

## 20V(D-S) N-Channel Enhancement Mode Power MOS FET

### General Features

- $V_{DS} = 20V, I_D = 4A$   
 $R_{DS(ON)} < 59m\Omega @ V_{GS}=2.5V$   
 $R_{DS(ON)} < 45m\Omega @ V_{GS}=4.5V$
- High power and current handling capability
- Lead free product is acquired
- Surface mount package

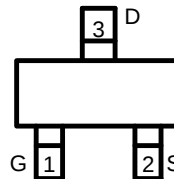


**Lead Free**

### Application

- Battery protection
- Load switch
- Power management

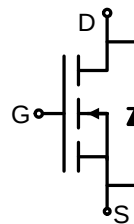
### PIN Configuration



Marking and pin assignment



SOT-23 top view



Schematic diagram

### Package Marking and Ordering Information

| Device Marking | Device   | Device Package | Reel Size | Tape width | Quantity   |
|----------------|----------|----------------|-----------|------------|------------|
|                | MSN2302A | SOT-23         | Ø180mm    | 8 mm       | 3000 units |

### Absolute Maximum Ratings ( $T_A=25^\circ\text{C}$ unless otherwise noted)

| Parameter                                        | Symbol         | Limit      | Unit             |
|--------------------------------------------------|----------------|------------|------------------|
| Drain-Source Voltage                             | $V_{DS}$       | 20         | V                |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 12$   | V                |
| Drain Current-Continuous                         | $I_D$          | 4          | A                |
| Drain Current-Pulsed <sup>(Note 1)</sup>         | $I_{DM}$       | 10         | A                |
| Maximum Power Dissipation                        | $P_D$          | 1          | W                |
| Operating Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 To 150 | $^\circ\text{C}$ |

### Thermal Characteristic

|                                                             |                 |     |                    |
|-------------------------------------------------------------|-----------------|-----|--------------------|
| Thermal Resistance, Junction-to-Ambient <sup>(Note 2)</sup> | $R_{\theta JA}$ | 125 | $^\circ\text{C/W}$ |
|-------------------------------------------------------------|-----------------|-----|--------------------|

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

| Parameter                          | Symbol              | Condition                                                                                 | Min | Typ  | Max  | Unit |
|------------------------------------|---------------------|-------------------------------------------------------------------------------------------|-----|------|------|------|
| Off Characteristics                |                     |                                                                                           |     |      |      |      |
| Drain-Source Breakdown Voltage     | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V I <sub>D</sub> =250μA                                                 | 20  | 22   | -    | V    |
| Zero Gate Voltage Drain Current    | I <sub>DSS</sub>    | V <sub>DS</sub> =20V, V <sub>GS</sub> =0V                                                 | -   | -    | 1    | μA   |
| Parameter                          | Symbol              | Condition                                                                                 | Min | Typ  | Max  | Unit |
| Gate-Body Leakage Current          | I <sub>GSS</sub>    | V <sub>GS</sub> =±12V, V <sub>DS</sub> =0V                                                | -   | -    | ±100 | nA   |
| On Characteristics (Note 3)        |                     |                                                                                           |     |      |      |      |
| Gate Threshold Voltage             | V <sub>GS(th)</sub> | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                                  | 0.5 | 0.85 | 1.2  | V    |
| Drain-Source On-State Resistance   | R <sub>DS(ON)</sub> | V <sub>GS</sub> =2.5V, I <sub>D</sub> =2.5A                                               | -   | 37   | 59   | mΩ   |
|                                    |                     | V <sub>GS</sub> =4.5V, I <sub>D</sub> =2.9A                                               | -   | 30   | 45   | mΩ   |
| Forward Transconductance           | g <sub>FS</sub>     | V <sub>DS</sub> =5V, I <sub>D</sub> =2.9A                                                 | -   | 8    | -    | S    |
| Dynamic Characteristics (Note4)    |                     |                                                                                           |     |      |      |      |
| Input Capacitance                  | C <sub>ISS</sub>    | V <sub>DS</sub> =10V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                    | -   | 300  | -    | PF   |
| Output Capacitance                 | C <sub>OSS</sub>    |                                                                                           | -   | 120  | -    | PF   |
| Reverse Transfer Capacitance       | C <sub>RSS</sub>    |                                                                                           | -   | 80   | -    | PF   |
| Switching Characteristics (Note 4) |                     |                                                                                           |     |      |      |      |
| Turn-on Delay Time                 | t <sub>d(on)</sub>  | V <sub>DD</sub> =10V, I <sub>D</sub> =2.9A<br>V <sub>GS</sub> =4.5V, R <sub>GEN</sub> =6Ω | -   | 10   | 15   | nS   |
| Turn-on Rise Time                  | t <sub>r</sub>      |                                                                                           | -   | 50   | 85   | nS   |
| Turn-Off Delay Time                | t <sub>d(off)</sub> |                                                                                           | -   | 17   | 45   | nS   |
| Turn-Off Fall Time                 | t <sub>f</sub>      |                                                                                           | -   | 10   | 20   | nS   |
| Total Gate Charge                  | Q <sub>g</sub>      | V <sub>DS</sub> =10V, I <sub>D</sub> =2.9A,<br>V <sub>GS</sub> =4.5V                      | -   | 4.0  | 10   | nC   |
| Gate-Source Charge                 | Q <sub>GS</sub>     |                                                                                           | -   | 0.65 | -    | nC   |
| Gate-Drain Charge                  | Q <sub>gd</sub>     |                                                                                           | -   | 1.2  | -    | nC   |
| Drain-Source Diode Characteristics |                     |                                                                                           |     |      |      |      |
| Diode Forward Voltage (Note 3)     | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =2.9A                                                 | -   | 0.75 | 1.2  | V    |
| Diode Forward Current (Note 2)     | I <sub>S</sub>      |                                                                                           | -   | -    | 4    | A    |

**Notes:**

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production

## Typical Electrical and Thermal Characteristics

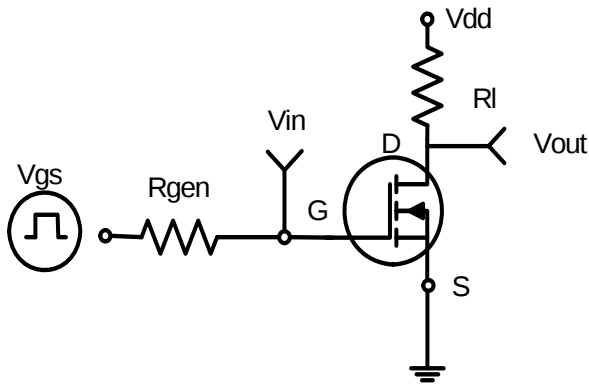


Figure 1: Switching Test Circuit

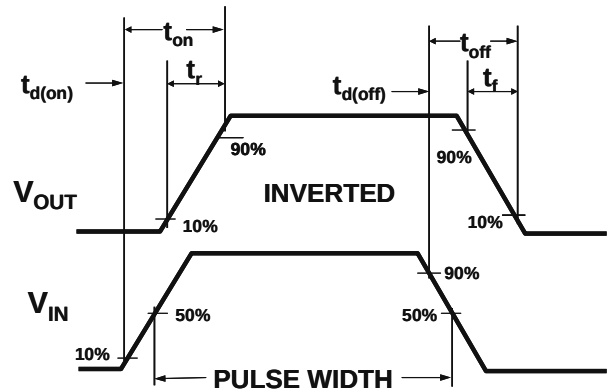


Figure 2: Switching Waveforms

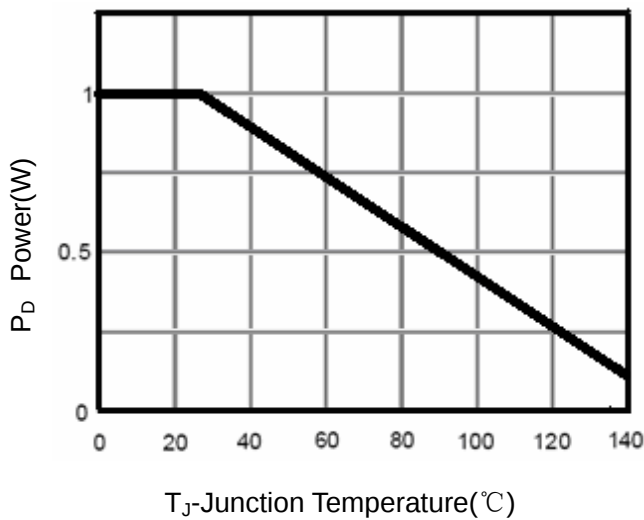


Figure 3: Power Dissipation

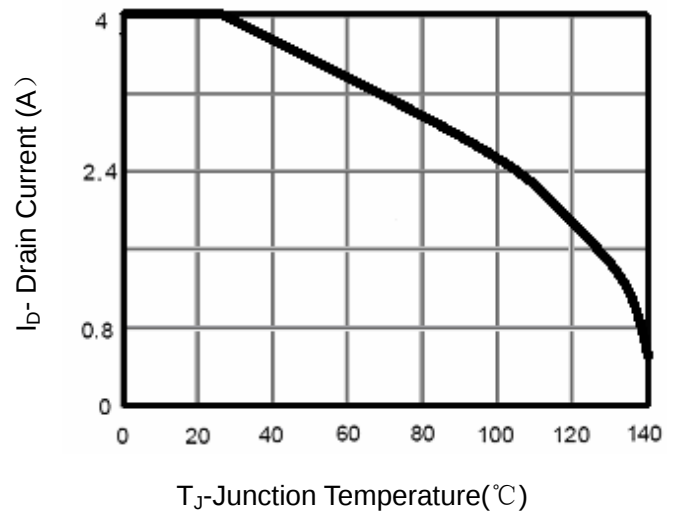


Figure 4: Drain Current

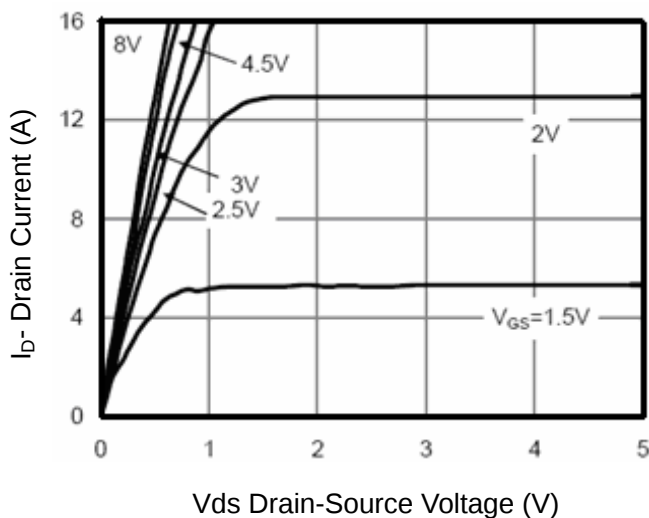


Figure 5: Output Characteristics

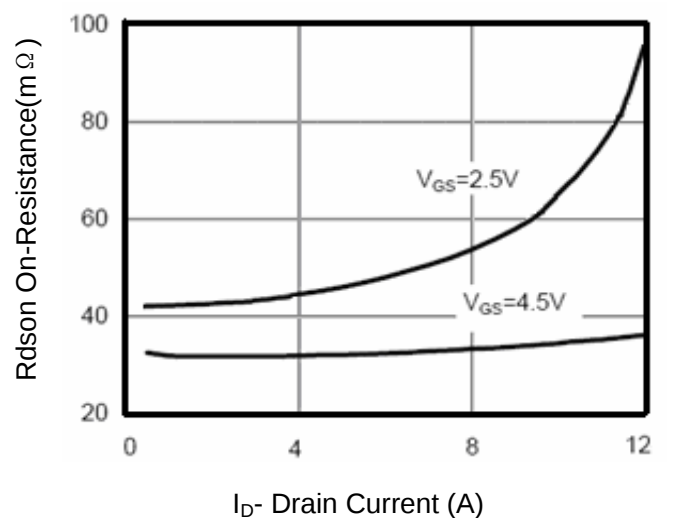


Figure 6: Drain-Source On-Resistance

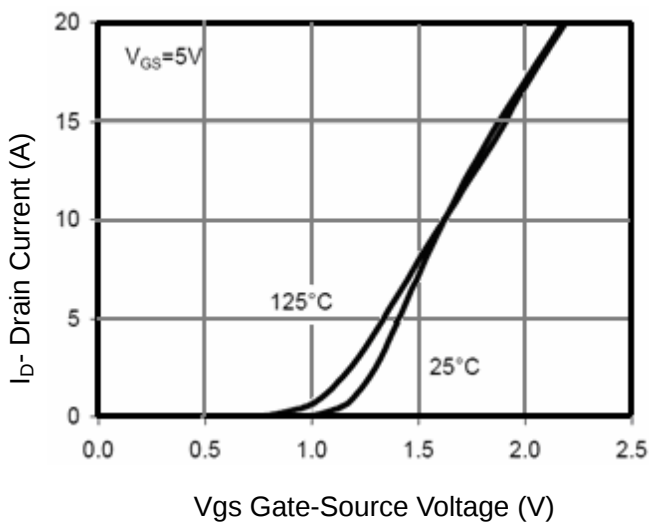


Figure 7 Transfer Characteristics

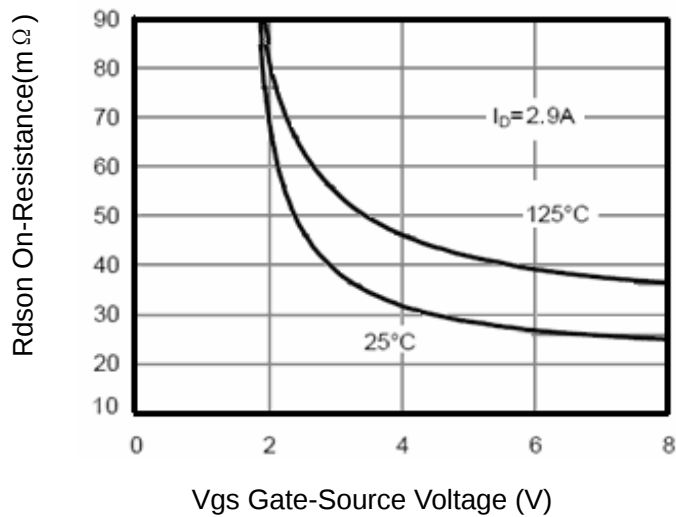


Figure 9  $R_{DS(on)}$  vs  $V_{GS}$

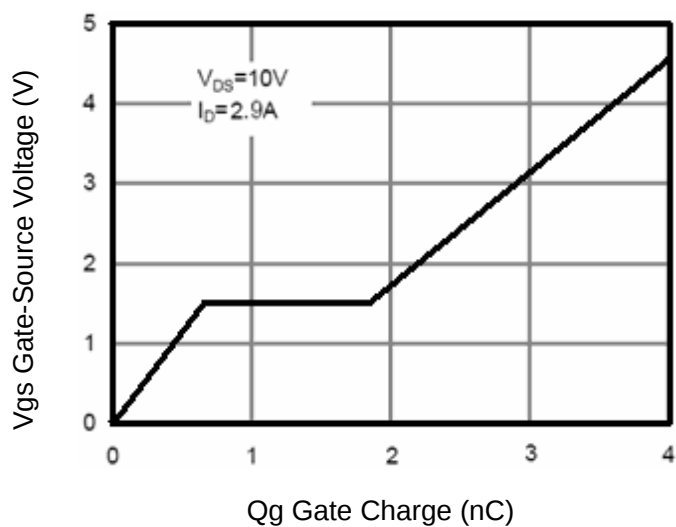


Figure 11 Gate Charge

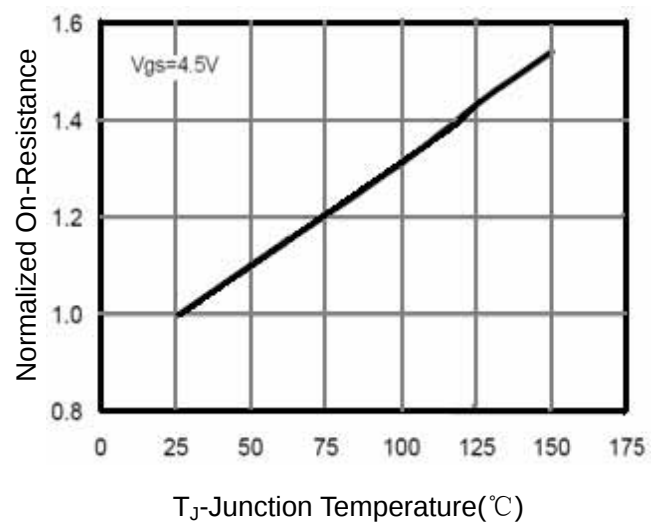


Figure 8 Drain-Source On-Resistance

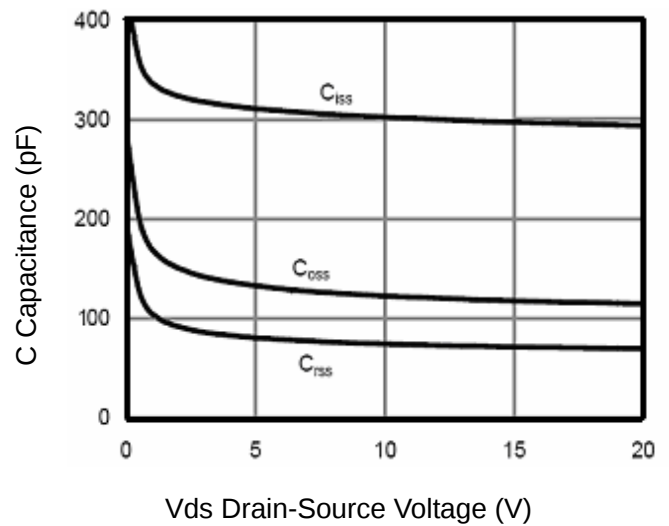


Figure 10 Capacitance vs  $V_{DS}$

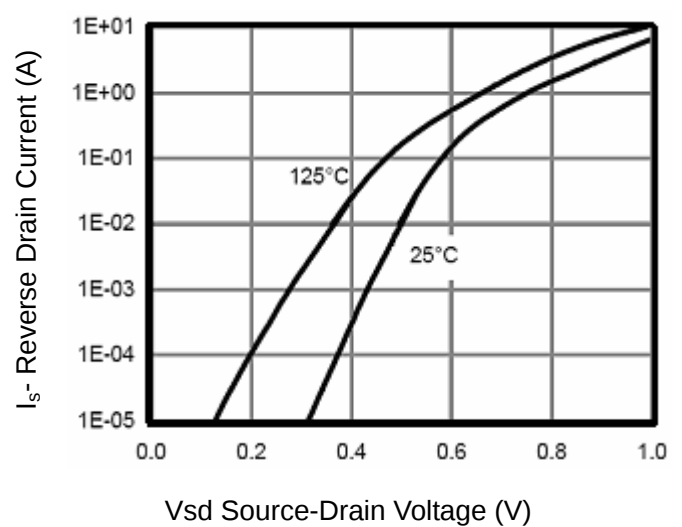


Figure 12 Source- Drain Diode Forward

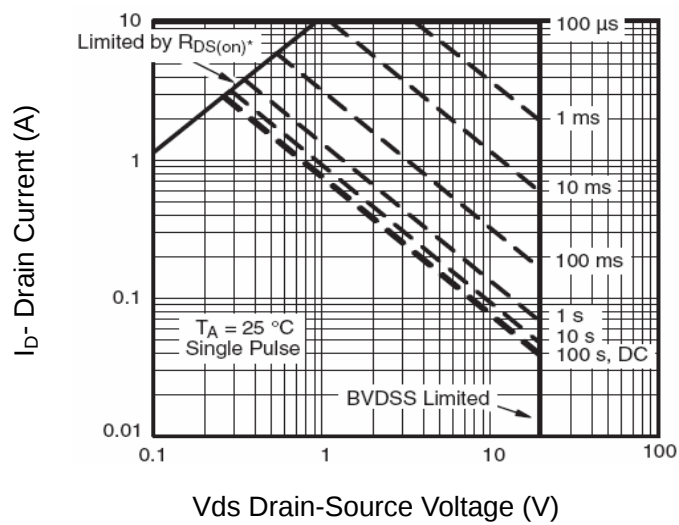


Figure 13 Safe Operation Area

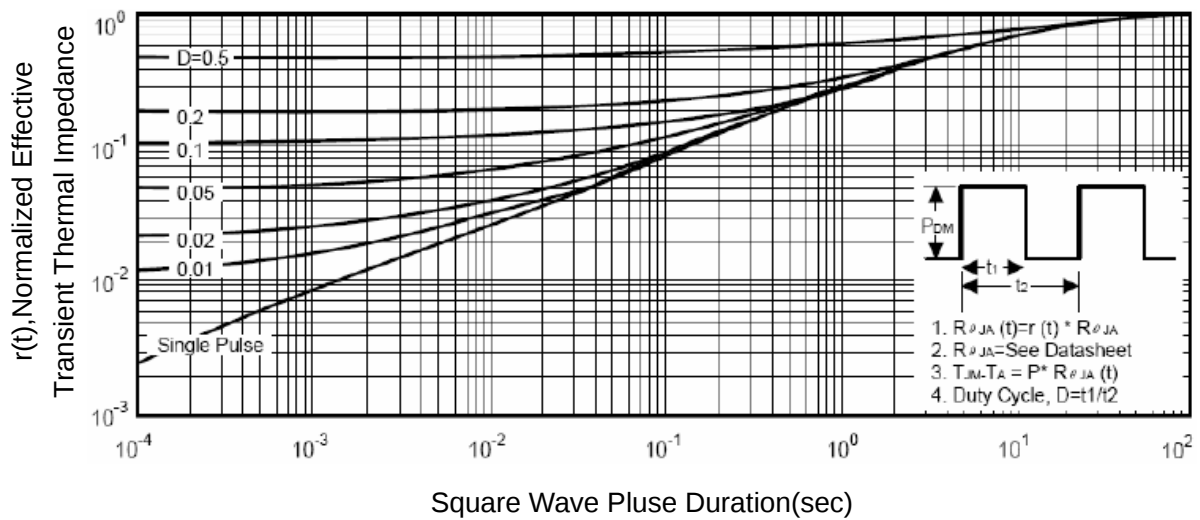
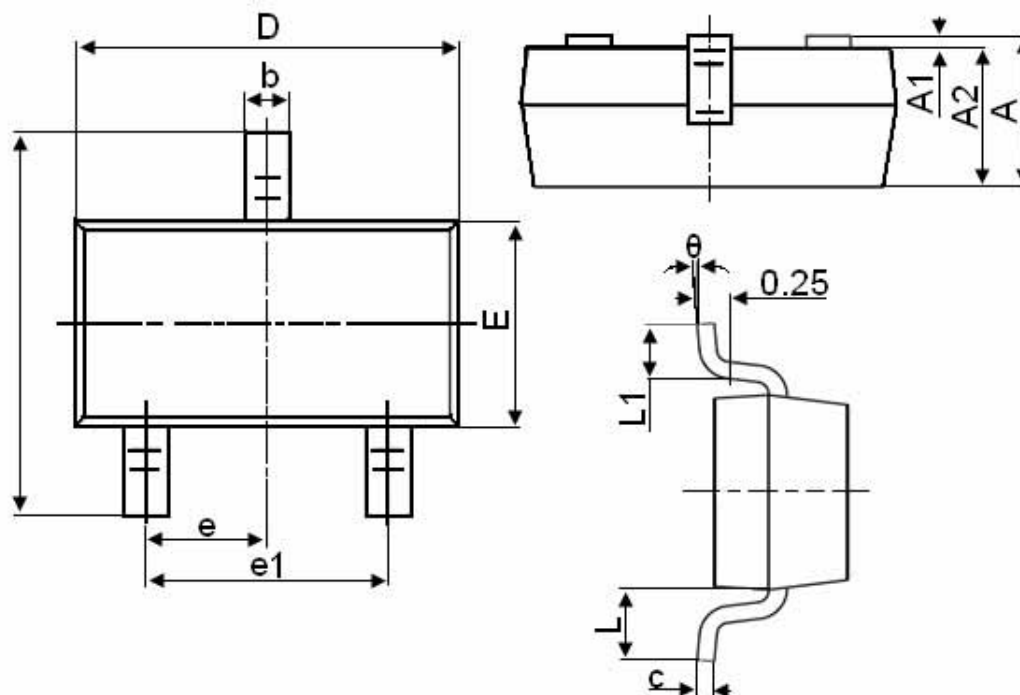


Figure 14 Normalized Maximum Transient Thermal Impedance

## SOT-23 Package Information



| 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 |
| $\theta$ | 0°                        | 8°    |

## Notes

1. All dimensions are in millimeters.
2. Tolerance  $\pm 0.10\text{mm}$  (4 mil) unless otherwise specified
3. Package body sizes exclude mold flash and gate burrs. Mold flash at the non-lead sides should be less than 5 mils.
4. Dimension L is measured in gauge plane.
5. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.