Current Mode PWM Controller

Features

- Burst Mode Control
- 6.5uA ultra-low startup current
- 2.3mA Low operating current
- Built-in Leading-edge blanking
- Built-in synchronous slope compensation circuit
- Current Mode Operation
- Soft-start 4ms
- Soft-driver
- Optional latch for OTP、OLP、OVP
- External Programmable over temperature protection
- Cycle by cycle over current protection (OCP)
- Internal OCP compensation
- Optional VDD OVP
- under voltage lockout（UVLO）
- Maximum Gate output voltage clamped at 12V
- Frequency jittering
- Constant Output Power Limit
- Self-recovery over load protection (OLP)
- Audio Noise Free Operation

Applications

Universal switch power supply equipment and offline AC/DC flyback power converter

- Laptop Power Adapter
- Set-Top Box Power Supplies
- Open-frame SMPS
- Battery Charger
- Printer Power

General Description

WS2299 is a high performance current mode PWM controller, optimized for low power AC/DC adapter applications.

For lower the standby power and higher RoHS compliant, the IC offers a Burst Mode control feature and ultra-low start-up current and operating current, that is, at the condition of no load or light load, WS2299 can reduce the switch frequency linearly which minimize the switching power loss; the ultra-low startup current and operating current make a reliable power for startup design, and also large resistor can be used in the startup circuit to improve switching efficiency.

The internal synchronous slope compensation circuit reduces the possible sub-harmonic oscillation at high PWM duty cycle output. Leading-edge blanking on current sense(CS) input removes the signal glitch due to snubber diode circuit reverse recovery and thus greatly reduces the external component count and system cost in the design.

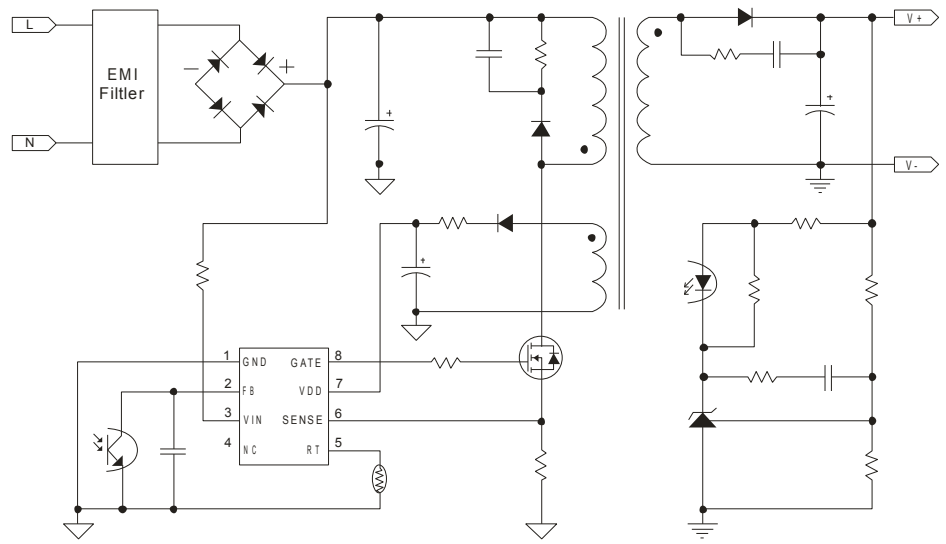
WS2299 offers comprehensive protection coverage with automatic self-recovery feature, including cycle by cycle over current protection (OCP), over load protection (OLP), over temperature protection (OTP), VDD OVP, under voltage lockout (UVLO). The gate-driven output is clamped to maximum 12V to protect the external MOSFET.

In WS2299, OCP threshold slope is internally optimized for 65khz switching frequency application to reach constant output power limit over universal AC input range.

Excellent EMI performance is achieved by using the Soft-switching and frequency jittering 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. The WS2299 is the ideal substitute of the linear power supply or the RCC-mode power, for a better performance of the whole switch power system and a lower cost.

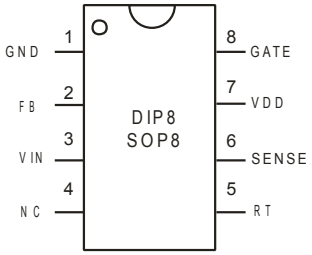
WS2299 is available in SOP8 & DIP8 package.

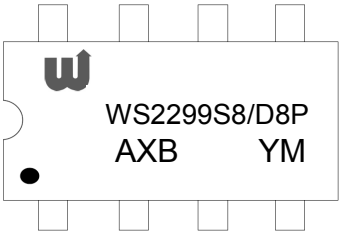
Typical Application Circuit



Pin Definition and Device Marking

WS2299 is available in DIP8 package:



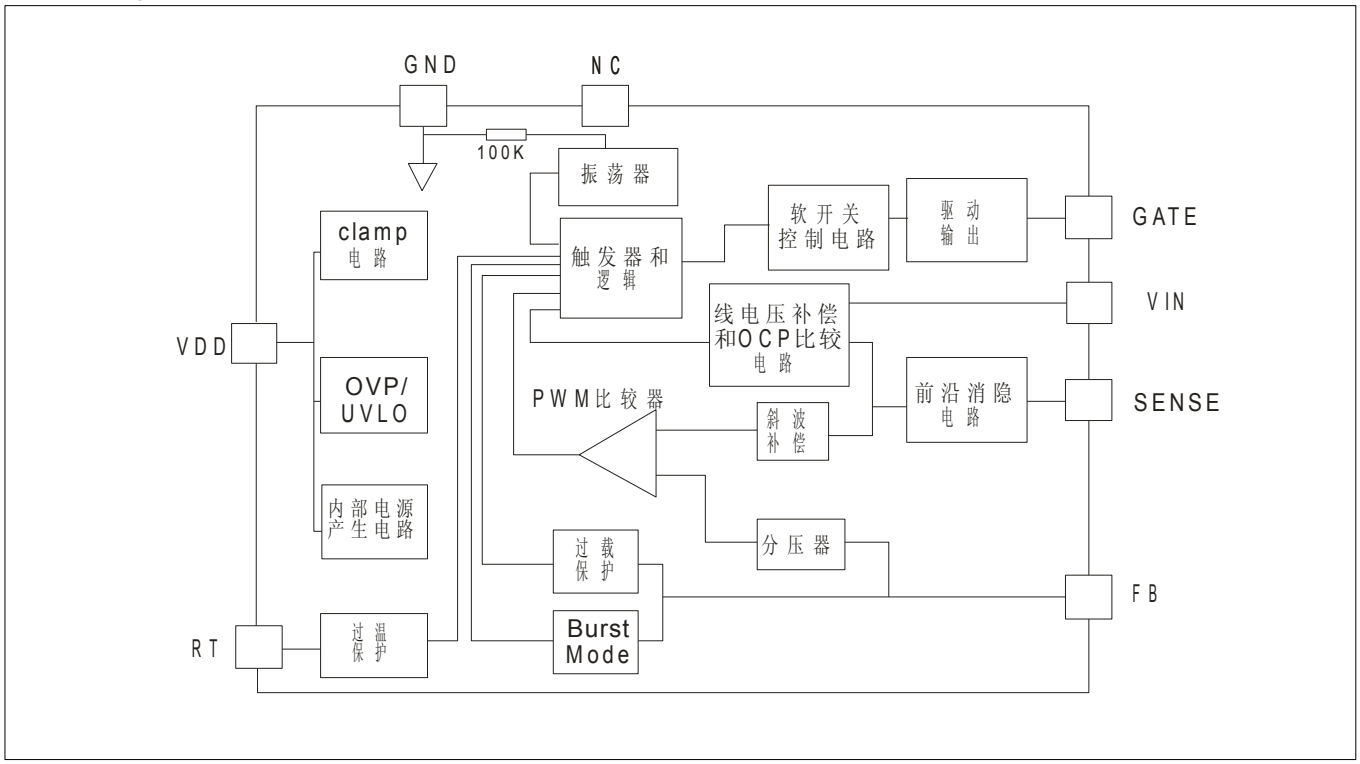


D: DIP8 S: SOP8 P: no Pb
A:wafer information;
1:Ver.;
a: Package Code
2C:Y+M(2=2012 C=12 Month
(1,2…A=10,B=11,C=12)

Pin Function Description

Pin Name	Pin Number	Pin Type	Function Description
GND	1	GND	Ground.
FB	2	Feedback Input	Feedback input pin. The PWM duty cycle is determined by voltage level into this pin and the current-sense signal at Pin 6 The internal protection circuit will automatically shutdown when the FB voltage level exceeds a preset threshold voltage.
VIN	3	Startup Input	Connected through a large value resistor to rectified line input for Startup IC supply and line voltage sensing.
NC	4		
RT	5	OTP Setting	Temperature sensing input pin. Connected through a NTC resistor to GND.
SENSE	6	Current Monitoring	Current sense input. Connected to MOSFET current sensing resistor node.
VDD	7	Power	Power supply
GATE	8	Gate-driven output	Totem-pole gate driver output for power MOSFET.

Block Diagram



Ordering Information

Package	IC Marking Information	Purchasing Device Name
8-Pin DIP8, Pb-free，Have OVP	WS2299D8P	WS2299D8P
8-Pin SOP8, Pb-free，Have OVP	WS2299S8P	WS2299S8P

Recommended Operating Condition

Symbol	Parameter	Value	Unit
VDD	VDD supply voltage	12~23	V
T_A	Operating temperature	-20~85	℃

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
VDD	DC supply voltage	30	V
V_{FB}	FB input voltage	-0.3~7	V
V_{SENSE}	SENSE input voltage	-0.3~7	V
V_{RT}	RT input voltage	-0.3~7	V
T_J	Operating junction temperature	-20~150	℃
T_{STG}	Storage temperature	-55~150	℃
V_{CV}	VDD clamp voltage	36	V
I_{CC}	VDD DC clamp current	10	mA

Note: Stresses above 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 in the Recommended Operating Conditions section are not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

ESD Information

Symbol	Parameter	Value	Unit
$V_{ESD-HBM}$	ESD Capacitor，Human Body Model	3	KV
V_{ESD-MM}	ESD Capacitor，Machine Model	250	V

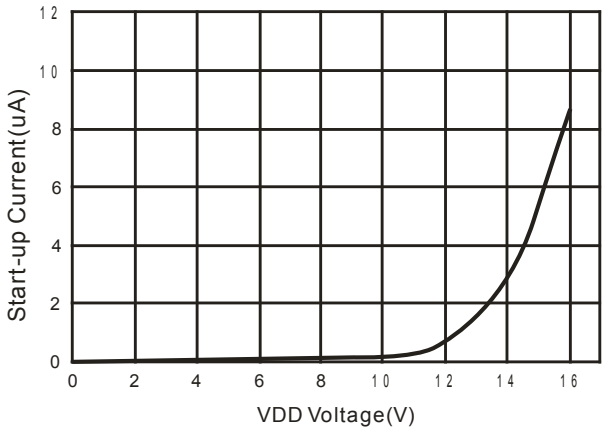
Electrical Characteristics (T_A=25℃，VDD=16V, RI=26Kohm, if not otherwise noted)

symbol	parameter	Conditions	Min	Typ	Max	Unit
I_VDD_Startup	VDD startup current	VDD=15V ， measure current into VDD		6.5	20	uA
I_VDD_Operation	Operation Current	FB=3V		2.3		mA
UVLO(ON)	VDD under voltage lockout enter		9.5	10.5	11.5	V
UVLO(OFF)	VDD under voltage lockout exit		16	17	18.5	V
OVP(ON)	VDD Over Voltage Protection Enter		23.5	25	26.5	V
OVP(OFF)	VDD Over Voltage Protection Exit		21.5	23.2	24.7	V
TD_OVP	OVP Debounce time			80		us
VDD_Clamp	VDD Clamp Voltage	I(V_{DD})=5mA		36		V
Feedback Input Section(FB Pin)						
A_{VCS}	PWM Input Gain	$\Delta V_{FB}/\Delta V_{CS}$		2.6		V/V
VFB_Open	VFB Open Voltage			6		V
I_{FB}_Short	FB pin short current	Short FB pin to GND		0.8		mA
VTH_FM	Green Mode FB Threshold Voltage			2.5		V
VTH_BM	Burst Mode FB Threshold Voltage			1.9		V
VTH_PL	Power Limiting FB Threshold			4.4		V
T_D_PL	Power limiting Debounce Time			80		mSec
Z_{FB}_IN	Input Impedance			7.5		kohm
Current Sense Input(Sense Pin)						
T_blanking	Sense Input Leading Edge Blanking Time			300		nSec
Zsense_IN	Sense Input impedance			39		kohm
TD_OC	Over Current Detection and Control Delay	C_L=1nF at GATE		120		nSec
VTH_OC_0	Current Limiting Threshold at No Compensation	I(VIN)=0uA	0.85	0.9	0.95	V
VTH_OC_1	Current Limiting Threshold at Compensation	I(VIN)=150uA		0.81		V
Oscillator						
Fosc	Normal Oscillation Frequency		60	65	70	khz
Δf_Temp	Frequency Temperature Stability	-20℃ to 100℃		5		%
Δf_VDD	Frequency Voltage Stability	VDD = 12 to 24V		5		%
F_BM	Burst mode Base frequency			22		KHz
DC_max	Maximum Duty Cycle		75	80	85	%
Gate Drive Output						
VOL	Output low level	Io = -20mA			0.3	V
VOH	Output high level	Io = +20mA	11			V
VG_Clamp	Output Clamp Voltage Level	VDD=20V		12		V
T_r	Output rising time	C_{GATE}=1nF		202		ns
T_f	Output falling time	C_{GATE}=1nF		50		ns
Over Temperature Protection						
I_RT	Output Current of RT Pin			70		uA
VTH_OTP	OTP Threshold Voltage		1	1.065	1.13	V
VTH_OTP_off	OTP Recovery Threshold Voltage			1.165		V
TD_OTP	OTP De_bounce Time			100		uSec
V_RT_Open	RT Pin Open Voltage			3.5		V

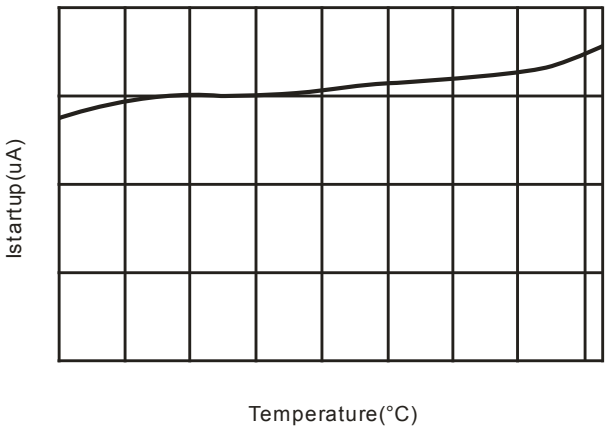
Latch section						
I_VDD_latch	VDD current when latch	VDD=7.2V		35		uA
VDD_latch_release	De-latch voltage		5	6	7	V
Frequency Shuffling						
Δf_OSC	Frequency Modulation range /Base frequency		-3		3	%
Freq_Shuffling	Shuffling Frequency			32		HZ

Typical Operating Characteristics(T_A=25℃， VDD=16V, if not otherwise noted)

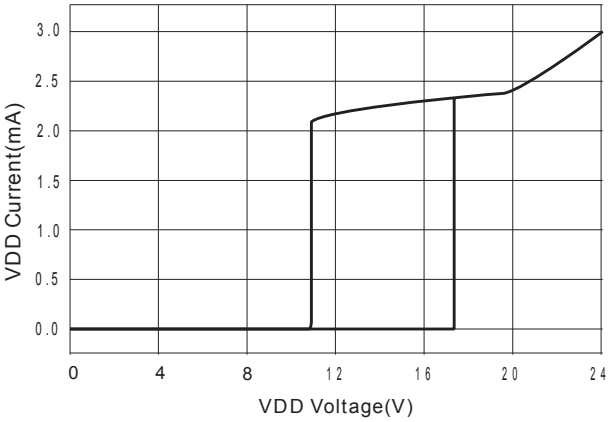
VDD Start Current vs voltage



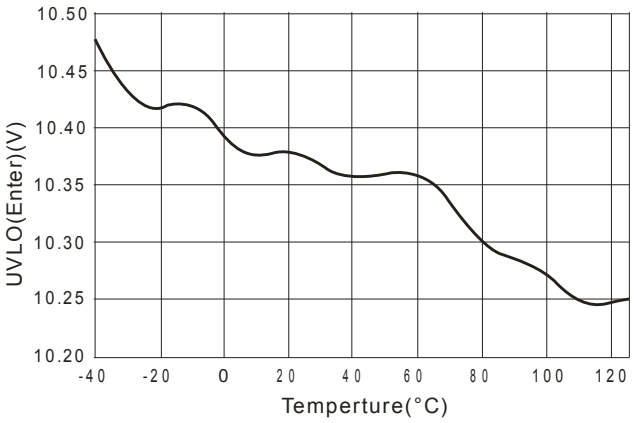
VDD Starup Current vs Temperature



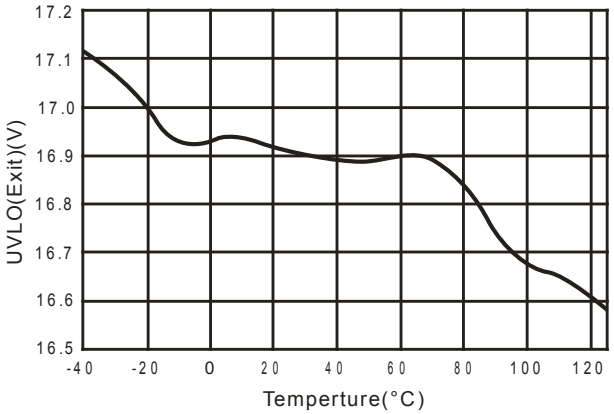
VDD UVLO and Operation Current



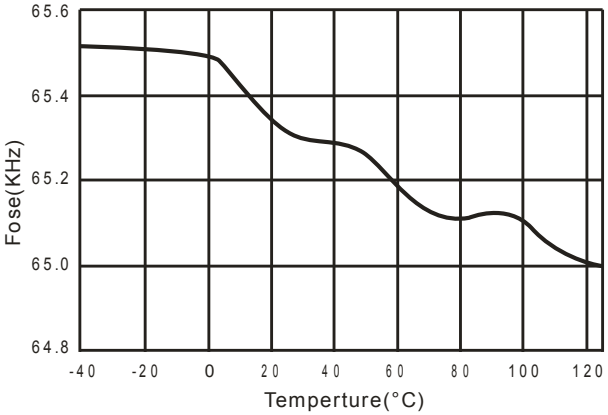
VDD UVLO(Enter)vs Temperture

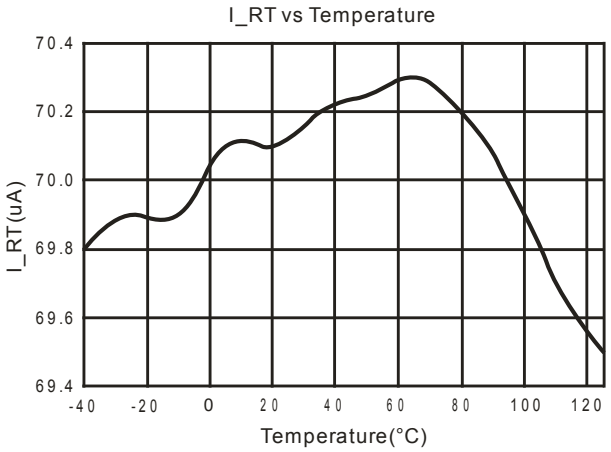


VDD UVLO(Exit)vs Temperture



Fose vs Temperature




I_RT vs Temperature
70.4
70.2
70.0
69.8
69.6
69.4
I_RT(uA)
-40
-20
0
20
40
60
80
100
120
Temperature(°C)

Function Description

WS2299 is a highly integrated, high performance current mode PWM controller, optimized for medium/high power AC/DC converter application, such as laptop power adapter. Ultra low startup current and operating current together with burst mode feature minimize the standby power consumption and improve the switching efficiency. In addition to reduce the external component count, the internal synchronous slope compensation combines with the leading-edge blanking improves system large stability and reduces the possible sub-harmonic oscillation. WS2299 also have multiform general recovery protection mode. The main function is described as below:

Startup Current and Startup Control

Startup current of WS2299 is designed to be extremely low at 6.5uA, 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, predigest the design of startup circuit and provides reliable startup in application. For the design of AC/DC adaptor with universal input range, a startup resistor of 2 MΩ, 1/8 W could be used together with a VDD capacitor to provide a fast startup and low power dissipation solution.

Operating Current

The operating current of WS2299 is low at 2.3mA. Excellent efficiency is achieved with low operating current together and burst mode control circuit.

Soft-start

As soon as VDD reaches UVLO (on), the soft-start function operates; the peak current is then gradually increased from zero. Every restart attempt is followed by 4ms soft-start.

Extended Burst Mode Operation

At zero load or light load, most of the power dissipation of the switching power supply comes from the MOSFET 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 number of switching events within a period of time. Therefore reducing the switch event leads to reduction on the power loss and thus saving the energy.

For the burst mode control circuit, WS2299 self adjusts the switching mode according to the loading condition. At the condition of no load or light/medium load, the FB input voltage drops below burst mode threshold (1.8V) level. Device enters Burst Mode control on the basis of the judgment. The gate drive output switches only when VDD voltage drops below a preset level and FB input is active. Otherwise the gate drive remains at off to minimize the switching loss and power consumption to the greatest extend. The frequency control also eliminates the audio noise at any loading conditions.

Oscillator

The switching frequency is internal set to be 65KHz, so none external resistor is needed.

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in WS2299. The switch current is detected by a sense resistor into the sense pin. An internal leading edge blanking circuit chops off the sense voltage spike at initial MOSFET on state due to snubber diode reverse recovery so that the external RC filtering on sense input is no longer required. The current limit comparator is disabled and thus cannot turn off the external MOSFET during the blanking period. 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 slope voltage onto the current sense input voltage for PWM generation. This greatly enhances the close loop stability at CCM and prevents possible sub harmonic oscillation and thus reduces the output ripple voltage.

Gate Drive

The gate drive strength which is too weak leads to over switch loss of MOSFET while too strong gate drive output compromises in the over EMI. A good tradeoff between output strength and dead time control is achieved through the design of the built-in totem pole gate. The low standby dissipation and good EMI system design is easier to achieve through this dedicated devise. For MOSFET gate protection, an internal 12V clamp is added at higher than expected VDD input.

Over Temperature Protection (OTP)

A NTC resistor in series with a regular resistor should connect between RT and GND for temperature sensing and protection. NTC resistor value becomes lower when the ambient temperature rises. With the fixed internal current IRT flowing through the resistors, the voltage at RT pin becomes lower at high temperature. The internal OTP circuit is triggered and shutdown the MOSFET when the sensed input voltage is lower than VTH_OTP.

Protection Controls

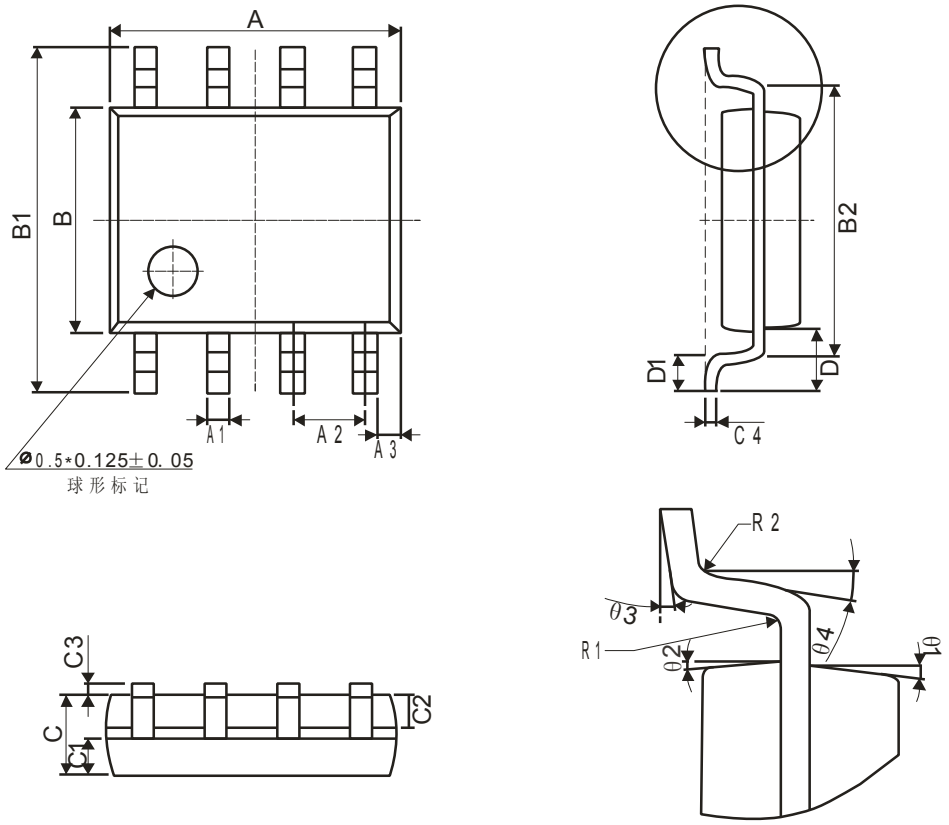
Excellent system stability is achieved by the comprehensive protection of WS2299. Including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP), Over Temperature Protection (OTP), On-Chip VDD OVP(optional), Under Voltage Lockout on VDD (UVLO). Optional latch can be select for OLP、OVP、OTP. The recovery of the AC/DC system could only start by resetting internal latch when VDD voltage drops below VDD_De-latch value. This could be achieved by unplugging/re-plugging of AC source

The OCP threshold value is self adjusted lower at higher current into VIN pin. This OCP threshold slope adjustment helps to compensate the increased output power limit at higher AC voltage caused by inherent Over-Current sensing and control delay. A constant output power limit is achieved with recommended OCP compensation scheme on WS2299.

At overload condition when FB input voltage exceeds power limit threshold value for more than 80ms, control circuit reacts to shut down the output power MOSFET. Similarly, control circuit shutdowns the power MOSFET when OTP. WS2299 resumes the operation when temperature drops below the hysteresis value. VDD is supplied with transformer auxiliary winding output. It is clamped when VDD is higher than 35V. MOSFET is shut down when VDD drops below UVLO limit and device enters power on startup sequence thereafter.

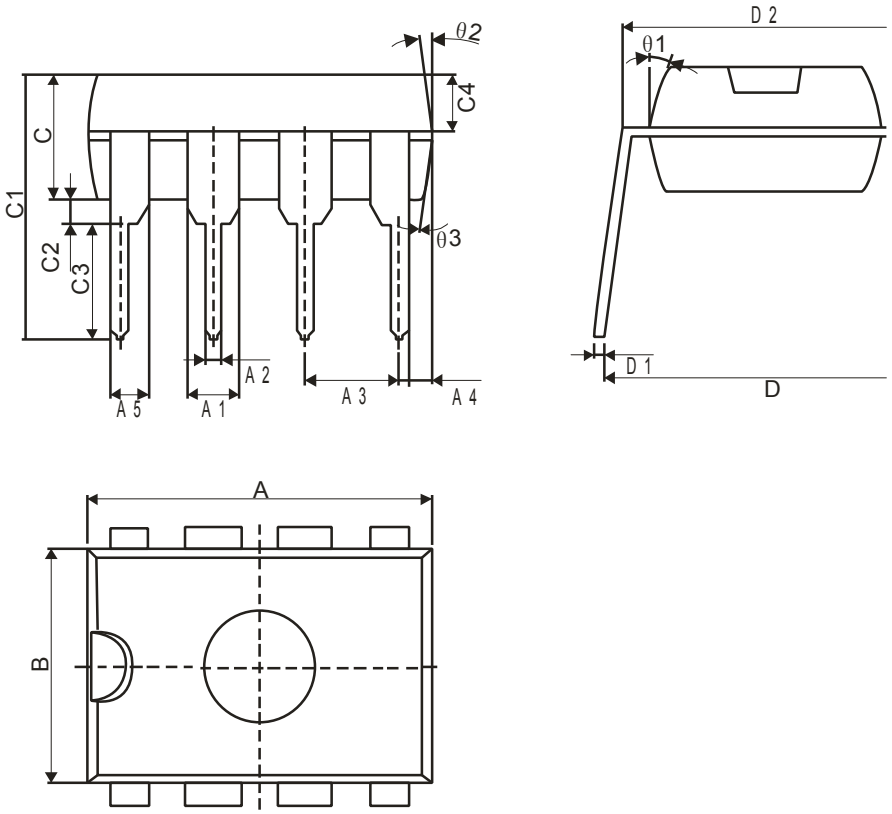
Package Information

SOP-8 Package Dimension



Symbol	Winsemi			
	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	4.70	5.10	0.185	0.201
B	3.70	4.10	0.146	0.161
C	1.30	1.50	0.051	0.059
A1	0.35	0.48	0.014	0.019
A2	1.27TYP		0.05TYP	
A3	0.345TYP		0.014TYP	
B1	5.80	6.20	0.228	0.244
B2	5.00TYP		0.197TYP	
C1	0.55	0.70	0.022	0.028
C2	0.55	0.70	0.022	0.028
C3	0.05	0.225	0.002	0.009
C4	0.203TYP		0.008TYP	
D	1.05TYP		0.041TYP	
D1	0.40	0.80	0.016	0.031

DIP-8 Package Dimension



Winsemi				
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	9.00	9.50	0.354	0.374
B	6.10	6.60	0.240	0.260
C	3.0	3.4	0.118	0.134
A1	1.474	1.574	0.058	0.062
A2	0.41	0.53	0.016	0.021
A3	2.44	2.64	0.096	0.104
A4	0.51TYP		0.02TYP	
A5	0.99TYP		0.04TYP	
C1	6.6	7.30	0.260	0.287
C2	0.50TYP		0.02TYP	
C3	3.00	3.40	0.118	0.134
C4	1.47	1.65	0.058	0.065
D	7.62	9.3	0.300	0.366
D1	0.24	0.32	0.009	0.013
D2	7.62TYP		0.3TYP	

NOTE:

1.We strongly recommend customers check carefully on the trademark when buying our product, if there is any question, please don't be hesitate to contact us.

2.Please do not exceed the absolute maximum ratings of the device when circuit designing.

3.Winsemi Microelectronics Co., Ltd reserved the right to make changes in this specification sheet and is subject to change without prior notice.

CONTACT:

Winsemi Microelectronics Co., Ltd.
ADD:Room 1002, East, Phase 2, HighTech Plaza,Tian-An Cyber Park,Chegongmiao, FuTian, Shenzhen, P.R. China
Post Code : 518040
Tel : +86-755-8250 6288
FAX : +86-755-8250 6299
Web Site : www.winsemi.com