

## N-Channel Enhancement Mode Power MOSFET

### Description

The HM60N03 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.

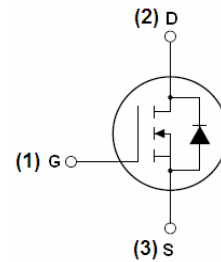
### General Features

- $V_{DS} = 30V, I_D = 60A$   
 $R_{DS(ON)} < 11m\Omega @ V_{GS} = 10V$   
 $R_{DS(ON)} < 13m\Omega @ V_{GS} = 4.5V$
- 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!**



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 |
|----------------|---------|----------------|-----------|------------|----------|
| HM60N03        | HM60N03 | TO-220-3L      | -         | -          | -        |

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

| Parameter                                     | Symbol             | Limit | Unit |
|---|--------------------|-------|------|
| Drain-Source Voltage                          | $V_{DS}$           | 30    | V    |
| Gate-Source Voltage                           | $V_{GS}$           | ±20   | V    |
| Drain Current-Continuous                      | $I_D$              | 60    | A    |
| Drain Current-Continuous( $T_C=100^\circ C$ ) | $I_D(100^\circ C)$ | 42    | A    |
| Pulsed Drain Current                          | $I_{DM}$           | 180   | A    |
| Maximum Power Dissipation                     | $P_D$              | 60    | W    |
| Derating factor                               |                    | 0.4   | W/°C |
| Single pulse avalanche energy (Note 5)        | $E_{AS}$           | 70    | mJ   |

|  |                |            |    |
|--|----------------|------------|----|
| Operating Junction and Storage Temperature Range | $T_J, T_{STG}$ | -55 To 175 | °C |
|--|----------------|------------|----|

### Thermal Characteristic

|  |                 |     |      |
|--|-----------------|-----|------|
| Thermal Resistance, Junction-to-Case(Note 2) | $R_{\theta JC}$ | 2.5 | °C/W |
|--|-----------------|-----|------|

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

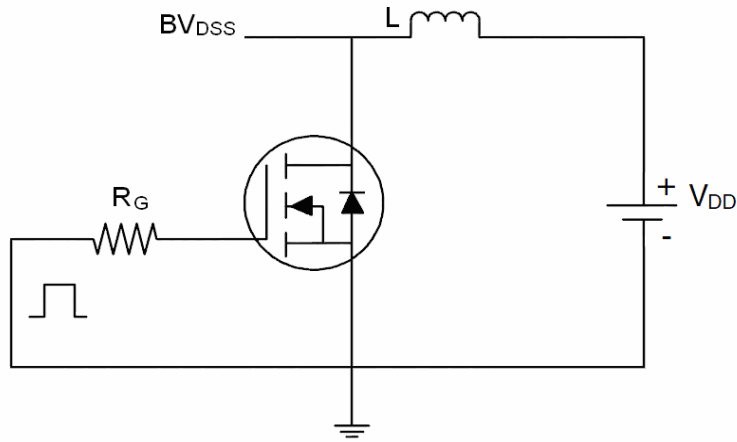
| Parameter                                 | Symbol       | Condition  | Min | Typ  | Max       | Unit       |
|---|--------------|--|-----|------|-----------|------------|
| <b>Off Characteristics</b>                |              |  |     |      |           |            |
| Drain-Source Breakdown Voltage            | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$  | 30  | 33   | -         | V          |
| Zero Gate Voltage Drain Current           | $I_{DSS}$    | $V_{DS}=30V, V_{GS}=0V$  | -   | -    | 1         | $\mu A$    |
| Gate-Body Leakage Current                 | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$  | -   | -    | $\pm 100$ | nA         |
| <b>On Characteristics (Note 3)</b>        |              |  |     |      |           |            |
| Gate Threshold Voltage                    | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$  | 1   | 1.8  | 3         | V          |
| Drain-Source On-State Resistance          | $R_{DS(on)}$ | $V_{GS}=10V, I_D=25A$  | -   | 9    | 11        | m $\Omega$ |
|   |              | $V_{GS}=5V, I_D=20A$   | -   | 11   | 13        |            |
| Forward Transconductance                  | $g_{FS}$     | $V_{DS}=5V, I_D=20A$   | 15  | -    | -         | S          |
| <b>Dynamic Characteristics (Note 4)</b>   |              |  |     |      |           |            |
| Input Capacitance                         | $C_{iss}$    | $V_{DS}=15V, V_{GS}=0V,$<br>$F=1.0MHz$                               | -   | 2000 | -         | PF         |
| Output Capacitance                        | $C_{oss}$    |  | -   | 280  | -         | PF         |
| Reverse Transfer Capacitance              | $C_{rss}$    |  | -   | 160  | -         | PF         |
| <b>Switching Characteristics (Note 4)</b> |              |  |     |      |           |            |
| Turn-on Delay Time                        | $t_{d(on)}$  | $V_{DD}=15V, I_D=20A$<br>$V_{GS}=10V, R_{GEN}=1.8\Omega$             | -   | 10   | -         | nS         |
| Turn-on Rise Time                         | $t_r$        |  | -   | 8    | -         | nS         |
| Turn-Off Delay Time                       | $t_{d(off)}$ |  | -   | 30   | -         | nS         |
| Turn-Off Fall Time                        | $t_f$        |  | -   | 5    | -         | nS         |
| Total Gate Charge                         | $Q_g$        | $V_{DS}=10V, I_D=25A,$<br>$V_{GS}=10V$                               | -   | 23   | -         | nC         |
| Gate-Source Charge                        | $Q_{gs}$     |  | -   | 7    | -         | nC         |
| Gate-Drain Charge                         | $Q_{gd}$     |  | -   | 4.5  | -         | nC         |
| <b>Drain-Source Diode Characteristics</b> |              |  |     |      |           |            |
| Diode Forward Voltage (Note 3)            | $V_{SD}$     | $V_{GS}=0V, I_S=25A$   | -   | 0.85 | 1.2       | V          |
| Diode Forward Current (Note 2)            | $I_S$        |  | -   | -    | 40        | A          |
| Reverse Recovery Time                     | $t_{rr}$     | $T_J = 25^\circ C, I_F = 40A$<br>$di/dt = 100A/\mu s$ (Note3)        | -   | 22   | 35        | nS         |
| Reverse Recovery Charge                   | $Q_{rr}$     |  | -   | 12   | 20        | nC         |
| Forward Turn-On Time                      | $t_{on}$     | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD) |     |      |           |            |

### Notes:

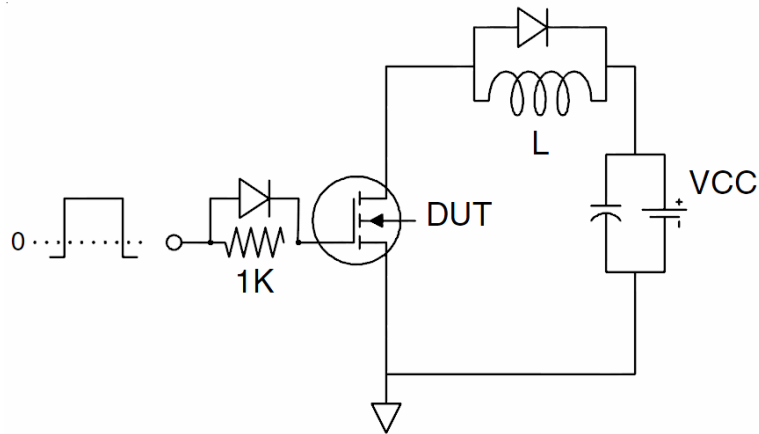
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition:  $T_J=25^\circ C, V_{DD}=15V, V_G=10V, L=1mH, R_g=25\Omega$

## Test circuit

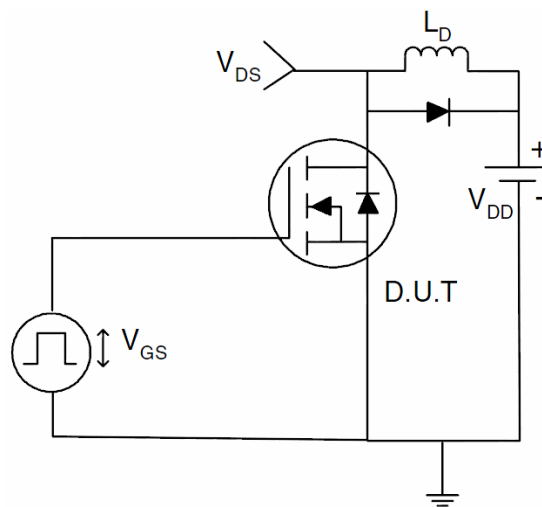
### 1) $E_{AS}$ test Circuits



### 2) Gate charge test Circuit:



### 3) Switch Time Test Circuit:



TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (Curves)

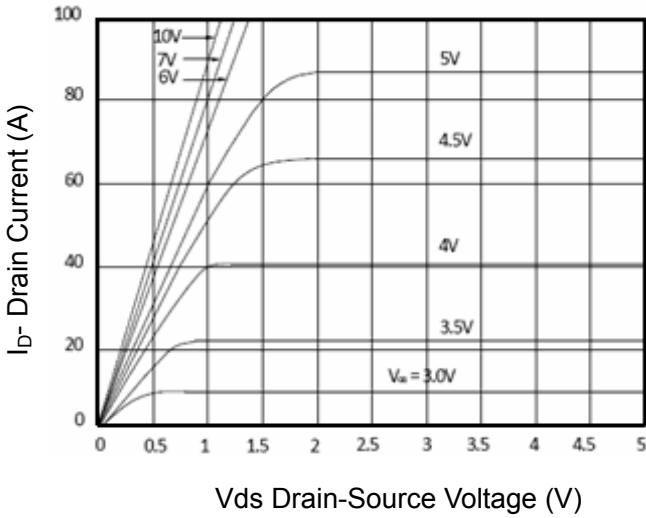


Figure 1 Output Characteristics

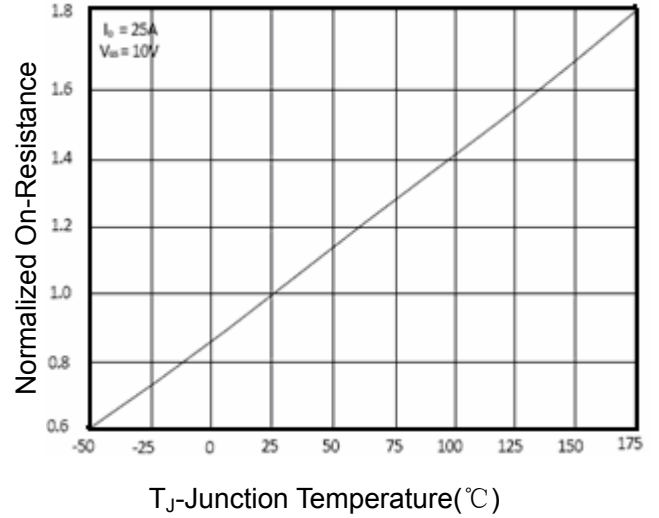


Figure 4  $R_{dson}$ -Junction Temperature

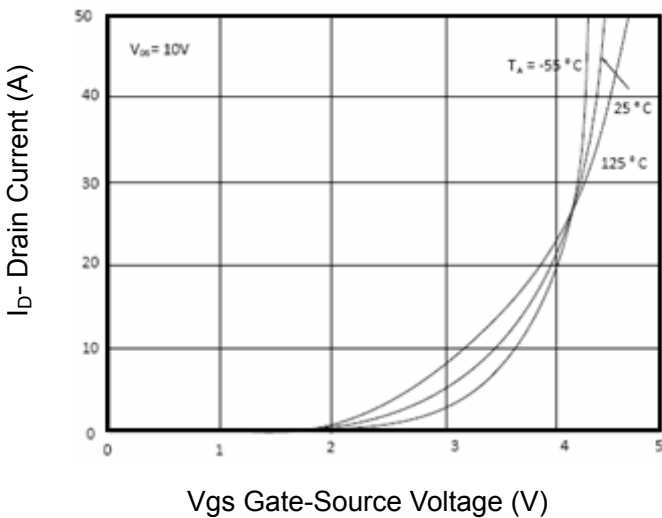


Figure 2 Transfer Characteristics

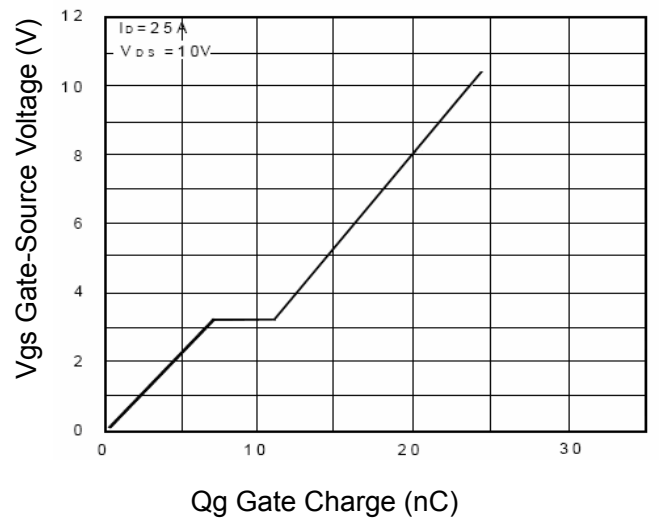


Figure 5 Gate Charge

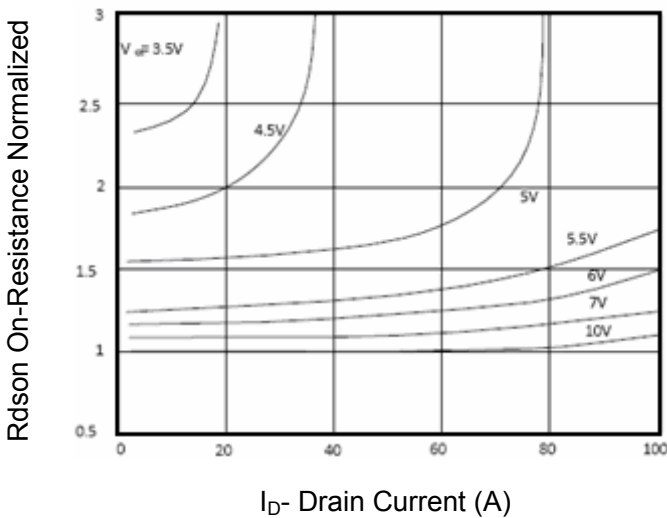


Figure 3  $R_{dson}$ - Drain Current

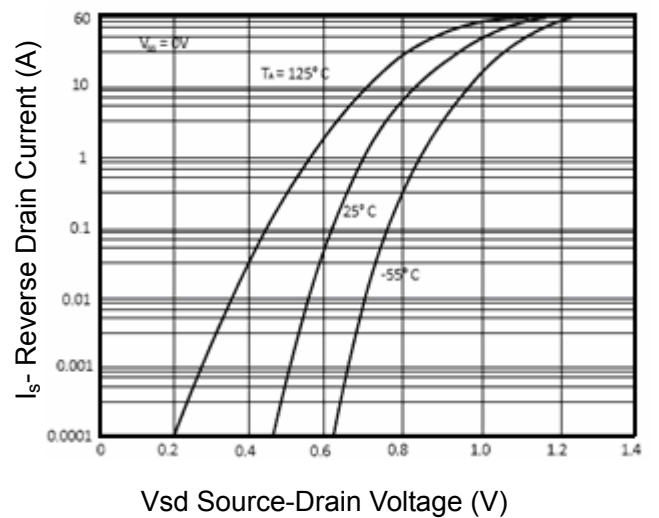
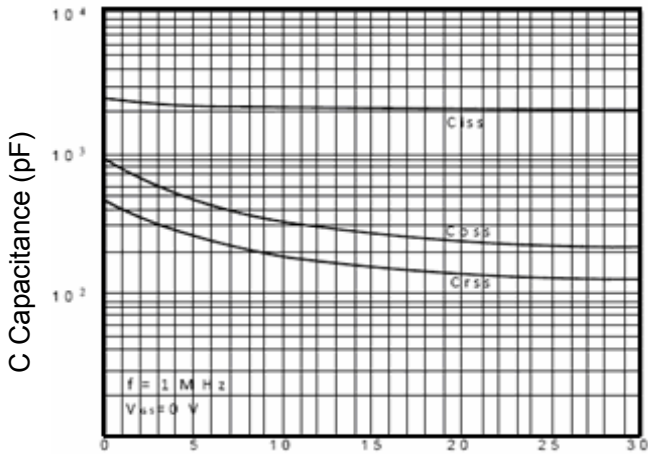
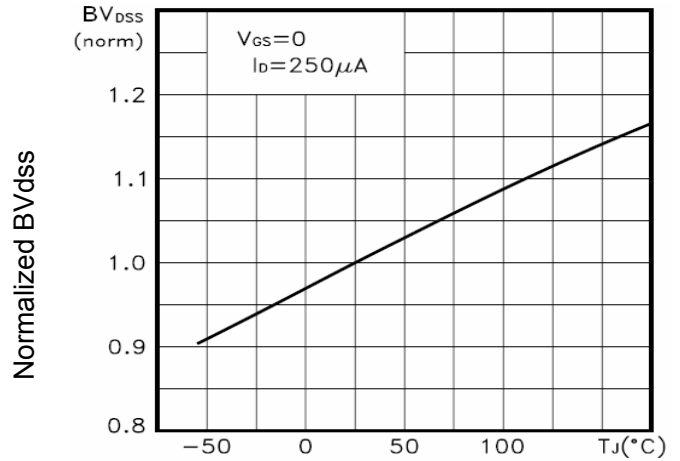


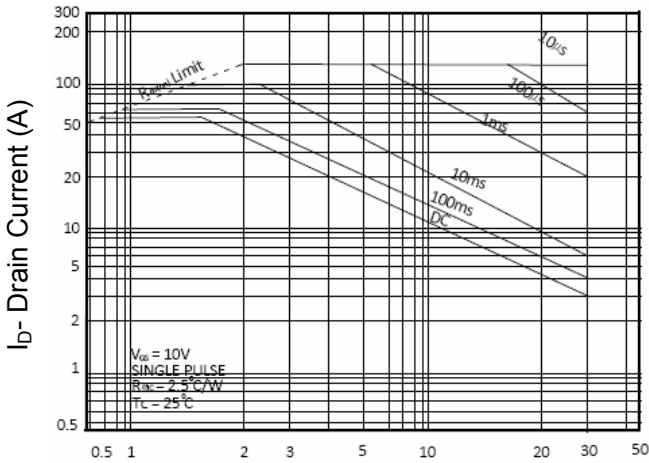
Figure 6 Source- Drain Diode Forward



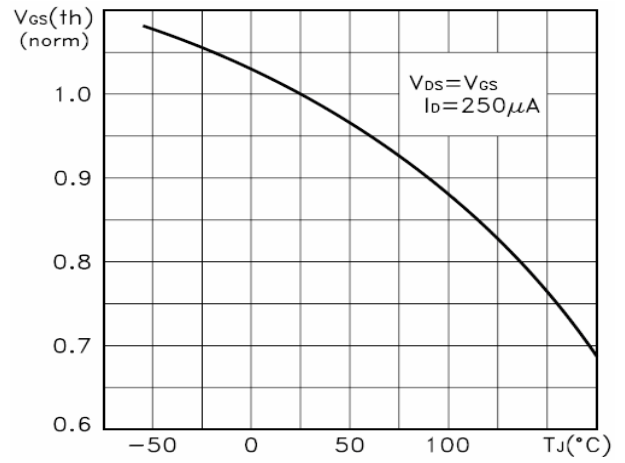
Vds Drain-Source Voltage (V)  
**Figure 7 Capacitance vs Vds**



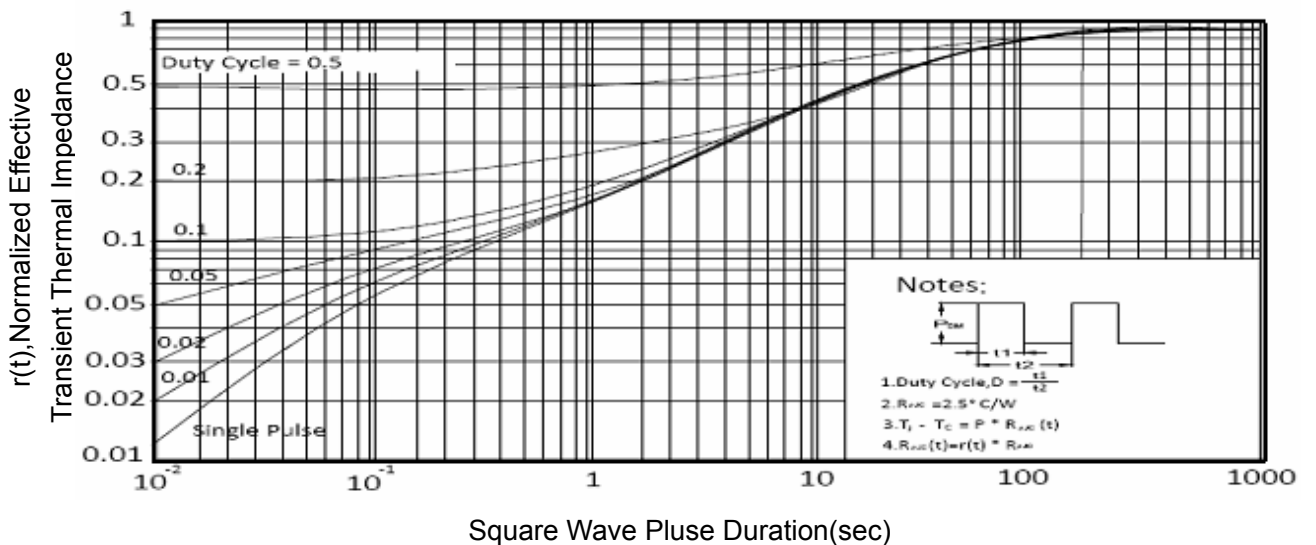
T<sub>J</sub>-Junction Temperature(°C)  
**Figure 9 BV<sub>DSS</sub> vs Junction Temperature**



Vds Drain-Source Voltage (V)  
**Figure 8 Safe Operation Area**

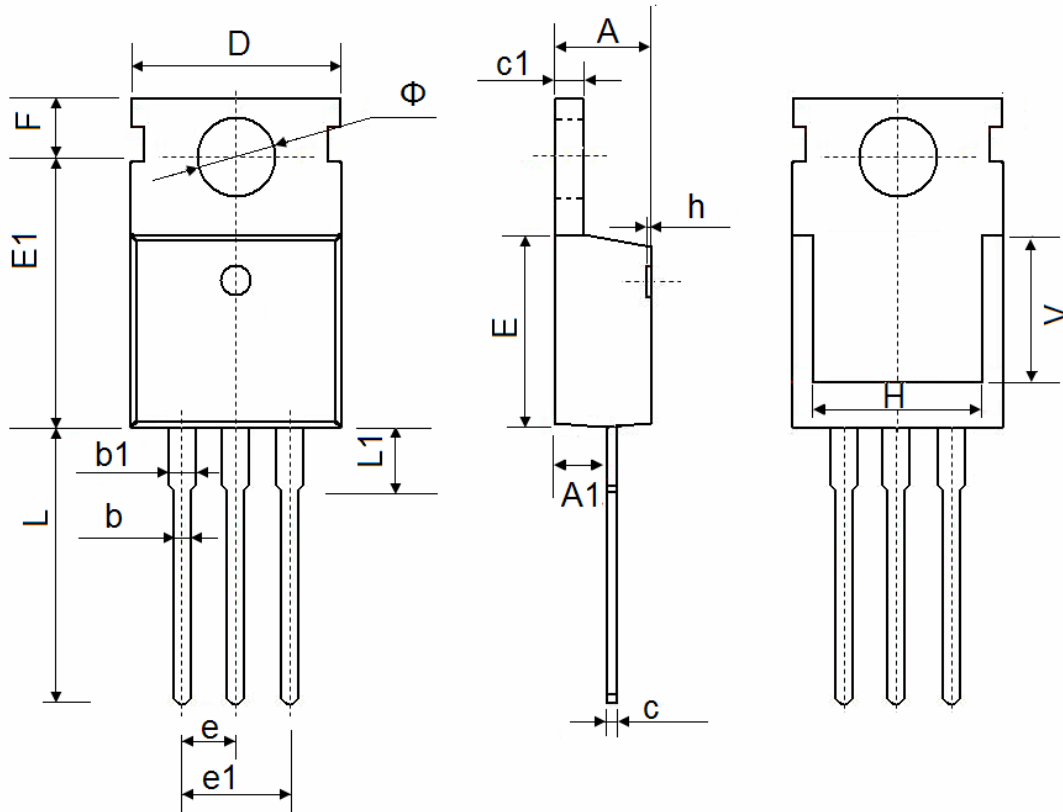


T<sub>J</sub>-Junction Temperature(°C)  
**Figure 10 V<sub>GS(th)</sub> vs Junction Temperature**



Square Wave Pulse Duration(sec)  
**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 |