

## NCE N-Channel Super Trench Power MOSFET

### Description

The NCEP60T12K uses **Super Trench** technology that is uniquely optimized to provide the most efficient high frequency switching performance. Both conduction and switching power losses are minimized due to an extremely low combination of  $R_{DS(on)}$  and  $Q_g$ . This device is ideal for high-frequency switching and synchronous rectification.

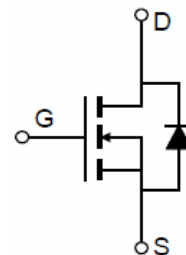
### General Features

- $V_{DS} = 60V, I_D = 120A$   
 $R_{DS(on)} < 4.0m\Omega @ V_{GS} = 10V$  (Typ: 3.6m $\Omega$ )
- Excellent gate charge x  $R_{DS(on)}$  product
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating
- 100% UIS tested

### Application

- DC/DC Converter
- Ideal for high-frequency switching and synchronous rectification

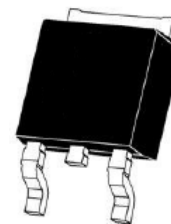
**100% UIS TESTED!**  
**100%  $\Delta V_{ds}$  TESTED!**



Schematic diagram



Marking and pin assignment



TO-252-2L top view

### Package Marking and Ordering Information

| Device Marking | Device     | Device Package | Reel Size | Tape width | Quantity |
|----------------|------------|----------------|-----------|------------|----------|
| NCEP60T12K     | NCEP60T12K | TO-252-2L      | -         | -          | -        |

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

| Parameter                                              | Symbol                    | Limit      | Unit                |
|--------------------------------------------------------|---------------------------|------------|---------------------|
| Drain-Source Voltage                                   | $V_{DS}$                  | 60         | V                   |
| Gate-Source Voltage                                    | $V_{GS}$                  | $\pm 20$   | V                   |
| Drain Current-Continuous (Silicon Limited)             | $I_D$                     | 120        | A                   |
| Drain Current-Continuous ( $T_C = 100^\circ\text{C}$ ) | $I_D (100^\circ\text{C})$ | 100        | A                   |
| Pulsed Drain Current                                   | $I_{DM}$                  | 480        | A                   |
| Maximum Power Dissipation                              | $P_D$                     | 180        | W                   |
| Derating factor                                        |                           | 1.2        | W/ $^\circ\text{C}$ |
| Single pulse avalanche energy <sup>(Note 5)</sup>      | $E_{AS}$                  | 500        | mJ                  |
| Operating Junction and Storage Temperature Range       | $T_J, T_{STG}$            | -55 To 175 | $^\circ\text{C}$    |

### Thermal Characteristic

|                                                          |                 |      |                    |
|----------------------------------------------------------|-----------------|------|--------------------|
| Thermal Resistance, Junction-to-Case <sup>(Note 2)</sup> | $R_{\theta JC}$ | 0.83 | $^\circ\text{C/W}$ |
|----------------------------------------------------------|-----------------|------|--------------------|

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

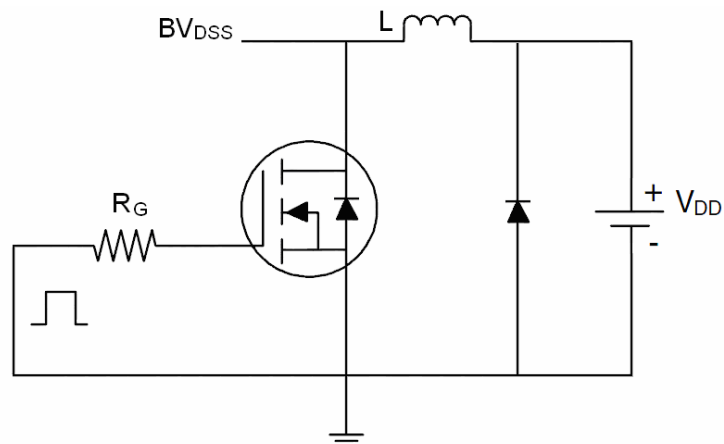
| Parameter                                     | Symbol              | Condition                                                                                    | Min | Typ  | Max  | Unit |
|-----------------------------------------------|---------------------|----------------------------------------------------------------------------------------------|-----|------|------|------|
| Off Characteristics                           |                     |                                                                                              |     |      |      |      |
| Drain-Source Breakdown Voltage                | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V I <sub>D</sub> =250μA                                                    | 60  |      | -    | V    |
| Zero Gate Voltage Drain Current               | I <sub>DSS</sub>    | V <sub>DS</sub> =60V, V <sub>GS</sub> =0V                                                    | -   | -    | 1    | μA   |
| Gate-Body Leakage Current                     | I <sub>GSS</sub>    | V <sub>GS</sub> =±20V, V <sub>DS</sub> =0V                                                   | -   | -    | ±100 | nA   |
| On Characteristics <sup>(Note 3)</sup>        |                     |                                                                                              |     |      |      |      |
| Gate Threshold Voltage                        | V <sub>GS(th)</sub> | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA                                     | 2.0 | 3.0  | 4.0  | V    |
| Drain-Source On-State Resistance              | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =60A                                                    | -   | 3.6  | 4.0  | mΩ   |
| Forward Transconductance                      | g <sub>FS</sub>     | V <sub>DS</sub> =10V, I <sub>D</sub> =60A                                                    | 40  | -    | -    | S    |
| Dynamic Characteristics <sup>(Note4)</sup>    |                     |                                                                                              |     |      |      |      |
| Input Capacitance                             | C <sub>iss</sub>    | V <sub>DS</sub> =30V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                       | -   | 3400 | -    | PF   |
| Output Capacitance                            | C <sub>oss</sub>    |                                                                                              | -   | 650  | -    | PF   |
| Reverse Transfer Capacitance                  | C <sub>rss</sub>    |                                                                                              | -   | 20   | -    | PF   |
| Switching Characteristics <sup>(Note 4)</sup> |                     |                                                                                              |     |      |      |      |
| Turn-on Delay Time                            | t <sub>d(on)</sub>  | V <sub>DD</sub> =30V, I <sub>D</sub> =60A<br>V <sub>GS</sub> =10V, R <sub>G</sub> =4.7Ω      | -   | 11   | -    | nS   |
| Turn-on Rise Time                             | t <sub>r</sub>      |                                                                                              | -   | 5    | -    | nS   |
| Turn-Off Delay Time                           | t <sub>d(off)</sub> |                                                                                              | -   | 56   | -    | nS   |
| Turn-Off Fall Time                            | t <sub>f</sub>      |                                                                                              | -   | 12   | -    | nS   |
| Total Gate Charge                             | Q <sub>g</sub>      | V <sub>DS</sub> =30V, I <sub>D</sub> =60A,<br>V <sub>GS</sub> =10V                           | -   | 51   |      | nC   |
| Gate-Source Charge                            | Q <sub>gs</sub>     |                                                                                              | -   | 12   |      | nC   |
| Gate-Drain Charge                             | Q <sub>gd</sub>     |                                                                                              | -   | 7.3  |      | nC   |
| Drain-Source Diode Characteristics            |                     |                                                                                              |     |      |      |      |
| Diode Forward Voltage <sup>(Note 3)</sup>     | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =120A                                                    | -   |      | 1.2  | V    |
| Diode Forward Current <sup>(Note 2)</sup>     | I <sub>S</sub>      |                                                                                              | -   | -    | 120  | A    |
| Reverse Recovery Time                         | t <sub>rr</sub>     | T <sub>J</sub> = 25°C, I <sub>F</sub> = I <sub>S</sub><br>di/dt = 100A/μs <sup>(Note3)</sup> | -   | 47   |      | nS   |
| Reverse Recovery Charge                       | Q <sub>rr</sub>     |                                                                                              | -   | 59   |      | nC   |

**Notes:**

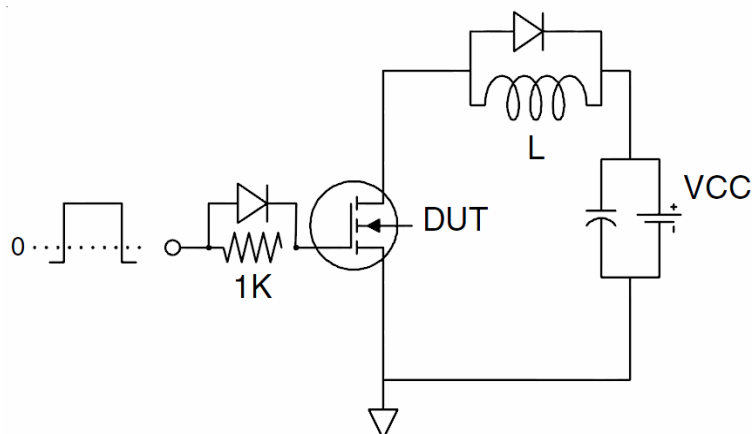
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition :  $T_J=25^{\circ}\text{C}, V_{DD}=30V, V_G=10V, L=0.5mH, R_g=25\Omega$

## Test Circuit

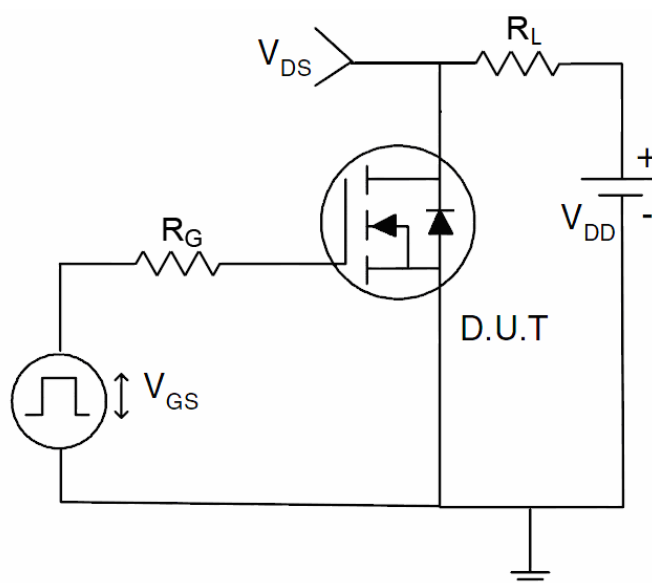
### 1) $E_{AS}$ test Circuit



### 2) Gate charge test Circuit



### 3) Switch Time Test Circuit



## Typical Electrical and Thermal Characteristics

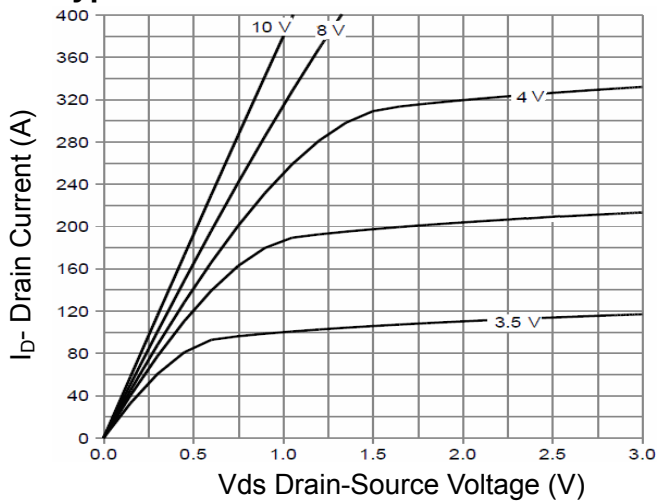


Figure 1 Output Characteristics

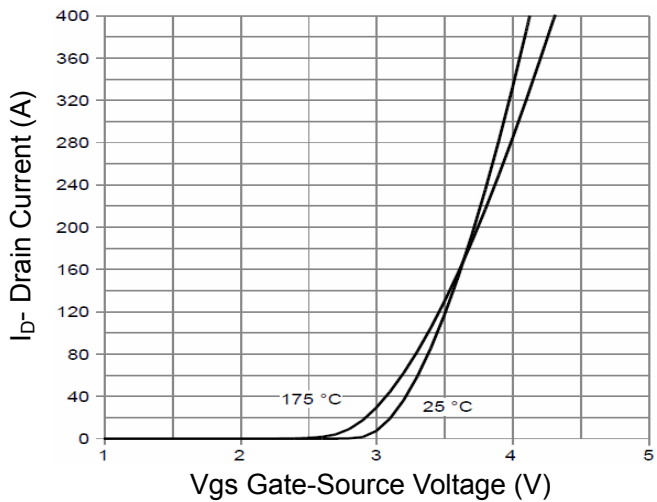


Figure 2 Transfer Characteristics

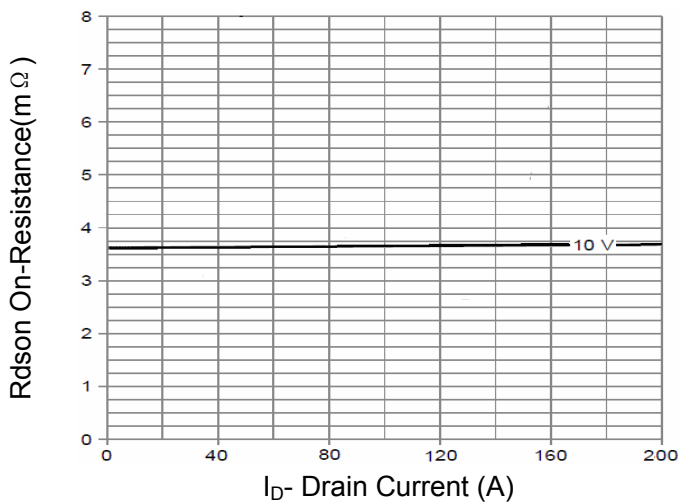


Figure 3  $R_{DS(on)}$ - Drain Current

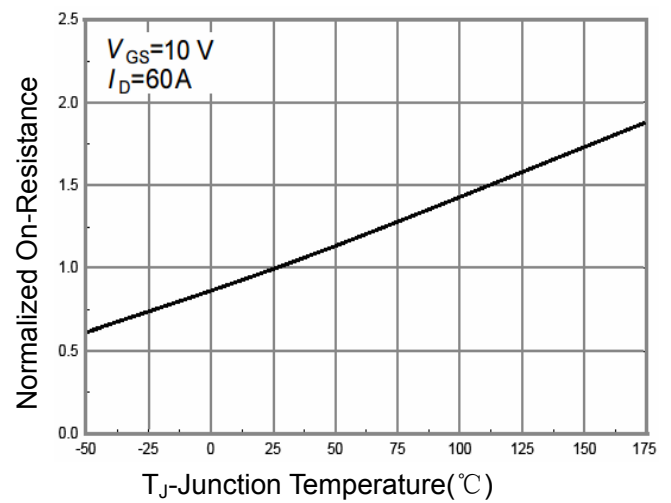


Figure 4  $R_{DS(on)}$ -Junction Temperature

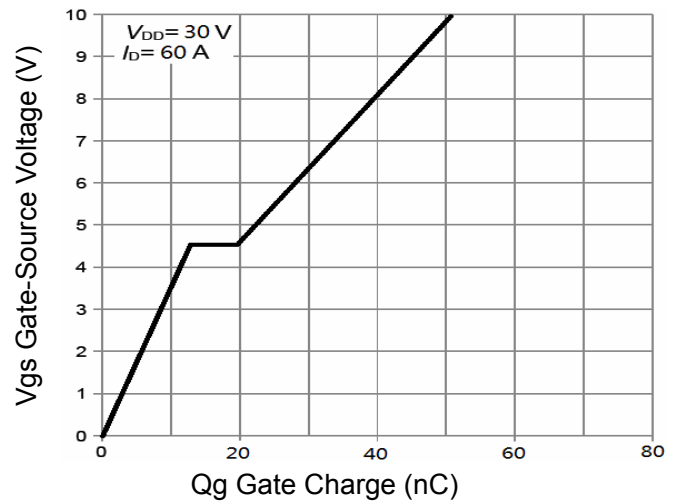


Figure 5 Gate Charge

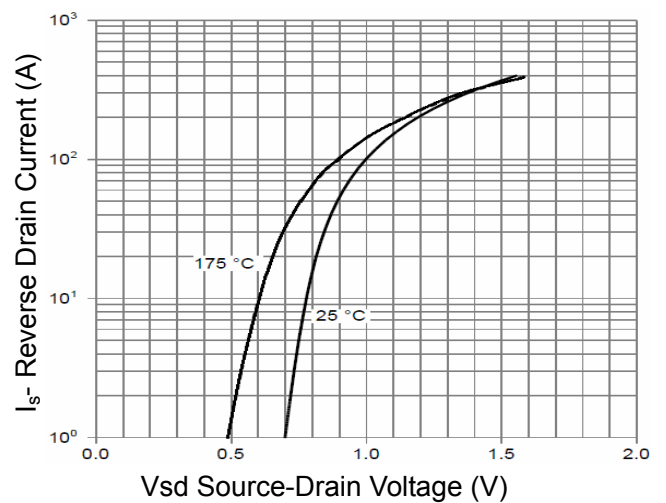


Figure 6 Source- Drain Diode Forward

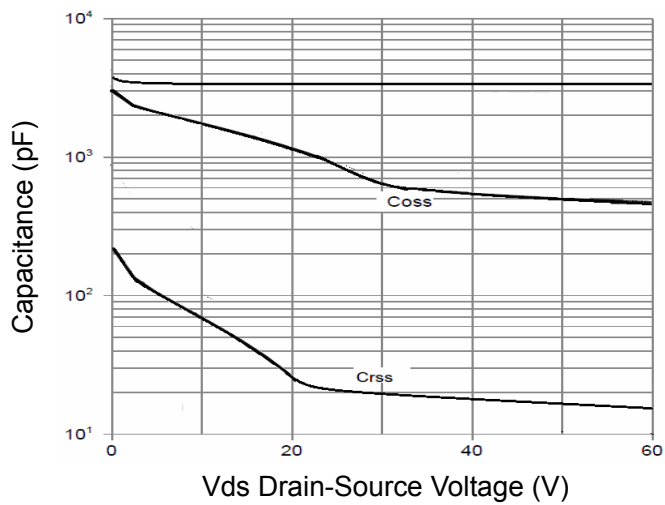


Figure 7 Capacitance vs Vds

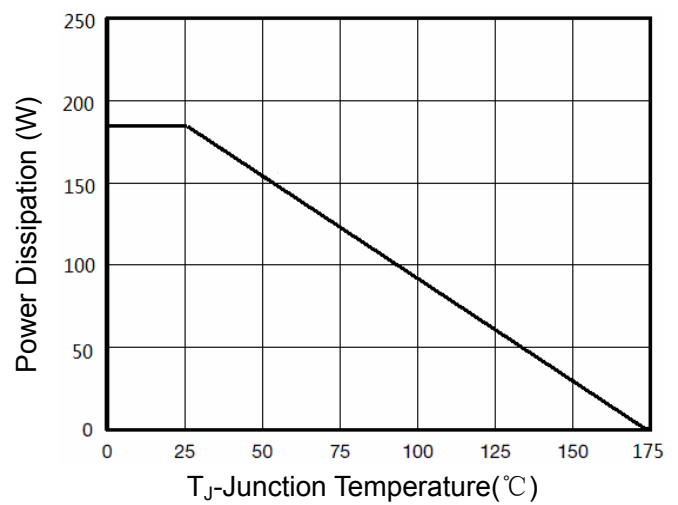


Figure 9 Power De-rating

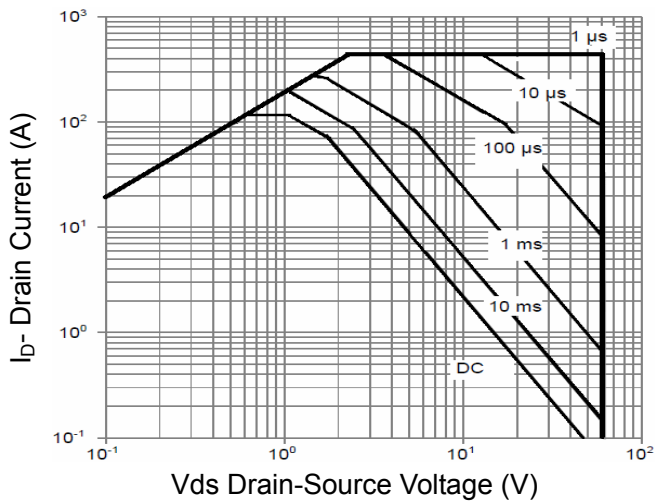


Figure 8 Safe Operation Area

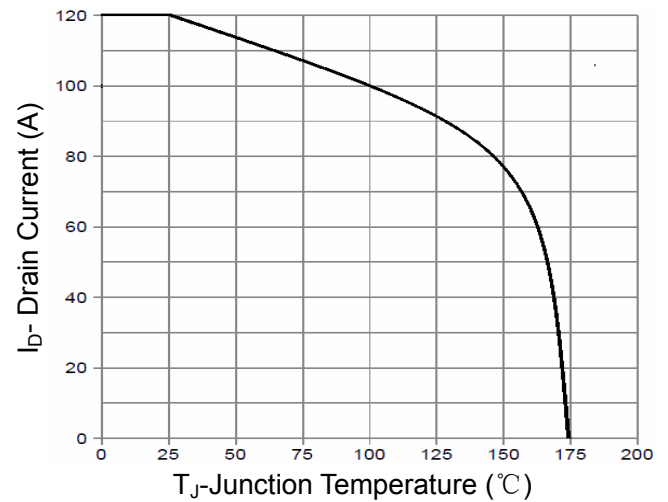


Figure 10 Current De-rating

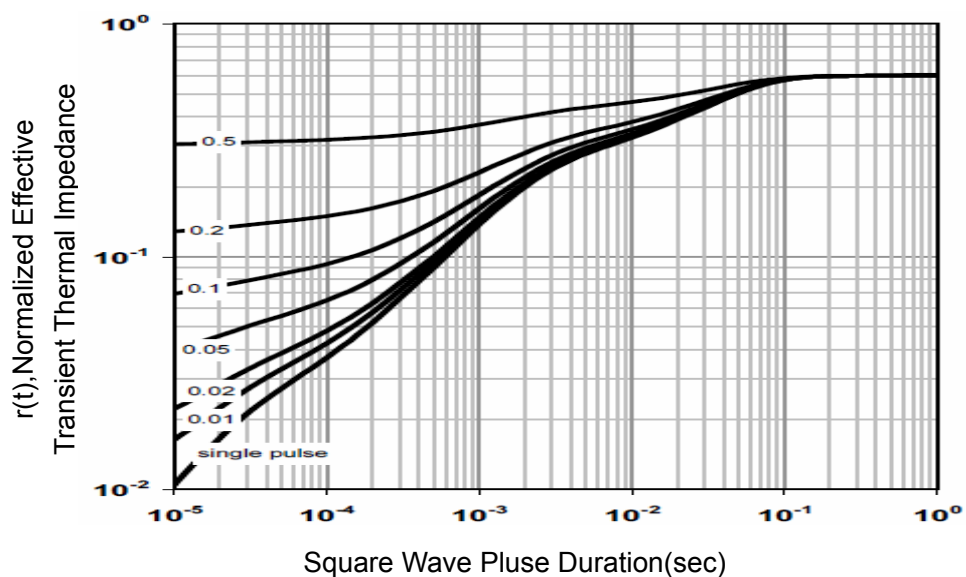
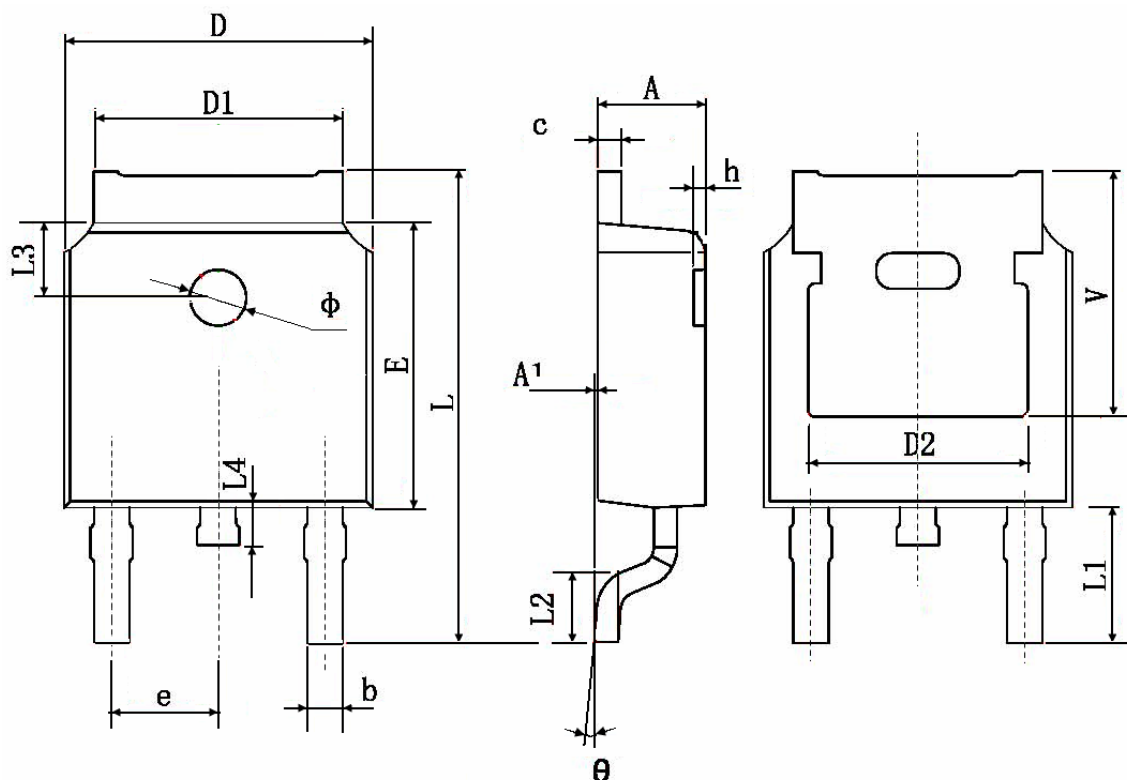


Figure 11 Normalized Maximum Transient Thermal Impedance

## TO-252 Package Information



| Symbol | Dimensions In Millimeters |        | Dimensions In Inches |       |
|--------|---------------------------|--------|----------------------|-------|
|        | Min.                      | Max.   | Min.                 | Max.  |
| A      | 2.200                     | 2.400  | 0.087                | 0.094 |
| A1     | 0.000                     | 0.127  | 0.000                | 0.005 |
| b      | 0.660                     | 0.860  | 0.026                | 0.034 |
| c      | 0.460                     | 0.580  | 0.018                | 0.023 |
| D      | 6.500                     | 6.700  | 0.256                | 0.264 |
| D1     | 5.100                     | 5.460  | 0.201                | 0.215 |
| D2     | 4.830 TYP.                |        | 0.190 TYP.           |       |
| E      | 6.000                     | 6.200  | 0.236                | 0.244 |
| e      | 2.186                     | 2.386  | 0.086                | 0.094 |
| L      | 9.800                     | 10.400 | 0.386                | 0.409 |
| L1     | 2.900 TYP.                |        | 0.114 TYP.           |       |
| L2     | 1.400                     | 1.700  | 0.055                | 0.067 |
| L3     | 1.600 TYP.                |        | 0.063 TYP.           |       |
| L4     | 0.600                     | 1.000  | 0.024                | 0.039 |
| Φ      | 1.100                     | 1.300  | 0.043                | 0.051 |
| θ      | 0°                        | 8°     | 0°                   | 8°    |
| h      | 0.000                     | 0.300  | 0.000                | 0.012 |
| V      | 5.350 TYP.                |        | 0.211 TYP.           |       |

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