



## TM04N02I

## N-Channel Enhancement Mosfet

### General Description

- Low  $R_{DS(ON)}$
- RoHS and Halogen-Free Compliant

### Applications

- Load switch
- PWM

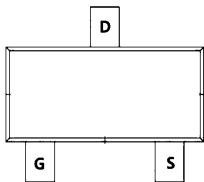
### General Features

$V_{DS} = 20V$   $I_D = 3.8A$   
 $R_{DS(ON)} = 35 m\Omega (Typ.) @ V_{GS} = 4.5V$

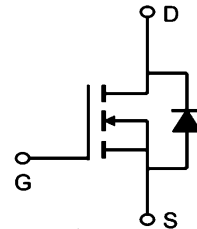
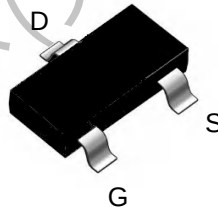
100% UIS Tested  
100%  $R_g$  Tested



I: SOT-23



Marking: A2SHB



### Absolute Maximum Ratings ( $T_C = 25^\circ C$ unless otherwise noted)

| Symbol                   | Parameter                                   | Rating     | Units      |
|--------------------------|---------------------------------------------|------------|------------|
| $V_{DS}$                 | Drain-Source Voltage                        | 20         | V          |
| $V_{GS}$                 | Gate-Source Voltage                         | $\pm 12$   | V          |
| $I_D @ T_A = 25^\circ C$ | Continuous Drain Current, $V_{GS} @ 4.5V^1$ | 3.8        | A          |
| $I_D @ T_A = 70^\circ C$ | Continuous Drain Current, $V_{GS} @ 4.5V^1$ | 2.47       | A          |
| $I_{DM}$                 | Pulsed Drain Current <sup>2</sup>           | 14         | A          |
| $P_D @ T_A = 25^\circ C$ | Total Power Dissipation <sup>3</sup>        | 1.05       | W          |
| $T_{STG}$                | Storage Temperature Range                   | -55 to 150 | $^\circ C$ |
| $T_J$                    | Operating Junction Temperature Range        | -55 to 150 | $^\circ C$ |

### Thermal Data

| Symbol          | Parameter                                        | Typ. | Max. | Unit         |
|-----------------|--------------------------------------------------|------|------|--------------|
| $R_{\theta JA}$ | Thermal Resistance Junction-ambient <sup>1</sup> | ---  | 162  | $^\circ C/W$ |
| R               | Thermal Resistance Junction Case <sup>1</sup>    |      |      | $^\circ C/W$ |

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### Electrical Characteristics

$T_C = 25^\circ\text{C}$  unless otherwise noted

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

#### Off Characteristics

|            |                                    |                                                     |    |    |      |               |
|------------|------------------------------------|-----------------------------------------------------|----|----|------|---------------|
| $BV_{DSS}$ | Drain-Source Breakdown Voltage     | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 20 | -- | --   | V             |
| $I_{DSS}$  | Zero Gate Voltage Drain Current    | $V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}$         | -- | -- | 1    | $\mu\text{A}$ |
|            |                                    | $V_{DS} = 16\text{ V}, T_C = 125^\circ\text{C}$     | -- | -- | 10   | $\mu\text{A}$ |
| $I_{GSSF}$ | Gate-Body Leakage Current, Forward | $V_{GS} = 10\text{ V}, V_{DS} = 0\text{ V}$         | -- | -- | 100  | nA            |
| $I_{GSSR}$ | Gate-Body Leakage Current, Reverse | $V_{GS} = -10\text{ V}, V_{DS} = 0\text{ V}$        | -- | -- | -100 | nA            |

#### On Characteristics

|              |                                   |                                                 |     |     |     |            |
|--------------|-----------------------------------|-------------------------------------------------|-----|-----|-----|------------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 0.5 | 0.7 | 0.9 | V          |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 4.5\text{ V}, I_D = 3.5\text{ A}$     | --  | 35  | 55  | m $\Omega$ |
|              |                                   | $V_{GS} = 2.5\text{ V}, I_D = 2.0\text{ A}$     | -   | 55  | 70  |            |

#### Dynamic Characteristics

|           |                              |                                                                      |    |     |    |    |
|-----------|------------------------------|----------------------------------------------------------------------|----|-----|----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 180 | -  | pF |
| $C_{oss}$ | Output Capacitance           |                                                                      | -- | 37  | -- | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                      | -- | 34  | -  | pF |

#### Switching Characteristics

|              |                     |                                                                                                                    |    |      |    |    |
|--------------|---------------------|--------------------------------------------------------------------------------------------------------------------|----|------|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{GS} = 5\text{ V}, V_{DS} = 10\text{ V}, I_D = 3\text{ A},$<br>$R_G = 6\text{ }\Omega, R_L = 2.7\text{ }\Omega$ | -- | 4.5  | -- | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                                                    | -- | 31   | -- | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                                                    | -- | 12   | -- | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                                                    | -- | 4.0  | -- | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 10\text{ V}, I_D = 3\text{ A},$<br>$V_{GS} = 5\text{ V}$                                                 | -- | 6.23 | -- | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                                                    | -- | 6    | -- | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                                                    | -- | 0.5  | -- | nC |

#### Drain-Source Diode Characteristics and Maximum Ratings

|          |                                                                                                             |    |    |     |   |
|----------|-------------------------------------------------------------------------------------------------------------|----|----|-----|---|
| $I_S$    | Maximum Continuous Drain-Source Diode Forward Current                                                       | -- | -- | 3.8 | A |
| $I_{SM}$ | Maximum Pulsed Drain-Source Diode Forward Current                                                           | -- | -- | 14  | A |
| $V_{SD}$ | Drain to Source Diode Forward Voltage, $V_{GS} = 0\text{ V}, I_{SD} = 3.5\text{ A}, T_J = 25^\circ\text{C}$ | -- | -- | 1.2 | V |

#### Notes:

1. Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature
2. Device mounted on FR-4 PCB, 1inch x 0.85inch x 0.062 inch
3. Pulse Test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycles  $\leq 0.5\%$

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### Typical Performance Characteristics

#### N- Channel Typical Characteristics

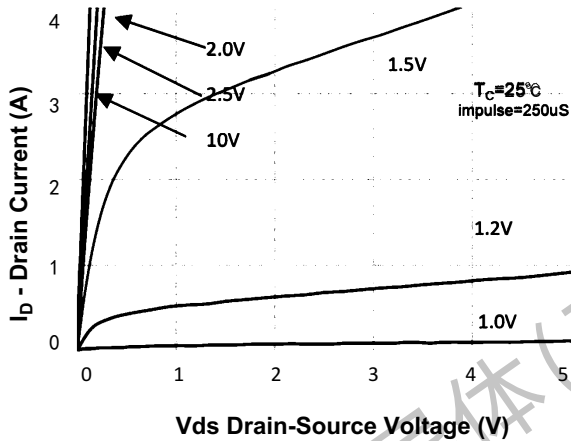


Figure 1. On-Region Characteristics

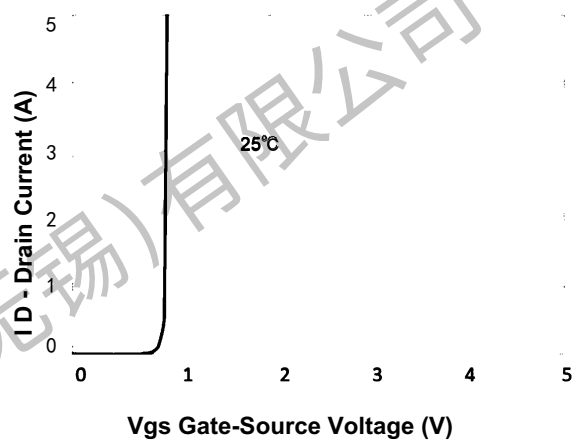


Figure 2. Transfer Characteristics

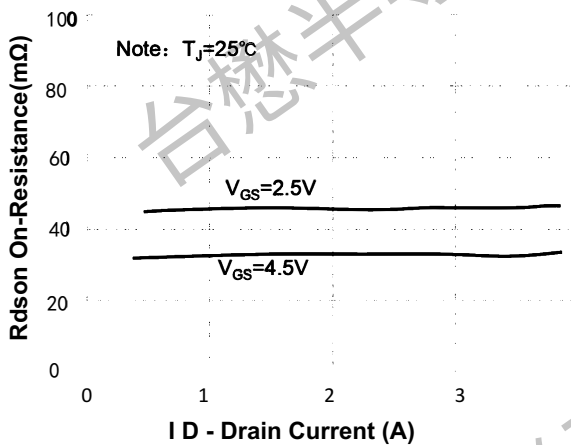


Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

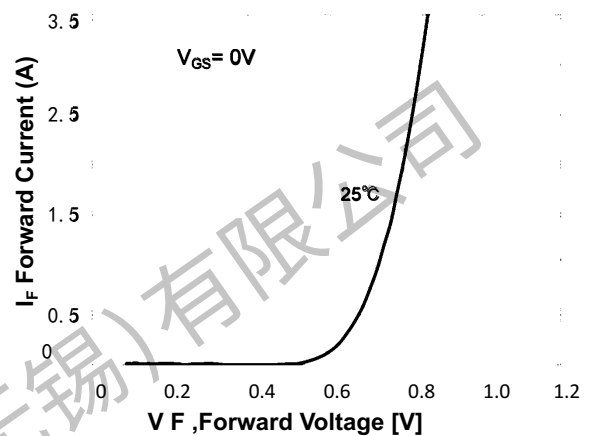


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

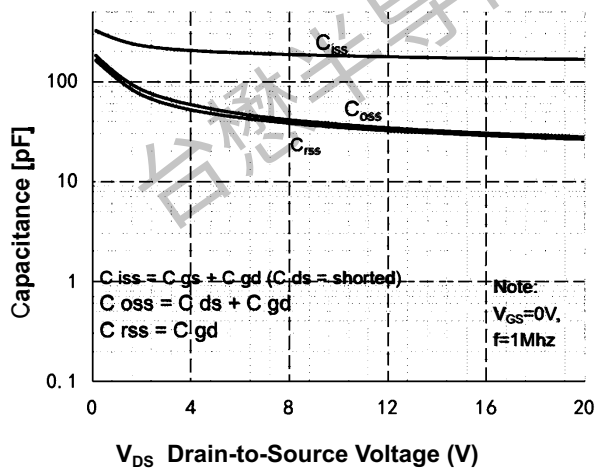


Figure 5. Capacitance Characteristics

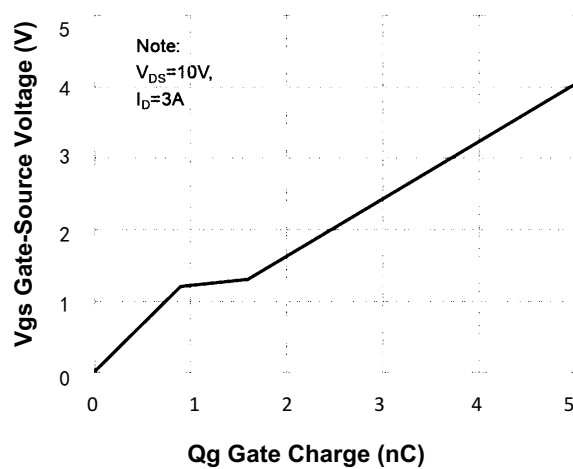
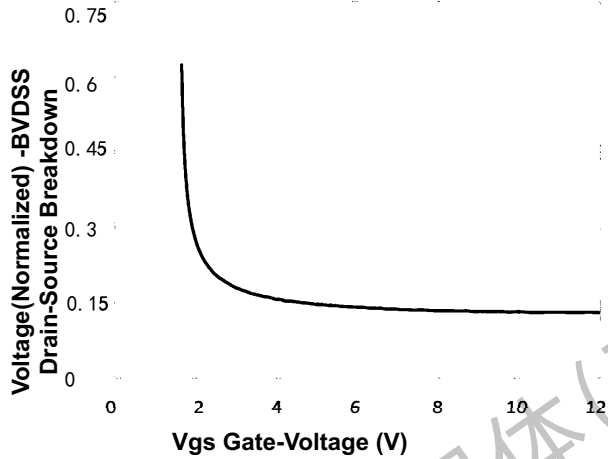


Figure 6. Gate Charge Characteristics

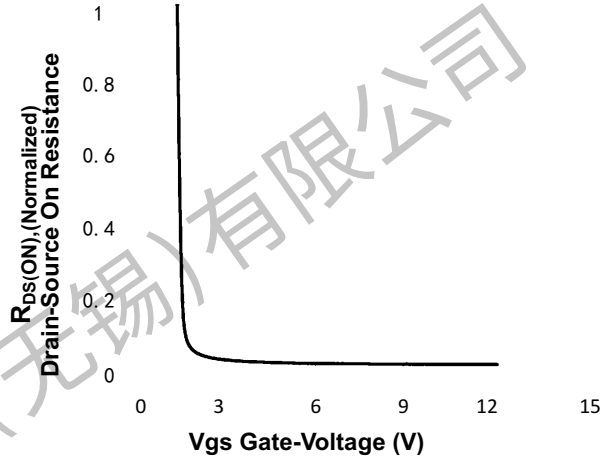
# TM04N02I

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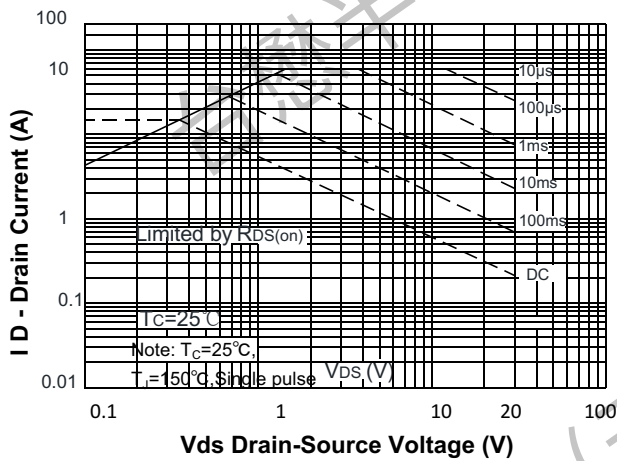
## N- Channel Typical Characteristics (Continued)



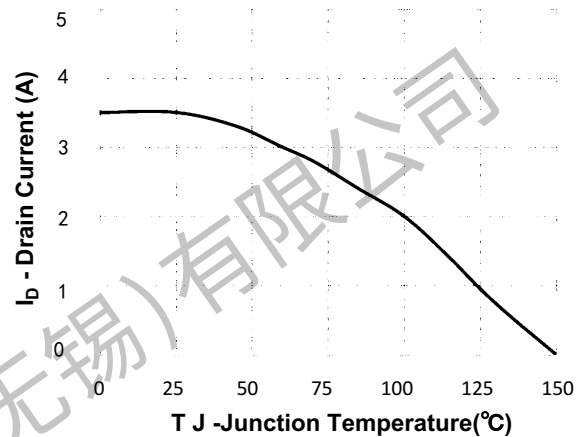
**Figure 7. Breakdown Voltage Variation vs Gate-Voltage**



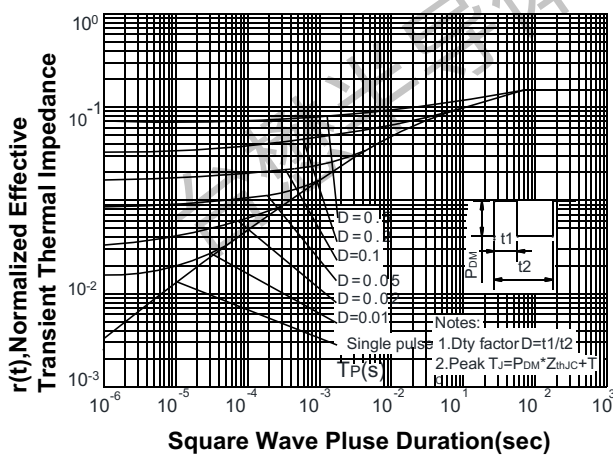
**Figure 8. On-Resistance Variation vs Gate Voltage**



**Figure 9. Maximum Safe Operating Area**



**Figure 10. Maximum PContinuous Drain Current vs Case Temperature**



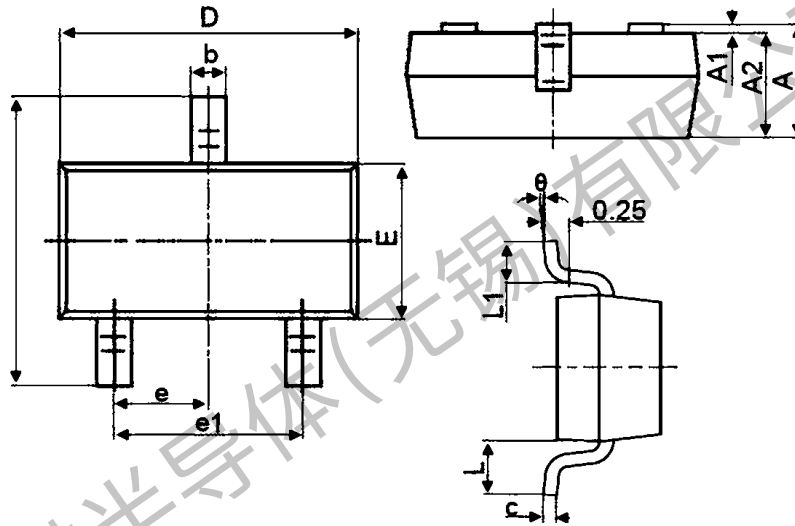
**Figure 11. Transient Thermal Response Curve**



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### Package Mechanical Data:SOT-23



| Symbol | Dimensions in Millimeters |       |
|--------|---------------------------|-------|
|        | MIN.                      | MAX.  |
| A      | 0.900                     | 1.150 |
| A1     | 0.000                     | 0.100 |
| A2     | 0.900                     | 1.050 |
| b      | 0.300                     | 0.500 |
| c      | 0.080                     | 0.150 |
| D      | 2.800                     | 3.000 |
| E      | 1.200                     | 1.400 |
| E1     | 2.250                     | 2.550 |
| e      | 0.950TYP                  |       |
| e1     | 1.800                     | 2.000 |
| L      | 0.550REF                  |       |
| L1     | 0.300                     | 0.500 |
| θ      | 0°                        | 8°    |

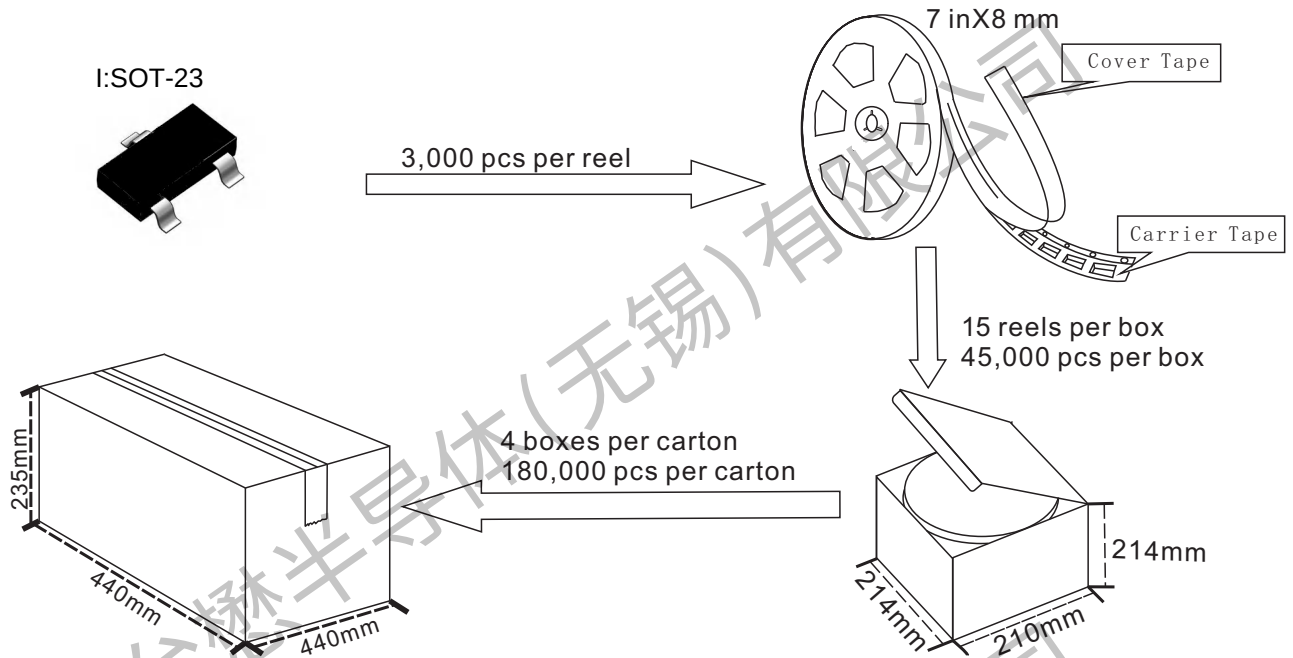


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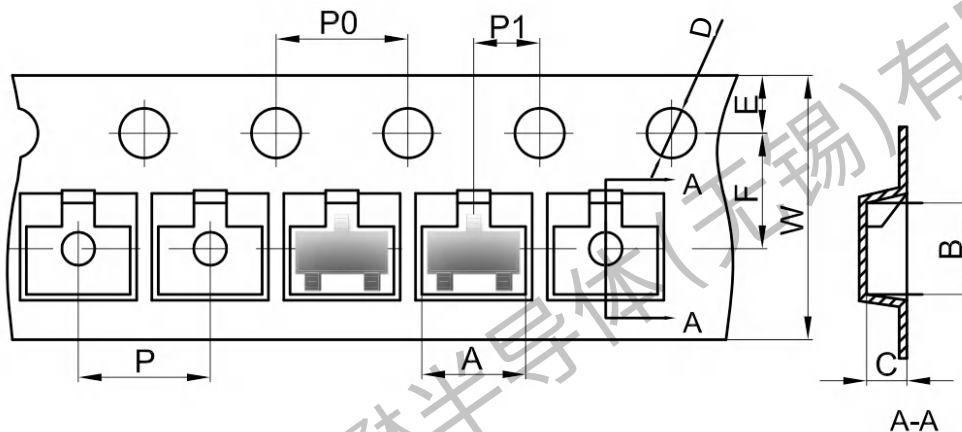
## N-Channel Enhancement Mosfet

### SOT-23 Packing

1. The method of packaging and dimension are shown as below figure. (Dimension in mm)



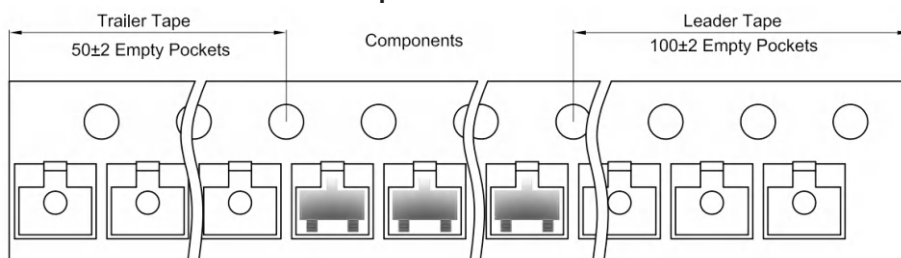
### SOT-23 Embossed Carrier Tape



Dimensions are in millimeter

| Pkg type | A    | B    | C    | D     | E    | F    | P0   | P    | P1   | W    |
|----------|------|------|------|-------|------|------|------|------|------|------|
| SOT-23   | 3.15 | 2.77 | 1.22 | Ø1.50 | 1.75 | 3.50 | 4.00 | 4.00 | 2.00 | 8.00 |

### SOT-23 Tape Leader and Trailer





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#### Revision history:

| Date       | Rev   | Description | Page |
|------------|-------|-------------|------|
| 2024.05.09 | 24.05 | Original    |      |