

## NCE N-Channel Super Trench Power MOSFET

### Description

The NCEP01T13B 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.

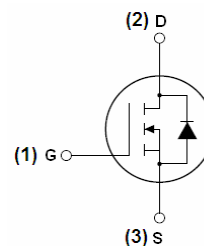
### General Features

- $V_{DS} = 100V, I_D = 135A$
- $R_{DS(ON)} < 4.3m\Omega @ V_{GS} = 10V$
- $R_{DS(ON)} < 5m\Omega @ V_{GS} = 4.5V$
- 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-220-3L top view

### Package Marking and Ordering Information

| Device Marking | Device     | Device Package | Reel Size | Tape width | Quantity |
|----------------|------------|----------------|-----------|------------|----------|
| NCEP01T13B     | NCEP01T13B | TO-220-3L      | -         | -          | -        |

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

| Parameter                                              | Symbol                    | Limit      | Unit                |
|--------------------------------------------------------|---------------------------|------------|---------------------|
| Drain-Source Voltage                                   | $V_{DS}$                  | 100        | V                   |
| Gate-Source Voltage                                    | $V_{GS}$                  | $\pm 20$   | V                   |
| Drain Current-Continuous (Silicon Limited)             | $I_D$                     | 150        | A                   |
| Drain Current-Continuous (Package Limited)             | $I_D$                     | 135        | A                   |
| Drain Current-Continuous ( $T_C = 100^\circ\text{C}$ ) | $I_D (100^\circ\text{C})$ | 108        | A                   |
| Pulsed Drain Current                                   | $I_{DM}$                  | 500        | A                   |
| Maximum Power Dissipation                              | $P_D$                     | 220        | W                   |
| Derating factor                                        |                           | 1.5        | W/ $^\circ\text{C}$ |
| Single pulse avalanche energy (Note 5)                 | $E_{AS}$                  | 1156       | 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> | $R_{\theta JC}$ | 0.7 | $^{\circ}\text{C/W}$ |
|----------------------------------------------------------|-----------------|-----|----------------------|

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

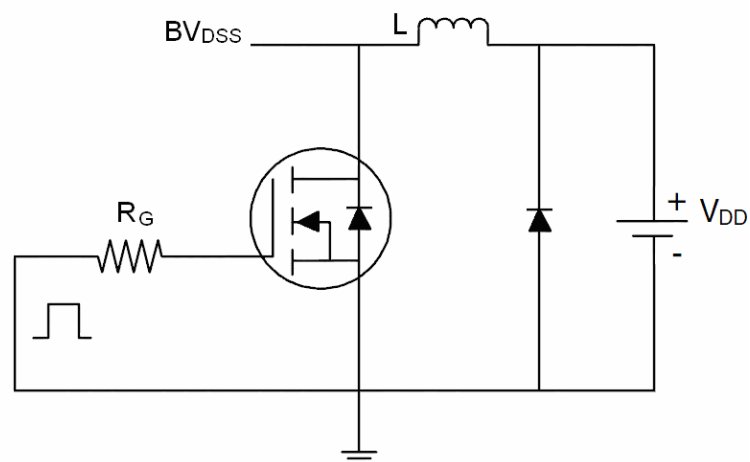
| Parameter                                     | Symbol              | Condition                                                                               | Min | Typ   | Max  | Unit |
|-----------------------------------------------|---------------------|-----------------------------------------------------------------------------------------|-----|-------|------|------|
| Off Characteristics                           |                     |                                                                                         |     |       |      |      |
| Drain-Source Breakdown Voltage                | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V I <sub>D</sub> =250μA                                               | 100 |       | -    | V    |
| Zero Gate Voltage Drain Current               | I <sub>DSS</sub>    | V <sub>DS</sub> =100V, 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                                | 1.0 | 1.9   | 3.0  | V    |
| Drain-Source On-State Resistance              | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =60A                                               | -   | 3.7   | 4.3  | mΩ   |
|                                               |                     | V <sub>GS</sub> =4.5V, I <sub>D</sub> =60A                                              | -   | 4.3   | 5.0  | mΩ   |
| Forward Transconductance                      | g <sub>FS</sub>     | V <sub>DS</sub> =10V, I <sub>D</sub> =60A                                               | 70  | -     | -    | S    |
| Dynamic Characteristics <sup>(Note4)</sup>    |                     |                                                                                         |     |       |      |      |
| Input Capacitance                             | C <sub>iss</sub>    | V <sub>DS</sub> =50V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                  | -   | 10900 | -    | PF   |
| Output Capacitance                            | C <sub>oss</sub>    |                                                                                         | -   | 840   | -    | PF   |
| Reverse Transfer Capacitance                  | C <sub>rss</sub>    |                                                                                         | -   | 36    | -    | PF   |
| Switching Characteristics <sup>(Note 4)</sup> |                     |                                                                                         |     |       |      |      |
| Turn-on Delay Time                            | t <sub>d(on)</sub>  | V <sub>DD</sub> =50V, I <sub>D</sub> =60A<br>V <sub>GS</sub> =10V, R <sub>G</sub> =4.7Ω | -   | 25    | -    | nS   |
| Turn-on Rise Time                             | t <sub>r</sub>      |                                                                                         | -   | 92    | -    | nS   |
| Turn-Off Delay Time                           | t <sub>d(off)</sub> |                                                                                         | -   | 62    | -    | nS   |
| Turn-Off Fall Time                            | t <sub>f</sub>      |                                                                                         | -   | 21    | -    | nS   |
| Total Gate Charge                             | Q <sub>g</sub>      | V <sub>DS</sub> =50V, I <sub>D</sub> =60A,<br>V <sub>GS</sub> =10V                      | -   | 150   |      | nC   |
| Gate-Source Charge                            | Q <sub>gs</sub>     |                                                                                         | -   | 38    |      | nC   |
| Gate-Drain Charge                             | Q <sub>gd</sub>     |                                                                                         | -   | 17.8  |      | 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> =135A                                               | -   |       | 1.2  | V    |
| Diode Forward Current <sup>(Note 2)</sup>     | I <sub>S</sub>      |                                                                                         | -   | -     | 135  | A    |
| Reverse Recovery Time                         | t <sub>rr</sub>     | T <sub>J</sub> = 25°C, I <sub>F</sub> = I <sub>S</sub>                                  | -   | 75    |      | nS   |
| Reverse Recovery Charge                       | Q <sub>rr</sub>     | di/dt = 100A/μs <sup>(Note3)</sup>                                                      | -   | 165   |      | nC   |

## Notes:

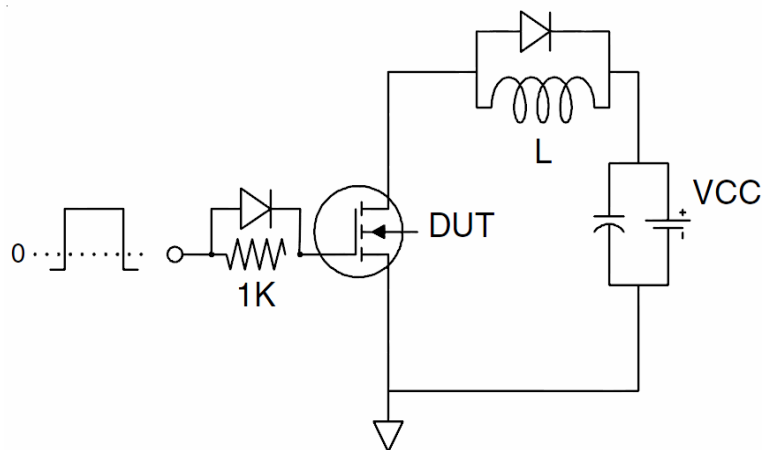
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition :  $T_J=25^{\circ}\text{C}, V_{DD}=50V, V_G=10V, L=0.5\text{mH}, R_G=25\Omega$

## Test Circuit

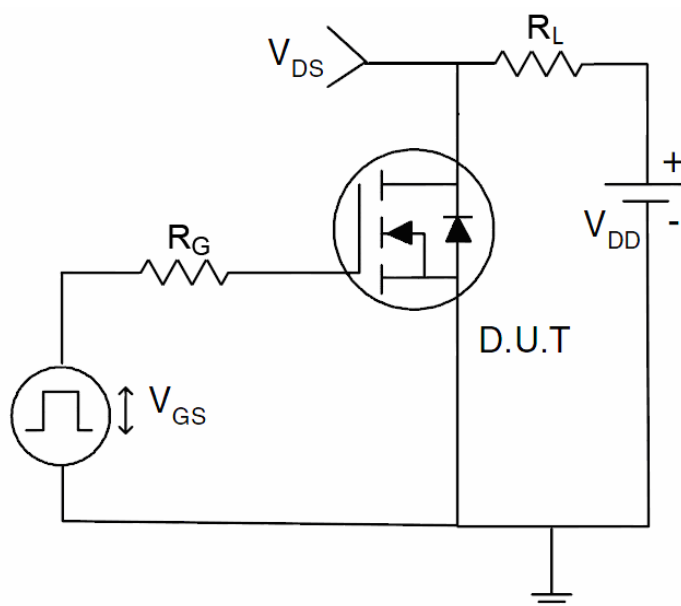
### 1) $E_{AS}$ test Circuit



### 2) Gate charge test Circuit



### 3) Switch Time Test Circuit



## Typical Electrical and Thermal Characteristics

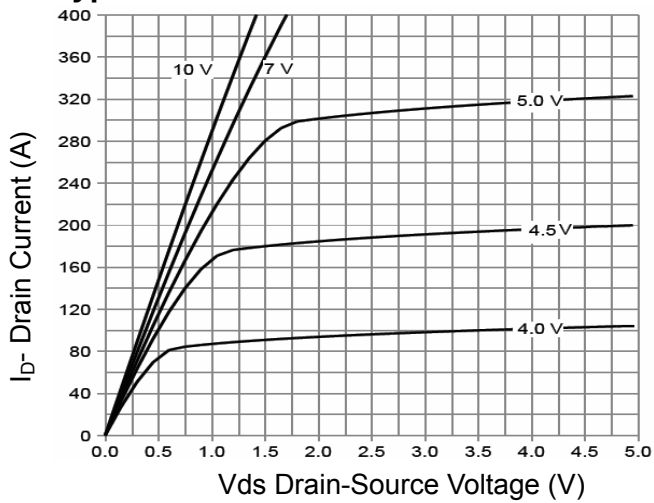


Figure 1 Output Characteristics

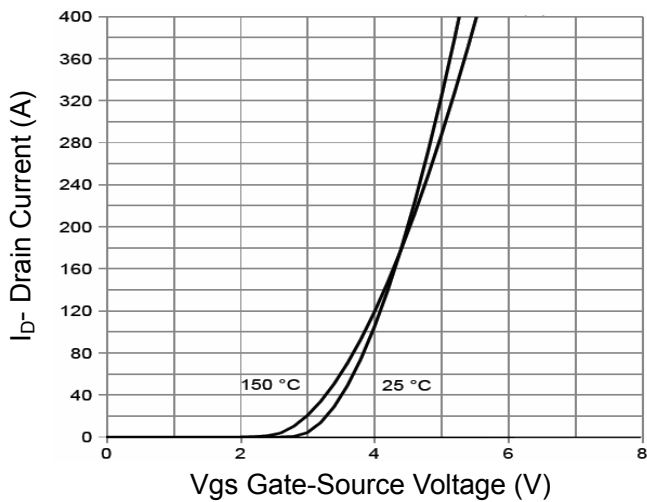


Figure 2 Transfer Characteristics

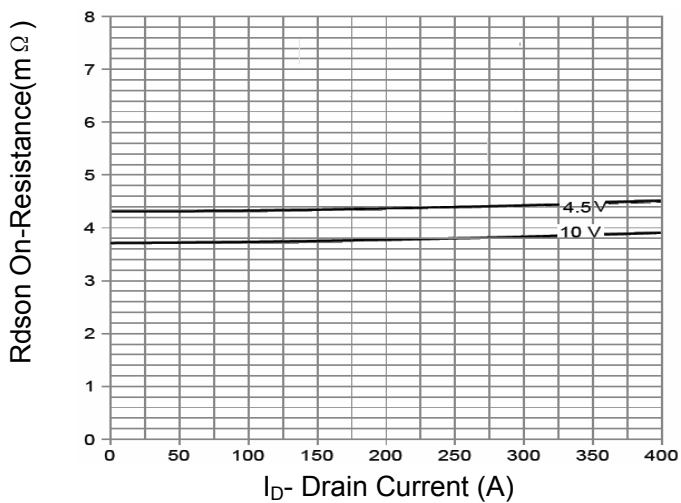


Figure 3  $R_{DS(on)}$ - Drain Current

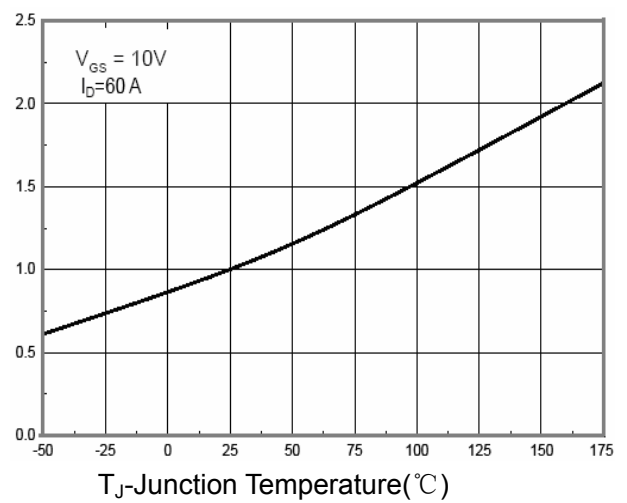


Figure 4  $R_{DS(on)}$ -Junction Temperature

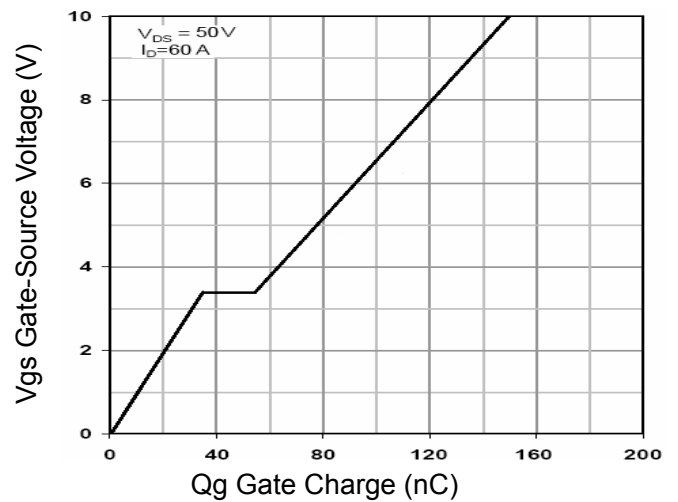


Figure 5 Gate Charge

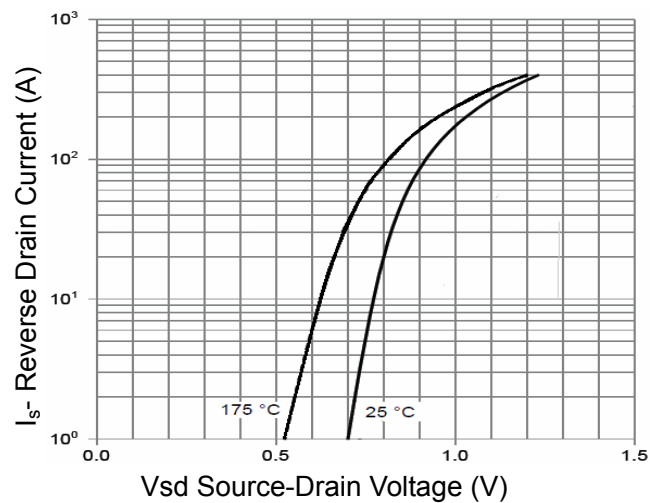


Figure 6 Source- Drain Diode Forward

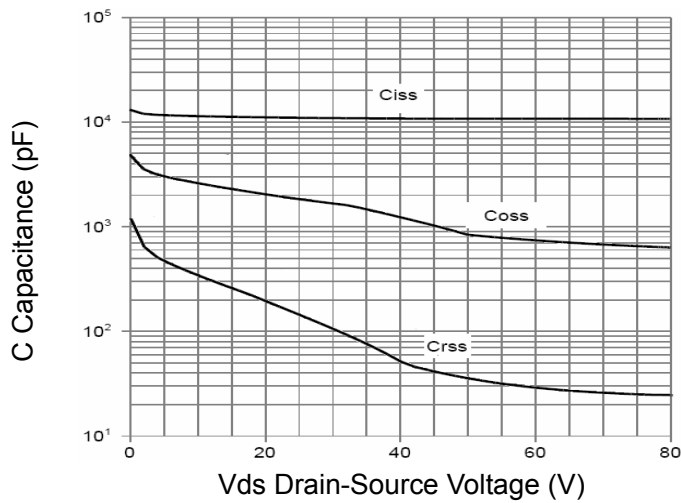


Figure 7 Capacitance vs Vds

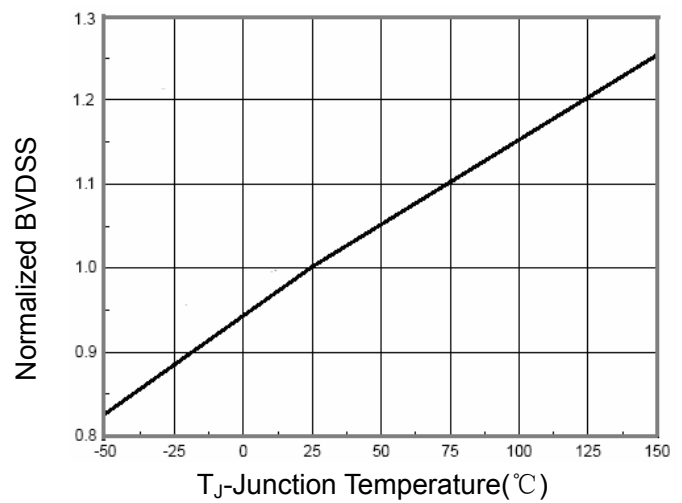
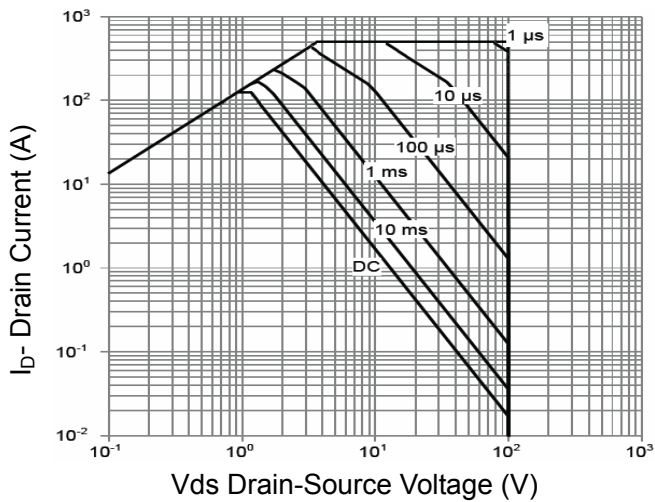

Figure 9  $BV_{DSS}$  vs Junction Temperature


Figure 8 Safe Operation Area

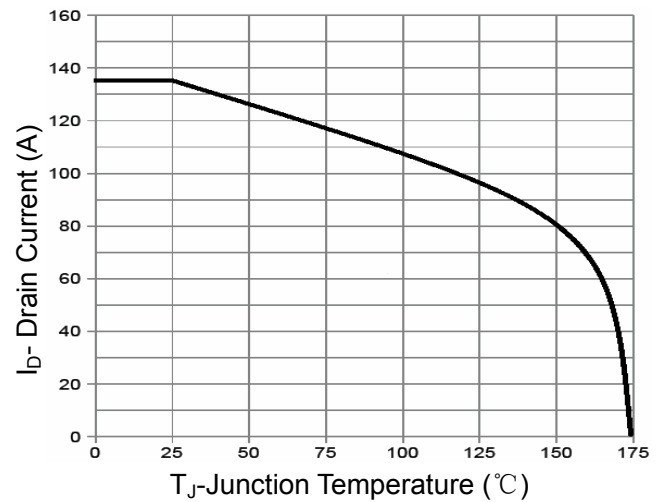


Figure 10 Current De-rating

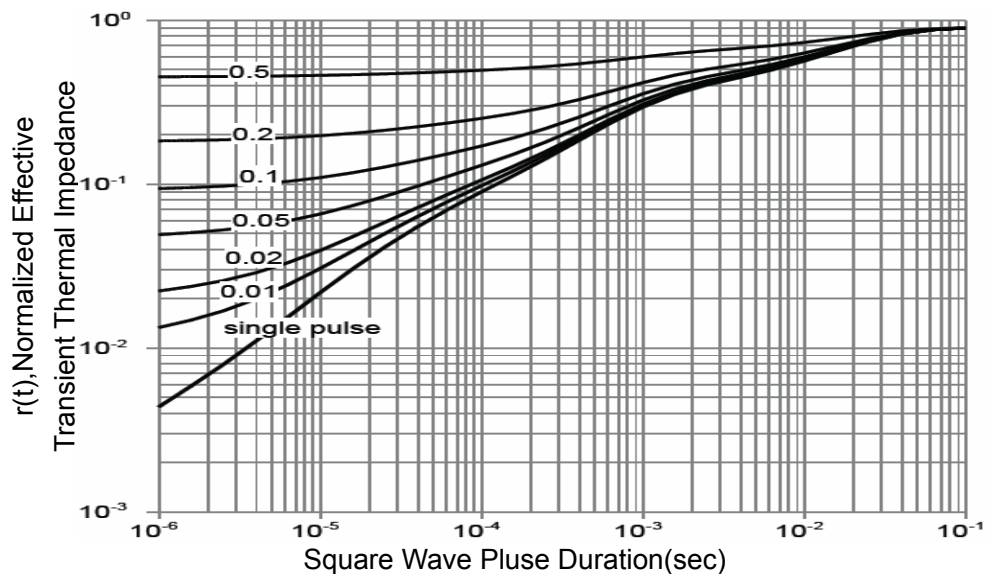
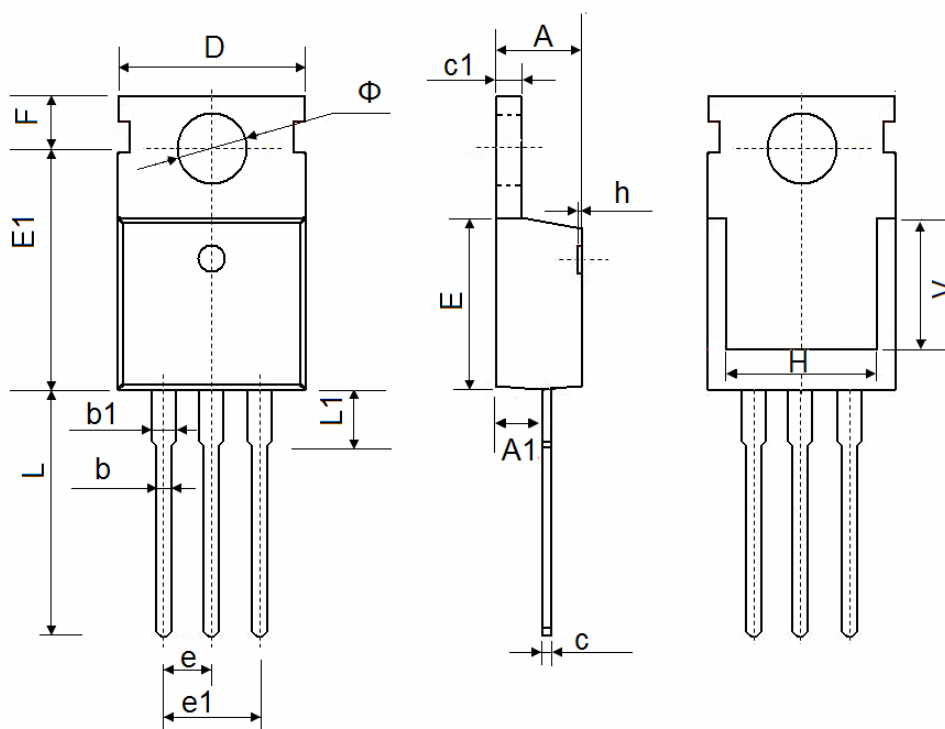


Figure 11 Normalized Maximum Transient Thermal Impedance

## TO-220-3L Package Information



| Symbol | Dimensions In Millimeters |        | Dimensions In Inches |       |
|--------|---------------------------|--------|----------------------|-------|
|        | Min.                      | Max.   | Min.                 | Max.  |
| A      | 4.400                     | 4.600  | 0.173                | 0.181 |
| A1     | 2.250                     | 2.550  | 0.089                | 0.100 |
| b      | 0.710                     | 0.910  | 0.028                | 0.036 |
| b1     | 1.170                     | 1.370  | 0.046                | 0.054 |
| c      | 0.330                     | 0.650  | 0.013                | 0.026 |
| c1     | 1.200                     | 1.400  | 0.047                | 0.055 |
| D      | 9.910                     | 10.250 | 0.390                | 0.404 |
| E      | 8.9500                    | 9.750  | 0.352                | 0.384 |
| E1     | 12.650                    | 12.950 | 0.498                | 0.510 |
| e      | 2.540 TYP.                |        | 0.100 TYP.           |       |
| e1     | 4.980                     | 5.180  | 0.196                | 0.204 |
| F      | 2.650                     | 2.950  | 0.104                | 0.116 |
| H      | 7.900                     | 8.100  | 0.311                | 0.319 |
| h      | 0.000                     | 0.300  | 0.000                | 0.012 |
| L      | 12.900                    | 13.400 | 0.508                | 0.528 |
| L1     | 2.850                     | 3.250  | 0.112                | 0.128 |
| V      | 7.500 REF.                |        | 0.295 REF.           |       |
| Φ      | 3.400                     | 3.800  | 0.134                | 0.150 |

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