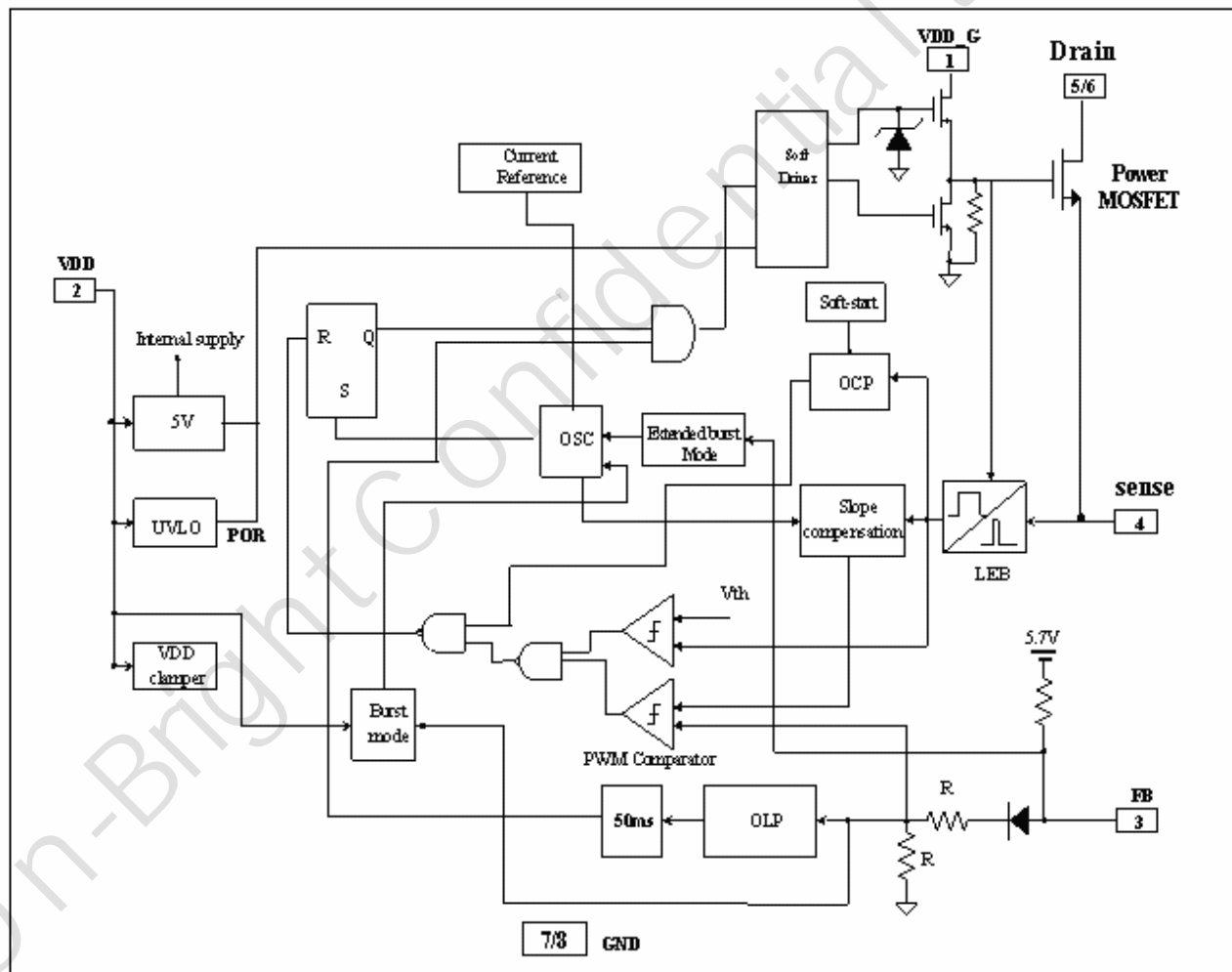
1. Maximum practical continuous power in an open frame design with sufficient drain pattern as a heat sink, at 50°C ambient.

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## TERMINAL ASSIGNMENTS

Pin Name	I/O	Description
GND	P	Ground
FB	I	Feedback input pin. The PWM duty cycle is determined by voltage level into this pin and the current-sense signal at Pin 4.
VDD-G	P	Internal Gate Driver Power Supply
SENSE	I	Current sense input
VDD	P	IC DC power supply Input
Drain	O	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer

## BLOCK DIAGRAM



## ELECTRICAL CHARACTERISTICS

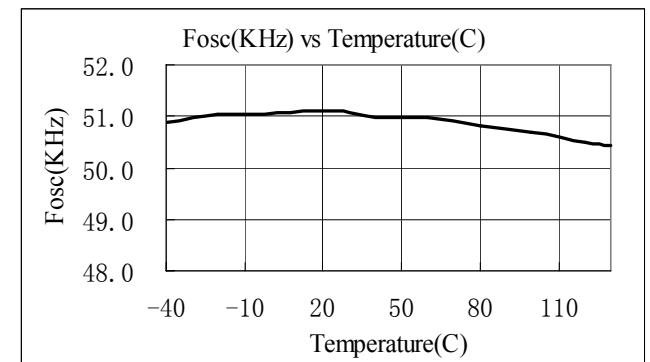
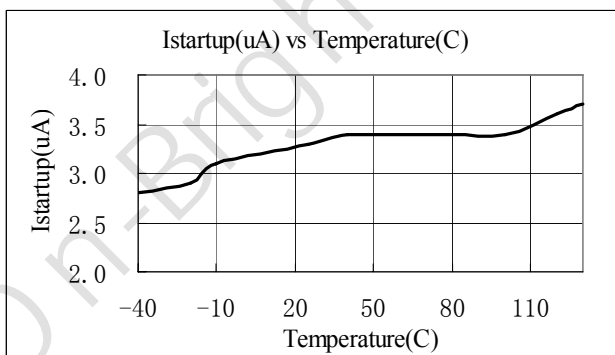
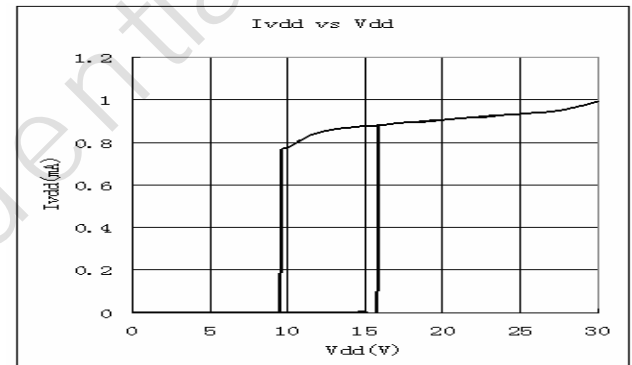
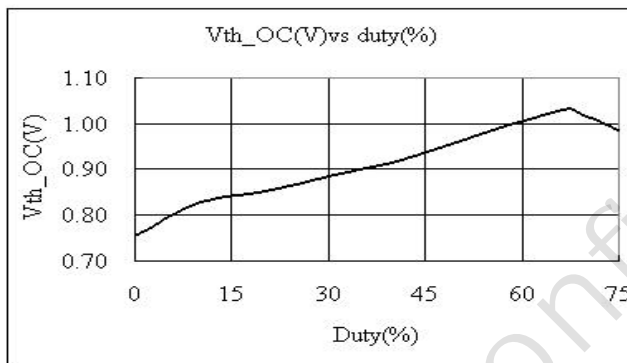
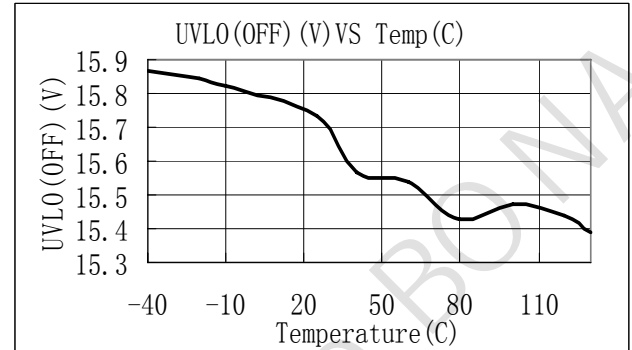
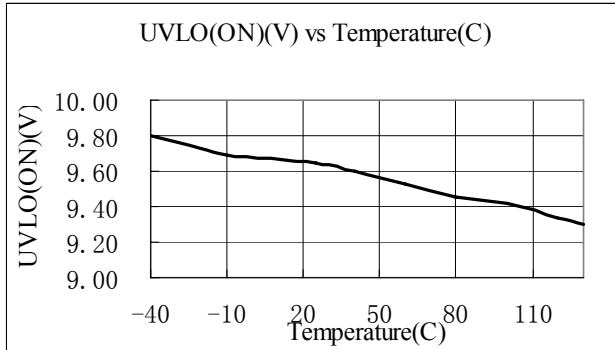
(T<sub>A</sub> = 25°C, VDD=16V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b>Supply Voltage (VDD)</b>						
I <sub>startup</sub>	VDD Start up Current	VDD=14.5V, Measure Leakage current into VDD		5	20	uA
I <sub>VDD_Operation</sub>	Operation Current	V <sub>FB</sub> =3V		1.6		mA
UVLO(ON)	VDD Under Voltage Lockout Enter		8.7	9.7	10.7	V
UVLO(OFF)	VDD Under Voltage Lockout Exit (Recovery)		14.6	15.8	17.0	V
OVP(ON)	Over voltage protection voltage	CS=0V,FB=3V Ramp up VDD until gate clock is off	27.0	28.5	30.0	V
VDD_Clamp	VDD Zener Clamp Voltage	I <sub>DD</sub> = 10 mA		30		V
<b>Feedback Input Section(FB Pin)</b>						
V <sub>FB_Open</sub>	V <sub>FB</sub> Open Loop Voltage		5.4	5.7	6.0	V
I <sub>FB_Short</sub>	FB pin short circuit current	Short FB pin to GND and measure current		1.45		mA
V <sub>TH_0D</sub>	Zero Duty Cycle FB Threshold Voltage			0.8		V
V <sub>TH_PL</sub>	Power Limiting FB Threshold Voltage			3.7		V
T <sub>D_PL</sub>	Power limiting Debounce Time			50		mSec
Z <sub>FB_IN</sub>	Input Impedance			4		Kohm
<b>Current Sense Input(Sense Pin)</b>						
Soft start time				4		ms
T <sub>blanking</sub>	Leading edge blanking time			270		ns
Z <sub>SENSE_IN</sub>	Input Impedance			40		Kohm
T <sub>D_OC</sub>	Over Current Detection and Control Delay	From Over Current Occurs till the Gatedrive output start to turn off		120		nSec
V <sub>TH_OC</sub>	Internal Current Limiting Threshold Voltage	FB=3.3V	0.72	0.77	0.82	V
<b>Oscillator</b>						
F <sub>OSC</sub>	Normal Oscillation Frequency		45	50	55	KHZ
Δf_Temp	Frequency Temperature Stability			5		%

$\Delta f\_VDD$	Frequency Voltage Stability			5		%
D_max	Maximum duty cycle	FB=3.3V, CS =0V	70	80	90	%
F_Burst	Burst Mode Base Frequency			22		KHZ
<b>Mosfet Section</b>						
BVdss	MOSFET Drain-Source Breakdown Voltage		650			V
RDS(on)	Static Drain to Source On Resistance			12	15	$\Omega$
<b>Frequency Shuffling</b>						
$\Delta f\_OSC$	Frequency Modulation range /Base frequency		-4		4	%

## CHARACTERIZATION PLOTS

(The characteristic graphs are normalized at Ta=25°C)



## OPERATION DESCRIPTION

The OB2352 is a low power off-line SMPS Switcher optimized for off-line flyback converter applications in sub 15W power range. The 'Extended burst mode' control greatly reduces the standby power consumption and helps the design easily to meet the international power conservation requirements.

- **Startup Current and Start up Control**

Startup current of OB2352 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. For AC/DC adaptor with universal input range design, a 2 MΩ, 1/8 W startup resistor could be used together with a VDD capacitor to provide a fast startup and yet low power dissipation design solution.

- **Operating Current**

The Operating current of OB2352 is low at 2mA. Good efficiency is achieved with OB2352 low operating current together with the 'Extended burst mode' control features.

- **Soft Start**

OB2352 features an internal 4ms soft start to soften the electrical stress occurring in the power supply during startup. It is activated during the power on sequence. As soon as VDD reaches UVLO(OFF), the peak current is gradually increased from nearly zero to the maximum level of 0.77V. Every restart up is followed by a soft start.

- **Frequency shuffling for EMI improvement**

The frequency Shuffling (switching frequency modulation) is implemented in OB2352. 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.

- **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 on the mosfet, 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.

The switching frequency is internally adjusted at no load or light load condition. The switch frequency reduces at light/no load condition to improve the conversion efficiency. At light load or no load condition, the FB input drops below burst mode threshold level and device enters Burst Mode control. The Gate drive output switches only when VDD voltage drops below a preset level and FB input is active to output an on state. Otherwise the gate drive remains at off state to minimize the switching loss and reduces the standby power consumption to the greatest extend.

The switching frequency control also eliminates the audio noise at any loading conditions.

- **Oscillator Operation**

The switching frequency of OB2352 is internally fixed at 50KHZ. No external frequency setting components are required for PCB design simplification.

- **Current Sensing and Leading Edge Blanking**

Cycle-by-Cycle current limiting is offered in OB2352 current mode PWM control. The switch current is detected by a sense resistor into the sense pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial internal power MOSFET on state due to snubber diode reverse recovery and surge gate current of internal power MOSFET so that the external RC filtering on sense input is no longer needed. The current limiting comparator is disabled and cannot turn off the internal power MOSFET during the blanking period. The PWM duty cycle is determined by the current sense input voltage and the FB input voltage.

- **Internal Synchronized Slope Compensation**

Built-in slope compensation circuit adds voltage ramp onto the current sense input voltage for PWM generation. This greatly improves the close loop stability at CCM and prevents the sub-harmonic oscillation and thus reduces the output ripple voltage.

- **Drive**

The internal power MOSFET in OB2352 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 results the compromise of EMI.

A good tradeoff is achieved through the built-in totem pole gate design with right output strength and dead time control. The low idle loss and good EMI system design is easier to achieve with this dedicated control scheme.

In addition to the gate drive control scheme mentioned, the gate drive strength can also be adjusted externally by a resistor connected between VDD and VDDG, the falling edge of the Drain output can be well controlled. It provides great flexibility for system EMI design.

- **Protection Controls**

Good power supply system reliability is achieved with its rich protection features including Cycle-by-

Cycle current limiting (OCP), Over Load Protection (OLP) and over voltage clamp, Under Voltage Lockout on VDD (UVLO).

With On-Bright Proprietary technology, the OCP is line voltage compensated to achieve constant output power limit over the universal input voltage range.

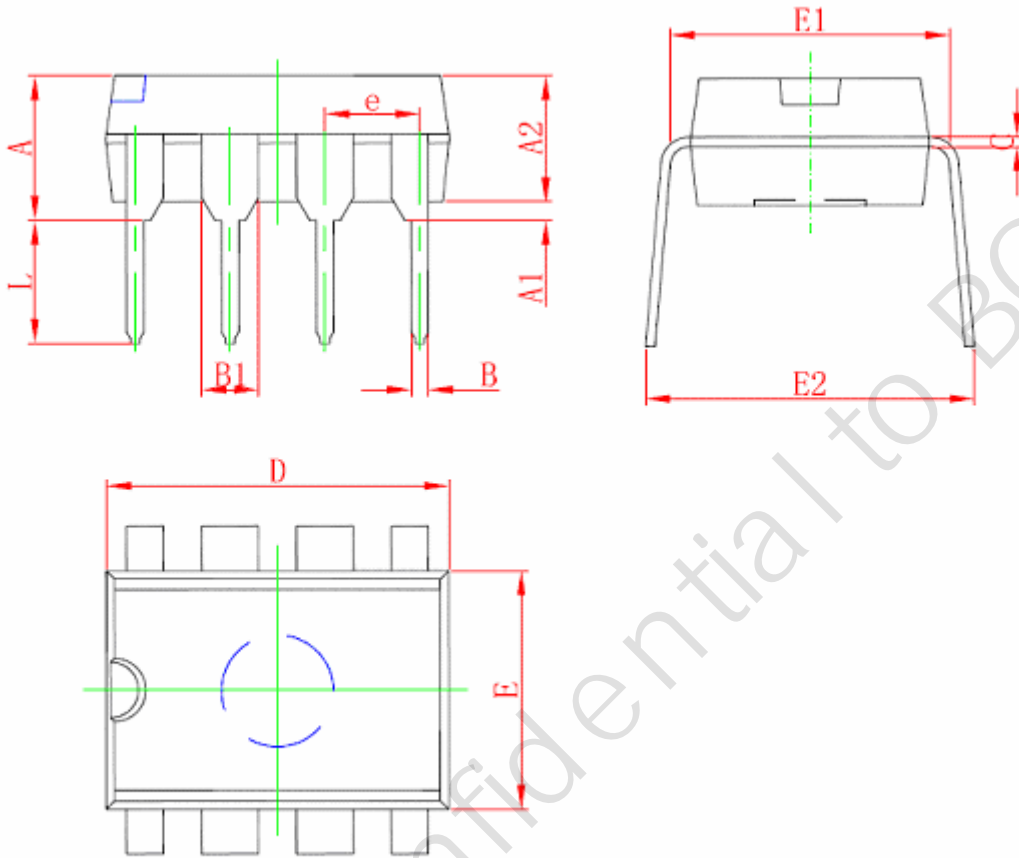
At overload condition when FB input voltage exceeds power limit threshold value for more than TD\_PL, control circuit reacts to shut down the switcher. Switcher restarts when VDD voltage drops below UVLO limit.

VDD is supplied by transformer auxiliary winding output. It is clamped when VDD is higher than 30V. The output of OB2352 is shut down when VDD drops below UVLO\_ON limit and Switcher enters power on start-up sequence thereafter.



## PACKAGE MECHANICAL DATA

### 8-Pin Plastic DIP



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.500		0.020	
A2	3.200	3.600	0.126	0.142
B	0.350	0.650	0.014	0.026
B1	1.524 (BSC)		0.060 (BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.500	0.354	0.374
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540 (BSC)		0.100 (BSC)	
L	3.000	3.600	0.118	0.142
E2	8.200	9.000	0.323	0.354

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