

## 2273 Current Mode PWM Controller

### Features

- Burst Mode Control
- 5uA ultra-low startup current
- 1.8mA Low operating current
- Built-in Leading-edge blanking
- Built-in synchronous slope compensation circuit
- Built-in Soft-Start
- 65kHz fixed switch frequency
- Cycle by cycle over current protection (OCP)
- VCC over voltage clamp & under voltage lockout( UVLO)
- Over load protection (OLP)
- OTP and OVP shut down latch
- Maximum Gate output voltage clamped at 12V
- Frequency jittering
- Adjustable OVP through external Zener

### Applications

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

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

### General Description

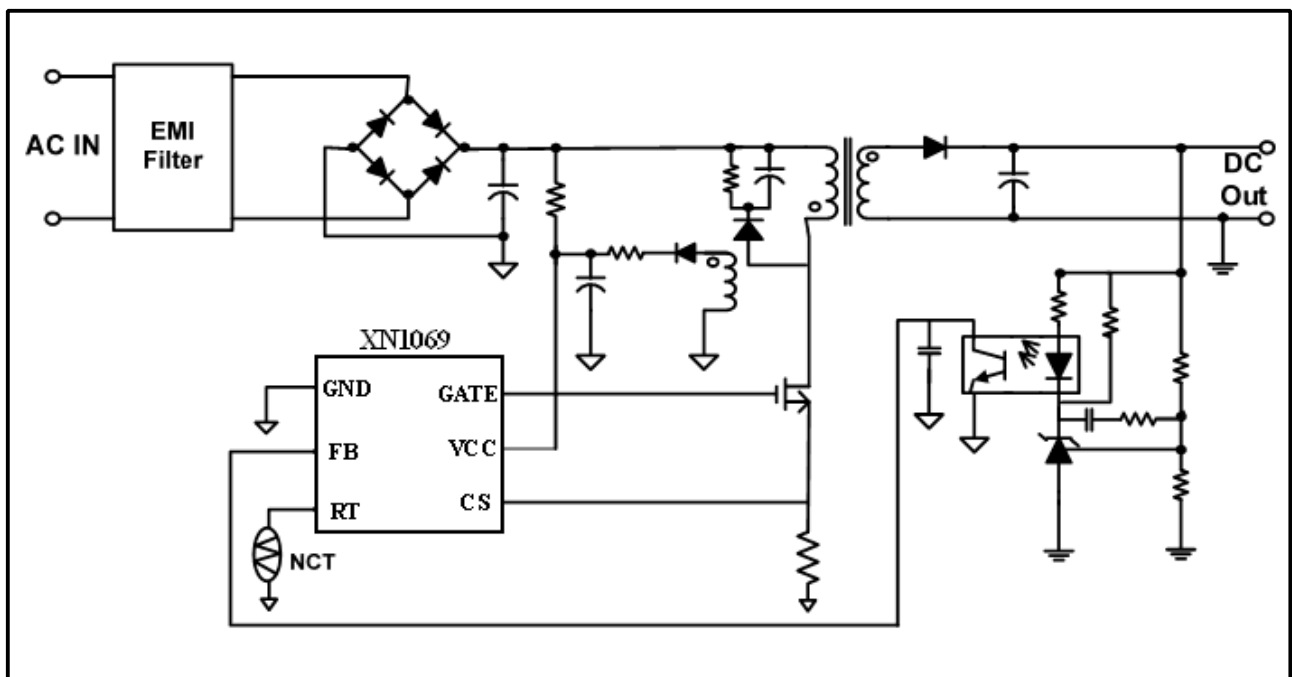
2273 is a high performance current mode PWM controller, optimized for low power power switch equipment.

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, 2273 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 subharmonic 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. 2273 offers comprehensive protection coverage with automatic self-recovery feature, including cycle by cycle over current protection (OCP), over load protection (OLP), VCC Clamp, under voltage lockout (UVLO), OTP and OVP shut down latch. The gate-driven output is clamped to maximum 12V to protect the internal MOSFET.

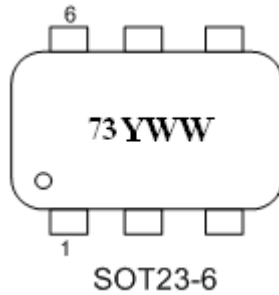
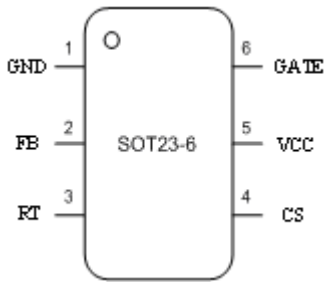
Excellent EMI performance is achieved by using the soft-switching and frequency jittering at the totem-pole-gate-drive output. The tone energy at below 20KHZ is minimized in the design and audio noise is eliminated during operation. The 2273 is the ideal substitute of the linear power supply or the RCC-mod e power, for a better performance of the whole switch power system and a lower cost.

2273 is available in SOT23-6 package.

### Typical Application Circuit



## Pin Definition and Device Marking

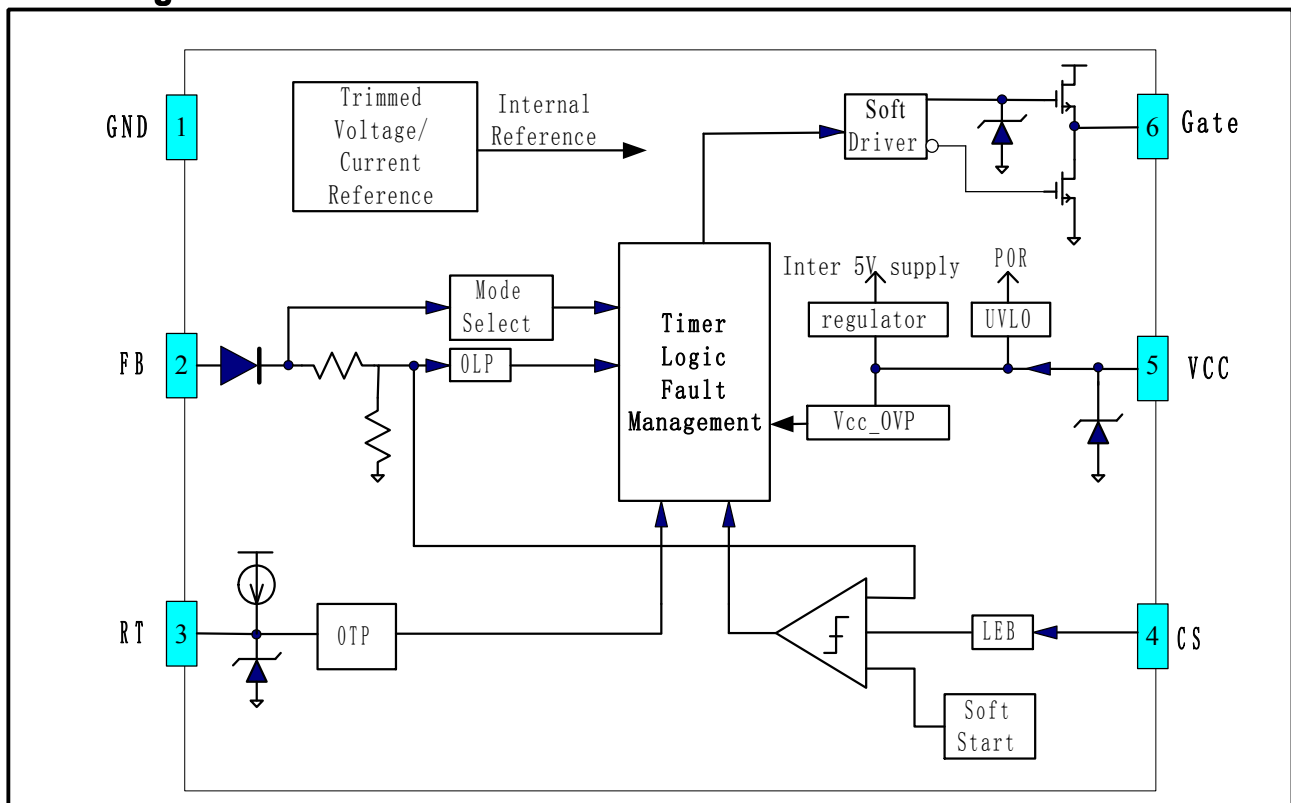


73: WS2273  
Y: Year Code (0-9)  
WW: Week Code (1-52)

## 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 4. The internal protection circuit will automatically shutdown when the FB voltage level exceeds a preset threshold voltage. |
| RT       | 3          | OTP Setting        | Dual function pin. Either connected through a NTC resistor to ground for over temperature shut down/latch control or connected through Zener to VCC for adjustable over voltage protection.                                                          |
| CS       | 4          | Current Monitoring | Current sense input.                                                                                                                                                                                                                                 |
| VCC      | 5          | Power              | Power supply                                                                                                                                                                                                                                         |
| GATE     | 6          | Gate-driven output | Totem-pole gate driver output for power MOSFET.                                                                                                                                                                                                      |

## Block Diagram



**Ordering Information**

| Package                | IC Marking Information | Purchasing Device Name |
|------------------------|------------------------|------------------------|
| 6-Pin SOT23-6, Pb-free | 73XX                   | 2273TP (SOT23-6)       |

**Recommended Operating Condition**

| Symbol | Parameter             | Value  | Unit |
|--------|-----------------------|--------|------|
| VCC    | VCC supply voltage    | 10~30  | V    |
| RT     | RT resistor value     | 100    | Kohm |
| TA     | Operating temperature | -20~85 | °C   |

**Absolute Maximum Ratings**

| Symbol | Parameter                      | Value   | Unit |
|--------|--------------------------------|---------|------|
| VCC    | DC supply voltage              | 30      | V    |
| VFB    | FB input voltage               | -0.3~7  | V    |
| VCS    | CS input voltage               | -0.3~7  | V    |
| VRT    | RT input voltage               | -0.3~7  | V    |
| TJ     | Operating junction temperature | -20~150 | °C   |
| TSTG   | Storage temperature            | -40~150 | °C   |
| VCV    | VCC clamp voltage              | 26      | V    |
| ICC    | VCC 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.

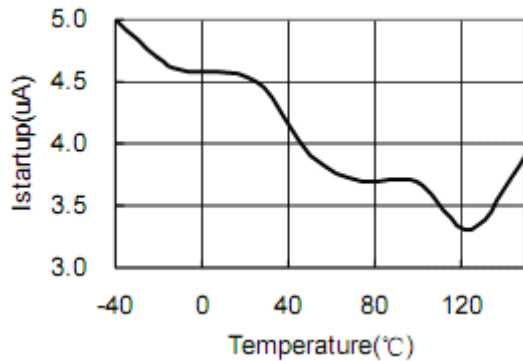
**Electrical Characteristics** (TA=25℃, VCC=16V, if not otherwise noted)

| <b>Supply Voltage (VCC)</b>   |                                              |                                                    |      |      |      |      |
|-------------------------------|----------------------------------------------|----------------------------------------------------|------|------|------|------|
| symbol                        | parameter                                    | Test condition                                     | Min  | Typ  | Max  | Unit |
| VCC_OP                        | Operation voltage                            |                                                    |      |      | 30   | V    |
| UVLO_ON                       | Turn on threshold Voltage                    |                                                    | 6    | 7    | 8    | V    |
| UVLO_OFF                      | Turn-off threshold Voltage                   |                                                    | 12.5 | 13.5 | 14.5 | V    |
| I_VCC_ST                      | Start up current                             | VCC=13V                                            |      | 5    | 20   | uA   |
| I_VCC_OP                      | Operation Current                            | VFB=3V                                             |      | 1.8  | 2.5  | mA   |
| Vpull_up                      | Pull-up PMOS active                          |                                                    |      | 13   |      |      |
| VCC_Clamp                     | VCC Zener Clamp Voltage                      | IVCC=10mA                                          | 30   | 32   | 34   | V    |
| OVP(ON)                       | Over voltage protection voltage              | CS=0.3V,FB=3V, Ramp up VCC until gate clock is off | 26   | 28   | 30   |      |
| Vlatch_release                | Latch release voltage                        |                                                    |      | 5    |      |      |
| <b>Feedback Input Section</b> |                                              |                                                    |      |      |      |      |
| VFB_Open                      | VFB Open Loop Voltage                        |                                                    | 3.9  | 4.2  |      | V    |
| Avcs                          | PWM input gain $\Delta V_{fb}/\Delta V_{cs}$ |                                                    |      | 2    |      | V/V  |
| Vref_green                    | The threshold enter green mode               |                                                    |      | 2.1  |      | V    |
| Vref_burst_H                  | The threshold exit burst mode                |                                                    |      | 1.3  |      | V    |
| Vref_burst_L                  | The threshold enter burst mode               |                                                    |      | 1.2  |      | V    |
| IFB_Short                     | FB Pin Short Current                         | FB Shorted to GND                                  |      | 0.4  |      | mA   |
| VTH_PL                        | Power limiting FB Threshold                  |                                                    |      | 3.7  |      | V    |
| TD_PL                         | Power limiting Debounce                      |                                                    | 80   | 88   | 96   | ms   |
| ZFB_IN                        | Input Impedance                              |                                                    |      | 16   |      | kΩ   |
| Max_Duty                      | Maximum duty cycle                           |                                                    | 75   | 80   | 85   | %    |
| <b>Current CS Section</b>     |                                              |                                                    |      |      |      |      |
| SST                           | Soft Start time                              |                                                    |      | 4    |      | ms   |
| TLEB                          | Leading edge Blanking Time                   |                                                    |      | 220  |      | ns   |
| ZCS                           | Input impedance                              |                                                    |      | 40   |      | kΩ   |
| TD_OC                         | OCP control delay                            | GATE with 1nF to GND                               |      | 120  |      | ns   |
| VTH_OC                        | OCP threshold                                | FB=3V                                              |      | 0.75 |      | V    |
| Vocp_clamping                 |                                              |                                                    |      | 0.9  |      | V    |
| <b>Oscillator Section</b>     |                                              |                                                    |      |      |      |      |
| Fosc                          | Normal Oscillation Frequency                 | VCC=14V,FB=3V,CS=0.3V                              | 60   | 65   | 70   | khz  |
| Fosc_BM                       | Burst mode frequency                         |                                                    |      | 22   |      | khz  |
| Δf_temp                       | Frequency variation versus temp. Deviation   | TEMP = -20 to 85℃                                  |      | 1    |      | %    |
| Δf_VCC                        | Frequency variation versus VCC               | VCC = 12 to 25V                                    |      | 1    |      | %    |
| F_shuffling                   | Shuffling Frequency                          |                                                    |      | 32   |      | Hz   |
| Δf_OSC                        | Frequency Jittering                          |                                                    |      | ±4   |      | %    |

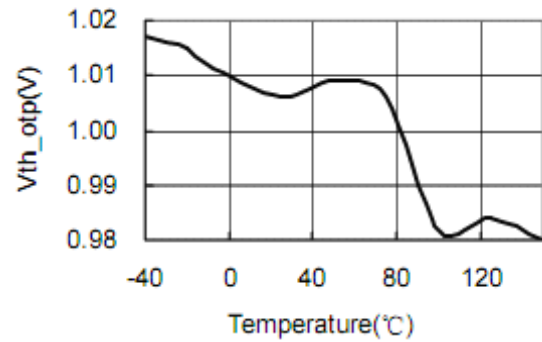
| GATE Output Section         |                                |                                       |      |     |      |       |
|-----------------------------|--------------------------------|---------------------------------------|------|-----|------|-------|
| VOL                         | Output voltage Low             | VCC = 14V, Io = -5mA                  |      |     | 1    | V     |
| VOH                         | Output voltage high            | VCC = 14V, Io = 20mA                  | 6    |     |      | V     |
| VClamp                      | Output clamp voltage           |                                       |      | 12  |      | V     |
| Tr                          | Rising time                    | GATE with 1nF to GND,<br>Gate 从 1~12V |      | 175 |      | ns    |
| Tf                          | Falling time                   | GATE with 1nF to GND,<br>Gate 从 12~1V |      | 85  |      | ns    |
| Over temperature protection |                                |                                       |      |     |      |       |
| IRT                         | Output current of RT pin       |                                       | 95   | 100 | 105  | uA    |
| Votp                        | Threshold voltage for OTP      |                                       | 0.95 | 1   | 1.05 | V     |
| Td_OTP                      | OTP debounce time              |                                       |      | 16  |      | Cycle |
| VRT_FL                      | Float voltage at RT pin        |                                       |      | 2.3 |      | V     |
| Vth_OVP                     | External OVP threshold voltage |                                       |      | 4   |      | V     |

## Typical Operating Characteristics

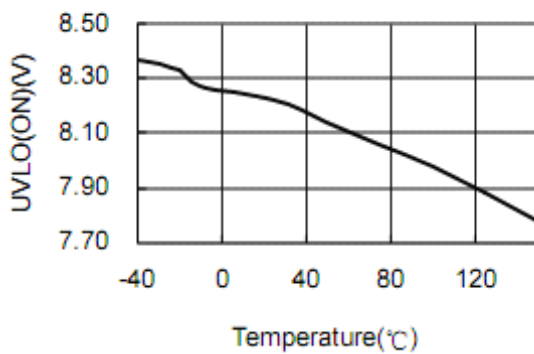
I<sub>startup</sub>( $\mu$ A) vs Temperature( $^{\circ}$ C)



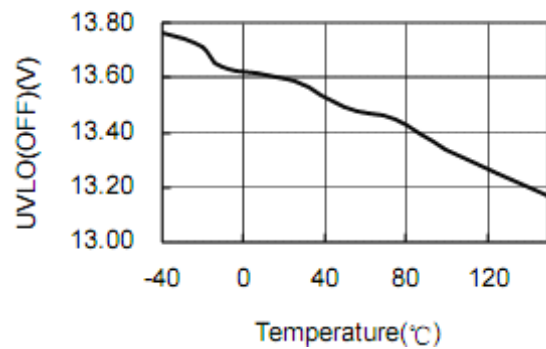
V<sub>th\_otp</sub>(V) vs Temperature( $^{\circ}$ C)



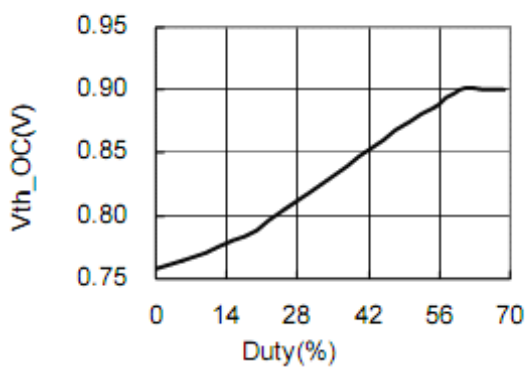
UVLO(ON)(V) vs Temperature( $^{\circ}$ C)



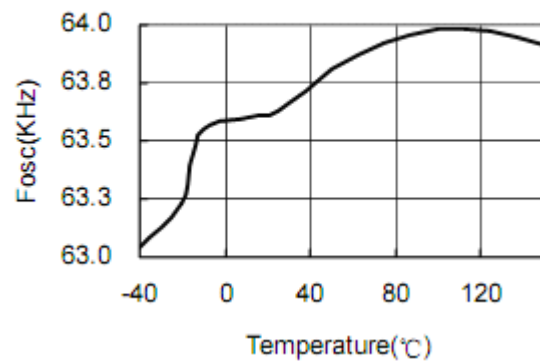
UVLO(OFF)(V) vs Temperature( $^{\circ}$ C)



V<sub>th\_OC</sub>(V) vs duty(%)



F<sub>osc</sub>(KHz) vs Temperature( $^{\circ}$ C)



## Function Description

2273 is a high performance current mode PWM controller, optimized for low power AC/DC application. 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 subharmonic oscillation. 2273 also have multiform general recovery protection mode. The main function is described as below .

## Startup Current and Startup Control

Startup current of 2273 is designed to be extremely low at 5uA, so that VCC 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 M $\Omega$ , 1/8 W could be used together with a VCC capacitor to provide a fast startup and low power dissipation solution.

## Operating Current

The operating current of 2273 is low at 1.8mA. Excellent efficiency is achieved with low operating current together and extended burst mode control circuit.

## Soft Start

2273 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 VCC reaches UVLO ( OFF ), the CS peak voltage is gradually increased from 0.15V to the maximum level. Every restart up is followed by a 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, 2273 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 level. Device enters Burst Mode control on the basis of the judgment. The gate drive output switches only when VCC 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 Operation

The switching frequency is internally fixed at 65kHz. 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 2273. 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 internal 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 subharmonic 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

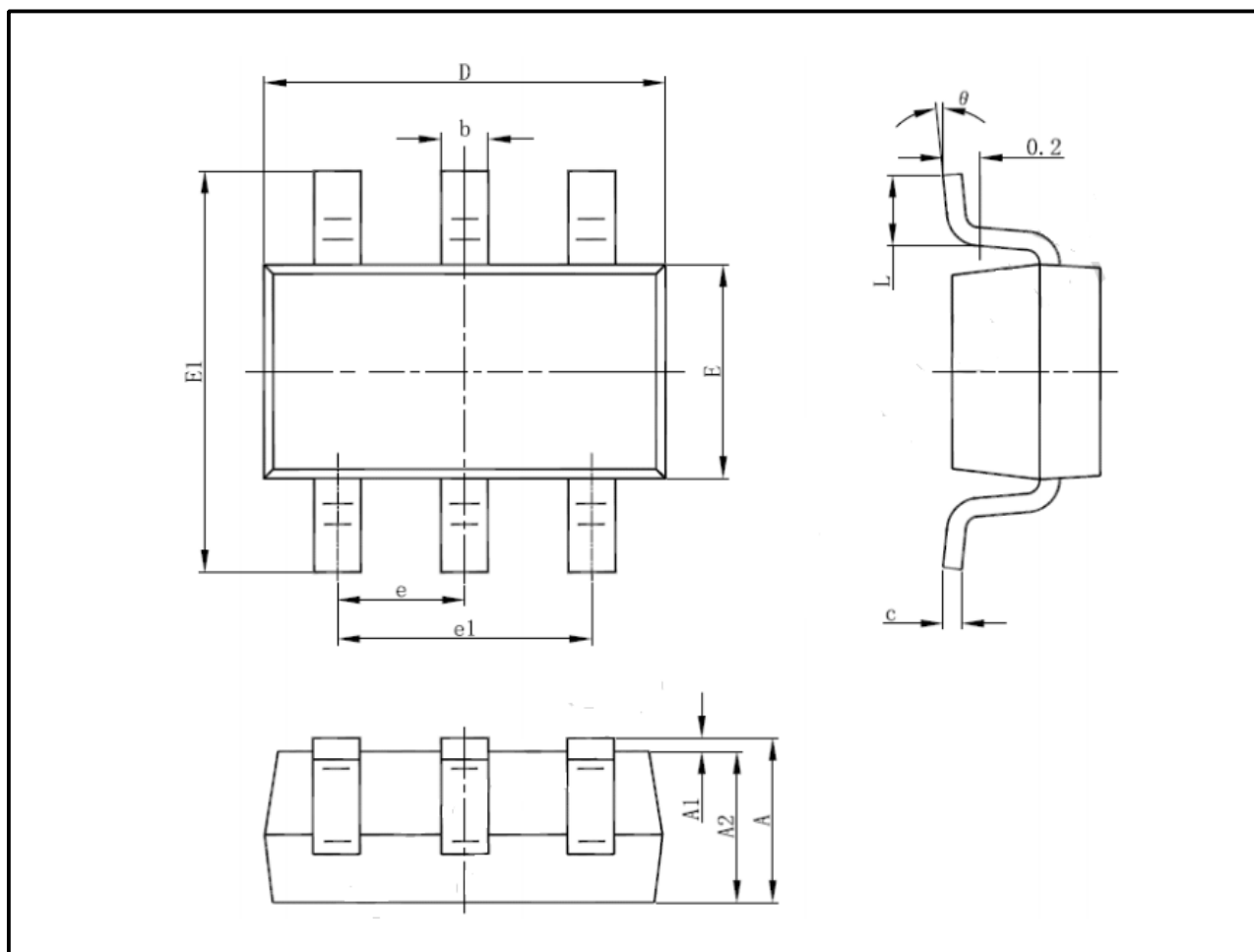
design is easier to achieve through this dedicated device. For MOSFET gate protection, an internal 12V clamp is added at higher than expected VCC input.

### **Protection Controls**

Excellent system stability is achieved by the comprehensive protection of 2273. Including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP) and over voltage clamp, VCC Clamp,

Under Voltage Lockout on VCC (UVLO), OTP and OVP shut down latch. At overload condition when FB input voltage exceeds power limit threshold value for more than TD\_PL, control circuit reacts to shut down the output power MOSFET. Device restarts when VCC voltage drops below UVLO limit. It is clamped when VCC is higher than threshold value. The power MOSFET is shut down when VCC drops below UVLO limit and device enters power on start-up sequence thereafter.



**SOT23-6 Package Outline Dimensions**


| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 1.000                     | 1.300 | 0.039                | 0.051 |
| A1     | 0.000                     | 0.150 | 0.000                | 0.006 |
| A2     | 1.000                     | 1.200 | 0.039                | 0.047 |
| b      | 0.300                     | 0.500 | 0.012                | 0.020 |
| c      | 0.100                     | 0.200 | 0.004                | 0.008 |
| D      | 2.800                     | 3.020 | 0.110                | 0.119 |
| E      | 1.500                     | 1.700 | 0.059                | 0.067 |
| E1     | 2.600                     | 3.000 | 0.102                | 0.118 |
| e      | 0.950(BSC)                |       | 0.037(BSC)           |       |
| e1     | 1.800                     | 2.000 | 0.071                | 0.079 |
| L      | 0.300                     | 0.600 | 0.012                | 0.024 |
| θ      | 0°                        | 8°    | 0°                   | 8°    |