# WS2295B Switch Power Supply PWM Controller

## Features

- Low startup current (4uA)
- Low operation current (1.7mA,0.9mA operation current at no-load)
- Low Standby power
- Current mode operation
- Advanced frequency jittering control
- Secondary Rectifier Short Protection
- Cycle by cycle Over Current Protection (OCP)
- CS open protection
- Over temperature protection(OTP）
- Soft-start function
- VDD over voltage protection and clamp
- Under voltage lockout with hysteresis (UVLO）
- Wide operation voltage (7.5-34V)
- Driver Output clamped(13V)
- Soft-driver function for lower EMI
- Frequency jittering
- Constant output power limited
- Over load protection(OLP)

## Applications

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

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

## Description

The WS2295B is a highly integrated current mode PWM switch 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 contribute to minimize the power consumption (<75mw) and meet the efficiency standard of DoE or ErP VI.

The WS2295B 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 avoids 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 WS2295B 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. The gate-driven output is clamped to maximum 13V to protect the external MOSFET.

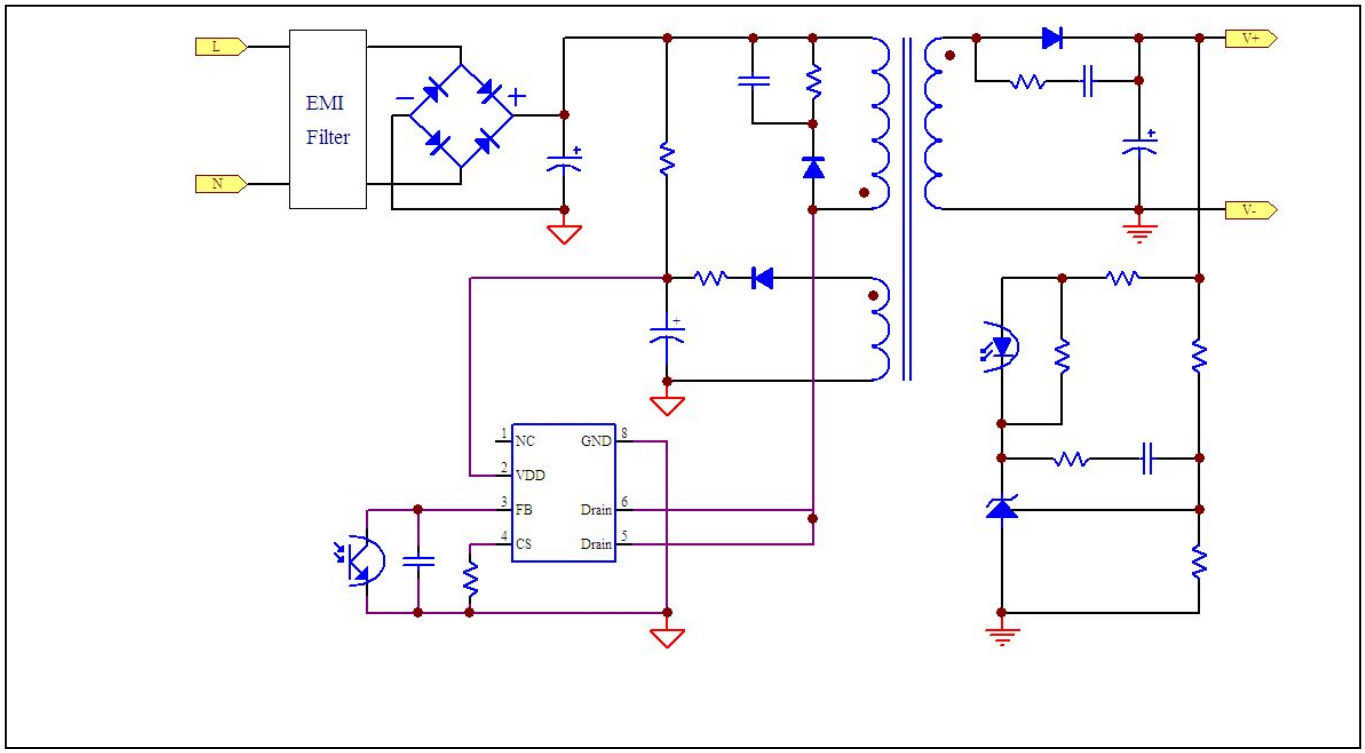
Excellent EMI performance is achieved by using the frequency jitter and the soft-switching at the totem pole gate drive output. The audio energy at below 20KHz is minimized in the design and audio noise is eliminated during operation.

The WS2295B 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 WS2295B is available in DIP7 package.

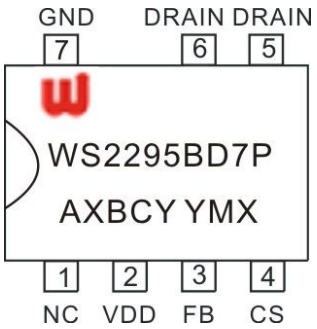
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## Typical Application Circuit




## Pin Configuration and Marking Information

The WS2295B is available in DIP7 Package. The top marking is shown as below:

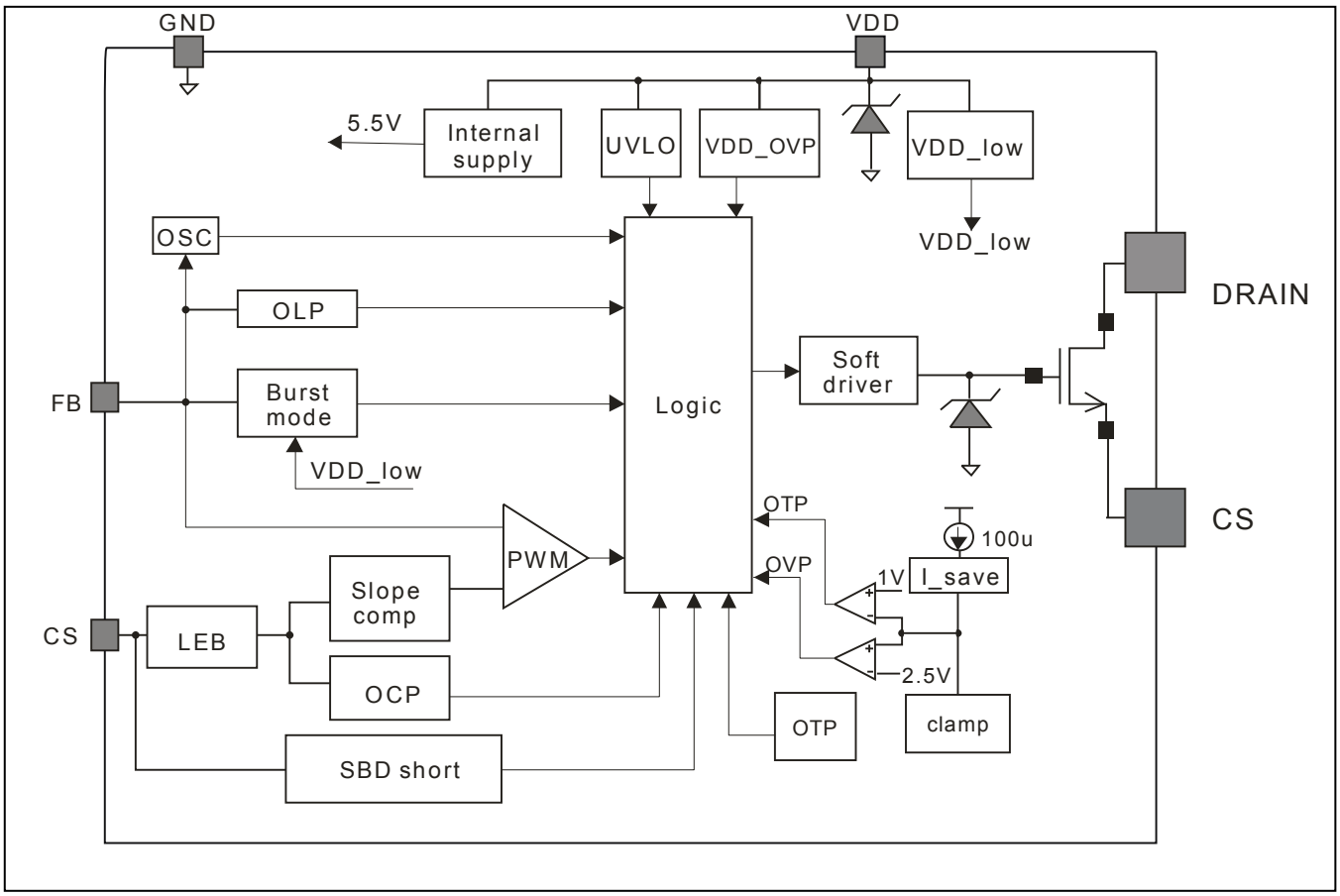



WS2295BD7P：Product Code
A：Product Code
X：Internal Code
BCY：Internal Code For QC
YMX：D/C

## Pin Definition

| Pin Name | Pin No. | Pin Type | Function Description |
|---|---|---|---|
| NC | 1 | NC | Hanged out |
| VDD | 2 | Power | Power Supply |
| FB | 3 | Feedback Input | Feedback input pin. The PWM duty cycle is determined by voltage into this pin and the current-sense signal at Pin 4 |
| CS | 4 | Current monitoring | Current monitoring feed-back input pin.To determine whether to reach the limit value. |
| DRIAN | 5/6 | Drain | The drain terminal of Power MOSFET,connected with the transformer primary side. |
| GND | 7 | Ground | Ground |

## Internal Block Diagram




## Ordering Information

| Package | Marking | Part Number |
|---|---|---|
| 7-Pin DIP-7, Pb-free | WS2295BD7P | WS2295BD7P（DIP-7） |

## Output Power

| Product | 230VAC±15% | 85-265VAC |
|---|---|---|
| | Adapter1 | Adapter1 |
| WS2295B | 18W | 12W |

**NOTE:**The above data was tested in the adapter which in ambient temperature of 50 degrees Celsius and enough heat radiation

## 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 |
| $V_{DRAIN}$ | DRAIN pin voltage | -0.3~600 | 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 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 |
|---|---|---|---|
| $V_{ESD-HBM}$ | Human body model on all pins | 3 | KV |
| $V_{ESD-MM}$ | Machine model on all pins | 300 | V |

## Electrical Characteristics

| **Supply Voltage (VDD)** | | | | | | |
|---|---|---|---|---|---|---|
| **symbol** | **parameter** | **Test condition** | **Min** | **Typ** | **Max** | **Unit** |
| 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 | | 4 | 10 | uA |
| I_VDD_OP | Operation Current | VDD=16V, $V_{FB}$=3V<br>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 | 68 | 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 |
| ∆f_temp | Frequency variation versus temp. Deviation | TEMP = -20 to 85℃ | | 5 | | % |
| ∆f_VDD | Frequency variation versus VDD | VDD = 12 to 25V | | 5 | | % |
| **Thermal protection** | | | | | | |
| T_shutdown | Thermal shutdown temperature | | | 150 | | ℃ |
| **Power MOSFET Section** | | | | | | |
| BVdss | MOSFET Drain-Source breakdown voltage | | 600 | | | V |
| Ron | Static Drain to Source on resistance | WS2295B | | 3.4 | 4.5 | ohm |
| IDSS | Output clamp voltage | | | | 10 | uA |

## Application Information

The WS2295B is a highly integrated and high performance current mode PWM switch IC. It is applied for small and medium-sized power （≤18W） 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 WS2295B also has multiform auto-recovery protection. The main functions are described as below.

### Startup Current and Startup Control

Startup current of the WS2295B 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 1206 resistor of 1.5 MΩ could be used together with a VDD capacitor to provide a fast startup and low power dissipation solution.

### Operating Voltage

The WS2295B covers wide supply voltage from 7.7V to 34V, which helps easing the transform design, and a same transform can be used to design different output voltage, so that the compatibility is improved

### Operating Current

The operating current of the WS2295B 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

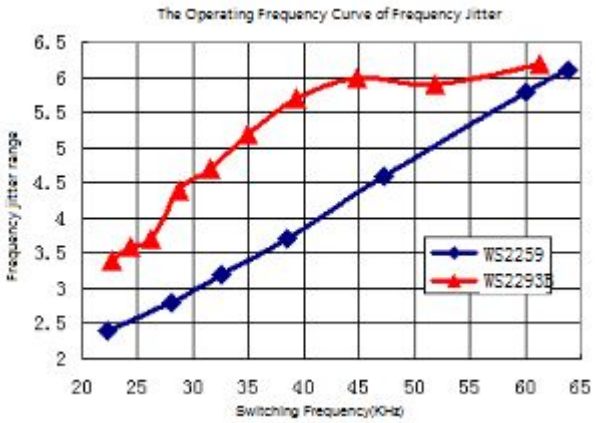
As soon as VDD reaches UVLO (on), the soft-start function operates; the peak current is then gradually increased from zero. Every restart attempt is followed by 4ms soft-start.

### 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 WS2295B 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 WS2295B 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 WS2295B. 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 WS2295B will shut down after a few cycles. When the secondary rectifier is short, the WS2295B will be in protection state after 8 pulse periods of VDD. The controller enters into UVLO auto recovery until the fault is removed.

**Gate Driver**

GATE pin of the WS2295B 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 WS2295B. 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.

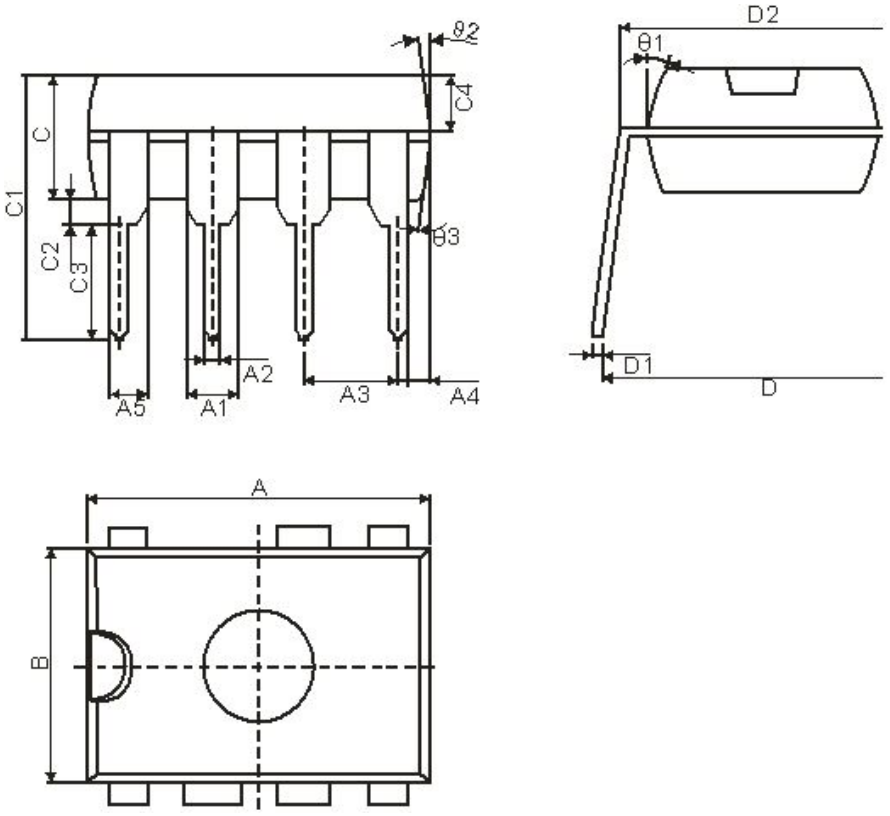
**Protection Controls**

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.

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

## Package Information

### DIP7 Package Outline Dimensions




| 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.

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