

## Features

- $V_{DS} = -40V$ ,  $I_D = -5A$   
 $R_{DS(ON)} < 85m\Omega$  @  $V_{GS} = -10V$   
 $R_{DS(ON)} < 115m\Omega$  @  $V_{GS} = -4.5V$
- Advanced Trench Technology
- Excellent  $R_{DS(ON)}$  and Low Gate Charge
- Lead free product is acquired

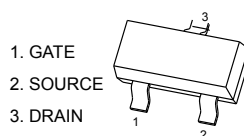
## Applications

- PWM Applications
- Load Switch
- Power Management

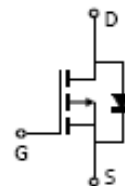
$V_{DSS}$     -40 V  
 $I_D$         -5 A  
 $R_{DS(ON)}$     65  $\Omega$

5P04

## SOT-23



## Equivalent Circuit



## MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

**Absolute Maximum Ratings** (@  $T_C = 25^\circ C$  unless otherwise specified)

| Symbol          | Parameter                               |                     | Max.        | Units        |
|-----------------|-----------------------------------------|---------------------|-------------|--------------|
| $V_{DSS}$       | Drain-Source Voltage                    |                     | -40         | V            |
| $V_{GSS}$       | Gate-Source Voltage                     |                     | $\pm 20$    | V            |
| $I_D$           | Continuous Drain Current                | $T_A = 25^\circ C$  | -5          | A            |
|                 |                                         | $T_A = 100^\circ C$ | -3.3        | A            |
| $I_{DM}$        | Pulsed Drain Current <sup>note1</sup>   |                     | -20         | A            |
| $P_D$           | Power Dissipation                       | $T_A = 25^\circ C$  | 3.4         | W            |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient |                     | 37          | $^\circ C/W$ |
| $T_J, T_{STG}$  | Operating and Storage Temperature Range |                     | -55 to +150 | $^\circ C$   |

## Electrical Characteristics ( $T_J=25^{\circ}\text{C}$ unless otherwise noted)

| Symbol                                                 | Parameter                                                 | Test Condition                                                                                  | Min. | Typ. | Max. | Units |
|--------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------|------|------|------|-------|
| Off Characteristic                                     |                                                           |                                                                                                 |      |      |      |       |
| V <sub>(BR)DSS</sub>                                   | Drain-Source Breakdown Voltage                            | V <sub>GS</sub> =0V, I <sub>D</sub> = -250μA                                                    | -40  | -    | -    | V     |
| I <sub>DSS</sub>                                       | Zero Gate Voltage Drain Current                           | V <sub>DS</sub> = -40V, V <sub>GS</sub> =0V                                                     | -    | -    | -1   | μA    |
| I <sub>GSS</sub>                                       | Gate to Body Leakage Current                              | V <sub>DS</sub> =0V, V <sub>GS</sub> = ±20V                                                     | -    | -    | ±100 | nA    |
| On Characteristics                                     |                                                           |                                                                                                 |      |      |      |       |
| V <sub>GS(th)</sub>                                    | Gate Threshold Voltage                                    | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> = -250μA                                      | -1.0 | -1.6 | -2.5 | V     |
| R <sub>DS(on)</sub>                                    | Static Drain-Source on-Resistance<br><small>note3</small> | V <sub>GS</sub> = -10V, I <sub>D</sub> = -3A                                                    | -    | 65   | 85   | mΩ    |
|                                                        |                                                           | V <sub>GS</sub> = -4.5V, I <sub>D</sub> = -2A                                                   | -    | 90   | 115  |       |
| Dynamic Characteristics                                |                                                           |                                                                                                 |      |      |      |       |
| C <sub>iss</sub>                                       | Input Capacitance                                         | V <sub>DS</sub> = -20V, V <sub>GS</sub> =0V,<br>f=1.0MHz                                        | -    | 573  | -    | pF    |
| C <sub>oss</sub>                                       | Output Capacitance                                        |                                                                                                 | -    | 53   | -    | pF    |
| C <sub>rss</sub>                                       | Reverse Transfer Capacitance                              |                                                                                                 | -    | 42   | -    | pF    |
| Q <sub>g</sub>                                         | Total Gate Charge                                         | V <sub>DS</sub> = -20V, I <sub>D</sub> = -3A,<br>V <sub>GS</sub> = -10V                         | -    | 7.1  | -    | nC    |
| Q <sub>gs</sub>                                        | Gate-Source Charge                                        |                                                                                                 | -    | 1.5  | -    | nC    |
| Q <sub>gd</sub>                                        | Gate-Drain(“Miller”) Charge                               |                                                                                                 | -    | 1.8  | -    | nC    |
| Switching Characteristics                              |                                                           |                                                                                                 |      |      |      |       |
| t <sub>d(on)</sub>                                     | Turn-on Delay Time                                        | V <sub>DD</sub> = -20V, I <sub>D</sub> = -5A,<br>V <sub>GS</sub> = -10V, R <sub>GEN</sub> =2.5Ω | -    | 6.5  | -    | ns    |
| t <sub>r</sub>                                         | Turn-on Rise Time                                         |                                                                                                 | -    | 14   | -    | ns    |
| t <sub>d(off)</sub>                                    | Turn-off Delay Time                                       |                                                                                                 | -    | 34   | -    | ns    |
| t <sub>f</sub>                                         | Turn-off Fall Time                                        |                                                                                                 | -    | 18   | -    | ns    |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                           |                                                                                                 |      |      |      |       |
| I <sub>S</sub>                                         | Maximum Continuous Drain to Source Diode Forward Current  |                                                                                                 | -    | -    | -5   | A     |
| I <sub>SM</sub>                                        | Maximum Pulsed Drain to Source Diode Forward Current      |                                                                                                 | -    | -    | -20  | A     |
| V <sub>SD</sub>                                        | Drain to Source Diode Forward Voltage                     | V <sub>GS</sub> =0V, I <sub>S</sub> = -5A                                                       | -    | -0.8 | -1.2 | V     |
| t <sub>rr</sub>                                        | Reverse Recovery Time                                     | V <sub>GS</sub> =0V, I <sub>S</sub> = -5A,                                                      | -    | 23   | -    | ns    |
| Q <sub>rr</sub>                                        | Reverse Recovery Charge                                   | di/dt=100A/μs                                                                                   | -    | 25.2 | -    | nC    |

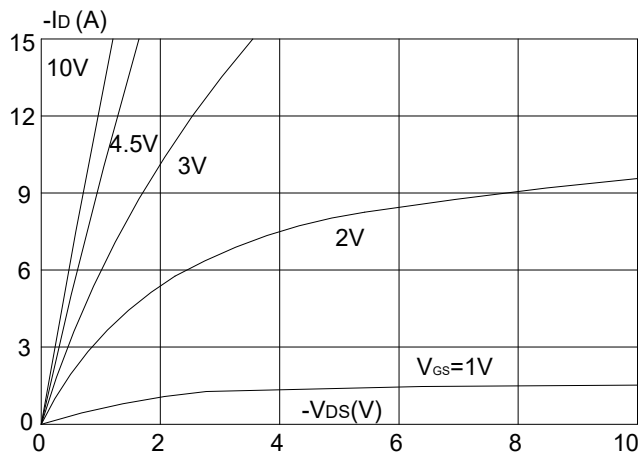
Notes: 1. Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature

2. Pulse Test: Pulse Width $\leq 300\mu s$ , Duty Cycle $\leq 2\%$

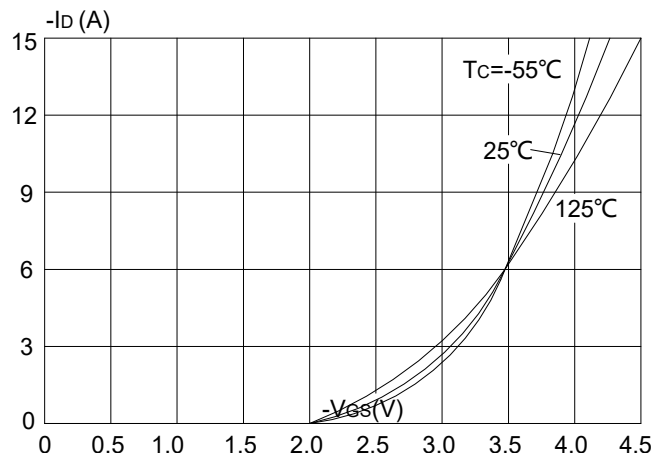


## RATING AND CHARACTERISTIC CURVES

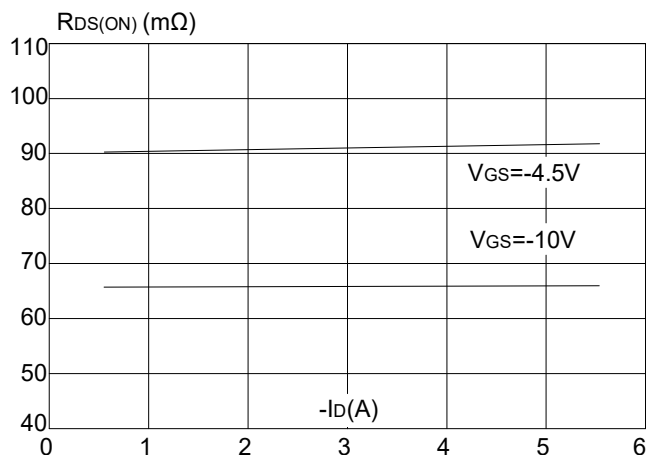
**Figure1: Output Characteristics**



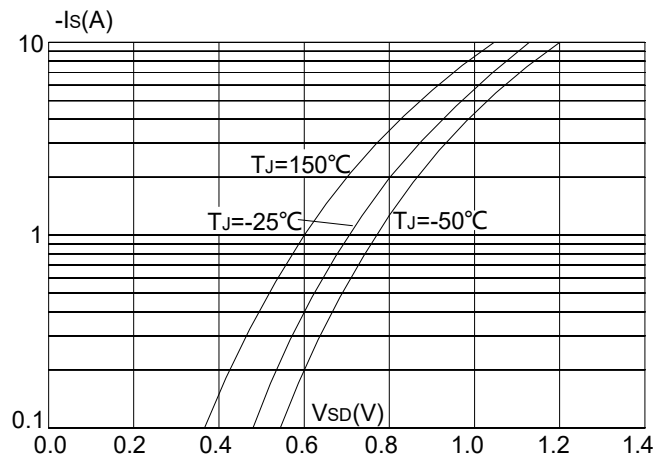
**Figure 2: Typical Transfer Characteristics**



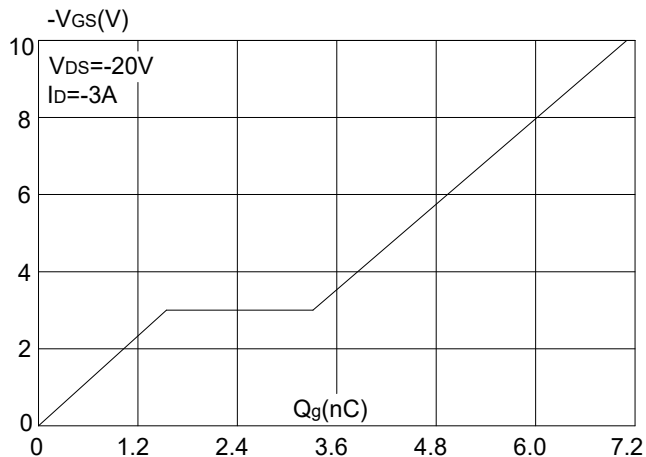
**Figure 3: On-resistance vs. Drain Current**



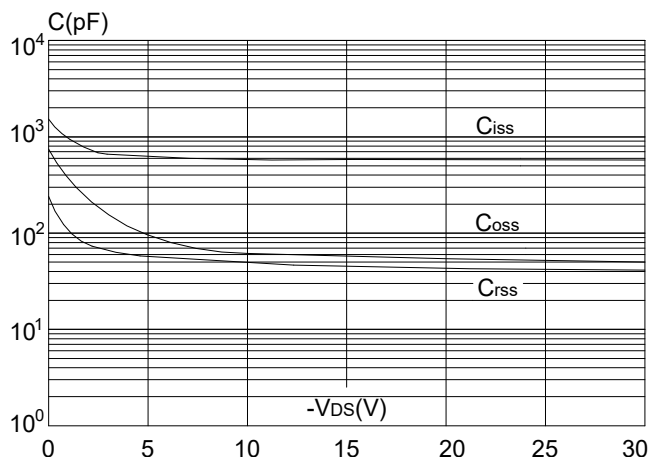
**Figure 4: Body Diode Characteristics**



**Figure 5: Gate Charge Characteristics**

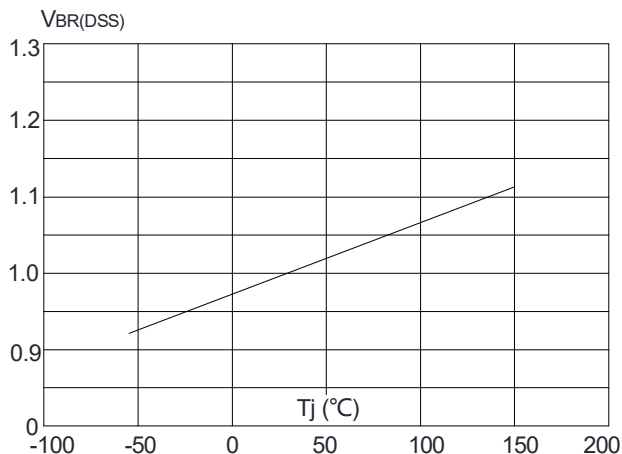


**Figure 6: Capacitance Characteristics**

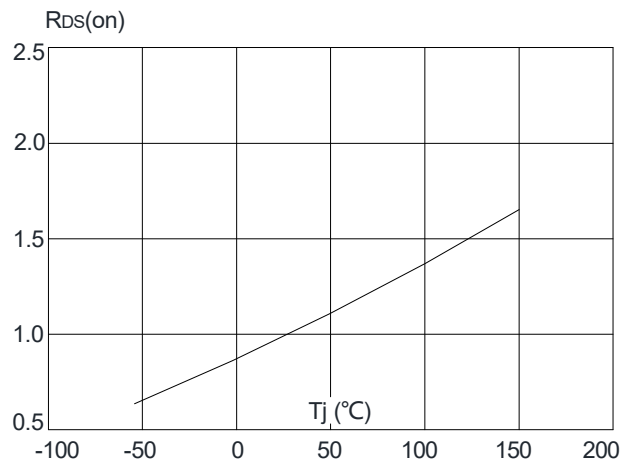


## RATING AND CHARACTERISTIC CURVES

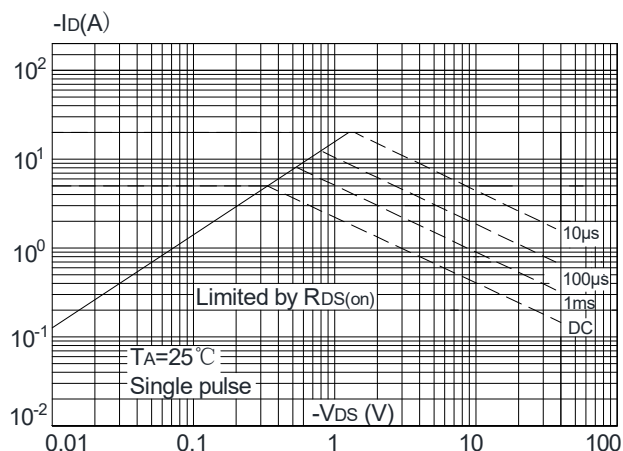
**Figure 7:** Normalized Breakdown Voltage vs. Junction Temperature



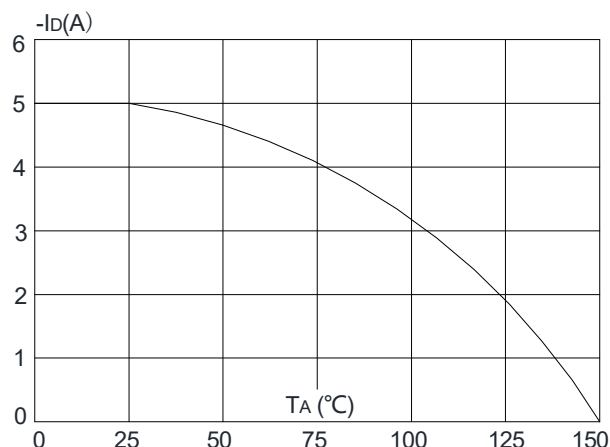
**Figure 8:** Normalized on Resistance vs. Junction Temperature



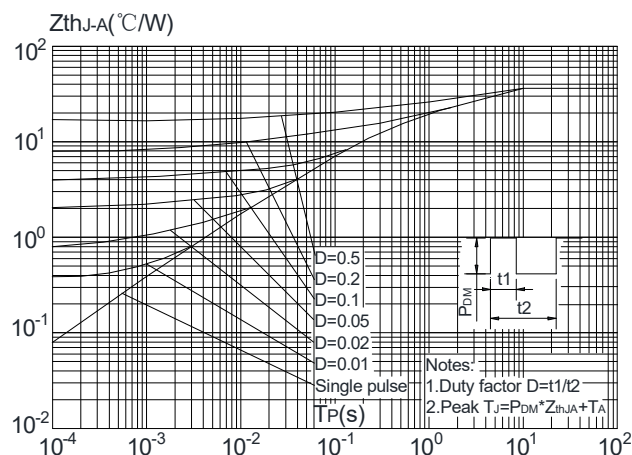
**Figure 9:** Maximum Safe Operating Area



**Figure 10:** Maximum Continuous Drain Current vs. Ambient Temperature



**Figure.11:** Maximum Effective Transient Thermal Impedance, Junction-to-Ambient



## Test Circuit

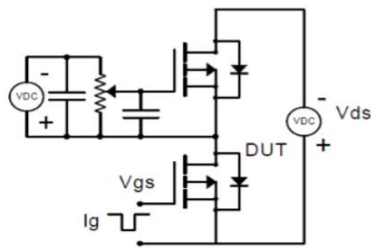


Figure 1: Gate Charge Test Circuit & Waveform

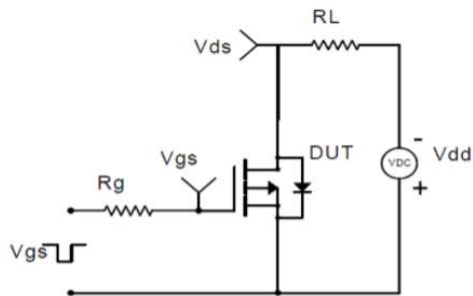


Figure 2: Resistive Switching Test Circuit & Waveform

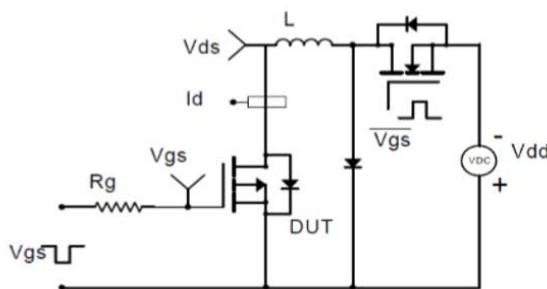


Figure 3: Unclamped Inductive Switching Test Circuit & Waveform

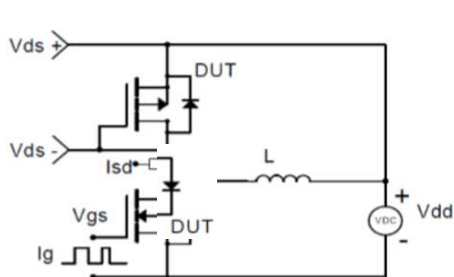
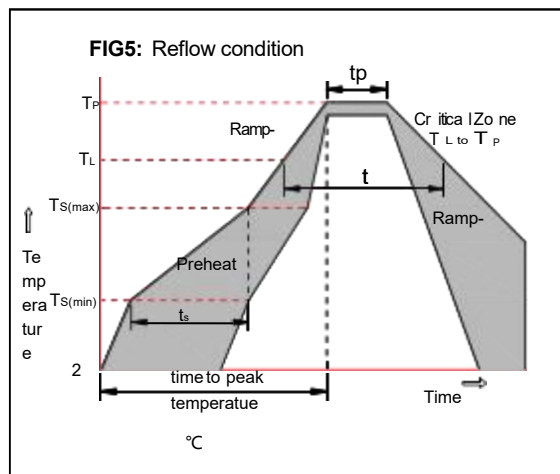


Figure 4: Diode Recovery Test Circuit & Waveform

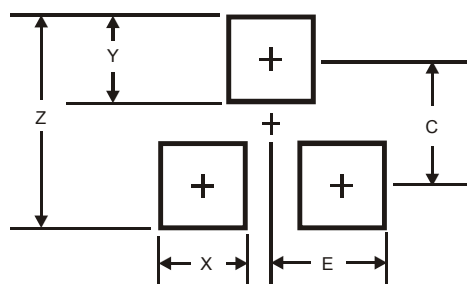
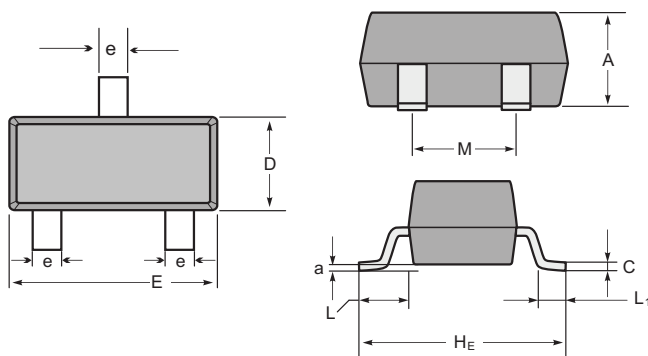
## Soldering parameters

| Reflow Condition                                        |                                   | Pb-Free assembly<br>(see as below) |
|---------------------------------------------------------|-----------------------------------|------------------------------------|
| Pre Heat                                                | -Temperature Min ( $T_{s(min)}$ ) | +150°C                             |
|                                                         | -Temperature Max( $T_{s(max)}$ )  | +200°C                             |
|                                                         | -Time (Min to Max) (ts)           | 60-180 secs.                       |
| Average ramp up rate (Liquid us Temp ( $T_L$ ) to peak) |                                   | 3°C/sec. Max                       |
| $T_{s(max)}$ to $T_L$ - Ramp-up Rate                    |                                   | 3°C/sec. Max                       |
| Reflow                                                  | -Temperature( $T_L$ )(Liquid us)  | +217°C                             |
|                                                         | -Temperature( $t_L$ )             | 60-150 secs.                       |
| Peak Temp ( $T_P$ )                                     |                                   | +260(+0/-5)°C                      |
| Time within 5°C of actual Peak Temp ( $t_P$ )           |                                   | 30 secs. Max                       |
| Ramp-down Rate                                          |                                   | 6°C/sec. Max                       |
| Time 25°C to Peak Temp ( $T_P$ )                        |                                   | 8 min. Max                         |
| Do not exceed                                           |                                   | +260°C                             |



## Package Dimensions & Suggested Pad Layout

### SOT23



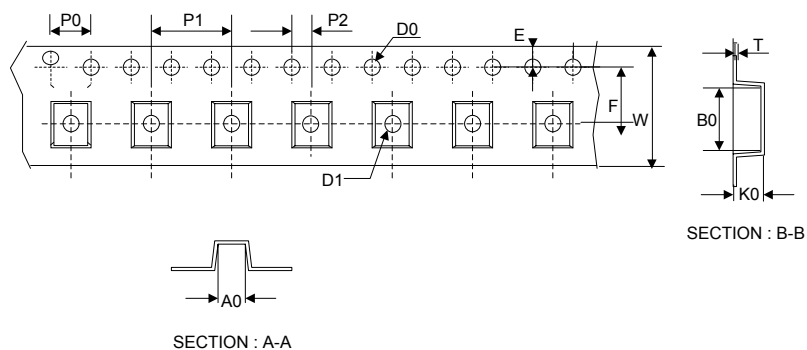
### SOT-23 mechanical data

| UNIT | A   | C   | D    | E   | H <sub>E</sub> | e   | M   | L    | L <sub>1</sub> | a    |
|------|-----|-----|------|-----|----------------|-----|-----|------|----------------|------|
| mm   | max | 1.1 | 0.15 | 1.4 | 3.0            | 2.6 | 0.5 | 1.95 | 0.55 (ref)     | 0.0  |
|      | min | 0.9 | 0.08 | 1.2 | 2.8            | 2.2 | 0.3 | 1.7  | 0.36 (ref)     | 0.15 |
| mil  | max | 43  | 6    | 55  | 118            | 102 | 20  | 77   | 22 (ref)       | 0.0  |
|      | min | 35  | 3    | 47  | 110            | 87  | 12  | 67   | 14 (ref)       | 6    |

| Dimensions | SOT23 |
|------------|-------|
| Z          | 2.9   |
| X          | 0.8   |
| Y          | 0.9   |
| C          | 2.0   |
| E          | 1.35  |

## Tape & reel specification

### Tape



| Symbol            | Dimension (mm) |
|-------------------|----------------|
| P0                | 4.00±0.10      |
| P1                | 4.00±0.10      |
| P2                | 2.00±0.10      |
| D0                | 1.55±0.10      |
| D1                | 1.05±0.10      |
| E                 | 1.55±0.10      |
| F                 | 3.60±0.10      |
| W                 | 8.00±0.10      |
| A0                | 3.80±0.20      |
| B0                | 3.25±0.20      |
| K0                | 1.45±0.10      |
| T                 | 0.25±0.05      |
| D2                | 178.0±3.0      |
| D3                | 55Min.         |
| D4                | R24.0±3.0      |
| G                 | R82.0±3.0      |
| I                 | 13.0±2.0       |
| W1                | 11.0±3.0       |
| Quantity: 3000PCS |                |

### 7" Reel

