Switching Mode Power Supply PWM Controller WS2293B

Features

- Low startup current (4uA)
- Low operation current (1.7mA)
- 0.9mA operation current at no-load
- Standby power <75mw
- Current mode operation
- Advanced frequency jittering control
- Patented RT Pin energy saving technology
- Secondary Rectifier Short Protection
- External programmable OTP and OVP
- Cycle by cycle Over Current Protection (OCP)
- CS open protection
- Over temperature protection(OTP）
- Soft-start function
- VDD over voltage protection and clamp
- VDD Under voltage lockout with hysteresis (UVLO）
- Wide operation voltage (7.5-34V)
- Driver Output clamped (13V)
- Soft-driver function for lower EMI
- Constant output power limited
- Over load protection(OLP)
- Maximum Driver Capability: 60W

Applications

Universal switching mode power supply and offline AC/DC flyback converter:

- Battery Charger
- Power Adaptor
- Set-Top Box Power Supplies
- Open-frame SMPS

Description

The WS2293B is a highly integrated current mode PWM control IC which is optimized for high performance. It is applied for small and medium-sized power supply devices, for example, the power adapter.

For lower standby power consumption and higher energy saving requirement, the IC has the Burst Mode function and very low startup current and operating current. At the condition of no load or light load, the IC operates in extended ‘burst mode’ to minimize switching loss by lower the switching frequency. The patented technologies of energy-saving at no-load and RT pin energy-saving contribute to minimize the power consumption (<75mw) and meet the efficiency standard of DoE or ErP VI.

The WS2293B applies advanced frequency jittering control to improve EMI performance at half load and light-load. Besides, it covers wide supply voltage(7.5-34V), which greatly facilitate the transformer design and the compatibility of the system.

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

The WS2293B offers complete protection coverage with automatic self-recovery feature including cycle by cycle over current protection (OCP), over load protection (OLP), over temperature protection (OTP), VDD over Voltage Protection (OVP), under voltage lockout (UVLO), Secondary rectifier short protection, and external programmable OTP and OVP with high precision. The gate-driven output is clamped to maximum 13V to protect the external MOSFET.

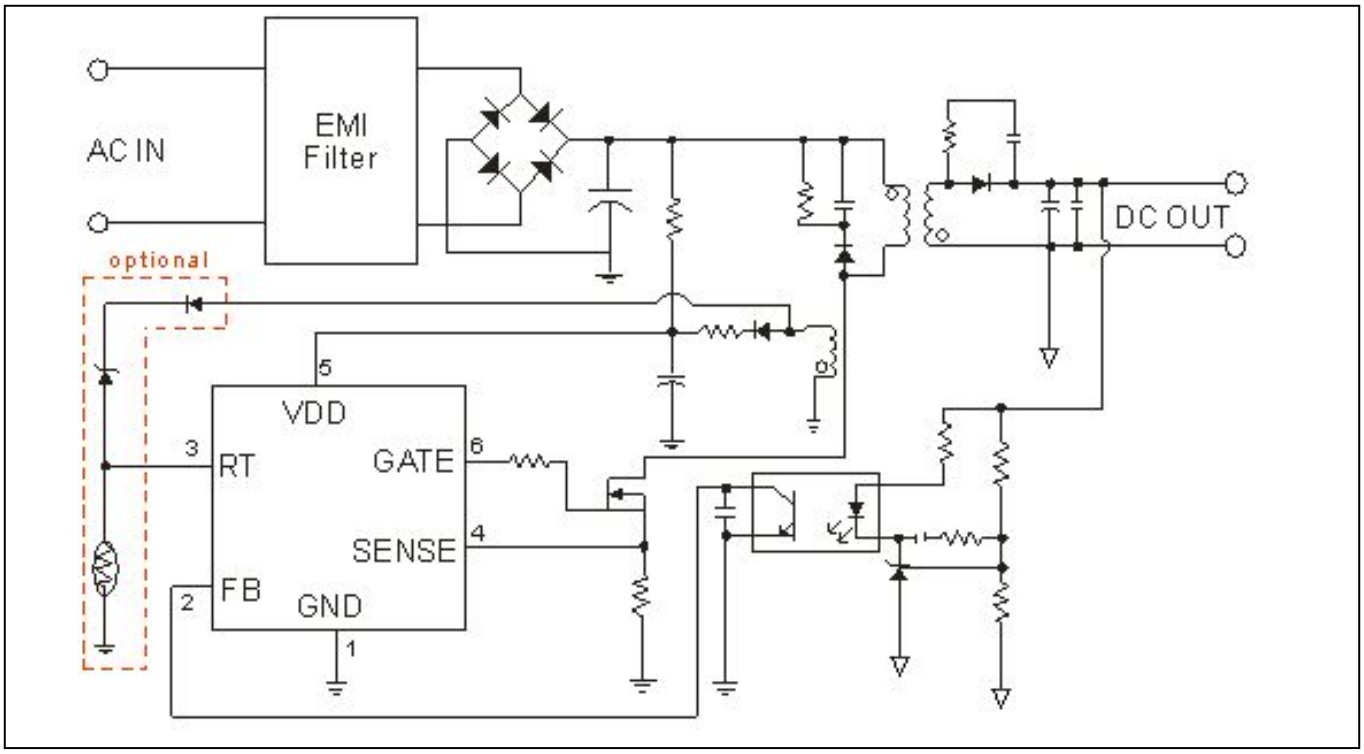
Excellent EMI performance is achieved by using the frequency jitter and the soft-switching at the totem pole gate drive output. The audio energy at below 20KHz is minimized in the design and audio noise is eliminated during operation.

The WS2293B can be used as the best alternative products of the linear power supply or the RCC-mode power to improve the whole performance of the switching power system and lower the cost.

The WS2293B is available in SOT23-6 package.

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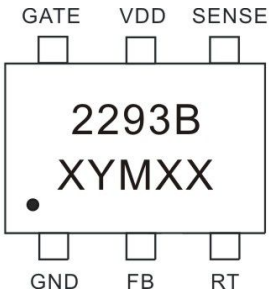
Typical Application Circuit



Note：Diode, zener and NTC resistor in the dashed box are optional components, which can be used for external programmable OTP and OVP.

Pin Configuration and Marking Information

The WS2293B is available in SOT23-6 Package. The top marking is shown as below:

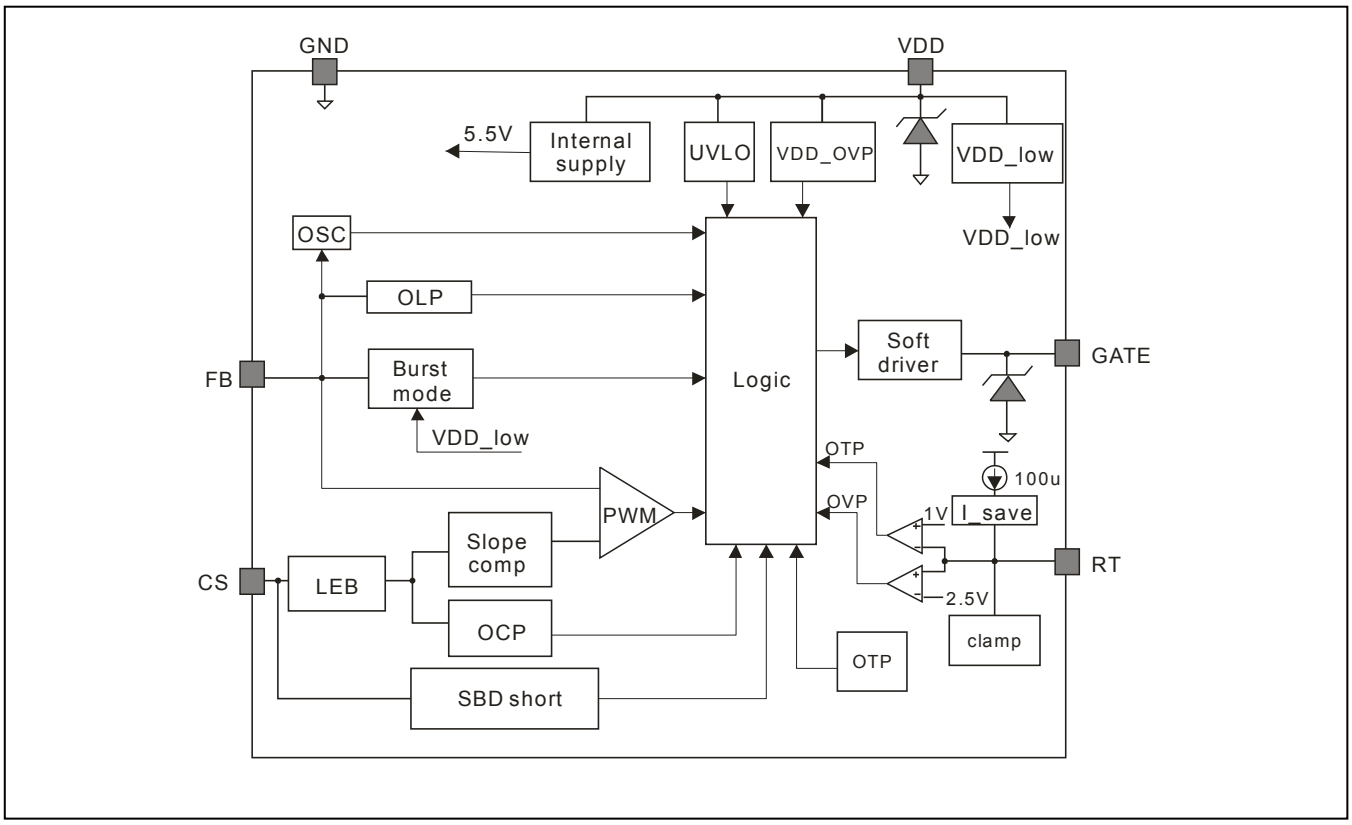


2293B：Product Code
X：Product Code
YM：Production Date
XX：Internal Code for QC

Pin Definition

Pin Name	Pin No.	Pin Type	Function Description
GND	1	Ground	Ground
FB	2	Feedback Input	Feedback input pin. The PWM duty cycle is determined by voltage into this pin and the current-sense signal at Pin 4
RT	3	Protection Setting	Used to set external programmable OTP and OVP; connect to auxiliary winding through diode and zener for accurate output OVP; connect to NTC resistor for accurate OTP; Must be floated when not in use.
SENSE	4	Current Monitoring	Current Sense Input. The current sense resistor between this pin and GND is used for current limit setting.
VDD	5	Power	Power Supply
GATE	6	Output	Gate Driver Output for External Power MOSFET.

Internal Block Diagram



Ordering Information

Package	Marking	Part Number
6-Pin SOT23-6, Pb-free	2293B	WS2293BYP

Recommended Operation Conditions

Symbol	Parameter	Value	Unit
VDD	VDD Supply Voltage	10~30	V
T_A	Operating temperature	-20~85	℃

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
VDD	DC Power Supply	34.5	V
V_{FB}	FB input voltage	-0.3~7	V
V_{SENSE}	SENSE input voltage	-0.3~7	V
V_{RI}	RI input voltage	-0.3~7	V
T_J	Operation Junction Temperature	-20~150	℃
T_{STG}	Storage Temperature	-40~150	℃
V_{CV}	Vcc Clamp Voltage	35.5	V
I_{CC}	Vcc Clamp Continuous Current	10	mA

Note: Stresses above those listed Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, functional operation of the device should not over these or any of these absolute maximum ratings. Operating above the absolute maximum-rated conditions may affect device reliability.

ESD Information

Symbol	Parameter	Value	Unit
$V_{ESD-HBM}$	Human body mode on all pins	3	KV
V_{ESD-MM}	Machine mode on all pins	300	V

Electrical Characteristics

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
Supply Voltage (VDD)						
VDD_OP	Operation voltage				34	V
UVLO_ON	Turn on threshold Voltage		7.2	7.9	9.0	V
UVLO_OFF	Turn-off threshold Voltage		14.0	15.0	16.0	V
I_VDD_ST	Start up current	VDD=13V,RI=100K		4	10	uA
I_VDD_OP	Operation Current	VDD=16V, V_{FB}=3V GATE with 1nF to GND		1.7	2.5	mA
VDD_OVP				34.5		V
VDD_Clamp	VDD Zener Clamp Voltage	IVDD=10mA		35.5		V
Feedback Input Section						
V_{FB}_Open	V_{FB} Open Loop Voltage	VDD=16V,FB open,	4.3	5.0	5.6	V
I_{FB}_Short	FB Pin Short Current	FB Shorted to GND	0.22	0.315	0.41	mA
V_{TH}_PL	Power limiting FB Threshold	VDD=16V	3.2	3.65	4.0	V
T_D_PL	Power limiting Debounce	VDD=16V，FB open	48	60	72	ms
Z_{FB}_IN	Input Impedance	VDD=16V，FB=2V/3V，CS open	13	16.5	20	kΩ
Current Sense Section						
TLEB	Leading edge Blanking Time			330		ns
T_D_OC	OCP control delay	GATE with 1nF to GND		70		ns
V_{TH}_OC	OCP threshold	FB＝3.4V	0.690	0.740	0.790	V
Max_OC	Max_OCP for line comp	FB＝3.4V	0.9	0.95	1	V
Vth_SBD	CS threshold for SBD short	VDD=16V		2.0		V
Td_SBD	Delay of SBD short protect	8 PWM cycle		8		CLK
Oscillator Section						
Fosc	Frequency	VDD=16V，FB=3.2V	60	65	70	khz
D_max	Max duty	VDD=16V，FB=3.2V	70	75	82	%
Jitter period		For 65K		4		ms
Jitter range		For 65K		±5		%
Fosc_BM	Burst mode frequency	VDD=16V, Fb fall from 2V to burst		22		khz
Δf_temp	Frequency variation versus temp. Deviation	TEMP = -20 to 85℃		5		%
Δf_VDD	Frequency variation versus VDD	VDD = 12 to 25V		5		%

Thermal protection						
T_shutdown	Thermal shutdown temperature			150		℃
RT section						
I_RT	RT source current	VDD=16V，RT<1.1V	95	100	105	uA
Vth_OTP	RT low protection	VDD=16V，RT fall from 1.2V	0.95	1	1.05	V
Vth_OVP	RT high protection	VDD=16V，RT rise from 1.5V	1.6	2.1	2.6	V
RT_float	RT floating voltage	VDD=16V	1.1	1.3	1.5	V
I_RT_sink	RT sink current @ clamp	VDD=16V，RT=2.1V		135		uA
TD_RT	Delay for RT protection	8 CLK cycle		8		CLK
GATE Output Section						
VOL	Output voltage Low	VDD = 16V, Io = -20mA			0.8	V
VOH	Output voltage high	VDD = 16V, Io = 20mA	9			V
VClamp	Output clamp voltage	VDD = 20V	11	13	14.5	V
Tr	Rising time	VDD = 16V, GATE with 1nF to GND		635		ns
Tf	Falling time	VDD = 16V, GATE with 1nF to GND		105		ns

Application Information

The WS2293B is a highly integrated and high performance current mode PWM control IC. It is applied for small and medium-sized power （≤60W）supply devices, for example, the power adapter and chargers. The low startup current, operation current and burst mode function at the condition of no load and light load can decrease the standby power of the system, and improve the power conversion efficiency. The patented technologies of energy-saving at no-load and RT pin energy-saving contribute to minimize the power consumption (<75mw) and meet the efficiency standard of DoE or ErP VI. The internal synchronous slope compensation and the leading edge blanking function of the Sense pin not only decrease the component number, but also improve the stability of the system and avoid the harmonics generation. The WS2293B also has multiform auto-recovery protection. The main functions are described as below.

Startup Current and Startup Control

Startup current of the WS2293B is designed to be very low（4uA） so that VDD could be charged up above UVLO threshold level and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss, predigest the design of startup circuit and provide 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 Voltage

The WS2293B covers wide supply voltage from 7.7V to 34V, which helps easing the transformer design, and a same transformer can be used to design different output voltage, so that the compatibility is improved.

Operating Current

The operating current of the WS2293B is very low. Good efficiency is achieved with low operating current together with extended burst mode control circuit which can decrease the value of VDD capacitor.

Soft-start

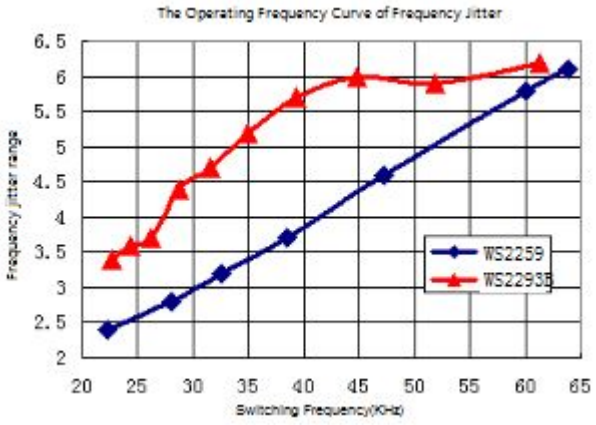
As soon as VDD reaches UVLO (on), the soft-start function operates; the peak current is then gradually increased from zero. Every restart attempt is followed by 4ms soft-start.

Burst Mode

At very light load or no load condition, the IC operates in Burst Mode. In this condition, the voltage at FB is below burst mode threshold level, thus system goes into burst mode. The gate dives output switching only when VDD voltage drops below a preset level or FB input is active to output an on state. Otherwise the gate drive remains at off state to minimize the switching loss thus reduce the standby power consumption. The frequency control also eliminates the audio noise at any load conditions.

Advanced Frequency Jittering Control

The WS2293B integrates the maximum operating frequency of 65 KHz. The frequency jittering range is in proportion to the switching frequency in traditional PWM controller, so that at half load or light load, the switching frequency is decreased, and the frequency jittering range is also decreased, which deteriorates the EMI performance. The WS2293B applies advanced frequency jittering control to keep better EMI performance at all load condition.



Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in WS2293B. The switching current is detected by a sense resistor at the SENSE pin. The internal Leading-edge blanking chops off the sense voltage spike at initial MOSFET on state due to snubber diode circuit reverse recovery and thus reduce the external RC filter circuit. The current limitation comparator is

disabled and cannot turn off the external MOSFET during the blanking period. PWM duty cycle is determined by voltage level at SENSE pin and FB pin.

Internal Synchronized Slope Compensation

Built-in slope compensation circuit adds slope voltage 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.

CS Open Protection & Secondary Rectifier Short Protection

When the CS pin is opened, the WS2293B will shut down after a few cycles. When the secondary rectifier is short, the WS2293B will be in protection state after 8 pulse periods of VDD. The controller enters into UVLO auto recovery until the fault is removed.

RT Pin Protection Setting (OTP and OVP)

The WS2293B offers external programmable OTP and OVP through RT pin. The RT Pin generates 100uA current and connects to a NTC resistor for external programmable OTP. When the voltage of RT is lower than 1.0V, the system starts the protection mode; when the Secondary Rectifier is off and the voltage of RT is higher than 2.1V, the system also is into protection and connects to auxiliary winding through diode and zener for external programmable OVP. To avoid the interference with OTP, the voltage of zener should be higher than the highest voltage of normal value with a margin of 3V or above, which is to ensure that there is no current from zener to the RT Pin in the normal operating state. The RT Pin must be floated when not used.

Gate Driver

GATE pin of the WS2293B is connected to the gate of an external MOSFET. If the gate drive capacity is too weak will cause higher switching loss of MOSFET, while too strong gate drive output cause EMI problem. A good tradeoff between output capacity and dead time control is achieved through the design of the built-in totem pole driver in the WS2293B. The low standby dissipation and good EMI system design is easier to achieve through this dedicated device. For MOSFET gate protection, an internal 13V clamp is added.

Protection Controls

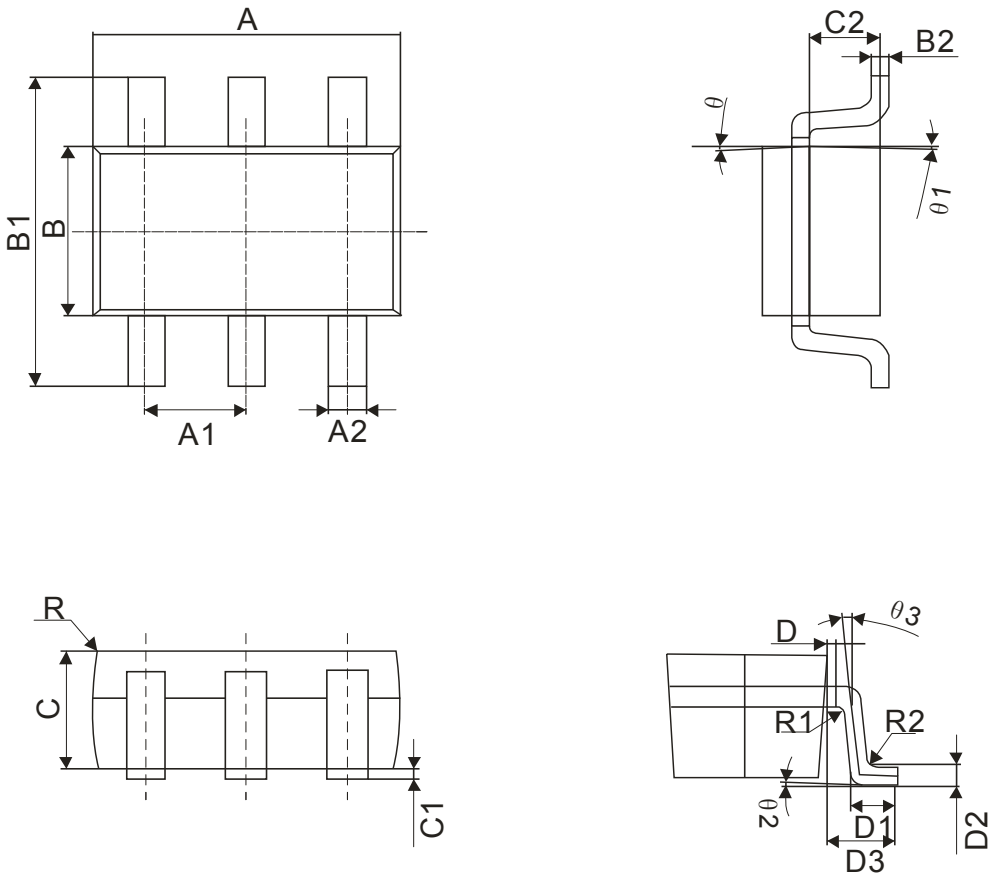
Good power supply system reliability is achieved with auto-recovery protection features including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP), Over Temperature Protection (OTP), CS open protection, Secondary Rectifier Short Protection, Under Voltage Lockout on VDD (UVLO), , and VDD over Voltage Protection & VDD clamp, and external programmable OTP and OVP.

Internal line voltage compensation of OCP helps to achieve constant output power limit over the universal input voltage range.

Package Information

SOT23-6 Package Outline Dimensions

Unit:mm



Symbol	Winsemi			
	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	2.72	3.12	0.107	0.123
B	1.40	1.80	0.055	0.071
C	1.00	1.20	0.039	0.047
A1	0.90	1.00	0.035	0.039
A2	0.30	0.50	0.012	0.020
B1	2.60	3.00	0.102	0.118
B2	0.119	0.135	0.005	0.005
C1	0.03	0.15	0.001	0.006
C2	0.55	0.75	0.022	0.030
D	0.03	0.13	0.001	0.005
D1	0.30	0.60	0.012	0.024
D2	0.25TYP		0.01TYP	
D3	0.60	0.70	0.024	0.028

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.

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