

## 30V,200mA,1.6uA,Low-Dropout Voltage Regulator

### Features

- Low Quiescent Current : 1.6uA
- Wide Input Voltage Range : 3V to 30V
- High Output Current : 200mA
- Low Dropout Voltage : 500mV@100mA
- Fixed Output Voltages : 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 3.6V, 4.0V, 4.2V and 5.0V.
- Output Voltage Tolerance :  $\pm 2\%$
- Current Limit Protection
- Short Circuit Protection
- Thermal Shutdown Protection
- Available Packages : SOT23-3, SOT89-3, SOT23-5

### Applications

- Battery-powered Equipment
- Smoke Detector and Sensor
- Micro Controller Applications
- Home Appliance

### Description

The MST52LXXB series is an ultra-small, low dropout (LDO) linear regulator that can source 200mA of output current. The MST52LXXB series is designed to provide high input voltage, and excellent load and line transient performance.

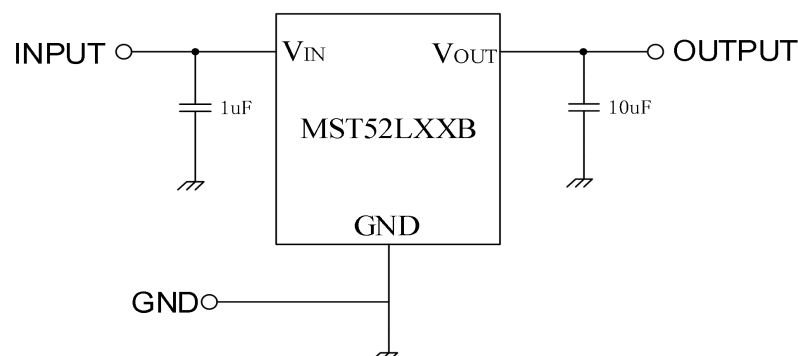
The MST52LXXB series has thermal shutdown, current limit, and short circuit protections for added safety.

The MST52LXXB series contains nine fixed output voltages of 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 3.6V, 4.0V, 4.2V and 5.0V.

| PART NUMBER | PACKAGE | BODY SIZE(NOM) |
|-------------|---------|----------------|
| MST52LXXBTE | SOT23-3 | 2.9mm*2.8mm    |
| MST52LXXBTS | SOT89-3 | 4.5mm*4.2mm    |
| MST52LXXBTG | SOT23-5 | 2.9mm*2.8mm    |

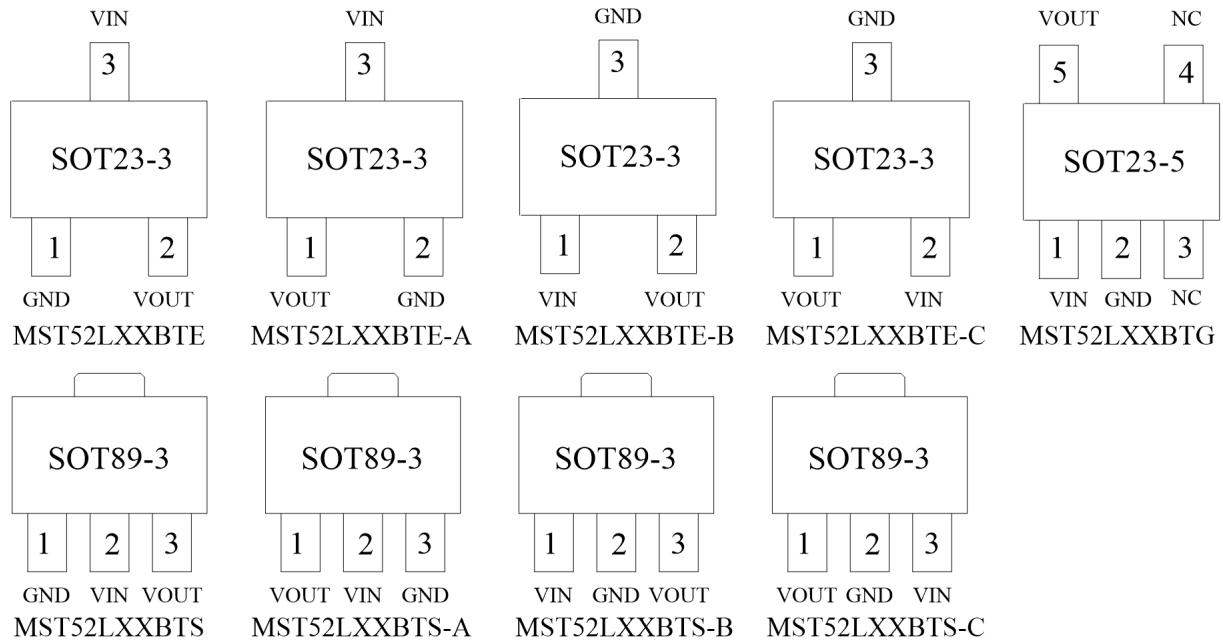
(1) For all available packages, see the orderable addendum at the end of the data sheet.

### Typical Application



30V, Low-Dropout Voltage Regulator

## Pin Configuration and Functions



## Pin Functions

| Name | SOT23-3         |                   |                   |                   | Description      |
|------|-----------------|-------------------|-------------------|-------------------|------------------|
|      | MST52LXX<br>BTE | MST52LXXBTE-<br>A | MST52LXXBTE-<br>B | MST52LXXBTE-<br>C |                  |
| GND  | 1               | 2                 | 3                 | 3                 | Ground Pin       |
| VOUT | 2               | 1                 | 2                 | 1                 | Output Pin       |
| VIN  | 3               | 3                 | 1                 | 2                 | Input Pin        |
| Name | SOT89-3         |                   |                   |                   | Description      |
|      | MST52LXX<br>BTS | MST52LXXBTS-<br>A | MST52LXXBTS-<br>B | MST52LXXBTS-<br>C |                  |
| GND  | 1               | 3                 | 2                 | 2                 | Ground Pin       |
| VOUT | 3               | 1                 | 3                 | 1                 | Output Pin       |
| VIN  | 2               | 2                 | 1                 | 3                 | Input Pin        |
| Name | SOT23-5         |                   |                   |                   | Description      |
|      | MST52LXXBTG     |                   |                   |                   |                  |
| VIN  | 1               |                   |                   |                   | Input Pin        |
| GND  | 2               |                   |                   |                   | Ground Pin       |
| NC   | 3               |                   |                   |                   | No<br>Connection |
| NC   | 4               |                   |                   |                   | No<br>Connection |
| VOUT | 5               |                   |                   |                   | Output Pin       |

## Absolute Maximum Ratings

| Parameter                                   | Description                 | Min                | Max | Unit |
|---------------------------------------------|-----------------------------|--------------------|-----|------|
| Input Voltage                               | VIN to GND                  | -0.3               | 36  | V    |
|                                             | VOUT to GND                 | -0.3               | 7   | V    |
|                                             | VIN to VOUT                 | -0.3               | 31  | V    |
| Current                                     | Peak output current         | Internally limited |     |      |
| Temperature                                 | Operating Temperature Range | -40                | 125 | °C   |
|                                             | Storage Temperature         | -40                | 150 | °C   |
| Thermal Resistance<br>(Junction to Ambient) | SOT89                       | 130                |     | °C/W |
|                                             | SOT23                       | 200                |     | °C/W |
| Power Dissipation                           | SOT89                       | 900                |     | mW   |
|                                             | SOT23                       | 600                |     | mW   |

**Note:**

exceeding the range specified by the rated parameters will cause damage to the chip, and the working state of the chip beyond the range of rated parameters cannot be guaranteed. Exposure outside the rated parameter range will affect the reliability of the chip.

## ESD Ratings

| Parameter        | Description               | Range | Unit |
|------------------|---------------------------|-------|------|
| V <sub>ESD</sub> | Human Body Model(HBM)     | 4     | KV   |
|                  | Charged Device Model(CDM) | 200   | V    |

**Note:**

JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

JEDEC document JEP157 states that 200-V CDM allows safe manufacturing with a standard ESD control process.

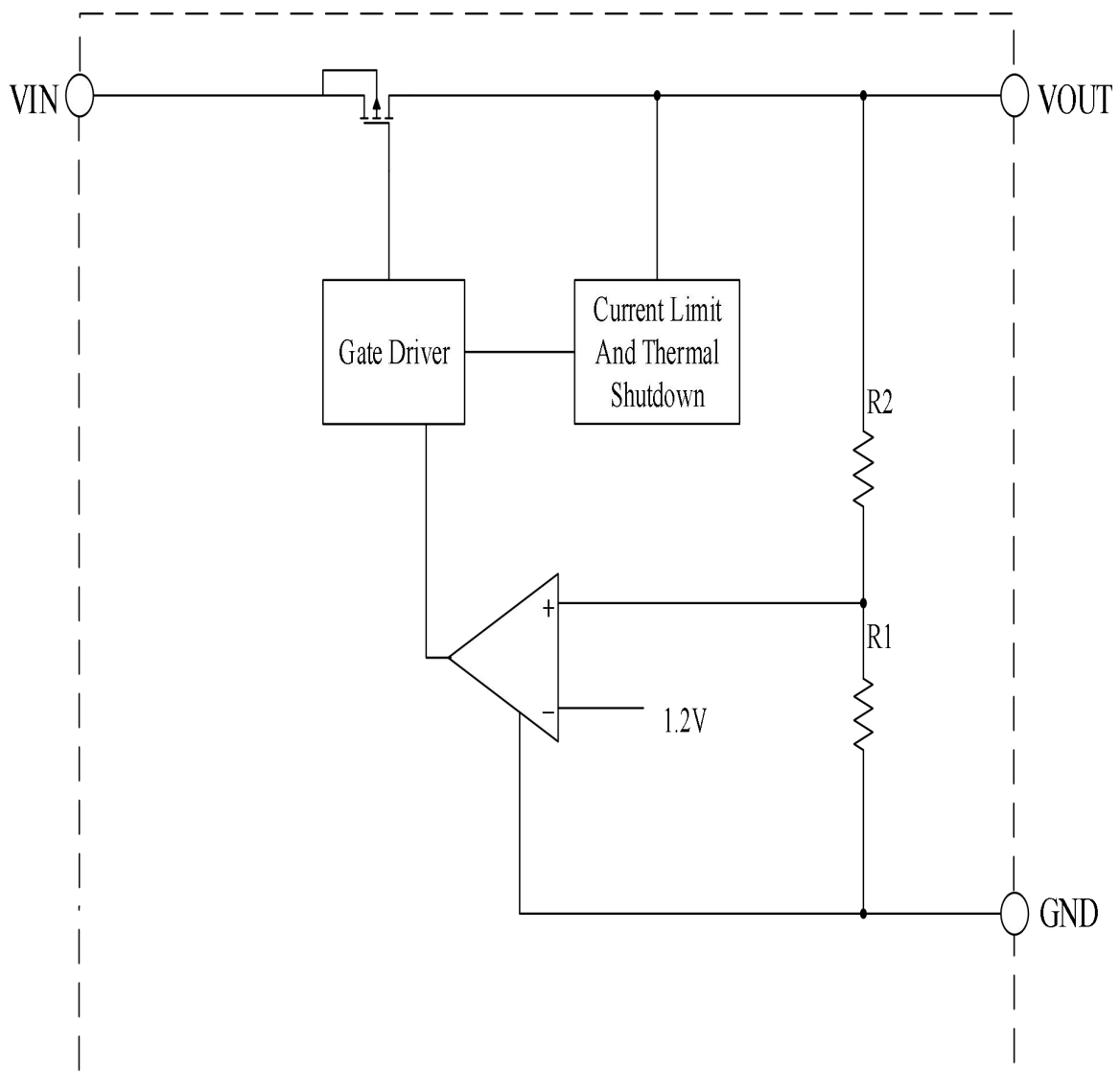
## Electrical Characteristics

( At  $T_A=25^{\circ}\text{C}$ ,  $C_{IN}=1\mu\text{F}$ ,  $V_{IN}=V_{OUTNOM}+1.0\text{V}$ ,  $C_{OUT}=10\mu\text{F}$ , unless otherwise noted )

| Symbol                          | Parameter                                  | Test Conditions                                                              | Min                 | Typ          | Max                 | Unit               |
|---------------------------------|--------------------------------------------|------------------------------------------------------------------------------|---------------------|--------------|---------------------|--------------------|
| $V_{IN}$                        | Operating input voltage                    |                                                                              | 3                   | —            | 30                  | V                  |
| $I_{GND}$                       | Quiescent Current                          | $V_{IN}=12\text{V}$ , No load                                                | 1.3                 | 1.6          | 1.8                 | $\mu\text{A}$      |
| $I_{SHUT}$                      | Shutdown Current                           | $V_{IN}=12\text{V}$ , $EN=0\text{V}$                                         | —                   | 130          | —                   | nA                 |
| $V_{OUT}$                       | Output Voltage                             | $V_{IN}=12\text{V}$ , $I_{OUT}=10\text{mA}$                                  | $V_{OUTNOM} * 0.98$ | $V_{OUTNOM}$ | $V_{OUTNOM} * 1.02$ | V                  |
| $I_{OUT\_MAX}$                  | Output Current                             |                                                                              | —                   | 200          | —                   | mA                 |
| $V_{DROP}$                      | Dropout Voltage (MST52L50B)                | $I_{OUT}=100\text{mA}$ ,<br>$V_{IN}=V_{OUTNOM}-0.1\text{V}$                  | —                   | 500          | —                   | mV                 |
|                                 |                                            | $I_{OUT}=150\text{mA}$ ,<br>$V_{IN}=V_{OUTNOM}-0.1\text{V}$                  | —                   | 700          | —                   |                    |
|                                 | Dropout Voltage <sup>(1)</sup> (MST52L33B) | $I_{OUT}=100\text{mA}$ ,<br>$V_{IN}=V_{OUTNOM}-0.1\text{V}$                  | —                   | 500          | —                   | mV                 |
|                                 |                                            | $I_{OUT}=150\text{mA}$ ,<br>$V_{IN}=V_{OUTNOM}-0.1\text{V}$                  | —                   | 800          | —                   |                    |
| $\Delta V_{OUT}/\Delta I_{OUT}$ | Load Regulation                            | $V_{IN}=7\text{V}$ ,<br>$1\text{mA} \leq I_{OUT} \leq 150\text{mA}$          | —                   | 0.1          | —                   | mV/mA              |
| $\Delta V_{OUT}/\Delta V_{IN}$  | Line Regulation                            | $I_{OUT}=1\text{mA}$ ,<br>$V_{OUTNOM}+1\text{V} \leq V_{IN} \leq 30\text{V}$ | —                   | 0.1          | —                   | mV/V               |
| $I_{LIMIT}$                     | Current Limit                              |                                                                              | —                   | 370          | —                   | mA                 |
| $I_{SHORT}$                     | Short Current                              | $V_{IN}=12\text{V}$                                                          | —                   | 120          | —                   | mA                 |
| $T_{SHDN}$                      | Thermal Shutdown Temperature               | Shutdown, temperature increasing                                             | —                   | 154          | —                   | $^{\circ}\text{C}$ |
|                                 |                                            | Reset, temperature decreasing                                                | —                   | 125          | —                   |                    |

Note : (1) Dropout Voltage is the voltage difference between the input and the output at which the output voltage drops 2% below its nominal value.

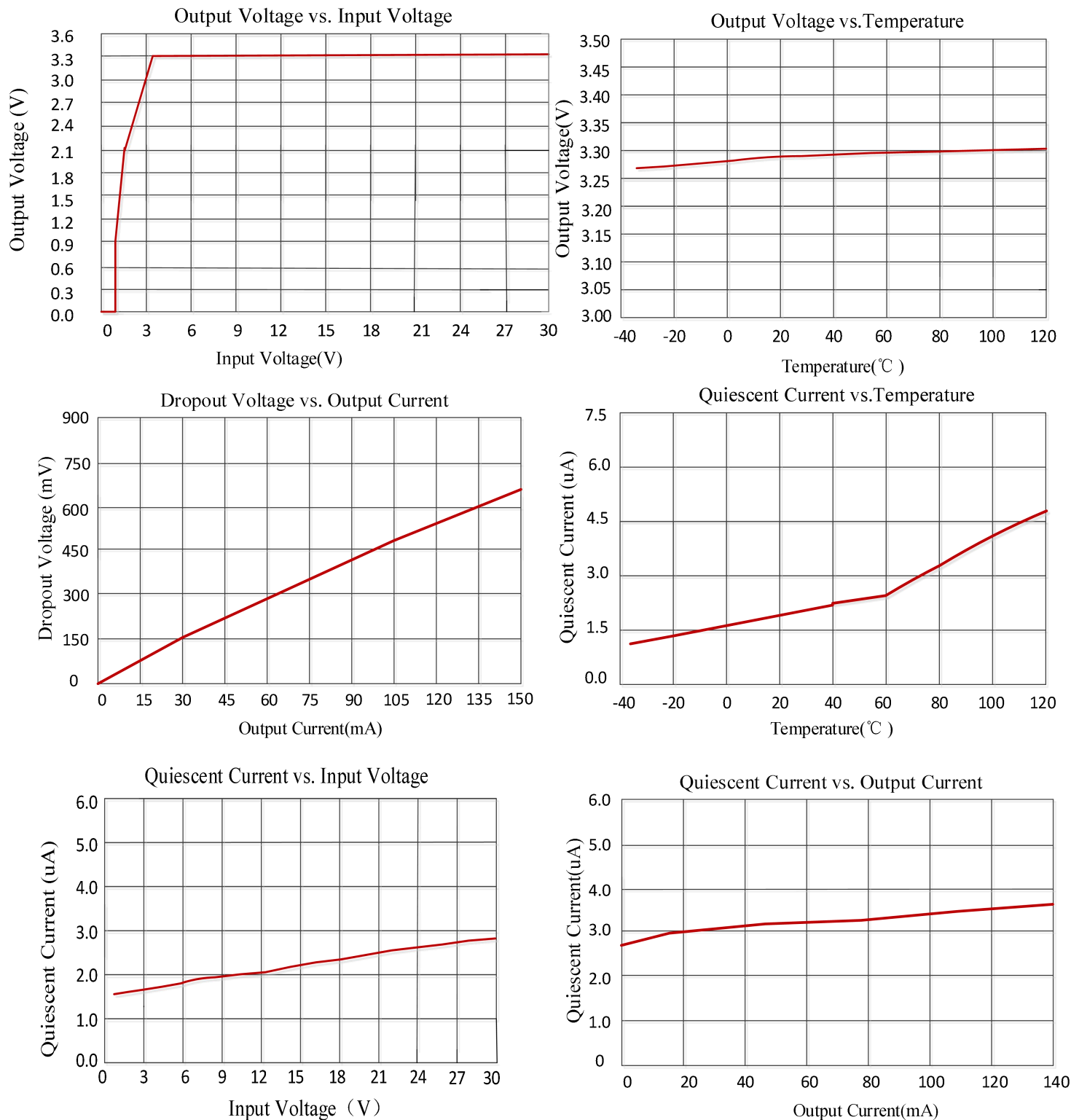
## Functional Block Diagram



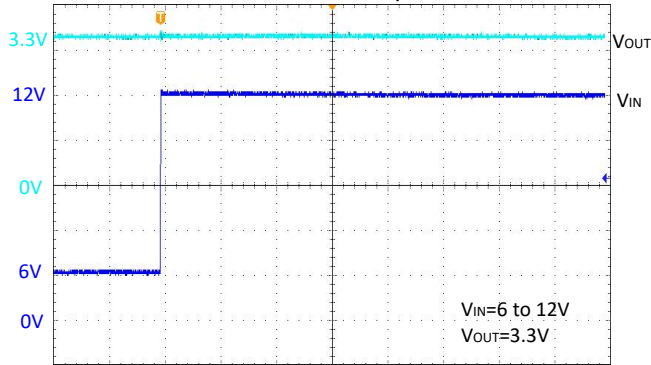
**Functional Block Diagram**

## Typical Characteristics

(Test Condition:  $T_A=25^{\circ}\text{C}$ ,  $V_{in}=12\text{V}$ ,  $I_{out}=1\text{mA}$ ,  $C_{OUT}=10\mu\text{F}$ ,  $V_{OUT}=3.3\text{V}$  unless otherwise note)

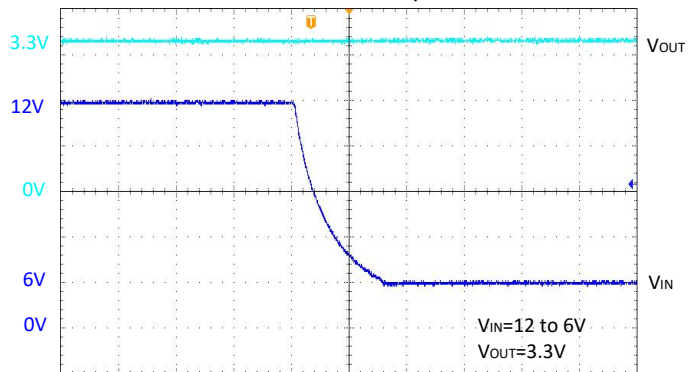


Line Transient Response



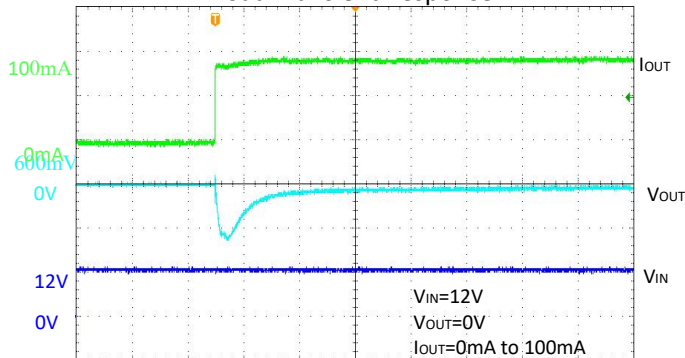
Time(4us/div)

Line Transient Response



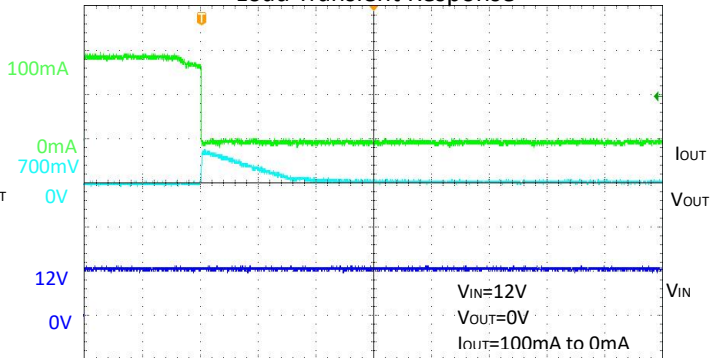
Time(4us/div)

Load Transient Response



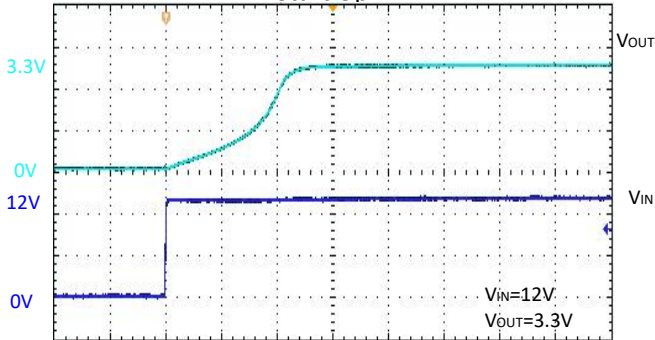
Time(200us/div)

Load Transient Response



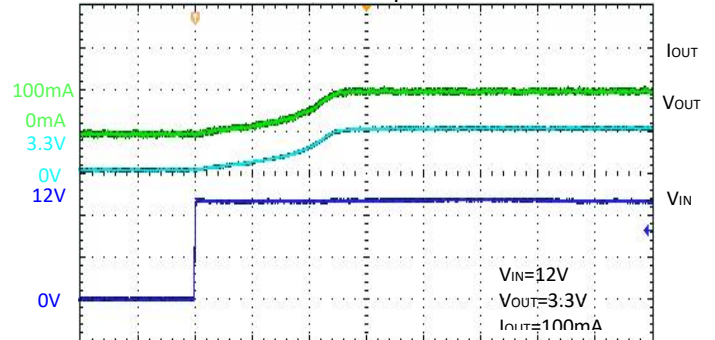
Time(200us/div)

Start Up



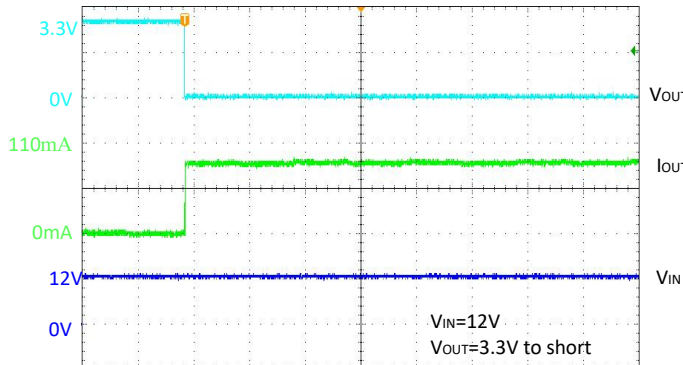
Time(40us/div)

Start Up



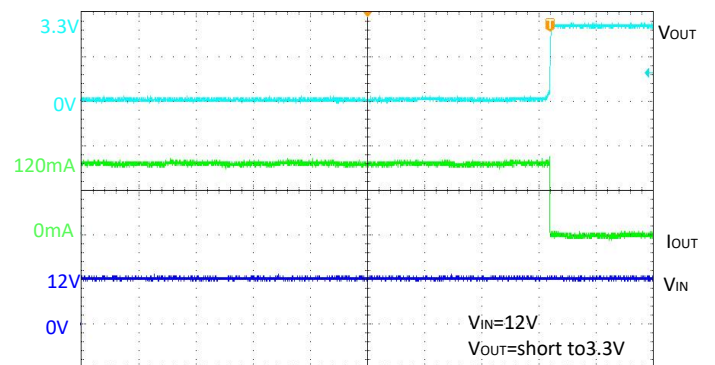
Time(40us/div)

Short Circuit Protection



Time(2ms/div)

Short Circuit Protection



Time(2ms/div)

## Detailed Description

### Overview

The MST52LXXB series is an ultra-small, low dropout (LDO) linear regulator that can source 200mA of output current.

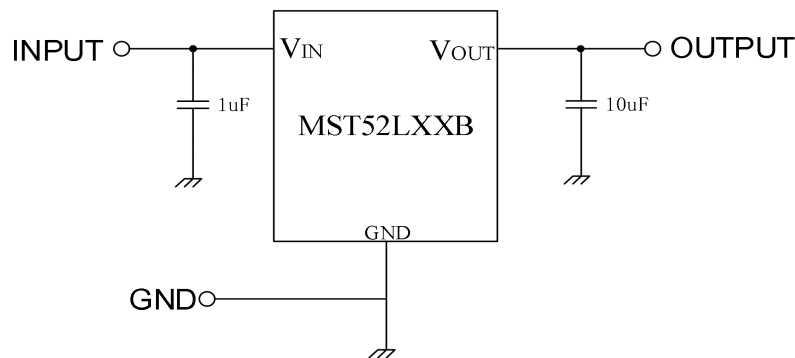
The MST52LXXB series is designed to provide high input voltage, and excellent load and line transient performance.

The MST52LXXB series has thermal shutdown, current limit, and short circuit protections for added safety.

The MST52LXXB series contains nine fixed output voltages of 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 3.6V, 4.0V, 4.2V and 5.0V.

### Input Capacitor and Output Capacitor

A 1 $\mu$ F ceramic capacitor is recommended to connect between VIN and GND pins to decouple input power supply glitch and noise. The amount of the capacitance may be increased without limit. This input capacitor must be located as close as possible to the device to assure input stability and less noise. For PCB layout, a wide copper trace is required for both VIN and GND. When  $V_{IN} \geq 18V$ , it is recommended to add R1 ( $R1 > 1\Omega$ , The resistance shall be adjusted according to the actual application) at the input end.



To ensure loop stability, the MST52LXXB series products requires an output capacitor with a minimum effective capacitance value of 3.3 $\mu$ F. And the series products could support output capacitor range from 3.3 $\mu$ F to 220 $\mu$ F and with an ESR range between 0.001 $\Omega$  and 5 $\Omega$ . MST recommends selecting a X5R- or X7R-type 4.7 $\mu$ F~10 $\mu$ F ceramic capacitor with low ESR over temperature range to improve the load transient response.

An output capacitor is required for the stability of the LDO. The recommended minimum output capacitance is 1 $\mu$ F, ceramic capacitor is recommended, and temperature characteristics are X5R or X7R. Higher capacitance values help to improve load/line transient response. The output capacitance may be increased to keep low undershoot/overshoot. Place output capacitor as close as possible to VOUT and GND pins.

### Current Limit and Short Circuit Protection

When output current at VOUT pin is higher than current limit threshold or the VOUT pin is direct short to GND, the current limit protection will be triggered and clamp the output current at a pre-designed level to prevent over-current and thermal damage.

## Power Dissipation and Thermal Protection

The MST52LXXB has internal thermal sense and protection circuits. When excessive power dissipation happens on the device, such as short circuit at the output pin or very heavy load current with a large voltage drop across the device, the internal thermal protection circuit will be triggered, and it will shut down the power MOSFET to prevent the LDO from damage. As soon as excessive thermal condition is removed and the temperature of the device drops down, the thermal protection circuit will lease the control of the power MOSFET, and the LDO device goes to normal operation.

Power dissipation caused by voltage drop across the LDO and by the output current flowing through the device needs to be dissipated out from the chip. The maximum junction temperature is dependent on power dissipation, package, the PCB layout, number of used Cu layers, Cu layers thickness and the ambient temperature.

During normal operation, LDO junction temperature should not exceed 150°C, or else it may result in deterioration of the properties of the chip. Using below equations to calculate the power dissipation and estimate the junction temperature.

The power dissipation can be calculated using Equation 1 .

$$PD = (VIN - VOUT) \times IOUT \quad (1)$$

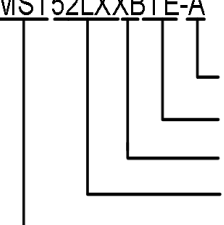
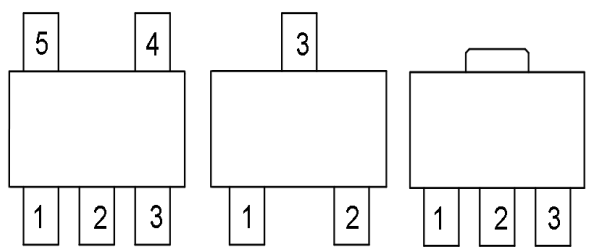
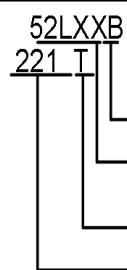
The junction temperature can be estimated using Equation .  $R\theta JA\_EVM$  is the junction-to-ambient thermal resistance based on customer's PCB. Verify the application and allow sufficient margins in the thermal design by the Equation 2.

$$TJ = TA + PD \times R\theta JA\_EVM \quad (2)$$

$R\theta JA\_EVM$  is a critical parameter and depends on many factors such as the following:

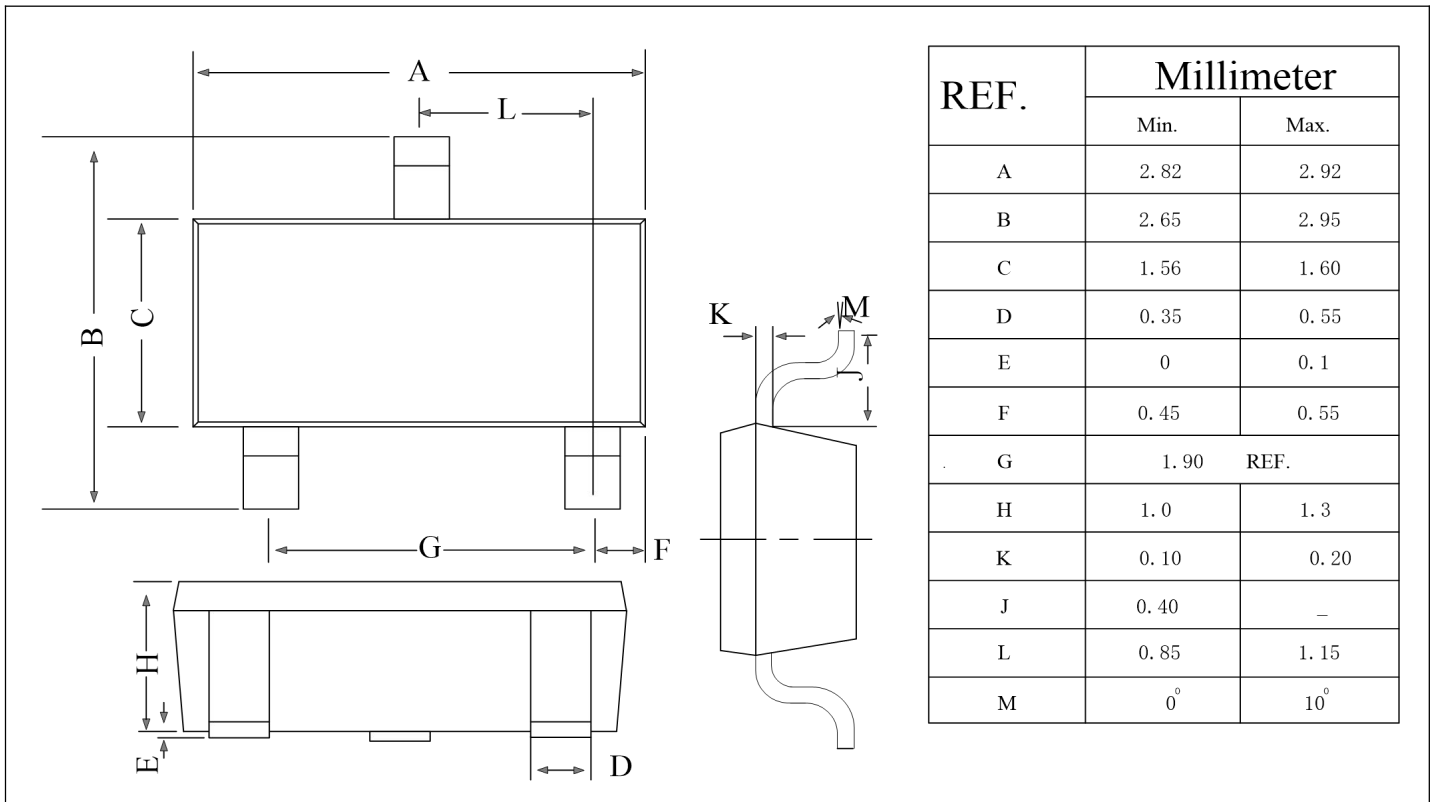
- Power dissipation
- Air temperature/flow
- PCB area
- Copper heat-sink area
- Number of thermal vias under the package
- Adjacent component placement

## Ordering And Marking Information

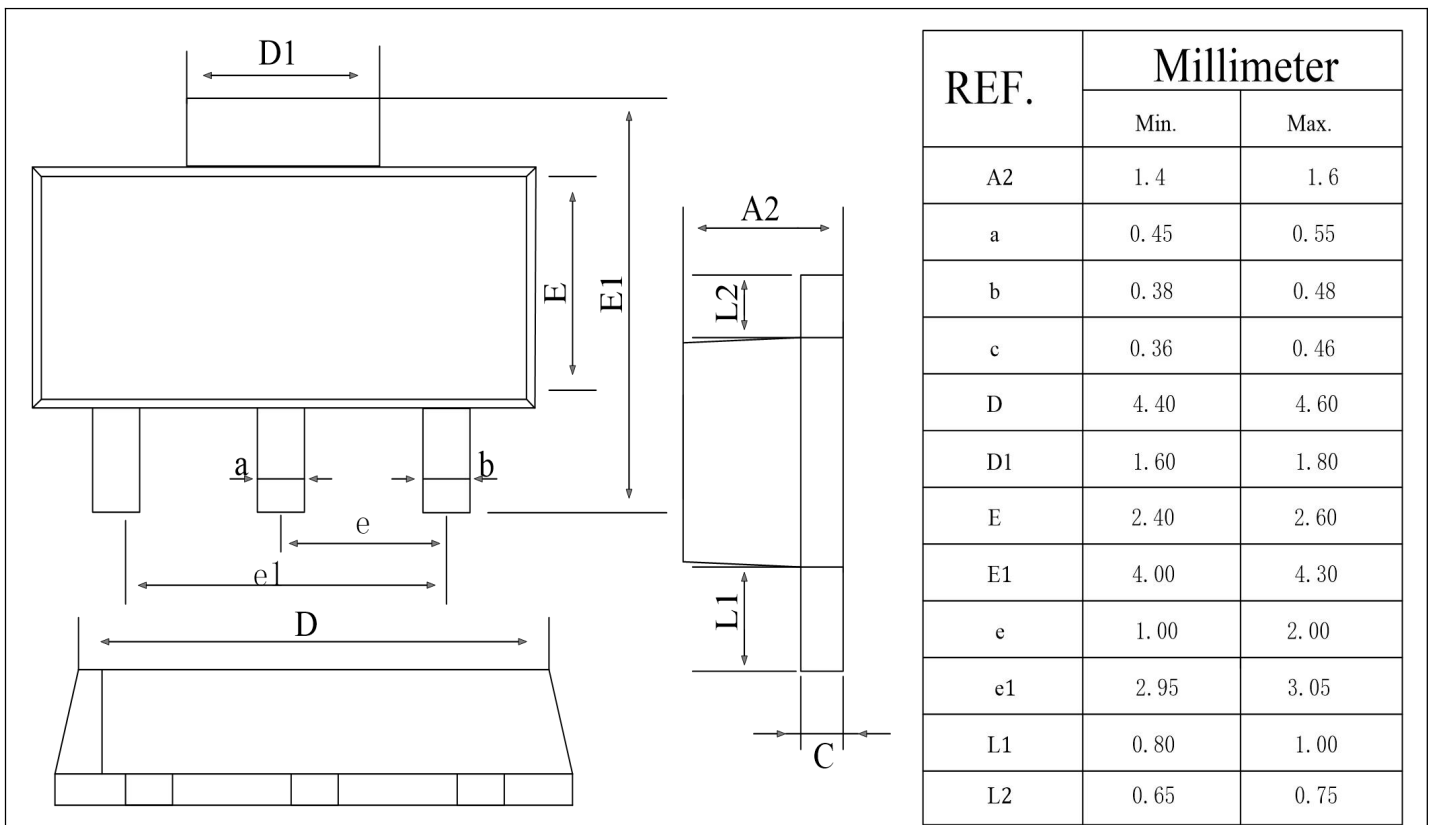
| Part Number                                                                                                                                                                                                                                                                  |                        |                                                                                                                                                                                                                                                                                                                                                                                 |                         |                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------------|
| <b>MST52LXXBTE-A</b><br> <ul style="list-style-type: none"> <li>Pin definition</li> <li>Package definition</li> <li>Voltage accuracy</li> <li>Product Name</li> <li>Company Name</li> </ul> | <b>Package Outline</b> |                                                                                                                                                                                                                                                                                               |                         |                         |
|                                                                                                                                                                                                                                                                              | <b>Minimum Package</b> | SOT23-5<br>3000pcs/Reel                                                                                                                                                                                                                                                                                                                                                         | SOT23-3<br>3000pcs/Reel | SOT89-3<br>1000pcs/Reel |
|                                                                                                                                                                                                                                                                              | <b>Marking</b>         |  <ul style="list-style-type: none"> <li>52LXXB: B: B(<math>\pm 2\%</math>) A(<math>\pm 1\%</math>) C(<math>\pm 3\%</math>)</li> <li>52LXX: 52L18(1.8V) 52L33(3.3V) 52L30(3.0V) 52L50(5.0V)</li> <li>T: Internal Code. Variable.</li> <li>221: 2-2022; 21-the 21th week of this year</li> </ul> |                         |                         |

## Package Outline

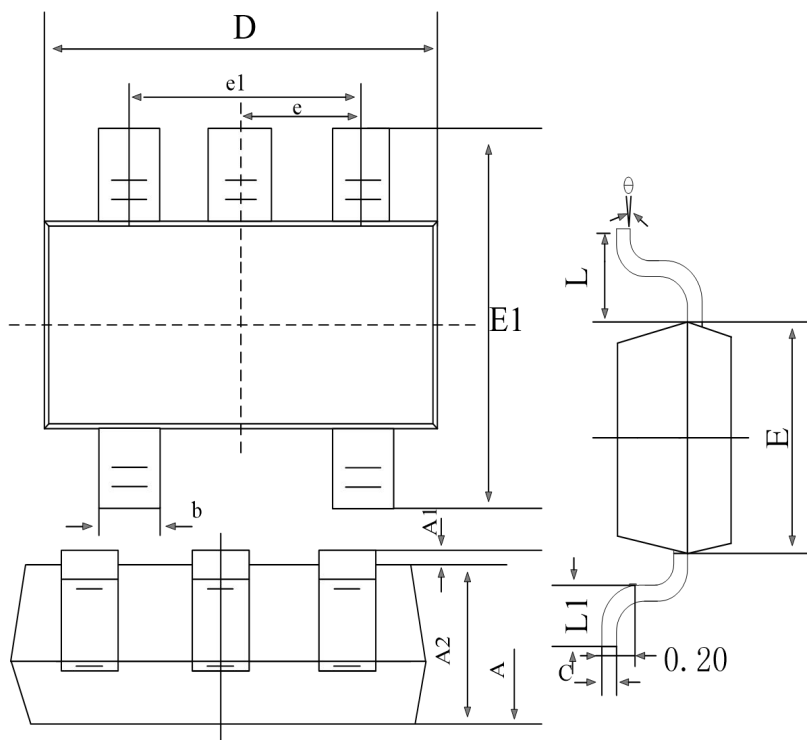
### SOT23-3



### SOT89-3

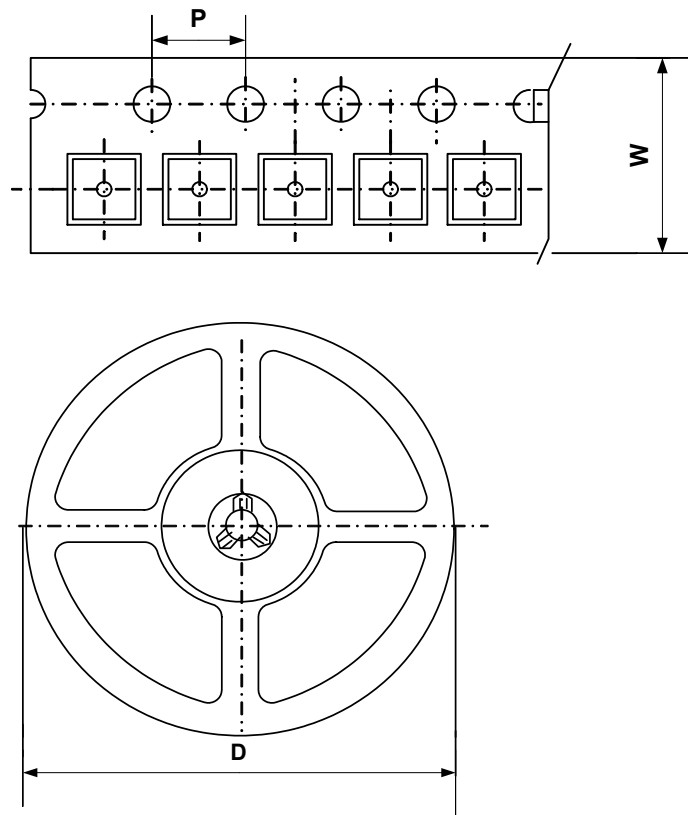


**SOT23-5**



| REF.     | Millimeter |      |
|----------|------------|------|
|          | Min.       | Max. |
| A        | 1.05       | 1.25 |
| A1       | 0          | 0.1  |
| A2       | 1.05       | 1.15 |
| b        | 0.3        | 0.5  |
| c        | 0.1        | 0.2  |
| D        | 2.85       | 3.05 |
| E        | 1.5        | 1.7  |
| E1       | 2.65       | 2.95 |
| e        | 0.95 (BSC) |      |
| e1       | 1.8        | 2.0  |
| L        | 0.3        | 0.6  |
| $\theta$ | 0°         | 8°   |

## Packing Information



| Type    | W(mm)       | P(mm)      | D(mm)    | Qty (pcs) |
|---------|-------------|------------|----------|-----------|
| SOT23-3 | 8.0±0.1 mm  | 4.0±0.1 mm | 180±1 mm | 3000pcs   |
| SOT23-5 | 8.0±0.1 mm  | 4.0±0.1 mm | 180±1 mm | 3000pcs   |
| SOT89-3 | 12.0±0.1 mm | 4.0±0.1 mm | 180±1 mm | 1000pcs   |



## Revision History and Checking Table

| Version | Date     | Revision Item | Modifier    | Function & Spec Checking | Package & Tape Checking |
|---------|----------|---------------|-------------|--------------------------|-------------------------|
| 1-0     | 2023-5-4 |               | Xingxiaolin | Xingxiaolin              | Xingxiaolin             |



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