

## NCE N-Channel Enhancement Mode Power MOSFET

### Description

The NCE60H15A uses advanced trench technology and design to provide excellent  $R_{DS(ON)}$  with low gate charge. It can be used in a wide variety of applications.

### General Features

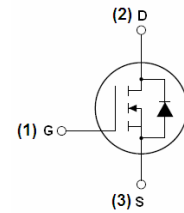
- $V_{DS} = 60V, I_D = 150A$   
 $R_{DS(ON)} < 4.0m\Omega @ V_{GS} = 10V$
- High density cell design for ultra low  $R_{dson}$
- Fully characterized avalanche voltage and current
- Good stability and uniformity with high  $E_{AS}$
- Excellent package for good heat dissipation
- Special process technology for high ESD capability

### Application

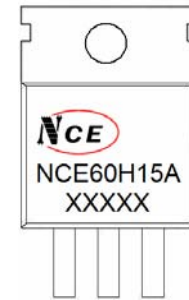
- Power switching application
- Hard switched and high frequency circuits
- Uninterruptible power supply

**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 |
|----------------|-----------|----------------|-----------|------------|----------|
| NCE60H15A      | NCE60H15A | TO-220-3L      | -         | -          | -        |

### Absolute Maximum Ratings ( $T_C = 25^\circ C$ 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                         | $I_D$              | 150        | A             |
| Drain Current-Continuous( $T_C = 100^\circ C$ )  | $I_D(100^\circ C)$ | 105        | A             |
| Pulsed Drain Current                             | $I_{DM}$           | 600        | A             |
| Maximum Power Dissipation                        | $P_D$              | 220        | W             |
| Derating factor                                  |                    | 1.47       | W/ $^\circ C$ |
| Single pulse avalanche energy (Note 5)           | $E_{AS}$           | 900        | mJ            |
| Operating Junction and Storage Temperature Range | $T_J, T_{STG}$     | -55 To 175 | $^\circ C$    |

## Thermal Characteristic

|  |                 |      |               |
|--|-----------------|------|---------------|
| Thermal Resistance, Junction-to-Case <sup>(Note 2)</sup> | $R_{\theta JC}$ | 0.68 | $^{\circ}C/W$ |
|--|-----------------|------|---------------|

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

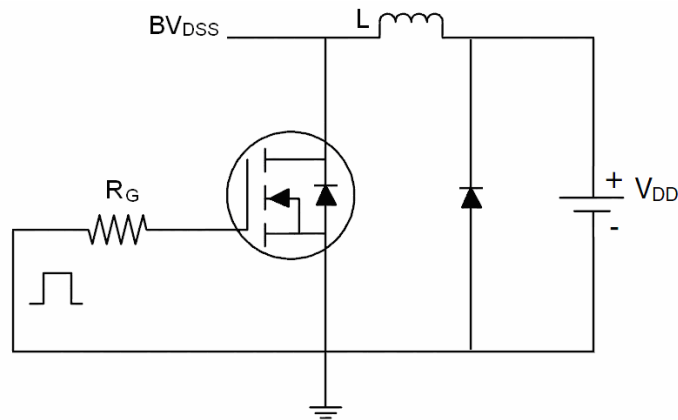
| Parameter  | Symbol       | Condition  | Min | Typ   | Max       | Unit       |
|--|--------------|--|-----|-------|-----------|------------|
| <b>Off Characteristics</b>                           |              |  |     |       |           |            |
| Drain-Source Breakdown Voltage                       | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$  | 60  |       | -         | V          |
| Zero Gate Voltage Drain Current                      | $I_{DSS}$    | $V_{DS}=60V, V_{GS}=0V$  | -   | -     | 1         | $\mu A$    |
| Gate-Body Leakage Current                            | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$  | -   | -     | $\pm 100$ | nA         |
| <b>On Characteristics</b> <sup>(Note 3)</sup>        |              |  |     |       |           |            |
| Gate Threshold Voltage                               | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$  | 2   | 3     | 4         | V          |
| Drain-Source On-State Resistance                     | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=75A$  | -   | 3.1   | 4.0       | m $\Omega$ |
| Forward Transconductance                             | $g_{FS}$     | $V_{DS}=50V, I_D=75A$  | 80  | -     | -         | S          |
| <b>Dynamic Characteristics</b> <sup>(Note 4)</sup>   |              |  |     |       |           |            |
| Input Capacitance                                    | $C_{iss}$    | $V_{DS}=30V, V_{GS}=0V,$<br>$F=1.0MHz$                                     | -   | 5451  | -         | PF         |
| Output Capacitance                                   | $C_{oss}$    |  | -   | 609   | -         | PF         |
| Reverse Transfer Capacitance                         | $C_{rss}$    |  | -   | 488   | -         | PF         |
| <b>Switching Characteristics</b> <sup>(Note 4)</sup> |              |  |     |       |           |            |
| Turn-on Delay Time                                   | $t_{d(on)}$  | $V_{DD}=30V, R_L=0.4\Omega$<br>$V_{GS}=10V, R_G=2.5\Omega$                 | -   | 25    | -         | nS         |
| Turn-on Rise Time                                    | $t_r$        |  | -   | 23    | -         | nS         |
| Turn-Off Delay Time                                  | $t_{d(off)}$ |  | -   | 90    | -         | nS         |
| Turn-Off Fall Time                                   | $t_f$        |  | -   | 38    | -         | nS         |
| Total Gate Charge                                    | $Q_g$        | $V_{DS}=30V, I_D=75A,$<br>$V_{GS}=10V$                                     | -   | 130.8 |           | nC         |
| Gate-Source Charge                                   | $Q_{gs}$     |  | -   | 22.8  |           | nC         |
| Gate-Drain Charge                                    | $Q_{gd}$     |  | -   | 56.9  |           | nC         |
| <b>Drain-Source Diode Characteristics</b>            |              |  |     |       |           |            |
| Diode Forward Voltage <sup>(Note 3)</sup>            | $V_{SD}$     | $V_{GS}=0V, I_S=75A$   | -   |       | 1.2       | V          |
| Diode Forward Current <sup>(Note 2)</sup>            | $I_S$        |  | -   | -     | 150       | A          |
| Reverse Recovery Time                                | $t_{rr}$     | $T_J = 25^{\circ}C, I_F = 75A$<br>$di/dt = 100A/\mu s$ <sup>(Note 3)</sup> | -   | -     | 60        | nS         |
| Reverse Recovery Charge                              | $Q_{rr}$     |  | -   | -     | 80        | nC         |
| Forward Turn-On Time                                 | $t_{on}$     | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)       |     |       |           |            |

## Notes:

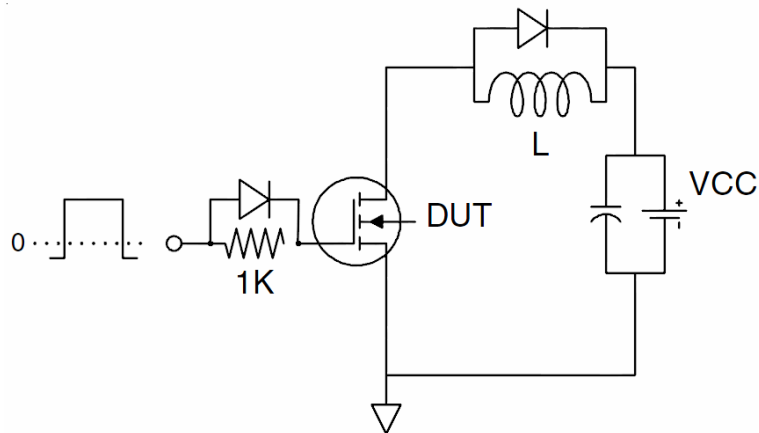
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition:  $T_J=25^{\circ}C, V_{DD}=30V, V_G=10V,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

## Test circuit

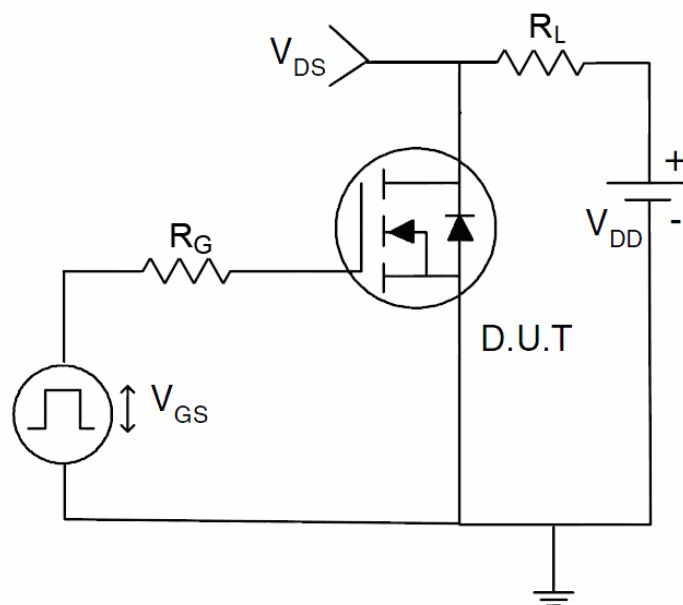
### 1) E<sub>AS</sub> test Circuits



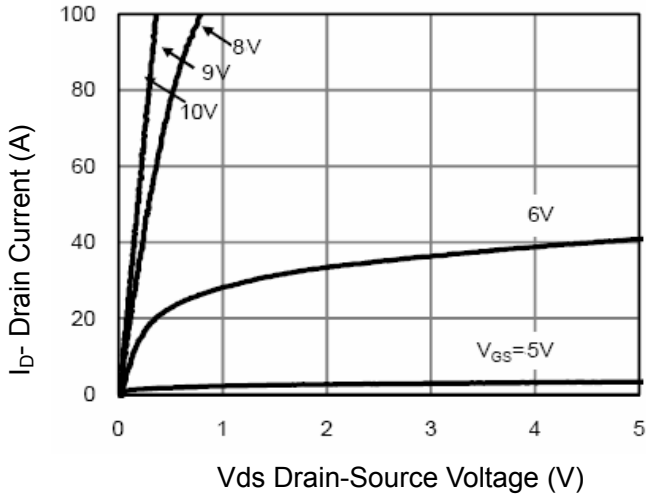
### 2) Gate charge test Circuit:



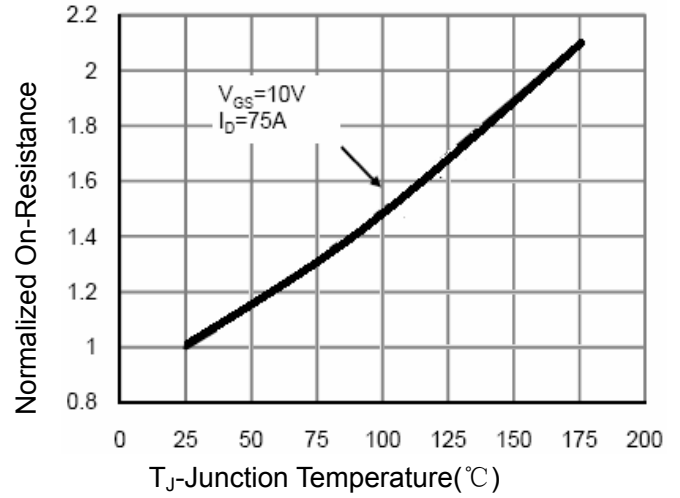
### 3) Switch Time Test Circuit:



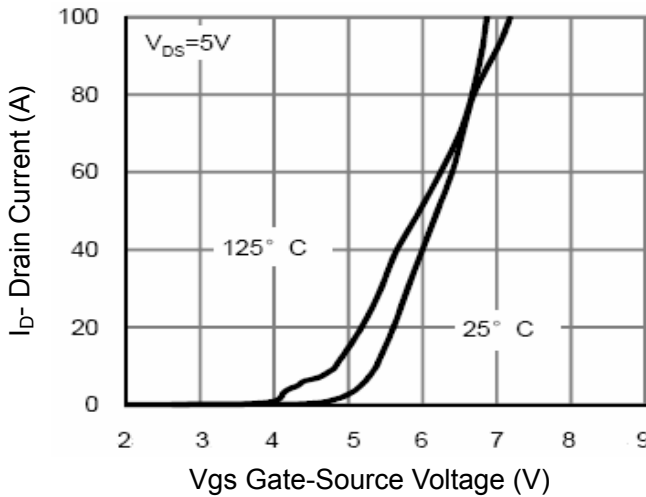
## Typical Electrical and Thermal Characteristics (Curves)



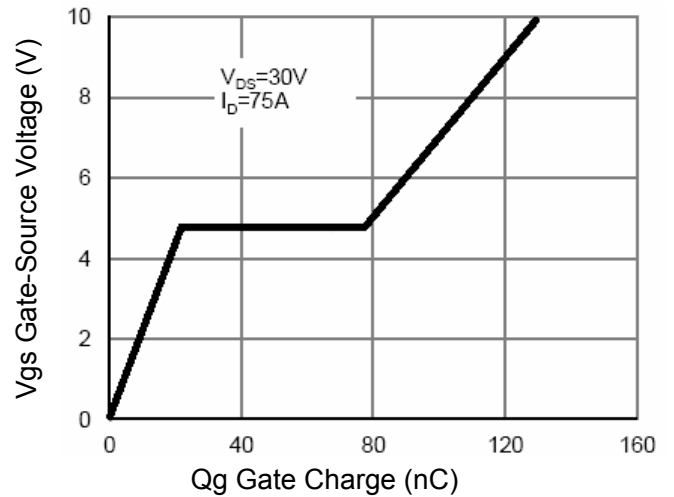
**Figure 1 Output Characteristics**



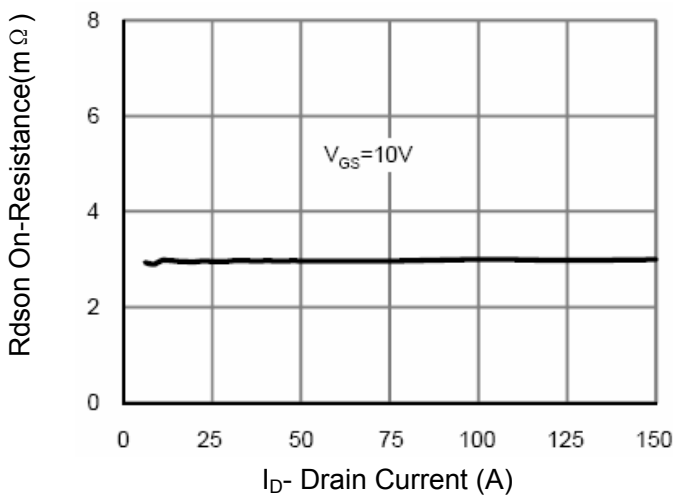
**Figure 4 Rds(on)-Junction Temperature**



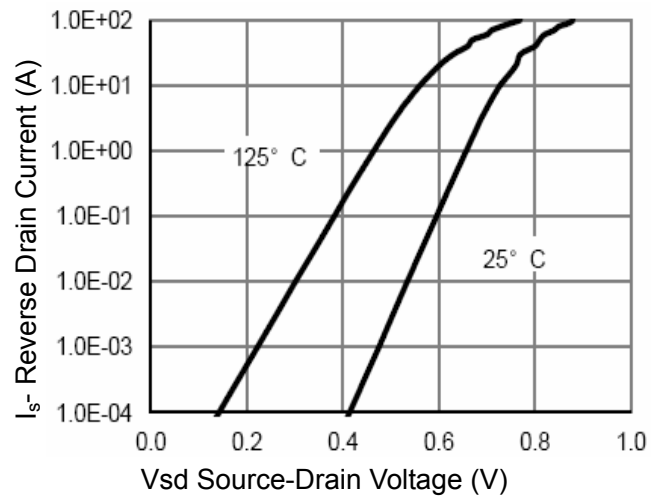
**Figure 2 Transfer Characteristics**



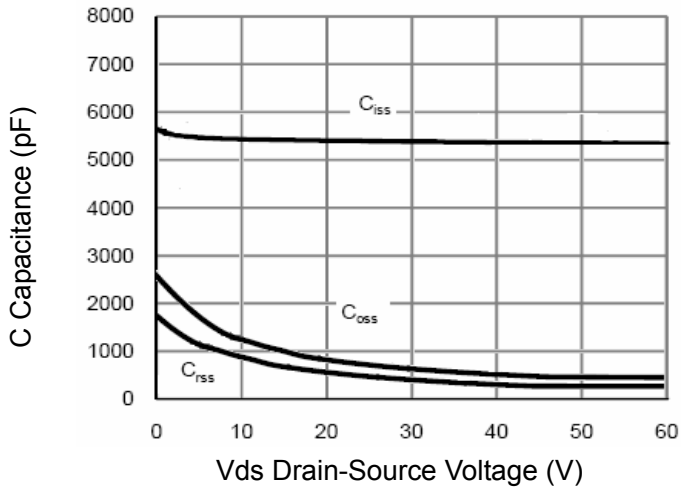
**Figure 5 Gate Charge**



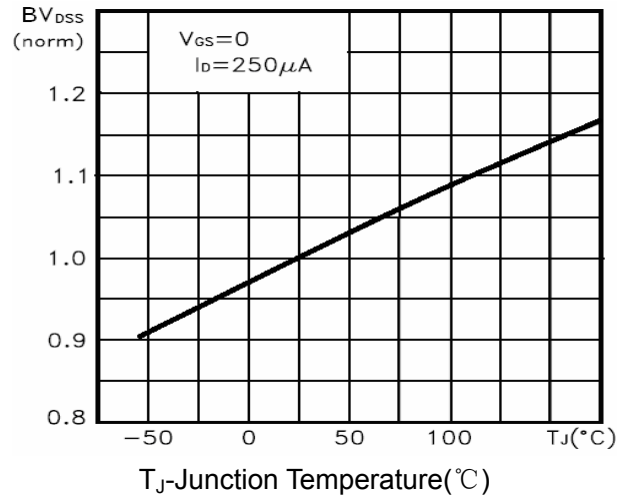
**Figure 3 Rds(on)- Drain Current**



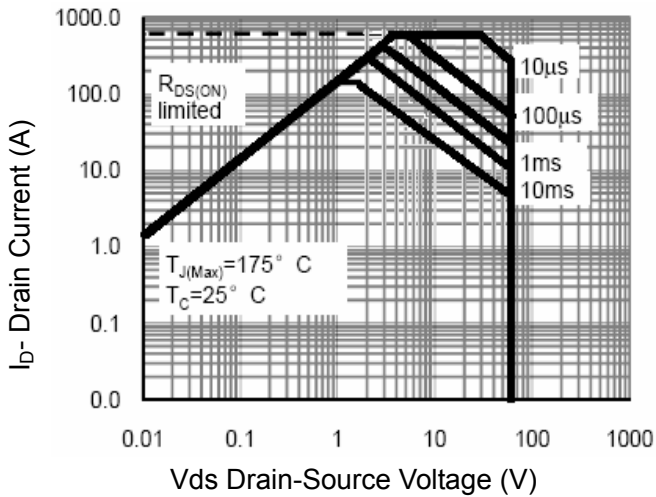
**Figure 6 Source- Drain Diode Forward**



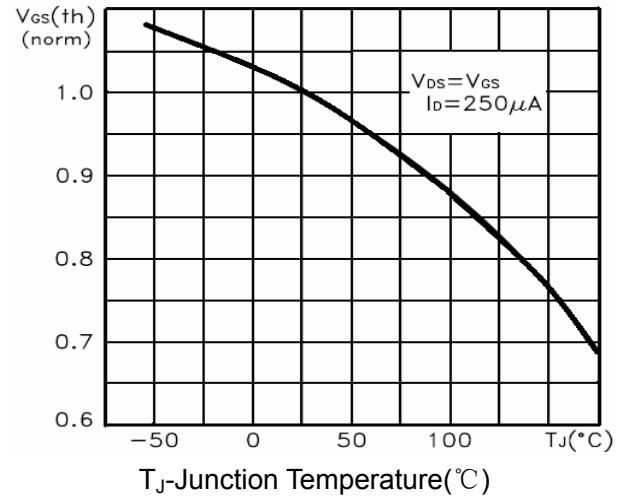
**Figure 7 Capacitance vs Vds**



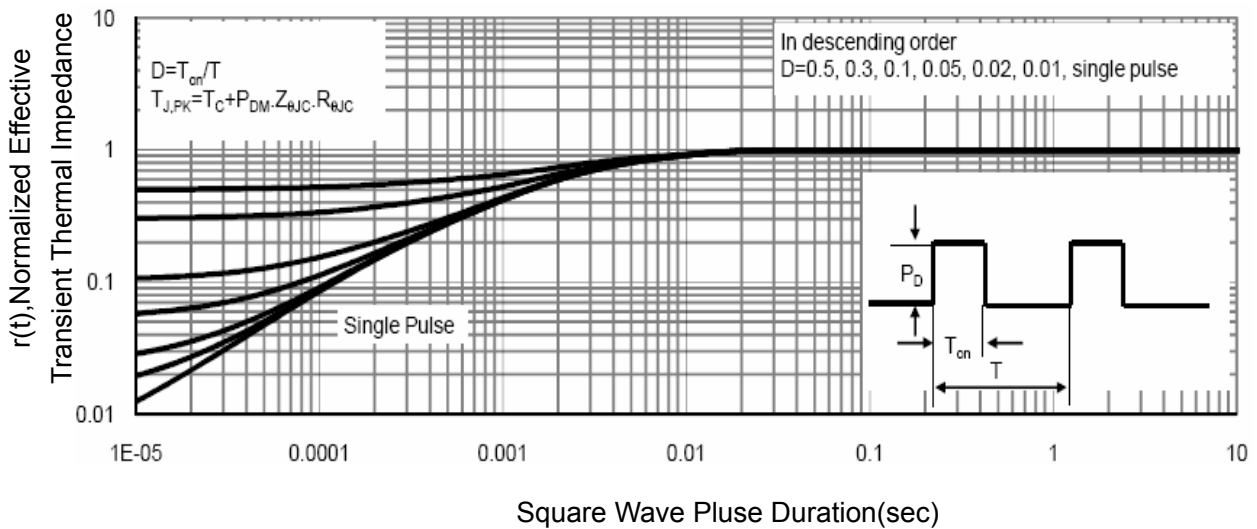
**Figure 9 BV<sub>DSS</sub> vs Junction Temperature**



**Figure 8 Safe Operation Area**

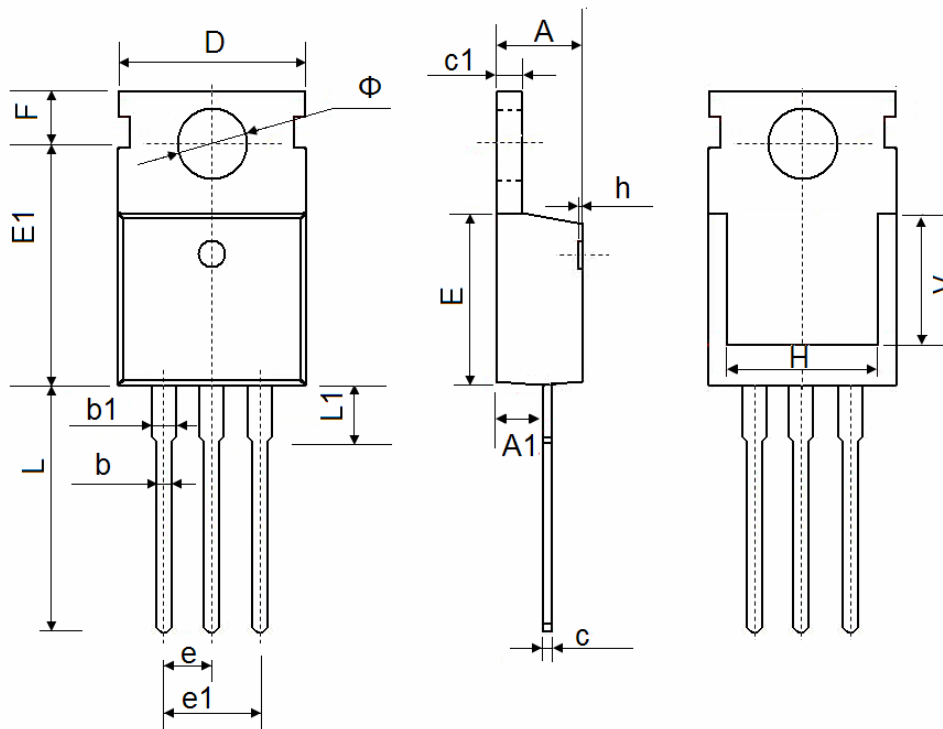


**Figure 10 V<sub>GS(th)</sub> vs Junction Temperature**



**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.           |       |
| $\Phi$ | 3.400                     | 3.800  | 0.134                | 0.150 |

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