

GENERAL DESCRIPTION

OB3398Ex is a primary side regulation off-line LED lighting power switch which can achieve accurate LED current. It significantly simplifies LED lighting system design by eliminating the secondary side feedback circuitry. Proprietary Constant Voltage (CV) and Constant Current (CC) control is integrated as shown in the figure below. The LED current (CC control) can be adjusted externally by the resistor R_s at CS pin.

OB3398Ex offers comprehensive protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD clamp and UVLO.

OB3398Ex is offered in DIP8/SOP7 package.

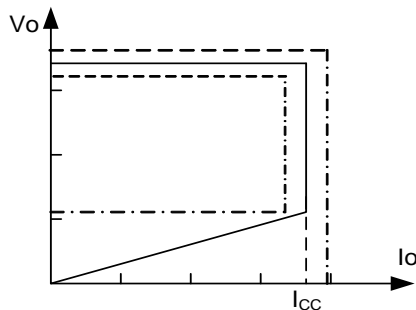


Fig.1. Typical CC/CV Curve

FEATURES

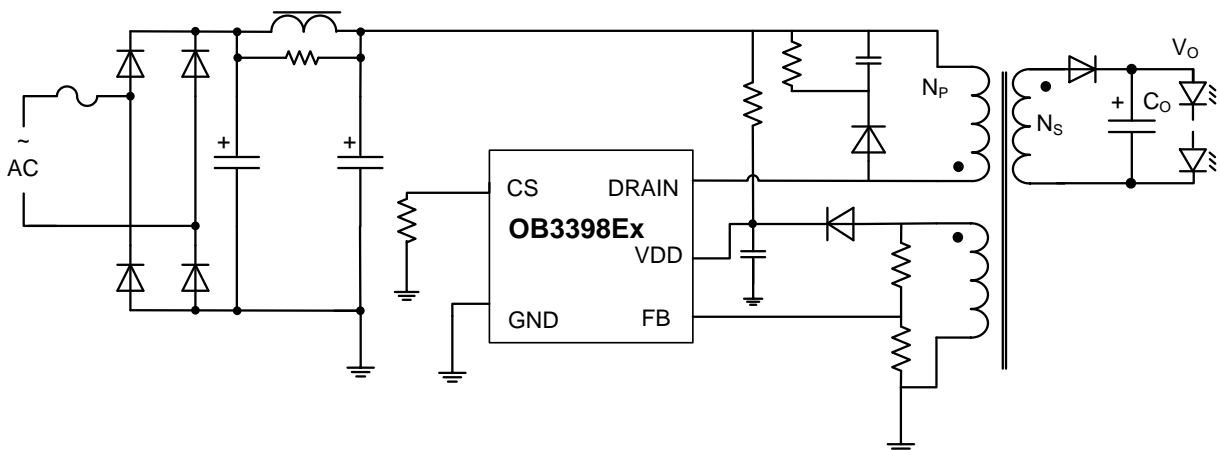
- High Precise Constant Current Regulation at Universal AC input
- Primary-side Sensing and Regulation Without TL431 and Opto-coupler
- HV MOSFET integrated
- Floating PSR control scheme with two transformer windings
- Adjustable Constant Current and Output Power Setting
- Built-in Primary winding inductance compensation
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis (UVLO)
- Latched over temperature protection (OTP)
- VDD Clamp

APPLICATIONS

Low Power AC/DC offline SMPS for

- LED applications

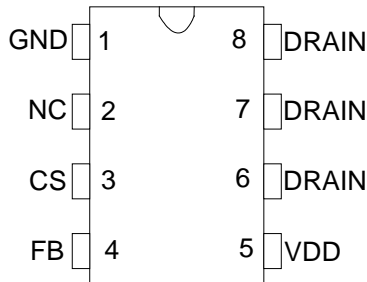
TYPICAL APPLICATION



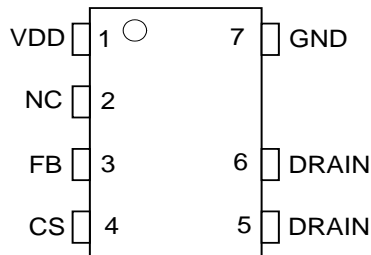
GENERAL INFORMATION

Pin Configuration

The pin map is shown as below for DIP8.



The pin map is shown as below for SOP7.



Ordering Information

Part Number	Description
OB3398ENJP	SOP7, Halogen-free, Tube
OB3398ENJPA	SOP7, Halogen-free, T&R
OB3398EPJP-H	SOP7, Halogen-free, Tube
OB3398EPJPA-H	SOP7, Halogen-free, T&R
OB3398ETJP-H	SOP7, Halogen-free, Tube
OB3398ETJPA-H	SOP7, Halogen-free, T&R
OB3398EPAP-H	DIP8, Halogen-free, Tube
OB3398ETAP-H	DIP8, Halogen-free, Tube
OB3398EVAP-H	DIP8, Halogen-free, Tube

Package Dissipation Rating

Package	RθJA (°C/W)
DIP8	75
SOP7	95

Absolute Maximum Ratings

Parameter	Value
Drain Voltage	-0.3 to BVdss
VDD Voltage	-0.3 to V _{DD_clamp}
CS Input Voltage	-0.3 to 7V
FB Input Voltage	-0.3 to 7V
Min/Max Operating Junction Temperature T _J	-40 to 150 °C
Operating Temperature T _A Ambient	-40 to 85 °C
Min/Max Storage Temperature T _{stg}	-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.

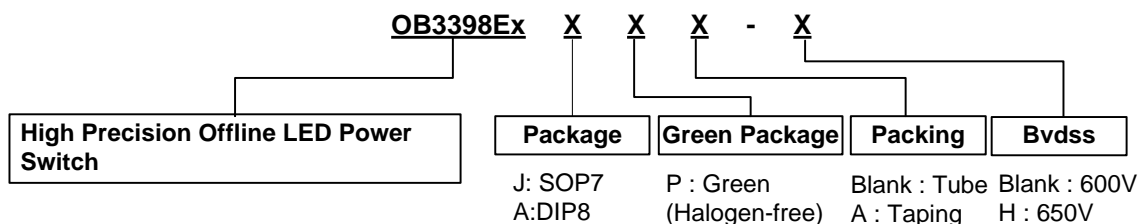
Output Power Table

Product	90Vac~264Vac Input	220Vac±20% Input
OB3398ENJP	7.7W	12.4W
OB3398EPJP-H	13.9W	21W
OB3398ETJP-H	15W	24W
OB3398EPAP-H	15.8W	28W
OB3398ETAP-H	20.6W	30.2W
OB3398EVAP-H	23.7W	33.8W

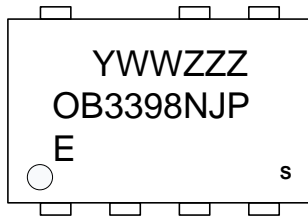
Note: Maximum practical continuous power in an open frame design with sufficient drain pattern as a heat sink, at 50°C ambient and 60°C temperature rise. Higher output power is possible with extra added heat sink, air circulation and decrease output current to reduce thermal resistance

Recommended Operating Condition

Symbol	Parameter	Range
VDD	VDD Supply Voltage	12 to 25 V



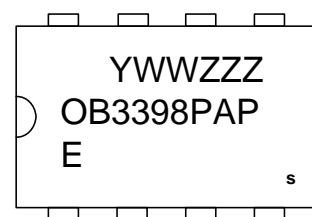
Marking Information



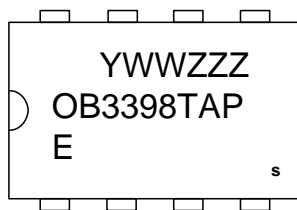
Y:Year Code
 WW:Week Code(01-52)
 ZZZ:Lot Code
 J:SOP7 Package
 P:Green Package(Halogen-free)
 E:Character Code
 S:Internal Code(Optional)



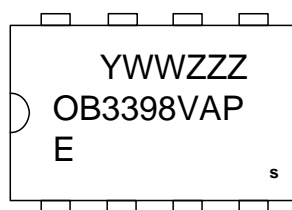
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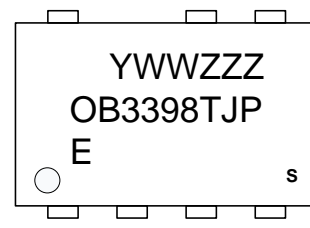
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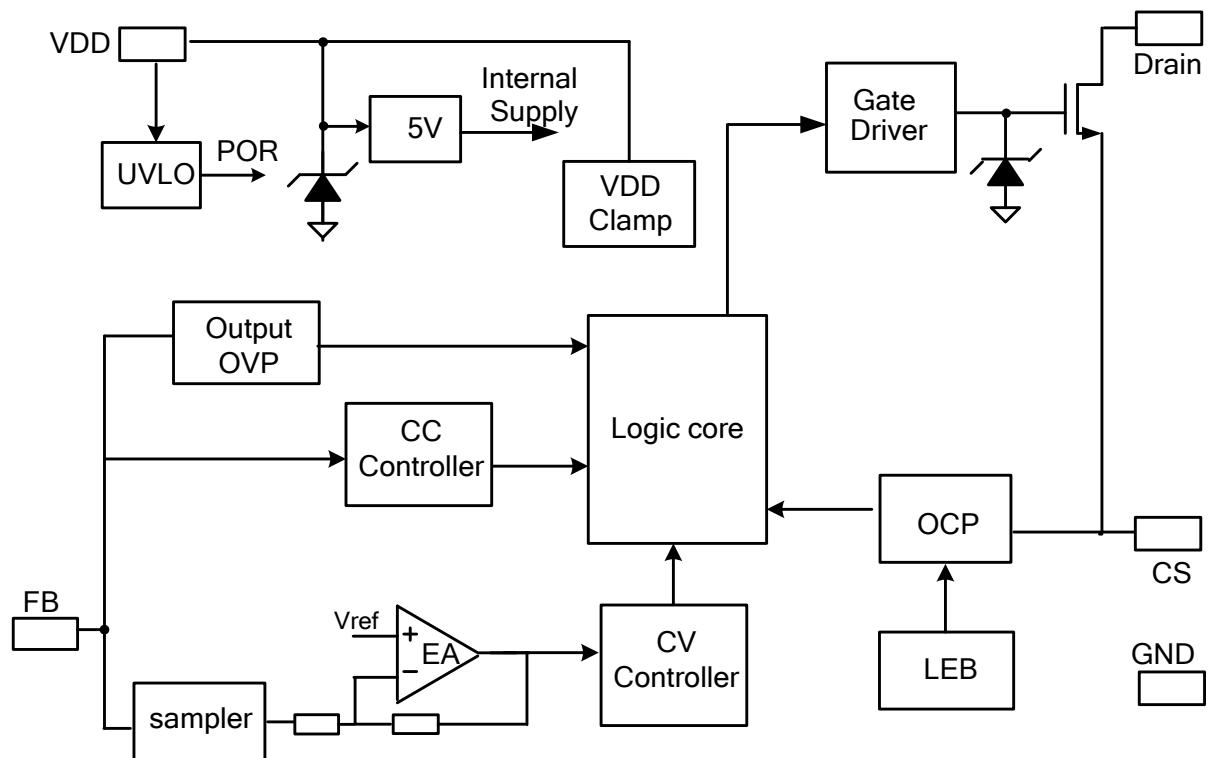
TERMINAL ASSIGNMENTS for OB3398EPAP

Pin Num	Pin Name	I/O	Description
1	GND	P	Ground
2	NC		No connect
3	CS	I	Current sense input.
4	FB	I	Connected to resistor divider from primary winding or auxiliary winding to reflect output voltage.
5	VDD	P	Power Supply
6,7,8	Drain	O	Drain of internal power MOSFET

TERMINAL ASSIGNMENTS for OB3398ENJP& OB3398EPJP& OB3398ETJP

Pin Num	Pin Name	I/O	Description
1	VDD	P	Power Supply
2	NC		No connect
3	FB	I	Connected to resistor divider from primary winding or auxiliary winding to reflect output voltage.
4	CS	I	Current sense input.
5,6	Drain	O	Drain of internal power MOSFET
7	GND	P	Ground

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

(TA = 25°C, VDD=16V, if not otherwise noted)

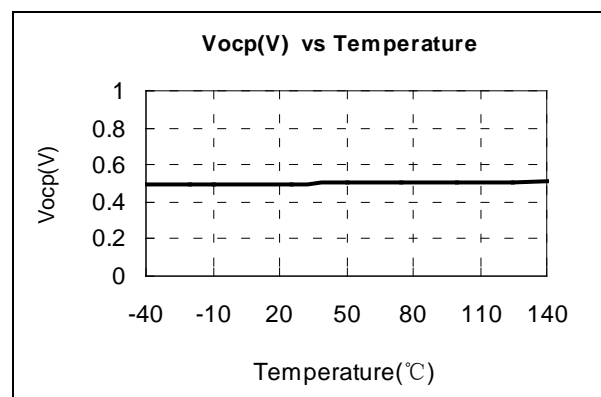
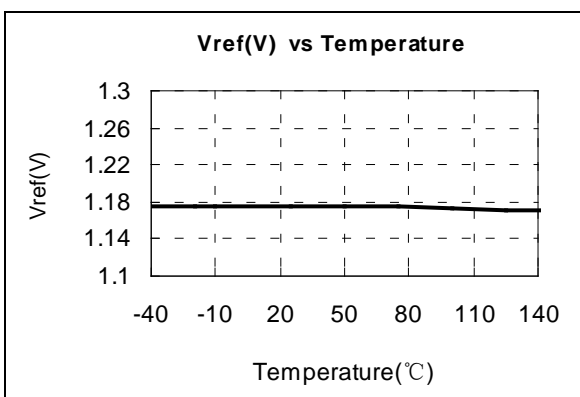
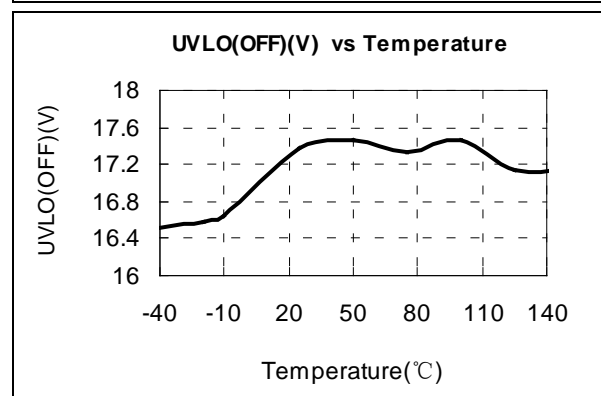
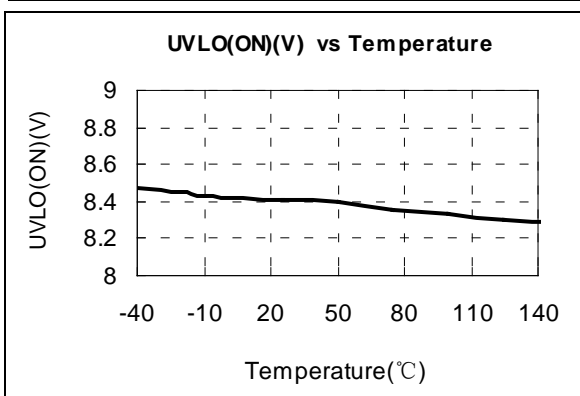
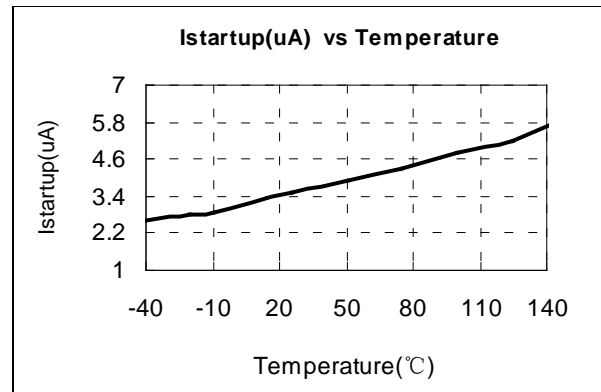
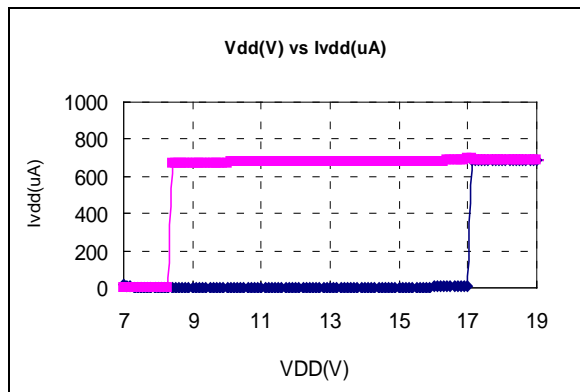
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
I _{startup}	Startup Current	VDD=UVLO_OFF-1V		4	20	uA
I _{DD op}	Operation Current	Operation supply current FB=1V, CS=0V, VDD= 20V		0.45	1	mA
UVLO(ON)	VDD Under Voltage Lockout Enter	VDD falling	7.3	8.3	9.3	V
UVLO(OFF)	VDD Under Voltage Lockout Exit	VDD rising	15.5	16.5	17.5	V
V _{DD_clamp}	Maximum VDD operation voltage	I _{DD} =20mA		25		V
Current Sense Input Section						
TLEB	LEB time			500		ns
V _{th_oc}	Over current threshold		492	500	508	mV
T _{d_oc}	OCP Propagation delay			100		ns
Frequency Section						
Freq_Max ^{Note}	IC Maximum frequency		103			KHz
T _{off_min}	Minimum Toff			4.0		us
F _{min}	Minimum frequency			103		Hz
Error Amplifier section						
V _{ref_EA}	Reference voltage for EA		1.14	1.2	1.26	V
Gain	DC gain of EA			40		
V _{th_OVP}	Load OVP threshold voltage			1.4		V
On chip Over temperature Section						
T _{otp}	latched over temperature protection trigger point			155		°C

Product	Parameter	BVdss(V) MOSFET Drain-Source Breakdown Voltage		
		Min	Typ.	Max
OB3398ENJP		600		
OB3398EPJP-H		650		
OB3398ETJP-H		650		
OB3398EPAP-H		650		
OB3398ETAP-H		650		
OB3398EVAP-H		650		

Note:

Freq_Max indicates IC internal maximum clock frequency. In system application, the maximum operation frequency of 103KHz nominal occurs at maximum output power or the transition point from CV to CC.

CHARACTERIZATION PLOTS



OPERATION DESCRIPTION

OB3398Ex is a cost effective PWM power switch optimized for off-line LED lighting applications. Based on floating flyback converter topology working in DCM mode, it operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. Proprietary built-in CC control can achieve high precision LED current meeting LED lighting application requirements.

Startup Current and Start up Control

Startup current of OB3398Ex 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 OB3398Ex is as low as 0.45mA(Typ.). Typical good efficiency is achieved with the low operating current together with 'Multi-mode' control features.

Principle of CC Operation

To support OB3398Ex proprietary CC control, system needs to be designed in DCM mode for flyback system (Refer to Typical Application Diagram on page1). The LED output current I_{LED} is given by:

$$I_{LED} = \frac{1}{2} L_P \cdot F_{SW} \cdot I_{PK}^2 \cdot \eta / V_O \quad (1)$$

Where L_P indicates the inductance of primary winding, I_{pk} is the peak current of primary winding.

Refer to the equation 1, the change of the primary winding inductance results in the change of the constant output current. To compensate the change from variations of primary winding inductance, the switching frequency is locked by an internal loop such that the switching frequency is

$$F_{SW} = \frac{1}{2T_{Demag}} \quad (2)$$

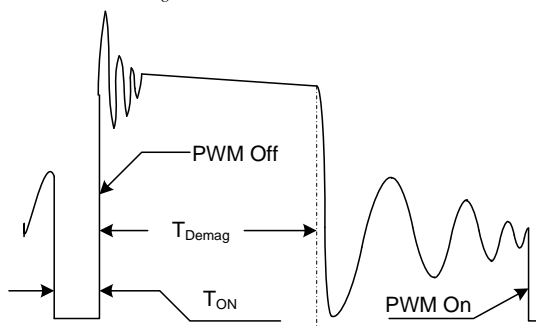


Figure.1 Primary voltage waveform

Since T_{Demag} is inversely proportional to the inductance, as a result, the product L_P and f_{sw} is constant, thus output current will not change as primary winding inductance changes. Up to $\pm 7\%$ variation of the primary winding inductance can be compensated.

The output LED current is

$$I_{LED} = \frac{1}{4} \cdot N \cdot \frac{V_{th-oc}}{R_s} \quad (3)$$

Where N is the ratio of transformer between primary winding and secondary winding.

Adjustable CC point and Output Power

In OB3398Ex, the CC point and maximum output power can be externally adjusted by external current sense resistor R_s at CS pin as illustrated in Typical Application Diagram. 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.

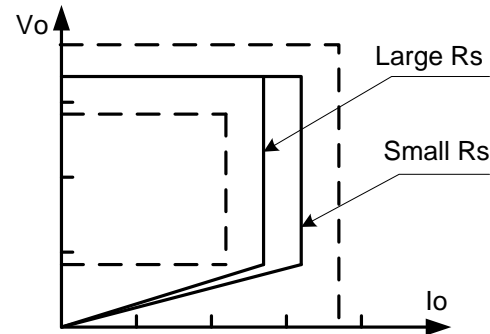


Figure.2 Adjustable output power by changing R_s

Operation switching frequency

The switching frequency of OB3398Ex is adaptively controlled according to the load conditions and the operation modes. No external frequency setting components are required. The operation switching frequency at maximum output power is set to 103K Hz internally.

For flyback operating in DCM, The maximum output power is given by

$$P_{Omax} = \frac{1}{2} \eta L_P F_{SW} I_{pk}^2 \quad (4)$$

Where L_P indicate the inductance of primary winding and I_{pk} is the peak current of primary winding.

The principle of CC operation sets the product L_P and f_{sw} to be a constant, thus the maximum output power and constant current in CC mode will not change as primary winding inductance changes. Up to $\pm 7\%$ variation of the primary winding inductance can be compensated.

CV / OVP Mode

When LED string is open, an output voltage condition is monitored independently by the voltage at FB pin. During normal operation, the voltage at FB pin is regulated at 1.2V (typ.), with dummy load over P_{min}.

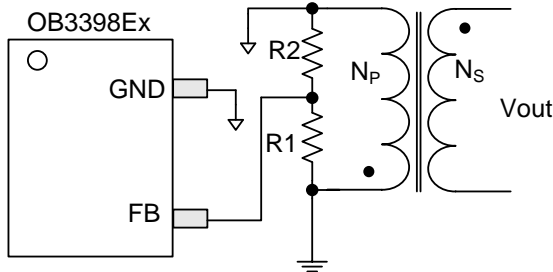


Figure.3 FB Section Circuit

$$V_{OUT} = \frac{N_s}{N_p} \times \frac{R1 + R2}{R2} \times V_{ref_CV}$$

R1 —Resistor connected between the FB pin and the input capacitor GND, the value suggested is 330Kohms~1Mohms

R2 —Resistor connected between the FB pin and the GND pin of IC, the value suggested is 5Kohms~15Kohms

$$P_{min} = \frac{1}{2} \times \left(\frac{V_{th_oc}}{R_{CS}} \right)^2 F_{min} L_{primary}$$

V_{th_oc} — Over current protection threshold voltage

F_{min} — Minimum switching frequency, which is 103Hz (typ.)

If the dummy load is less than P_{min}, the output voltage rises up. If the voltage at FB pin exceeds a threshold of approximately 1.4V (typical), the over-voltage protection function is activated and the switching is turned off immediately.

$$V_{OVP} = \frac{N_s}{N_p} \times \frac{R1 + R2}{R2} \times V_{vth_OVP}$$

CC Line Regulation

Adjust the R1 for better CC line regulation, while driving different type MOSFET. The larger MOSFET, the smaller R1 needed. R1 allow the change from 330K to 1M ohms to cover all the applications. If the resistance is too large, it causes the interference due to the floating ground, too small resistance results the efficiency decreased at HV AC line.

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in OB3398Ex. 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. The PWM duty cycle is determined by the current sense input voltage and the EA output voltage.

Protection Control

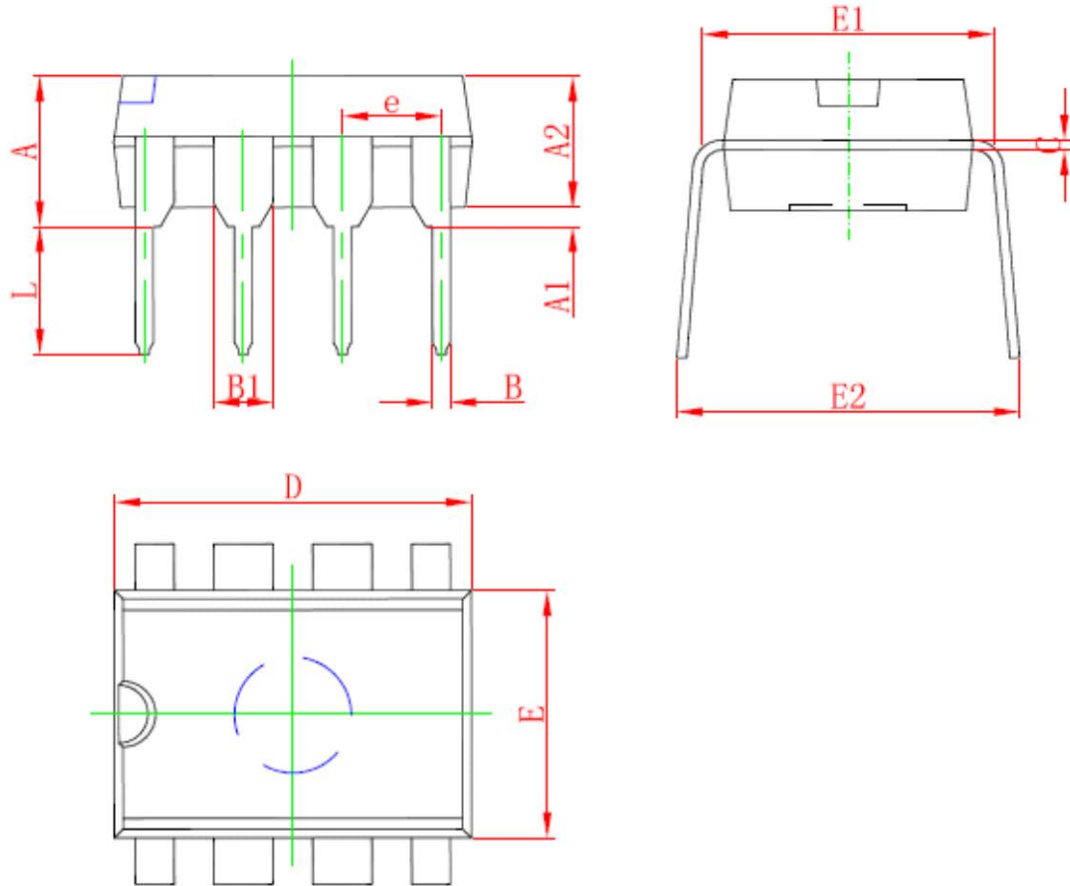
Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD clamp, on-chip OTP, and Under Voltage Lockout on VDD (UVLO).

Over temperature protection is offered in OB3398Ex. When temperature of the device rises over 155°C (typical), the switching frequency will decrease to half. And the state will be kept until the device restarts.

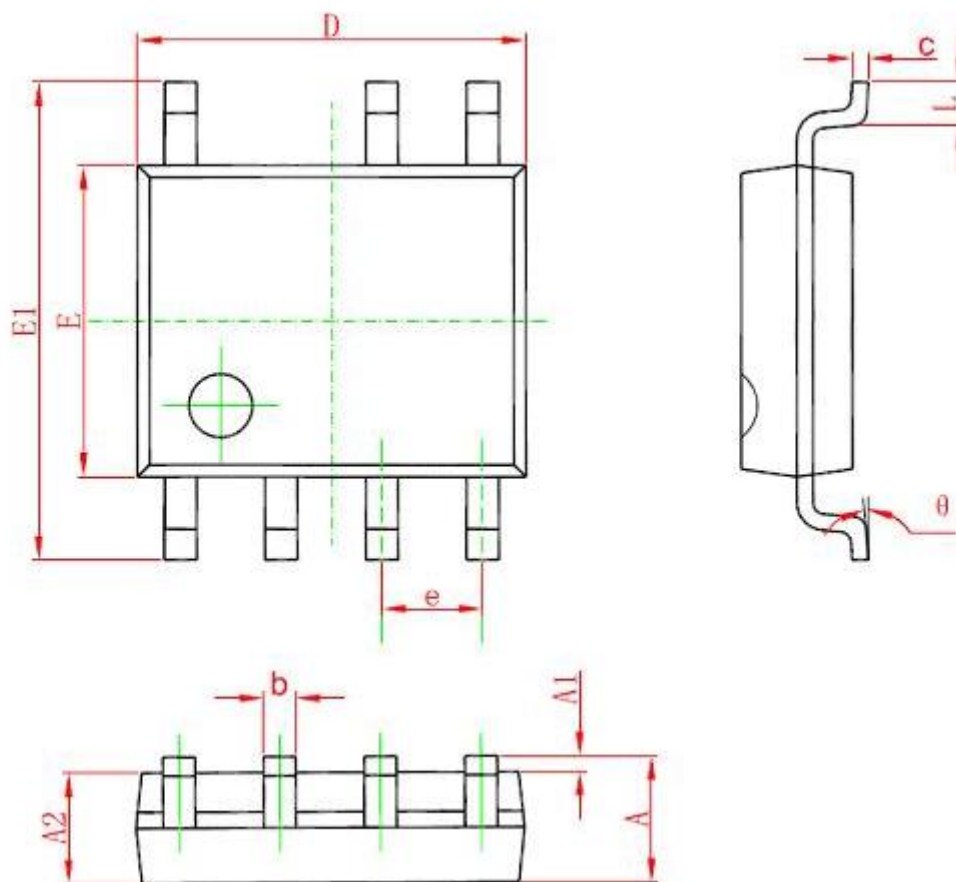
VDD is supplied by transformer primary winding output. The output of OB3398Ex is shut down when VDD drops below UVLO (ON) limit and the power converter enters power on start-up sequence thereafter.

PACKAGE MECHANICAL DATA

DIP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	5.334	0.146	0.210
A1	0.381		0.015	
A2	2.921	4.953	0.115	0.195
B	0.350	0.650	0.014	0.026
B1	1.524 (BSC)		0.06 (BSC)	
C	0.200	0.360	0.008	0.014
D	9.000	10.160	0.354	0.400
E	6.096	7.112	0.240	0.280
E1	7.320	8.255	0.288	0.325
e	2.540 (BSC)		0.1 (BSC)	
L	2.921	3.810	0.115	0.150
E2	7.620	10.920	0.300	0.430

SOP7 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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