

## QIAOXIN N-Channel **Super Trench** Power MOSFET

### Description

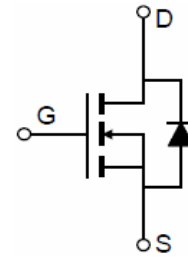
The VCRR60T20A uses **Super Trench** technology that is uniquely optimized to provide the most efficient high frequency switching performance. Both conduction and switching power losses are minimized due to an extremely low combination of  $R_{DS(on)}$  and  $Q_g$ . This device is ideal for high-frequency switching and synchronous rectification.

### General Features

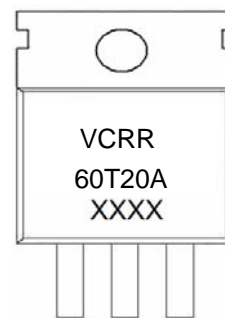
- $V_{DS} = 60V, I_D = 200A$   
 $R_{DS(on)} = 1.8m\Omega$  (typical) @  $V_{GS} = 10V$   
 $R_{DS(on)} = 2.1m\Omega$  (typical) @  $V_{GS} = 4.5V$
- Excellent gate charge x  $R_{DS(on)}$  product
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating
- 100% UIS tested

### Application

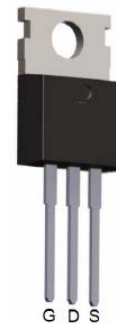
- DC/DC Converter
- Ideal for high-frequency switching and synchronous rectification



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 |
|----------------|------------|----------------|-----------|------------|----------|
| VCRR60T20A     | VCRR60T20A | 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 (Silicon Limited)        | $I_D$              | 200        | A             |
| Drain Current-Continuous ( $T_C = 100^\circ C$ )  | $I_D(100^\circ C)$ | 140        | A             |
| Pulsed Drain Current                              | $I_{DM}$           | 800        | A             |
| Maximum Power Dissipation                         | $P_D$              | 255        | W             |
| Derating factor                                   |                    | 1.7        | W/ $^\circ C$ |
| Single pulse avalanche energy <sup>(Note 5)</sup> | $E_{AS}$           | 2000       | 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> | $R_{\theta JC}$ | 0.59 | $^{\circ}C/W$ |
|--|-----------------|------|---------------|

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

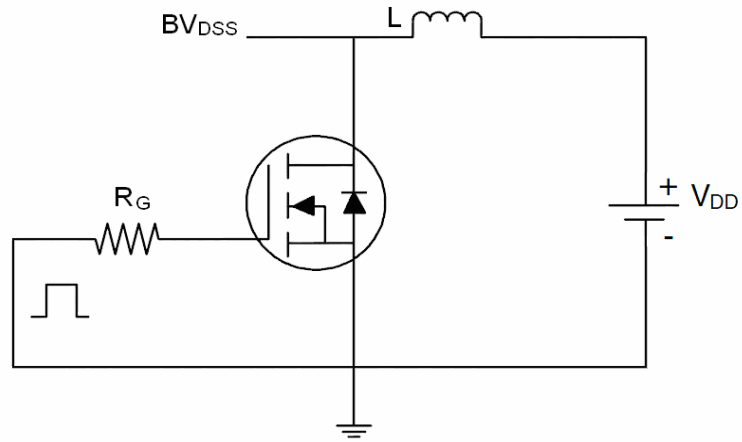
| Parameter  | Symbol       | Condition  | Min | Typ  | Max       | Unit       |
|--|--------------|--|-----|------|-----------|------------|
| <b>Off Characteristics</b>                           |              |  |     |      |           |            |
| Drain-Source Breakdown Voltage                       | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$  | 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                               | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$  | 1.0 | 1.5  | 2.2       | V          |
| Drain-Source On-State Resistance                     | $R_{DS(on)}$ | $V_{GS}=10V, I_D=100A$   | -   | 1.8  | 2.3       | m $\Omega$ |
|  |              | $V_{GS}=4.5V, I_D=100A$  | -   | 2.1  | 2.7       | m $\Omega$ |
| Forward Transconductance                             | $g_{FS}$     | $V_{DS}=10V, I_D=100A$   | -   | 60   | -         | S          |
| <b>Dynamic Characteristics</b> <sup>(Note 4)</sup>   |              |  |     |      |           |            |
| Input Capacitance                                    | $C_{iss}$    | $V_{DS}=30V, V_{GS}=0V,$<br>$F=1.0MHz$                                     | -   | 9760 | -         | PF         |
| Output Capacitance                                   | $C_{oss}$    |  | -   | 1600 | -         | PF         |
| Reverse Transfer Capacitance                         | $C_{rss}$    |  | -   | 65   | -         | PF         |
| <b>Switching Characteristics</b> <sup>(Note 4)</sup> |              |  |     |      |           |            |
| Turn-on Delay Time                                   | $t_{d(on)}$  | $V_{DD}=30V, I_D=100A$<br>$V_{GS}=10V, R_G=4.7\Omega$                      | -   | 24   | -         | nS         |
| Turn-on Rise Time                                    | $t_r$        |  | -   | 20   | -         | nS         |
| Turn-Off Delay Time                                  | $t_{d(off)}$ |  | -   | 60   | -         | nS         |
| Turn-Off Fall Time                                   | $t_f$        |  | -   | 15   | -         | nS         |
| Total Gate Charge                                    | $Q_g$        | $V_{DS}=30V, I_D=100A,$<br>$V_{GS}=10V$                                    | -   | 173  |           | nC         |
| Gate-Source Charge                                   | $Q_{gs}$     |  | -   | 32.1 |           | nC         |
| Gate-Drain Charge                                    | $Q_{gd}$     |  | -   | 24.6 |           | nC         |
| <b>Drain-Source Diode Characteristics</b>            |              |  |     |      |           |            |
| Diode Forward Voltage <sup>(Note 3)</sup>            | $V_{SD}$     | $V_{GS}=0V, I_S=200A$  | -   |      | 1.2       | V          |
| Diode Forward Current <sup>(Note 2)</sup>            | $I_S$        |  | -   | -    | 200       | A          |
| Reverse Recovery Time                                | $t_{rr}$     | $T_J = 25^{\circ}C, I_F = I_S$<br>$di/dt = 100A/\mu s$ <sup>(Note 3)</sup> | -   | 68   |           | nS         |
| Reverse Recovery Charge                              | $Q_{rr}$     |  | -   | 114  |           | nC         |

### Notes:

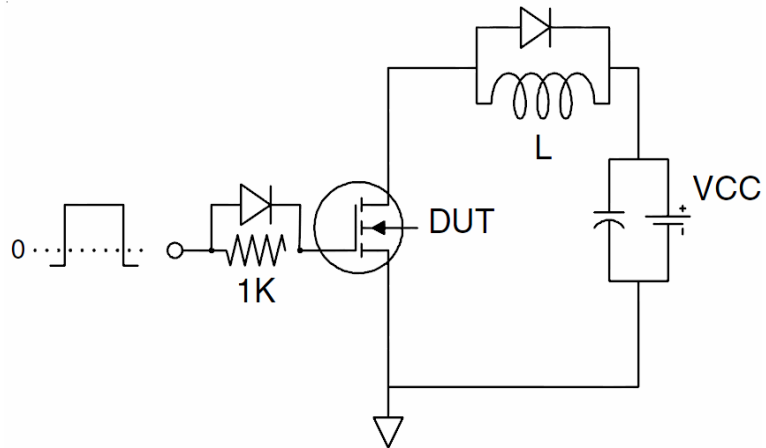
1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. Surface Mounted on FR4 Board,  $t \leq 10$  sec.
3. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
4. Guaranteed by design, not subject to production
5. EAS condition :  $T_J=25^{\circ}C, V_{DD}=30V, V_G=10V,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

**Test Circuit**

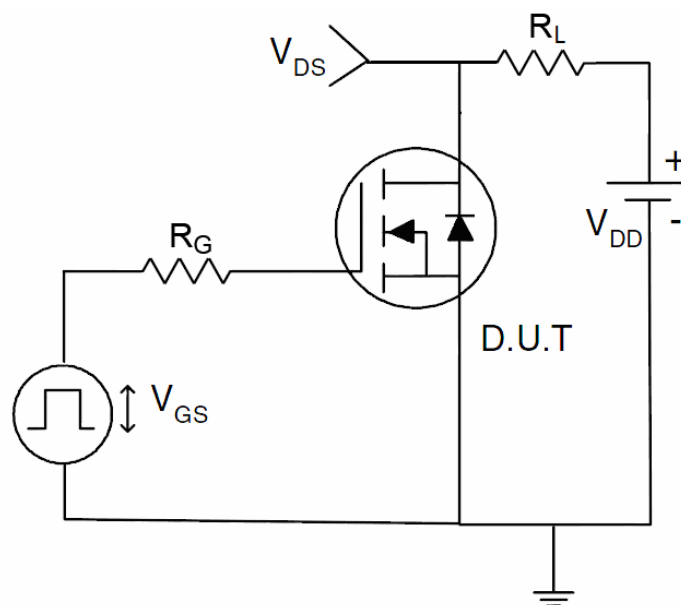
**1) E<sub>AS</sub> test Circuit**



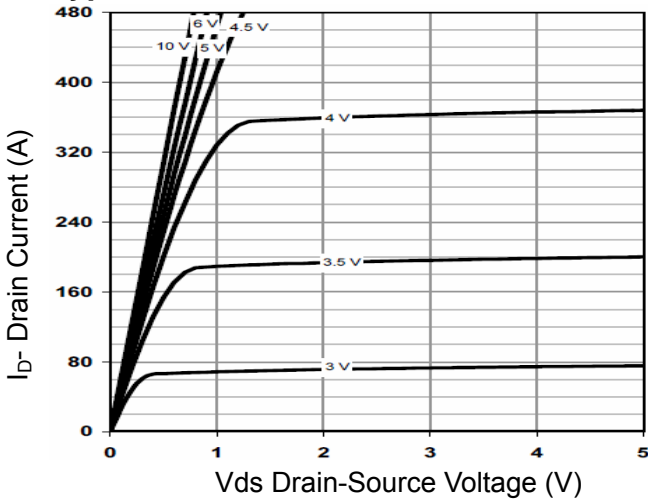
**2) Gate charge test Circuit**



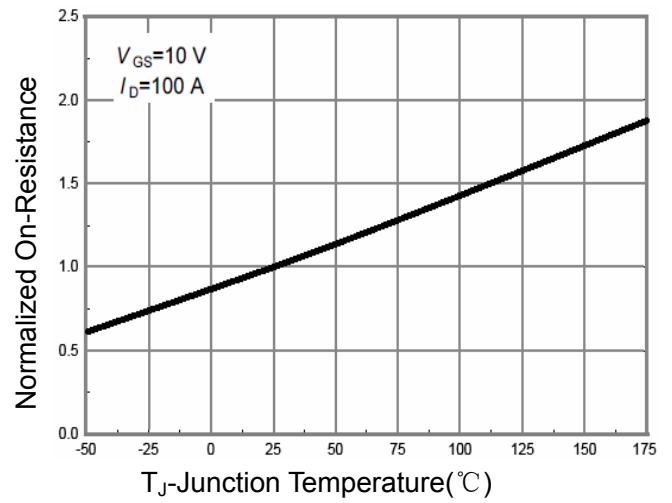
**3) Switch Time Test Circuit**



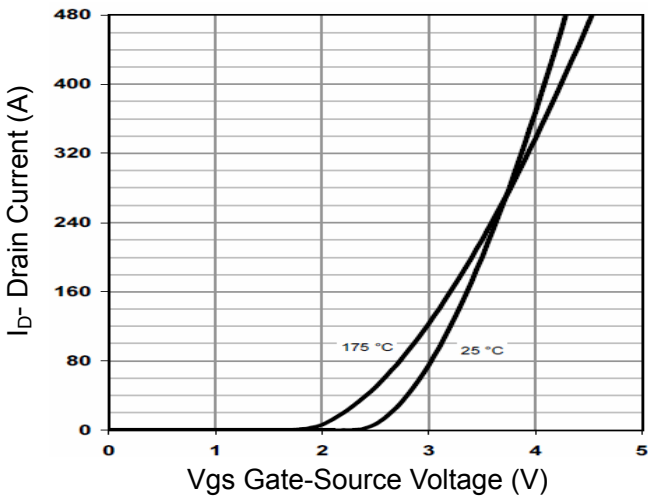
**Typical Electrical and Thermal Characteristics**



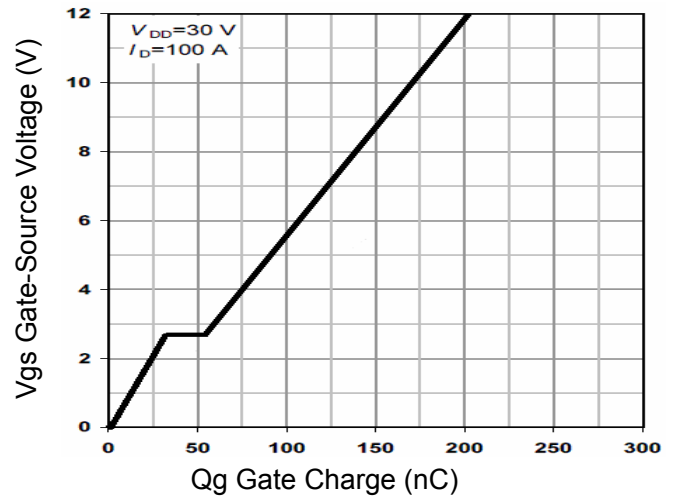
**Figure 1 Output Characteristics**



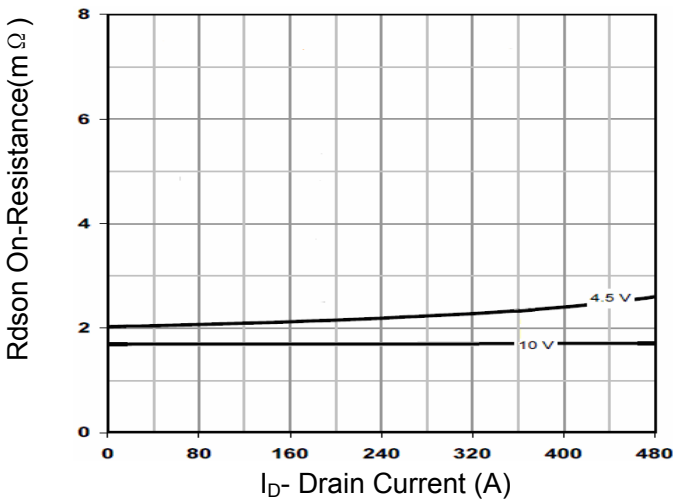
**Figure 4 Rds(on)-Junction Temperature**



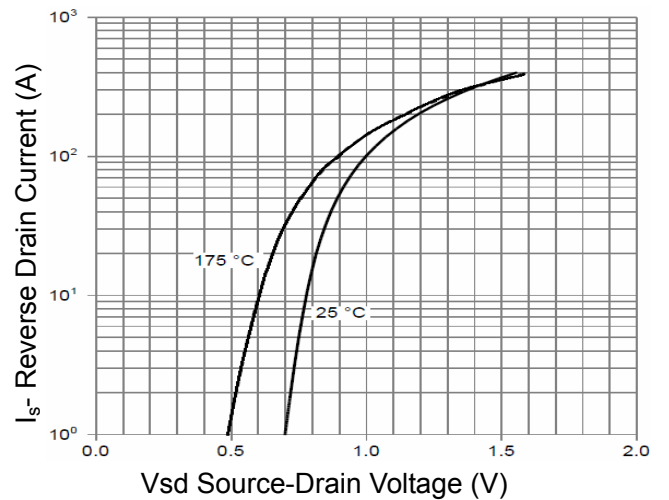
**Figure 2 Transfer Characteristics**



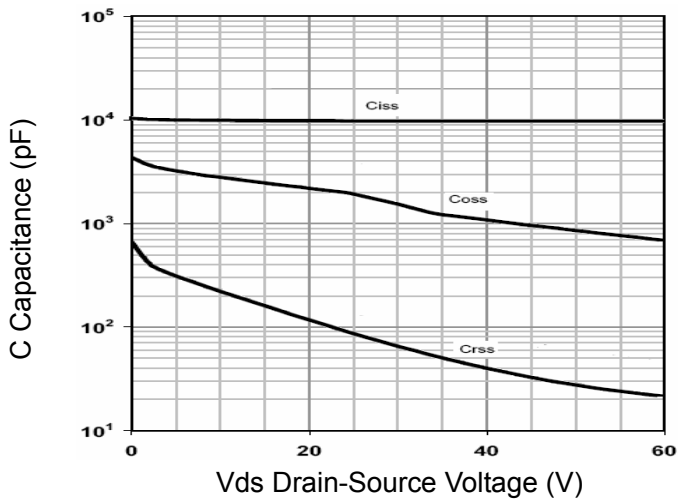
**Figure 5 Gate Charge**



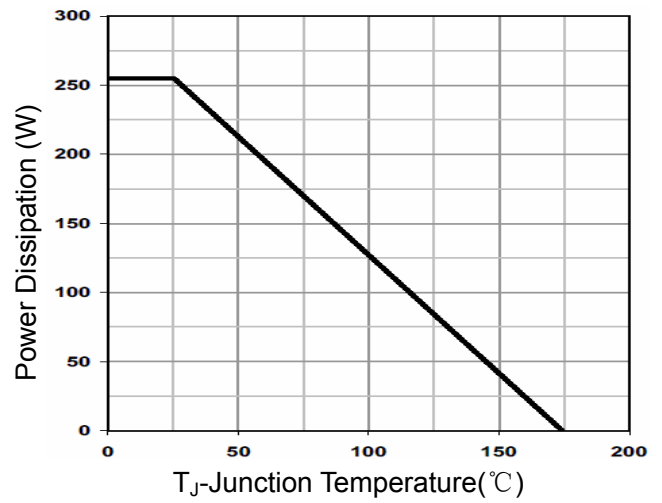
**Figure 3 Rds(on)- Drain Current**



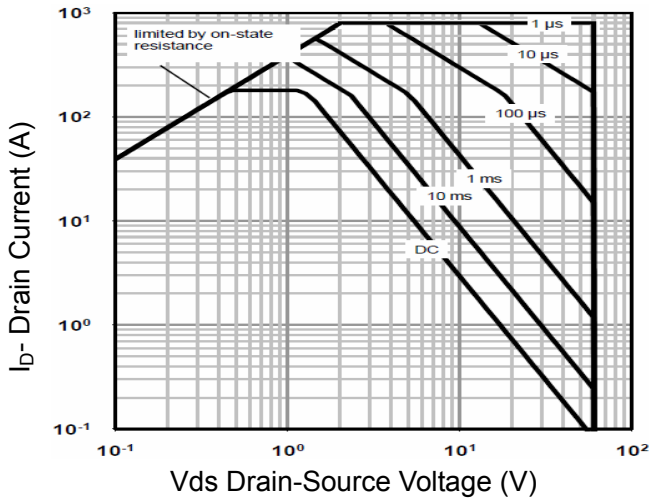
**Figure 6 Source- Drain Diode Forward**



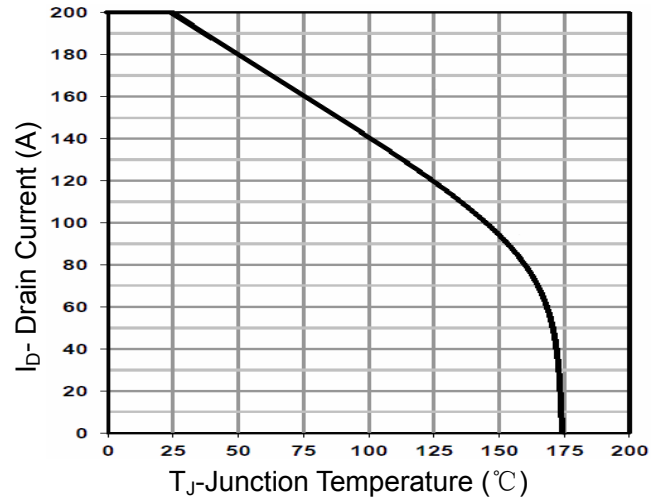
**Figure 7 Capacitance vs Vds**



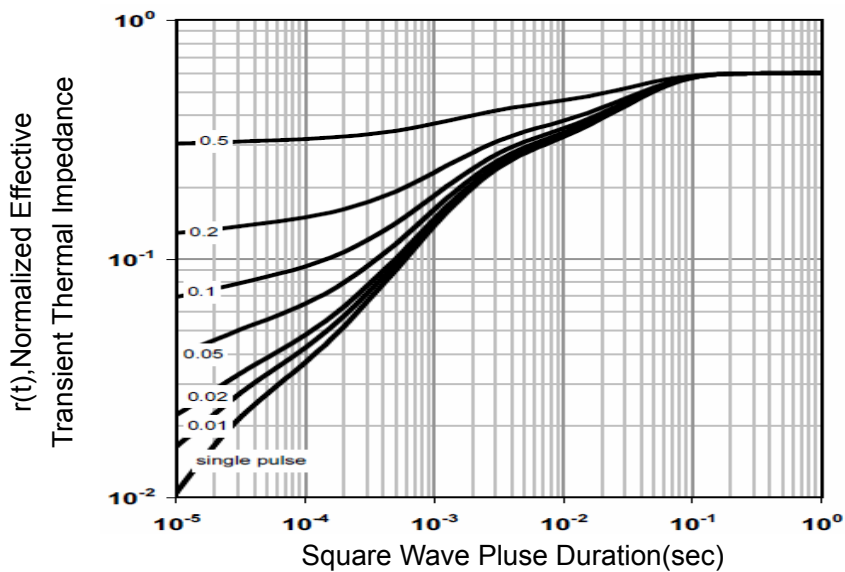
**Figure 9 Power De-rating**



**Figure 8 Safe Operation Area**

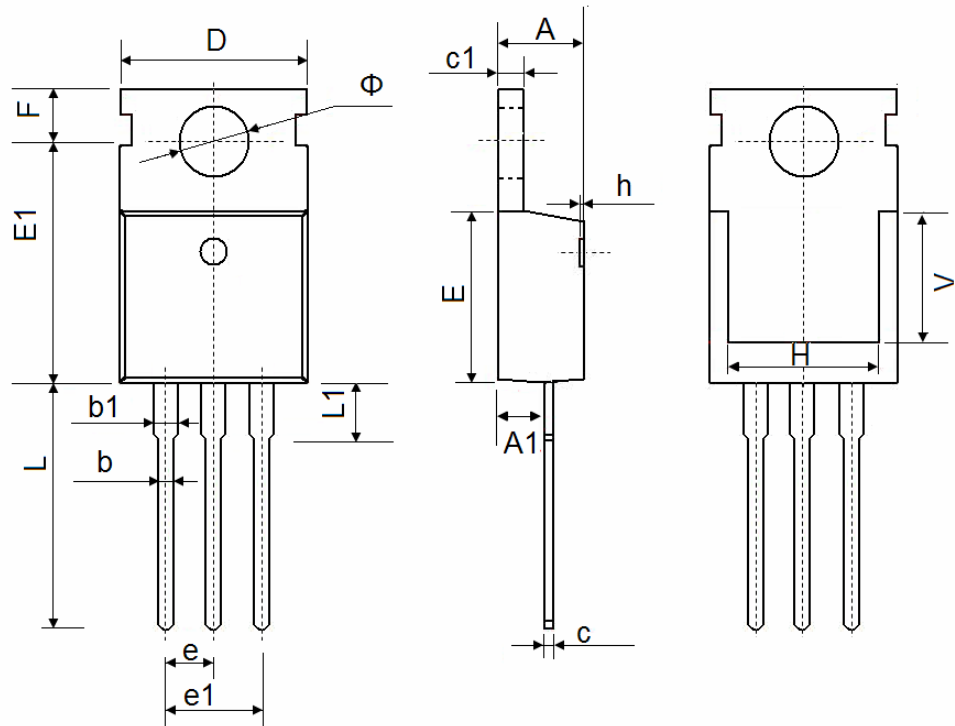


**Figure 10 Current De-rating**



**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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## Attention

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