

## 40V N-Ch Power MOSFET

### Feature

- ◇ High Speed Power Switching
- ◇ Enhanced Body diode dv/dt capability
- ◇ Enhanced Avalanche Ruggedness
- ◇ 100% UIS Tested, 100% Rg Tested
- ◇ Lead Free, Halogen Free

### Application

- ◇ Synchronous Rectification in SMPS
- ◇ Hard Switching and High Speed Circuit
- ◇ Power Tools
- ◇ UPS
- ◇ Motor Control

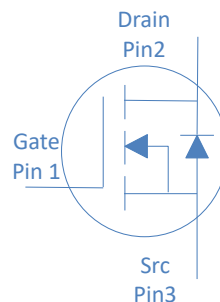
| Part Number | Package | Marking   |
|-------------|---------|-----------|
| KUGB012N04A | TO-263  | GB012N04A |
| KEGP012N04A | TO-220  | GP012N04A |

|                         |        |     |    |
|-------------------------|--------|-----|----|
| $V_{DS}$                |        | 40  | V  |
| $R_{DS(on),typ}$        | TO-263 | 1.2 | mΩ |
| $R_{DS(on),typ}$        | TO-220 | 1.5 | mΩ |
| $I_D$ (Silicon Limited) |        | 314 | A  |
| $I_D$ (Package Limited) |        | 180 | A  |

TO-263



TO-220



### Absolute Maximum Ratings at $T_J=25^{\circ}\text{C}$ (unless otherwise specified)

| Parameter                                 | Symbol            | Conditions                                  | Value      | Unit               |
|-------------------------------------------|-------------------|---------------------------------------------|------------|--------------------|
| Continuous Drain Current(Silicon Limited) | $I_D$             | $T_C=25^{\circ}\text{C}$                    | 314        | A                  |
|                                           |                   | $T_C=100^{\circ}\text{C}$                   | 198        |                    |
|                                           |                   | $T_C=25^{\circ}\text{C}$                    | 180        |                    |
| Continuous Drain Current(Package Limited) |                   |                                             |            |                    |
| Drain to Source Voltage                   | $V_{DS}$          | -                                           | 40         | V                  |
| Gate to Source Voltage                    | $V_{GS}$          | -                                           | $\pm 20$   | V                  |
| Pulsed Drain Current                      | $I_{DM}$          | -                                           | 820        | A                  |
| Avalanche Energy, Single Pulse            | $E_{AS}$          | $L=0.1\text{mH}$ , $T_C=25^{\circ}\text{C}$ | 180        | mJ                 |
| Power Dissipation                         | $P_D$             | $T_C=25^{\circ}\text{C}$                    | 227        | W                  |
| Operating and Storage Temperature         | $T_J$ , $T_{stg}$ | -                                           | -55 to 150 | $^{\circ}\text{C}$ |

### Absolute Maximum Ratings

| Parameter                           | Symbol          | Max  | Unit                 |
|-------------------------------------|-----------------|------|----------------------|
| Thermal Resistance Junction-Ambient | $R_{\theta JA}$ | 60   | $^{\circ}\text{C/W}$ |
| Thermal Resistance Junction-Case    | $R_{\theta JC}$ | 0.55 | $^{\circ}\text{C/W}$ |

**Electrical Characteristics at  $T_j=25^\circ\text{C}$  (unless otherwise specified)**

**Static Characteristics**

| Parameter                         | Symbol        | Conditions                                     | Value |     |           | Unit      |
|-----------------------------------|---------------|------------------------------------------------|-------|-----|-----------|-----------|
|                                   |               |                                                | min   | typ | max       |           |
| Drain to Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}=0V, I_D=250\mu A$                      | 40    | -   | -         | V         |
| Gate Threshold Voltage            | $V_{GS(th)}$  | $V_{GS}=V_{DS}, I_D=250\mu A$                  | 2     | 2.5 | 4         |           |
| Zero Gate Voltage Drain Current   | $I_{DSS}$     | $V_{GS}=0V, V_{DS}=40V, T_j=25^\circ\text{C}$  | -     | -   | 1         | $\mu A$   |
|                                   |               | $V_{GS}=0V, V_{DS}=40V, T_j=100^\circ\text{C}$ | -     | -   | 100       |           |
| Gate to Source Leakage Current    | $I_{GSS}$     | $V_{GS}=\pm 20V, V_{DS}=0V$                    | -     | -   | $\pm 100$ | nA        |
| Drain to Source on Resistance     | $R_{DS(on)}$  | $V_{GS}=10V, I_D=20A$ TO-263                   | -     | 1.2 | 1.45      | $m\Omega$ |
| Drain to Source on Resistance     | $R_{DS(on)}$  | $V_{GS}=10V, I_D=20A$ TO-220                   | -     | 1.5 | 1.75      | $m\Omega$ |
| Transconductance                  | $g_{fs}$      | $V_{DS}=5V, I_D=20A$                           | -     | 70  | -         | S         |
| Gate Resistance                   | $R_G$         | $V_{GS}=0V, V_{DS}$ Open, $f=1\text{MHz}$      | -     | 2.4 | -         | $\Omega$  |

**Dynamic Characteristics**

|                               |              |                                        |   |      |   |    |
|-------------------------------|--------------|----------------------------------------|---|------|---|----|
| Input Capacitance             | $C_{iss}$    | $V_{GS}=0V, V_{DS}=20V, f=1\text{MHz}$ | - | 5492 | - | pF |
| Output Capacitance            | $C_{oss}$    |                                        | - | 2182 | - |    |
| Reverse Transfer Capacitance  | $C_{rss}$    |                                        | - | 270  | - |    |
| Total Gate Charge             | $Q_g(10V)$   | $V_{DD}=20V, I_D=20A, V_{GS}=10V$      | - | 98   | - | nC |
| Gate to Source Charge         | $Q_{gs}$     |                                        | - | 24   | - |    |
| Gate to Drain (Miller) Charge | $Q_{gd}$     |                                        | - | 30   | - |    |
| Turn on Delay Time            | $t_{d(on)}$  | $V_{DD}=20V, I_D=20A, V_{GS}=10V$      | - | 18   | - | ns |
| Rise time                     | $t_r$        |                                        | - | 14   | - |    |
| Turn off Delay Time           | $t_{d(off)}$ |                                        | - | 42   | - |    |
| Fall Time                     | $t_f$        |                                        | - | 21   | - |    |

**Reverse Diode Characteristics**

|                         |          |                                        |   |     |     |    |
|-------------------------|----------|----------------------------------------|---|-----|-----|----|
| Diode Forward Voltage   | $V_{SD}$ | $V_{GS}=0V, I_F=20A$                   | - | 0.9 | 1.2 | V  |
| Reverse Recovery Time   | $t_{rr}$ | $V_R=20V, I_F=20A, dI_F/dt=100A/\mu s$ | - | 50  | -   | ns |
| Reverse Recovery Charge | $Q_{rr}$ |                                        | - | 60  | -   | nC |

Fig 1. Typical Output Characteristics

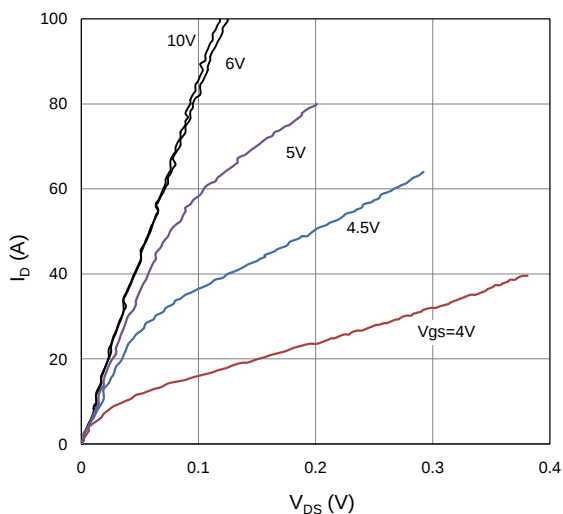


Figure 2. On-Resistance vs. Gate-Source Voltage

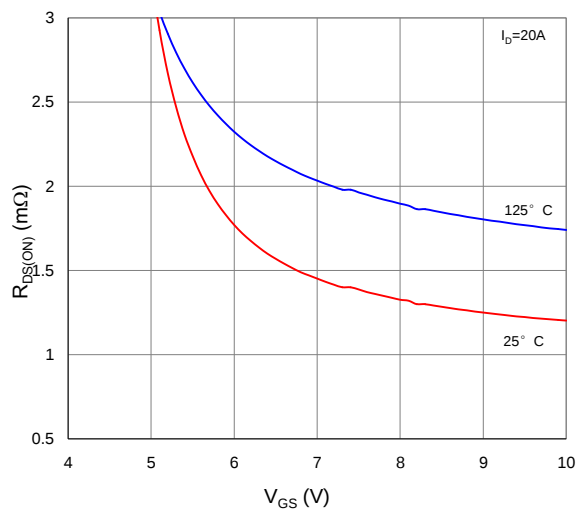


Figure 3. On-Resistance vs. Drain Current and Gate Voltage

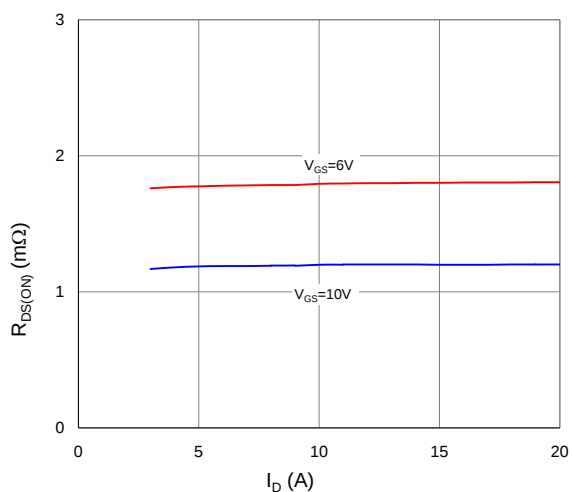


Figure 4. Normalized On-Resistance vs. Junction Temperature

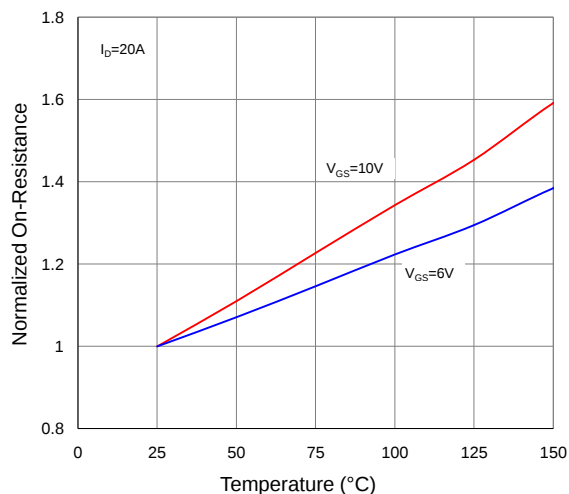


Figure 5. Typical Transfer Characteristics

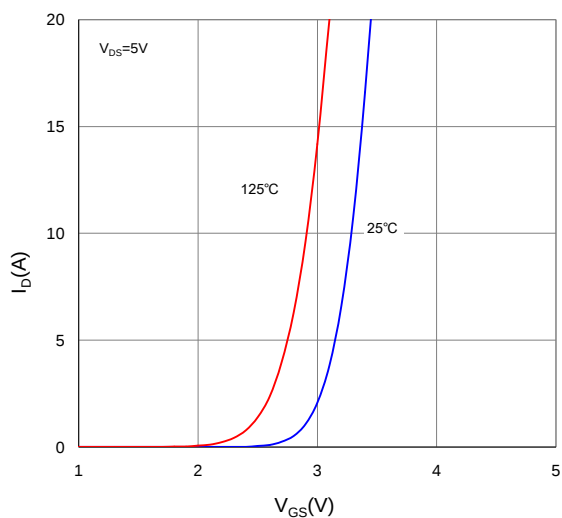


Figure 6. Typical Source-Drain Diode Forward Voltage

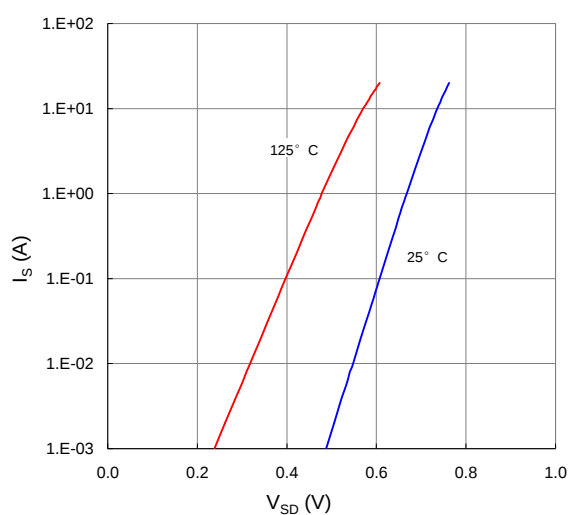


Figure 7. Typical Gate-Charge vs. Gate-to-Source Voltage

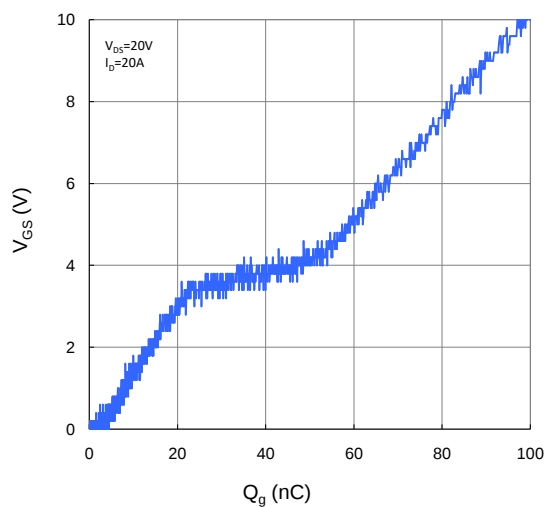


Figure 8. Typical Capacitance vs. Drain-to-Source Voltage

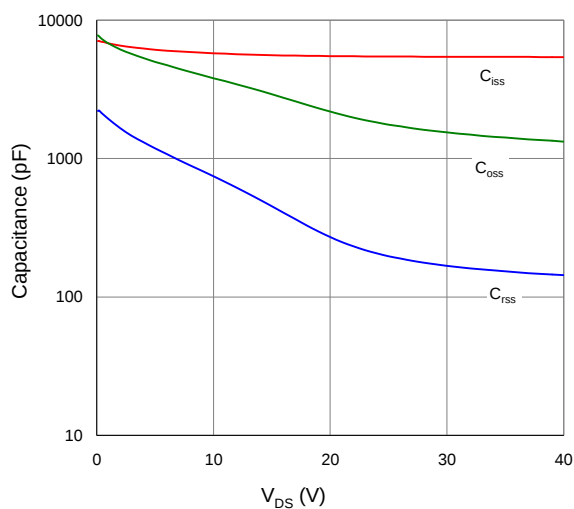


Figure 9. Maximum Safe Operating Area

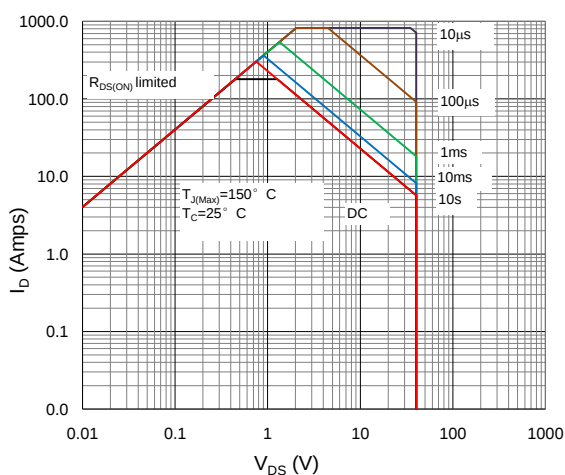


Figure 10. Maximum Drain Current vs. Case Temperature

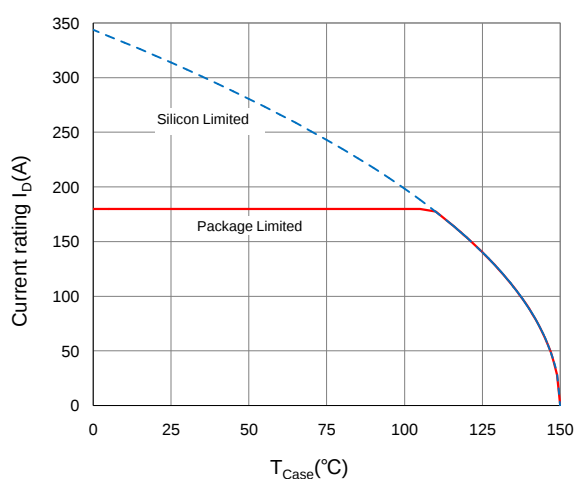
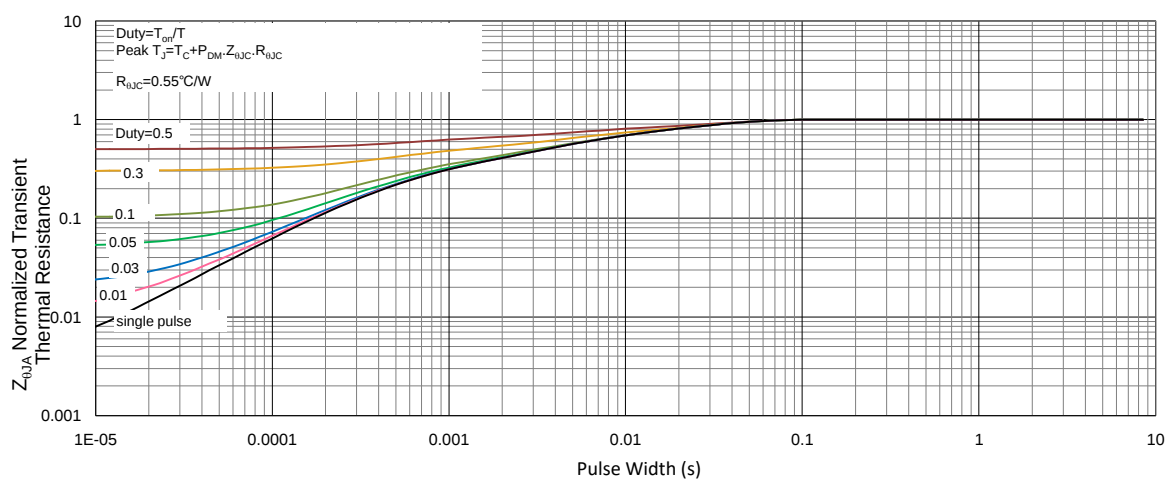
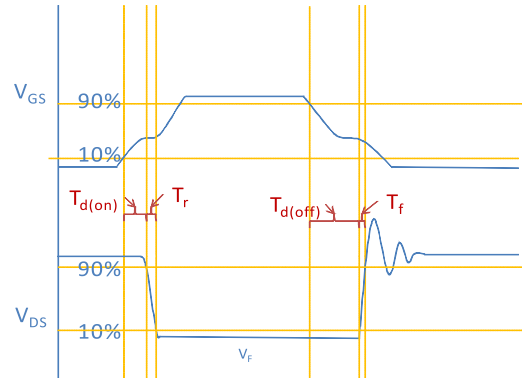
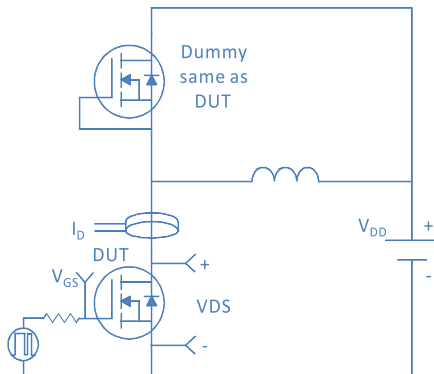


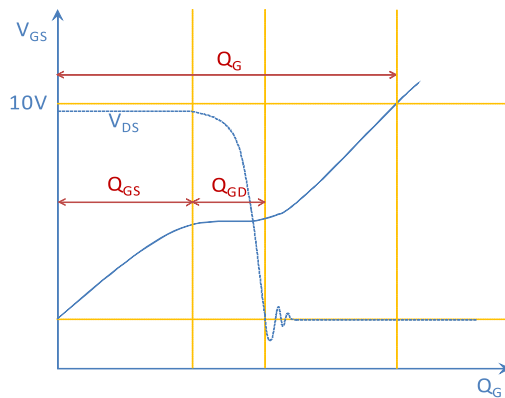
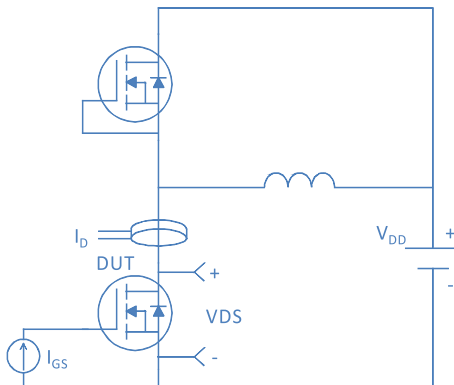
Figure 11. Normalized Maximum Transient Thermal Impedance, Junction-to-Ambient



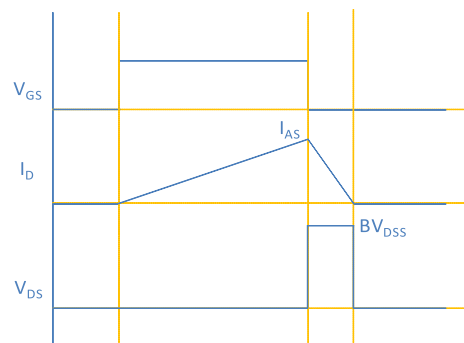
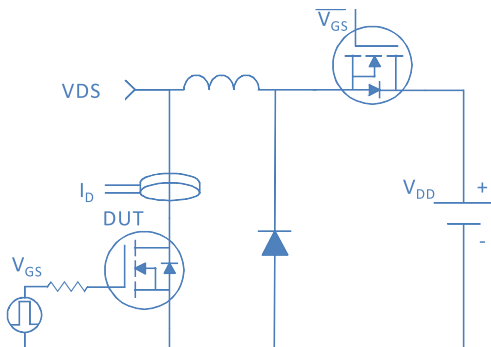
### Inductive switching Test



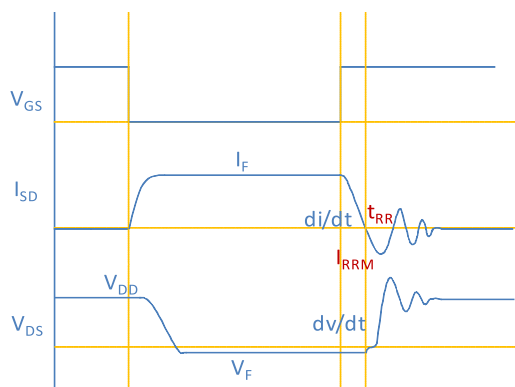
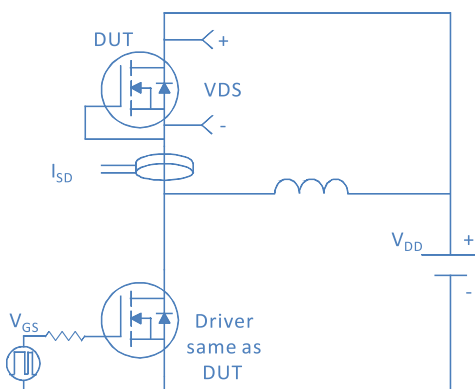
### Gate Charge Test



### Uclamped Inductive Switching (UIS) Test

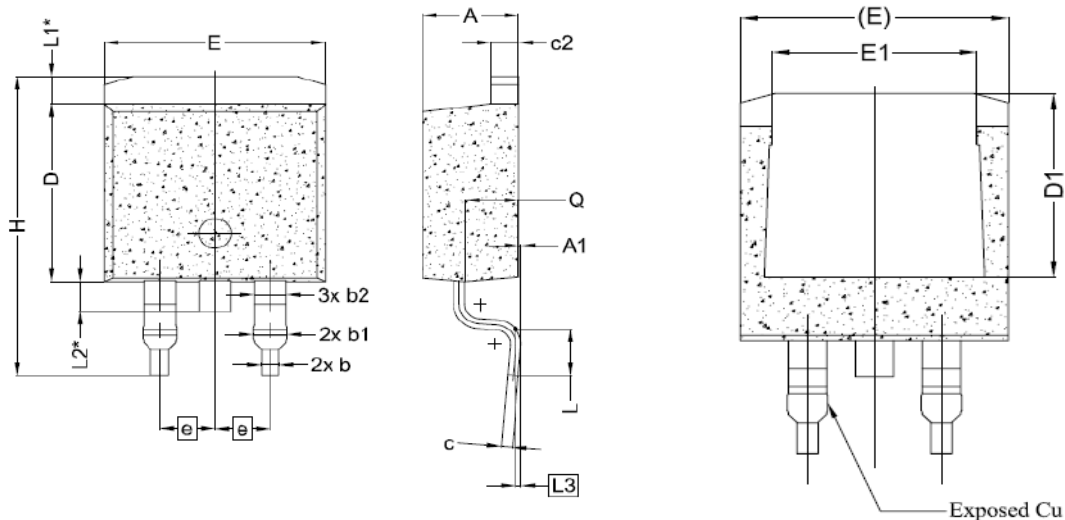


### Diode Recovery Test



Package Outline

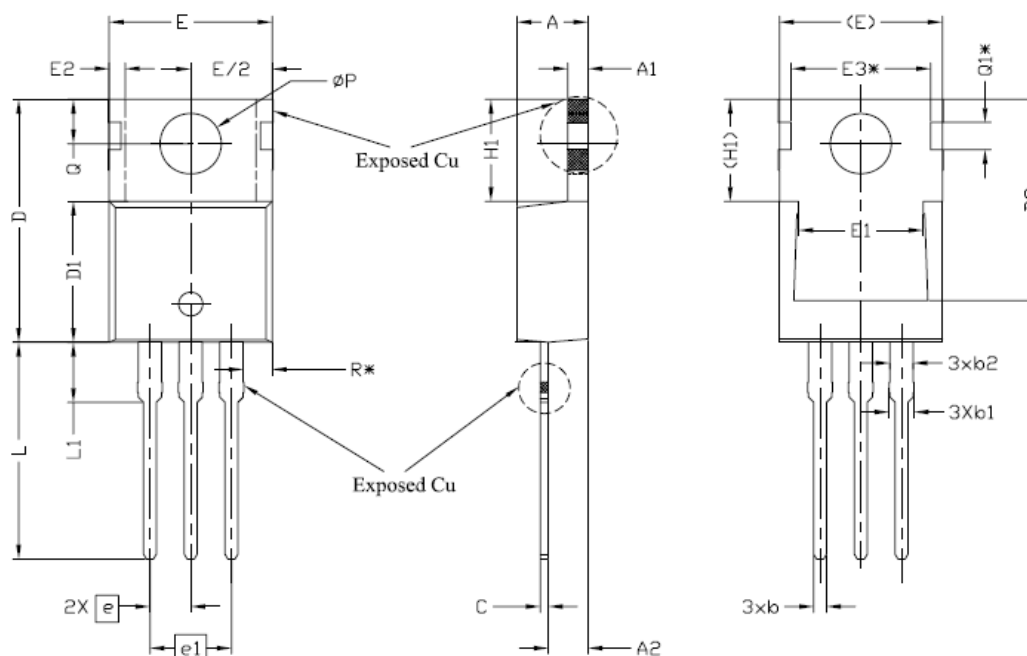
TO-263, 2 leads



| SYMBOL | DIMENSIONS |       |       |
|--------|------------|-------|-------|
|        | MIN.       | NOM.  | MAX.  |
| A      | 4.24       | 4.44  | 4.64  |
| A1     | 0.00       | 0.10  | 0.25  |
| b      | 0.70       | 0.80  | 0.90  |
| b1     | 1.20       | 1.55  | 1.75  |
| b2     | 1.20       | 1.45  | 1.70  |
| c      | 0.40       | 0.50  | 0.60  |
| c2     | 1.15       | 1.27  | 1.40  |
| D      | 8.82       | 8.92  | 9.02  |
| D1     | 6.86       | 7.65  | —     |
| E      | 9.96       | 10.16 | 10.36 |
| E1     | 6.89       | 7.77  | 7.89  |
| e      | 2.54 BSC   |       |       |
| H      | 14.61      | 15.00 | 15.88 |
| L      | 1.78       | 2.32  | 2.79  |
| L1     | 1.36 REF.  |       |       |
| L2     | 1.50 REF.  |       |       |
| L3     | 0.25 BSC   |       |       |
| Q      | 2.30       | 2.48  | 2.70  |

Package Outline

TO-220, 3 leads



| SYMBOL | DIMENSIONS |       |       | NOTES |
|--------|------------|-------|-------|-------|
|        | MIN.       | NOM.  | MAX.  |       |
| A      | 4.24       | 4.44  | 4.64  |       |
| A1     | 1.15       | 1.27  | 1.40  |       |
| A2     | 2.30       | 2.48  | 2.70  |       |
| b      | 0.70       | 0.80  | 0.90  |       |
| b1     | 1.20       | 1.55  | 1.75  |       |
| b2     | 1.20       | 1.45  | 1.70  |       |
| c      | 0.40       | 0.50  | 0.60  |       |
| D      | 14.70      | 15.37 | 16.00 | 4     |
| D1     | 8.82       | 8.92  | 9.02  |       |
| D2     | 12.63      | 12.73 | 12.83 | 5     |
| E      | 9.96       | 10.16 | 10.36 | 4,5   |
| E1     | 6.86       | 7.77  | 8.89  | 5     |
| E2     | -          | -     | 0.76  | 6     |
| E3*    | 8.70REF.   |       |       |       |
| e      | 2.54BSC    |       |       |       |
| e1     | 5.08BSC    |       |       |       |
| H1     | 6.30       | 6.45  | 6.60  | 5,6   |
| L      | 13.47      | 13.72 | 13.97 |       |
| L1     | 3.60       | 3.80  | 4.00  |       |
| ØP     | 3.75       | 3.84  | 3.93  |       |
| Q      | 2.60       | 2.80  | 3.00  |       |
| Q1*    | 1.73REF.   |       |       |       |
| R*     | 1.62REF.   |       |       |       |