

## P-Channel Enhancement Mode Power MOSFET

### Description

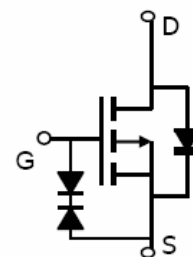
The HM3415E uses advanced trench technology to provide excellent  $R_{DS(ON)}$ , low gate charge and operation with gate voltages as low as 1.8V. This device is suitable for use as a load switch or in PWM applications. It is ESD protected.

### General Features

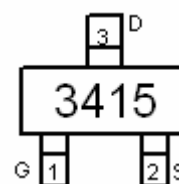
- $V_{DS} = -20V, I_D = -4A$   
 $R_{DS(ON)} < 53m\Omega @ V_{GS} = -2.5V$   
 $R_{DS(ON)} < 40m\Omega @ V_{GS} = -4.5V$   
ESD Rating: 2500V HBM
- High Power and current handling capability
- Lead free product is acquired
- Surface mount package

### Application

- PWM application
- Load switch



Schematic diagram



Marking and pin Assignment



SOT-23 top view

### Package Marking And Ordering Information

| Device Marking | Device  | Device Package | Reel Size | Tape width | Quantity   |
|----------------|---------|----------------|-----------|------------|------------|
| 3415           | HM3415E | SOT-23         | Ø180mm    | 8 mm       | 3000 units |

### Absolute Maximum Ratings (TA=25°C unless otherwise noted)

| Parameter                                        | Symbol         | Limit      | Unit |
|--------------------------------------------------|----------------|------------|------|
| Drain-Source Voltage                             | $V_{DS}$       | -20        | V    |
| Gate-Source Voltage                              | $V_{GS}$       | ±10        | V    |
| Drain Current-Continuous                         | $I_D$          | -4         | A    |
| Drain Current-Pulsed (Note 1)                    | $I_{DM}$       | -30        | A    |
| Maximum Power Dissipation                        | $P_D$          | 1.4        | W    |
| Operating Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 To 150 | °C   |

### Thermal Characteristic

|                                                  |                 |      |      |
|--------------------------------------------------|-----------------|------|------|
| Thermal Resistance, Junction-to-Ambient (Note 2) | $R_{\theta JA}$ | 89.3 | °C/W |
|--------------------------------------------------|-----------------|------|------|

### Electrical Characteristics (TA=25°C unless otherwise noted)

| Parameter                      | Symbol     | Condition                  | Min | Typ | Max | Unit |
|--------------------------------|------------|----------------------------|-----|-----|-----|------|
| <b>Off Characteristics</b>     |            |                            |     |     |     |      |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}=0V, I_D=-250\mu A$ | -20 |     | -   | V    |

|                                    |                     |                                                                                              |      |       |      |    |
|------------------------------------|---------------------|----------------------------------------------------------------------------------------------|------|-------|------|----|
| Zero Gate Voltage Drain Current    | I <sub>DSS</sub>    | V <sub>DS</sub> =-20V, V <sub>GS</sub> =0V                                                   | -    | -     | 1    | μA |
| Gate-Body Leakage Current          | I <sub>GSS</sub>    | V <sub>GS</sub> =±10V, V <sub>DS</sub> =0V                                                   | -    | -     | ±10  | μA |
| 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                                    | -0.4 | -0.65 | -1.0 | V  |
| Drain-Source On-State Resistance   | R <sub>DS(ON)</sub> | V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-4A                                                  | -    | 31    | 40   | mΩ |
|                                    |                     | V <sub>GS</sub> =-2.5V, I <sub>D</sub> =-4A                                                  | -    | 40    | 53   | mΩ |
| Forward Transconductance           | g <sub>FS</sub>     | V <sub>DS</sub> =-5V, I <sub>D</sub> =-4A                                                    | 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                                      | -    | 950   | -    | PF |
| Output Capacitance                 | C <sub>oss</sub>    |                                                                                              | -    | 165   | -    | PF |
| Reverse Transfer Capacitance       | C <sub>rss</sub>    |                                                                                              | -    | 120   | -    | PF |
| Switching Characteristics (Note 4) |                     |                                                                                              |      |       |      |    |
| Turn-on Delay Time                 | t <sub>d(on)</sub>  | V <sub>DD</sub> =-10V, R <sub>L</sub> =2. 5Ω<br>V <sub>GS</sub> =-4.5V, R <sub>GEN</sub> =3Ω | -    | 12    |      | nS |
| Turn-on Rise Time                  | t <sub>r</sub>      |                                                                                              | -    | 10    |      | nS |
| Turn-Off Delay Time                | t <sub>d(off)</sub> |                                                                                              | -    | 19    |      | nS |
| Turn-Off Fall Time                 | t <sub>f</sub>      |                                                                                              | -    | 25    |      | nS |
| Total Gate Charge                  | Q <sub>g</sub>      | V <sub>DS</sub> =-10V, I <sub>D</sub> =-4A,<br>V <sub>GS</sub> =-4.5V                        | -    | 12    |      | nC |
| Gate-Source Charge                 | Q <sub>gs</sub>     |                                                                                              | -    | 1.4   | -    | nC |
| Gate-Drain Charge                  | Q <sub>gd</sub>     |                                                                                              | -    | 3.6   | -    | nC |
| Drain-Source Diode Characteristics |                     |                                                                                              |      |       |      |    |
| Diode Forward Voltage (Note 3)     | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =-1A                                                     | -    | -     | -1.2 | V  |
| Diode Forward Current (Note 2)     | I <sub>S</sub>      |                                                                                              | -    | -     | -2.2 | 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

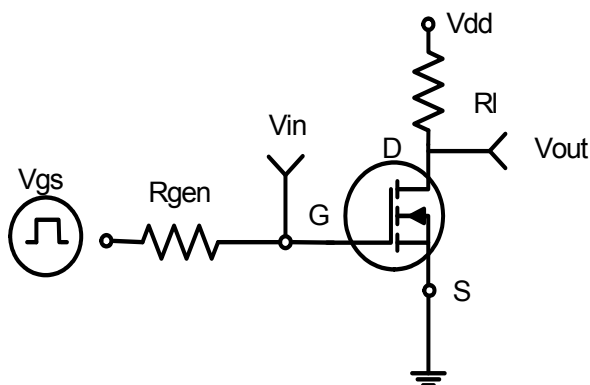


Figure 1: Switching Test Circuit

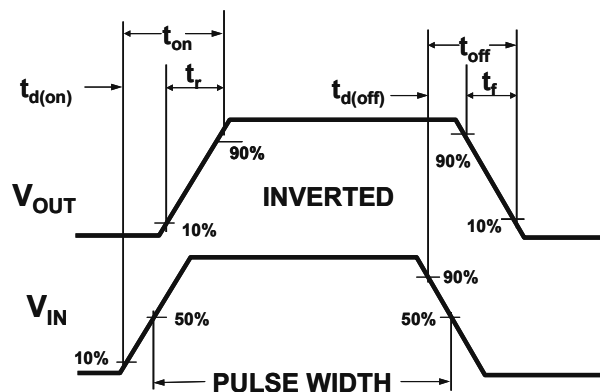


Figure 2: Switching Waveforms

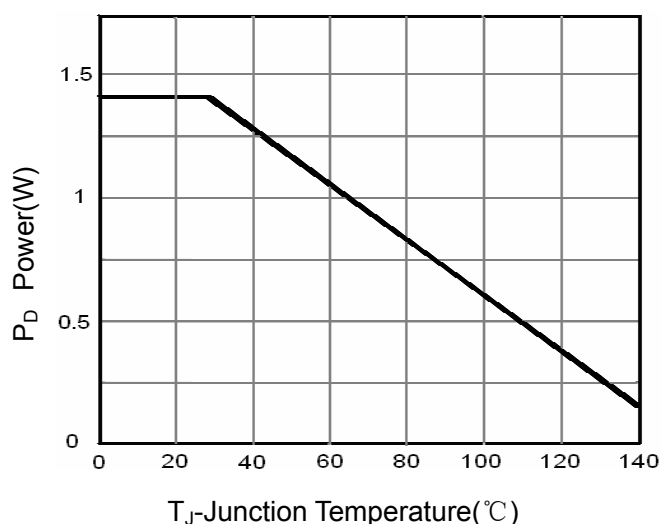


Figure 3 Power Dissipation

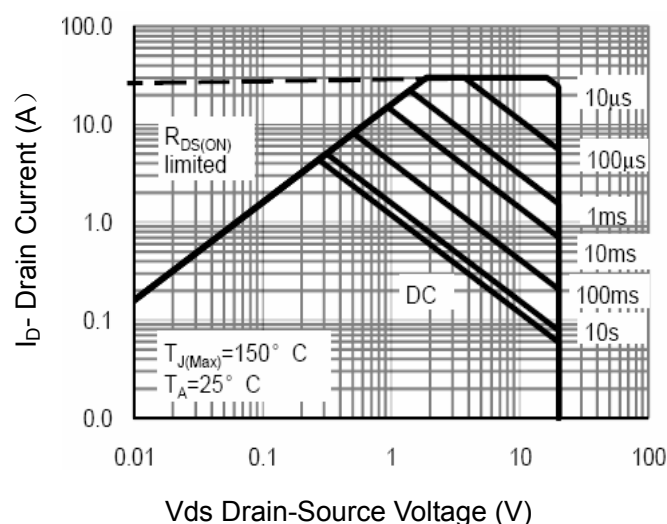


Figure 4 Safe Operation Area

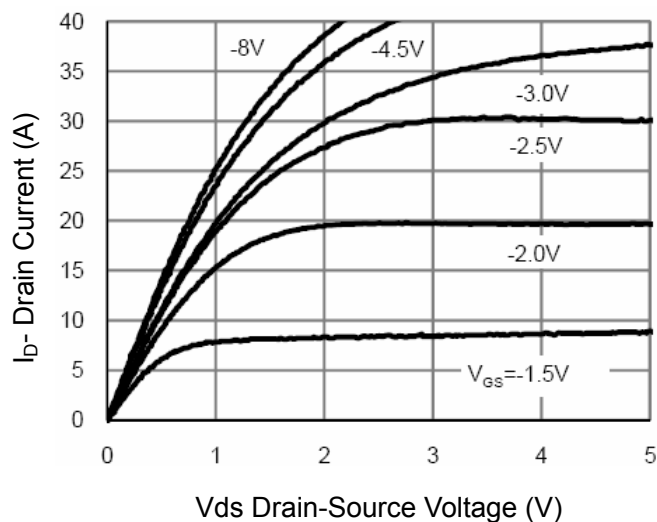


Figure 5 Output CHARACTERISTICS

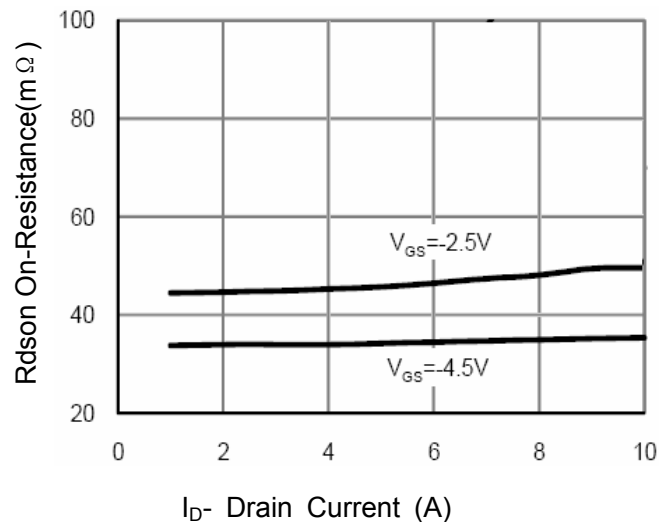


Figure 6 Drain-Source On-Resistance

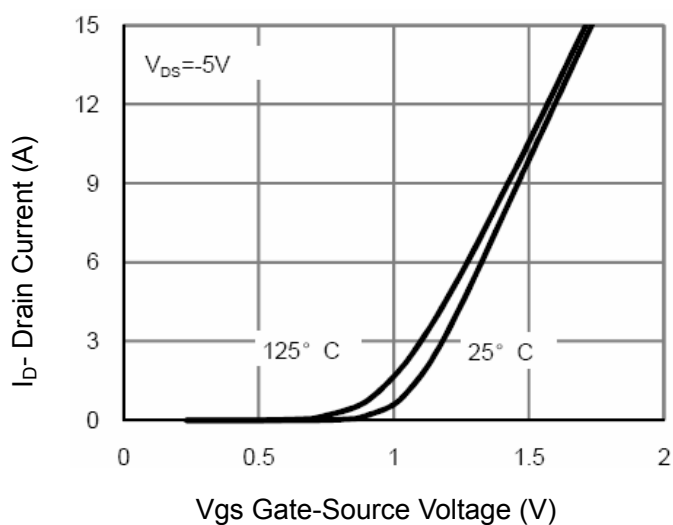


Figure 7 Transfer Characteristics

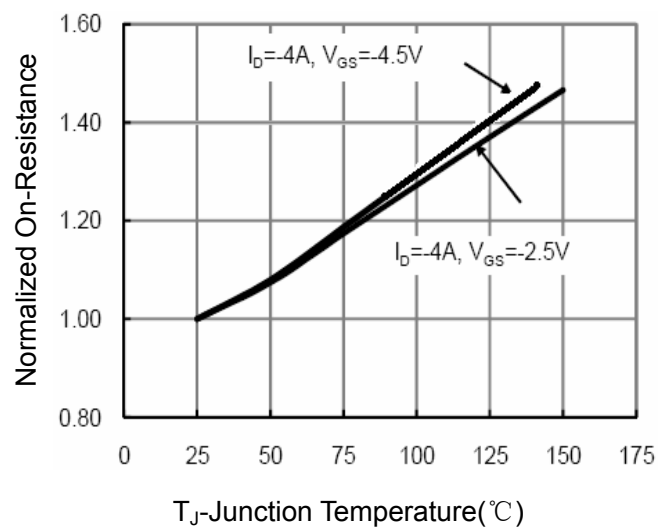


Figure 8 Drain-Source On-Resistance

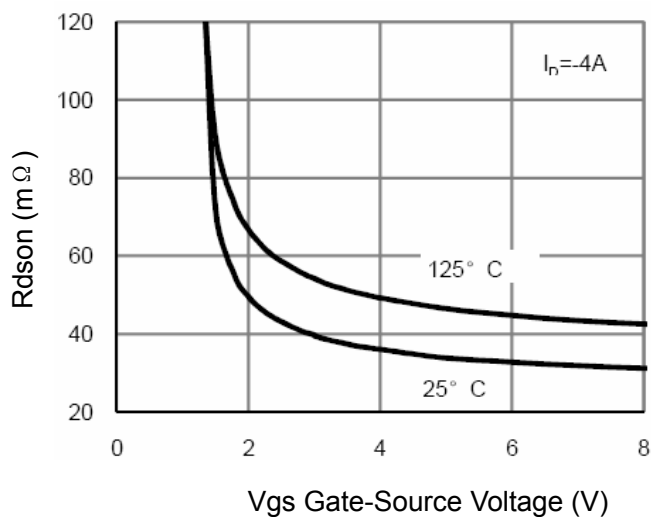


Figure 9  $R_{DS(on)}$  vs  $V_{GS}$

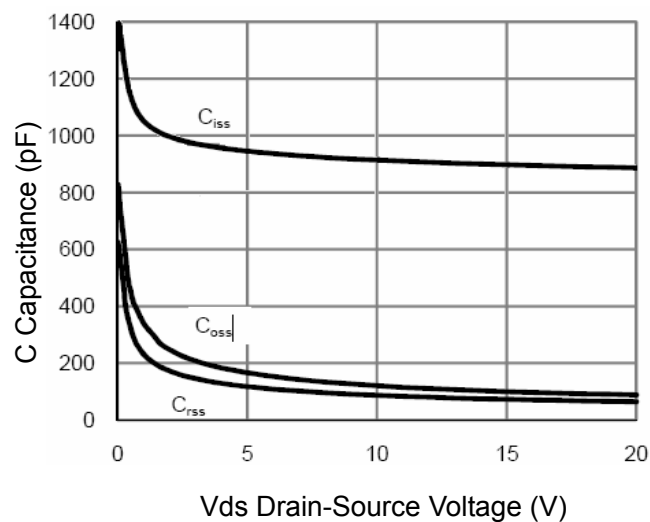


Figure 10 Capacitance vs  $V_{DS}$

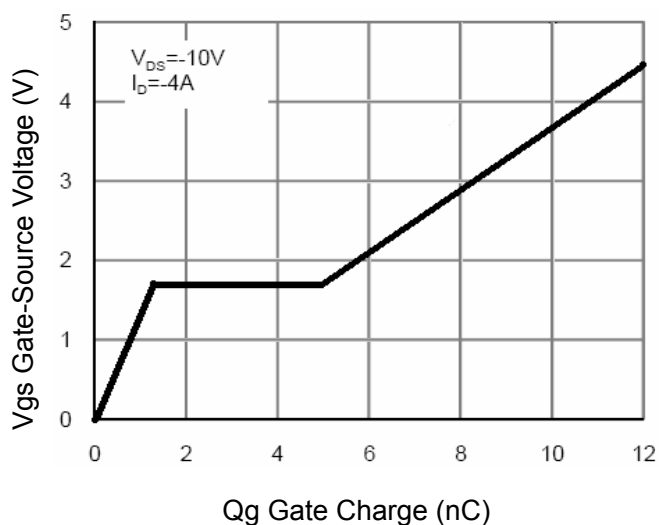


Figure 11 Gate Charge

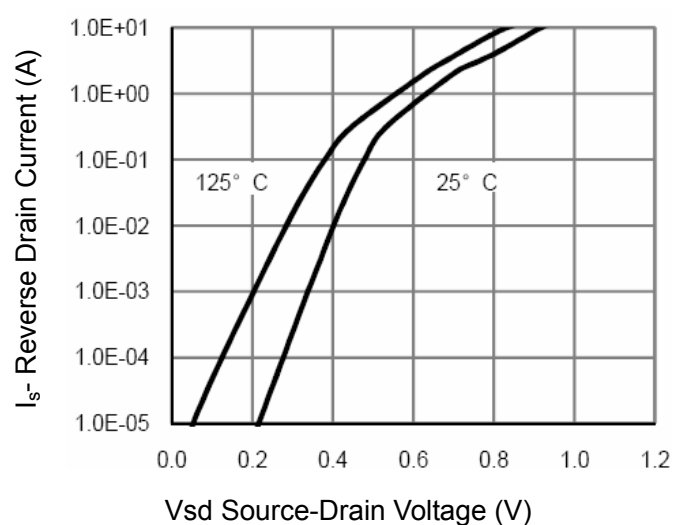


Figure 12 Source- Drain Diode Forward

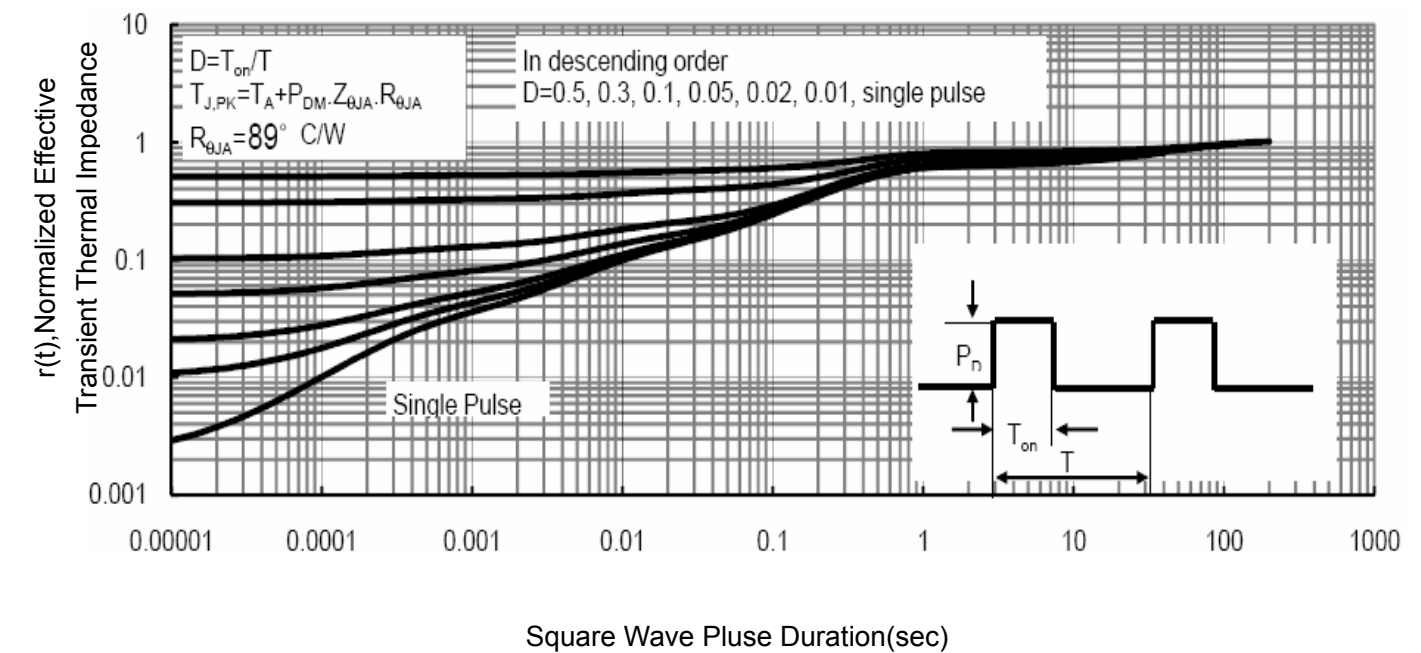
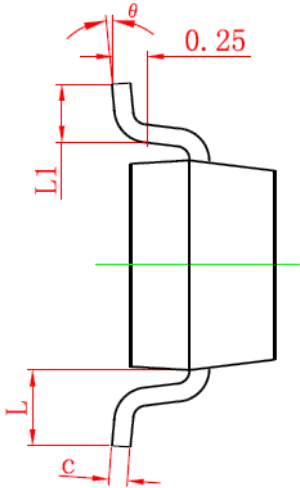
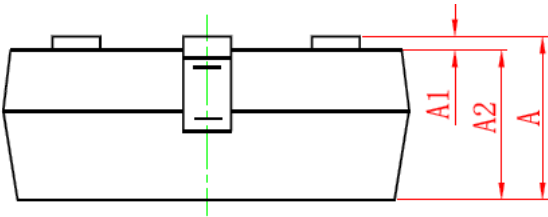
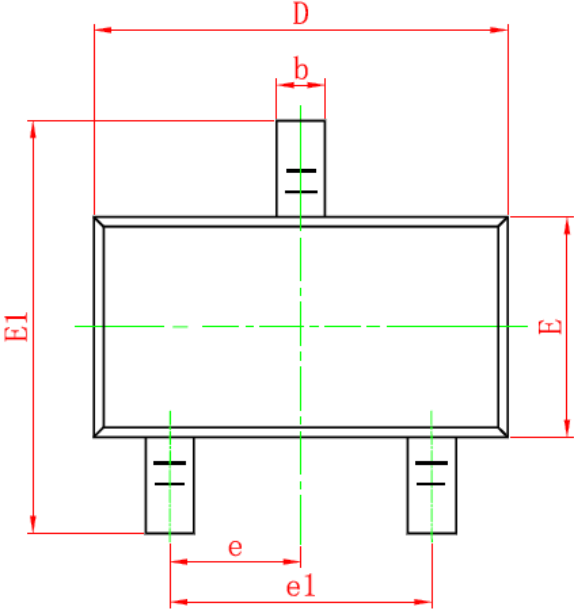


Figure 13 Normalized Maximum Transient Thermal Impedance

SOT-23 PACKAGE INFORMATION

Dimensions in Millimeters (UNIT:mm)



| 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°    |

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.