

## Power MOSFET

### PRODUCT SUMMARY

|                           |                        |      |
|---------------------------|------------------------|------|
| $V_{DS}$ (V)              | 200                    |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.40 |
| $Q_g$ (Max.) (nC)         | 43                     |      |
| $Q_{gs}$ (nC)             | 7.0                    |      |
| $Q_{gd}$ (nC)             | 23                     |      |
| Configuration             | Single                 |      |

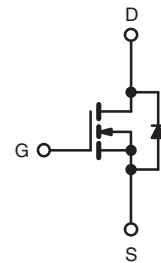
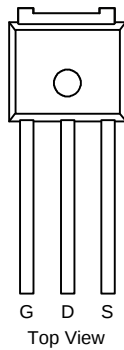
### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Surface Mount
- Available in Tape and Reel
- Dynamic  $dV/dt$  Rating
- Repetitive Avalanche Rated
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC



**RoHS\***  
COMPLIANT  
HALOGEN  
**FREE**  
Available

TO-251



N-Channel MOSFET

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

| PARAMETER                                          |                         |                         | SYMBOL          | LIMIT | UNIT |
|----------------------------------------------------|-------------------------|-------------------------|-----------------|-------|------|
| Drain-Source Voltage                               |                         |                         | V <sub>DS</sub> | 200   | V    |
| Gate-Source Voltage                                |                         |                         | V <sub>GS</sub> | ± 20  |      |
| Continuous Drain Current                           | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>  | 9.0   | A    |
|                                                    |                         | T <sub>C</sub> = 100 °C |                 | 5.7   |      |
| Pulsed Drain Current <sup>a</sup>                  |                         |                         | I <sub>DM</sub> | 36    | W/°C |
| Linear Derating Factor                             |                         |                         |                 | 0.59  |      |
| Linear Derating Factor (PCB Mount) <sup>e</sup>    |                         |                         |                 | 0.025 |      |
| Single Pulse Avalanche Energy <sup>b</sup>         |                         |                         | E <sub>AS</sub> | 250   | mJ   |
| Repetitive Avalanche Current <sup>a</sup>          |                         |                         | I <sub>AR</sub> | 9.0   | A    |
| Repetitive Avalanche Energy <sup>a</sup>           |                         |                         | E <sub>AR</sub> | 7.4   | mJ   |
| Maximum Power Dissipation                          | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>  | 74    | W    |
| Maximum Power Dissipation (PCB Mount) <sup>e</sup> | T <sub>A</sub> = 25 °C  |                         |                 | 3.0   |      |

\* Pb containing terminations are not RoHS compliant, exemptions may apply

|                               |         |     |      |
|-------------------------------|---------|-----|------|
| Peak Diode Recovery $dV/dt^c$ | $dV/dt$ | 5.0 | V/ns |
|-------------------------------|---------|-----|------|

**ABSOLUTE MAXIMUM RATINGS** ( $T_C = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                                        | SYMBOL         | LIMIT            | UNIT               |
|--------------------------------------------------|----------------|------------------|--------------------|
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | - 55 to + 150    | $^{\circ}\text{C}$ |
| Soldering Recommendations (Peak Temperature)     | for 10 s       | 300 <sup>d</sup> |                    |

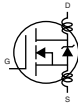
**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).  
 b.  $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $L = 4.6\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 9.0\text{ A}$  (see fig. 12).  
 c.  $I_{SD} \leq 9.0\text{ A}$ ,  $dl/dt \leq 120\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^{\circ}\text{C}$ .  
 d. 1.6 mm from case.  
 e. When mounted on 1" square PCB (FR-4 or G-10 material).

**THERMAL RESISTANCE RATINGS**

| PARAMETER                                            | SYMBOL     | MIN. | TYP. | MAX. | UNIT                        |
|------------------------------------------------------|------------|------|------|------|-----------------------------|
| Maximum Junction-to-Ambient (PCB Mount) <sup>c</sup> | $R_{thJA}$ | -    | -    | 40   | $^{\circ}\text{C}/\text{W}$ |
| Maximum Junction-to-Ambient                          | $R_{thJA}$ | -    | -    | 62   |                             |
| Maximum Junction-to-Case (Drain)                     | $R_{thJC}$ | -    | -    | 1.7  |                             |

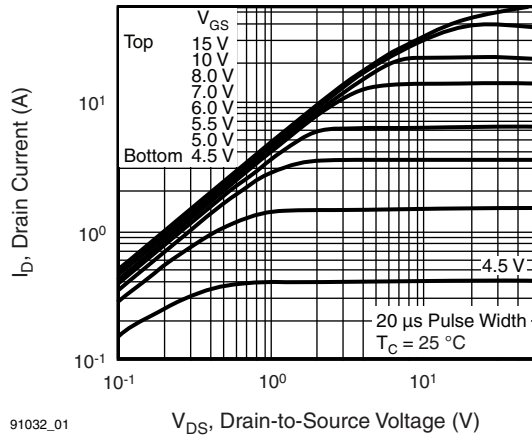
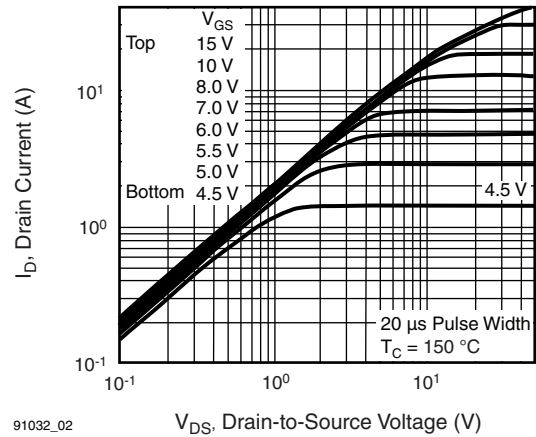
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                        | SYMBOL              | TEST CONDITIONS                                                                                                                                                     | MIN. | TYP. | MAX.      | UNIT                  |
|----------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-----------|-----------------------|
| <b>Static</b>                    |                     |                                                                                                                                                                     |      |      |           |                       |
| Drain-Source Breakdown Voltage   | $V_{DS}$            | $V_{GS} = 0$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                                       | 200  | -    | -         | V                     |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^{\circ}\text{C}$ , $I_D = 1\text{ mA}$                                                                                                     | -    | 0.24 | -         | V/ $^{\circ}\text{C}$ |
| Gate-Source Threshold Voltage    | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                                  | 2.0  | -    | 4.0       | V                     |
| Gate-Source Leakage              | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                                          | -    | -    | $\pm 100$ | nA                    |
| Zero Gate Voltage Drain Current  | $I_{DSS}$           | $V_{DS} = 200\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                                     | -    | -    | 25        | $\mu\text{A}$         |
|                                  |                     | $V_{DS} = 160\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$                                                                               | -    | -    | 250       |                       |
| Drain-Source On-State Resistance | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$ , $I_D = 5.4\text{ A}^b$                                                                                                                     | -    | 0.40 | -         | $\Omega$              |
| Forward Transconductance         | $g_{fs}$            | $V_{DS} = 50\text{ V}$ , $I_D = 5.4\text{ A}^b$                                                                                                                     | 3.8  | -    | -         | S                     |
| <b>Dynamic</b>                   |                     |                                                                                                                                                                     |      |      |           |                       |
| Input Capacitance                | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 25\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ , see fig. 5                                                                            | -    | 800  | -         | pF                    |
| Output Capacitance               | $C_{oss}$           |                                                                                                                                                                     | -    | 240  | -         |                       |
| Reverse Transfer Capacitance     | $C_{rss}$           |                                                                                                                                                                     | -    | 76   | -         |                       |
| Total Gate Charge                | $Q_g$               | $V_{GS} = 10\text{ V}$ ,<br>$I_D = 5.9\text{ A}$ , $V_{DS} = 160\text{ V}$<br>see fig. 6 and 13 <sup>b</sup>                                                        | -    | -    | 43        | nC                    |
| Gate-Source Charge               | $Q_{gs}$            |                                                                                                                                                                     | -    | -    | 7.0       |                       |
| Gate-Drain Charge                | $Q_{gd}$            |                                                                                                                                                                     | -    | -    | 23        |                       |
| Turn-On Delay Time               | $t_{d(on)}$         | $V_{DD} = 100\text{ V}$ , $I_D = 5.9\text{ A}$<br>$R_g = 12\text{ }\Omega$ , $R_D = 16\text{ }\Omega$<br>see fig. 10 <sup>b</sup>                                   | -    | 9.4  | -         | ns                    |
| Rise Time                        | $t_r$               |                                                                                                                                                                     | -    | 28   | -         |                       |
| Turn-Off Delay Time              | $t_{d(off)}$        |                                                                                                                                                                     | -    | 39   | -         |                       |
| Fall Time                        | $t_f$               |                                                                                                                                                                     | -    | 20   | -         |                       |
| Internal Drain Inductance        | $L_D$               | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact<br> | -    | 4.5  | -         | nH                    |
| Internal Source Inductance       | $L_S$               |                                                                                                                                                                     | -    | 7.5  | -         |                       |

| SPECIFICATIONS ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted) |          |                                                                                                                                                     |      |      |      |               |
|-------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| PARAMETER                                                                     | SYMBOL   | TEST CONDITIONS                                                                                                                                     | MIN. | TYP. | MAX. | UNIT          |
| Drain-Source Body Diode Characteristics                                       |          |                                                                                                                                                     |      |      |      |               |
| Continuous Source-Drain Diode Current                                         | $I_S$    | MOSFET symbol showing the integral reverse p - n junction diode  | -    | -    | 9.0  | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                     | $I_{SM}$ |                                                                                                                                                     | -    | -    | 36   |               |
| Body Diode Voltage                                                            | $V_{SD}$ | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_S = 9.0\text{ A}$ , $V_{GS} = 0\text{ V}^b$                                                                 | -    | -    | 2.0  | V             |
| Body Diode Reverse Recovery Time                                              | $t_{rr}$ | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_F = 5.9\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$                                                    | -    | 170  | 340  | ns            |
| Body Diode Reverse Recovery Charge                                            | $Q_{rr}$ |                                                                                                                                                     | -    | 1.1  | 2.2  | $\mu\text{C}$ |
| Forward Turn-On Time                                                          | $t_{on}$ | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )                                                                     |      |      |      |               |

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).  
 b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .  
 c. When mounted on 1" square PCB (FR-4 or G-10 material).

**TYPICAL CHARACTERISTICS** ( $25\text{ }^{\circ}\text{C}$ , unless otherwise noted)**Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^{\circ}\text{C}$** **Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^{\circ}\text{C}$**

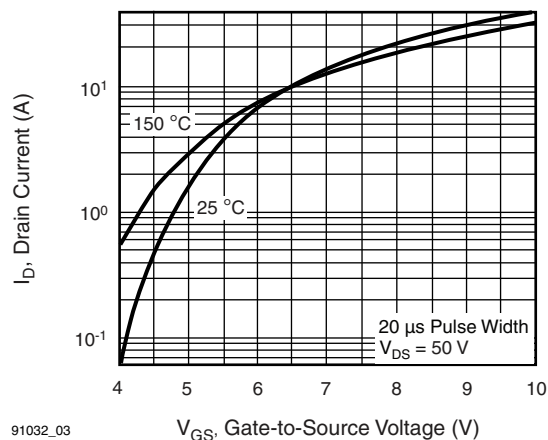


Fig. 3 - Typical Transfer Characteristics

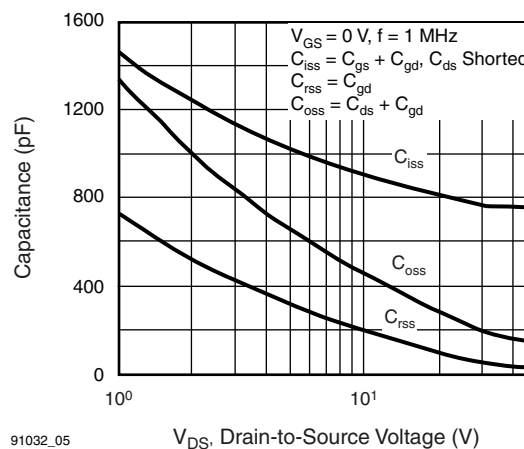


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

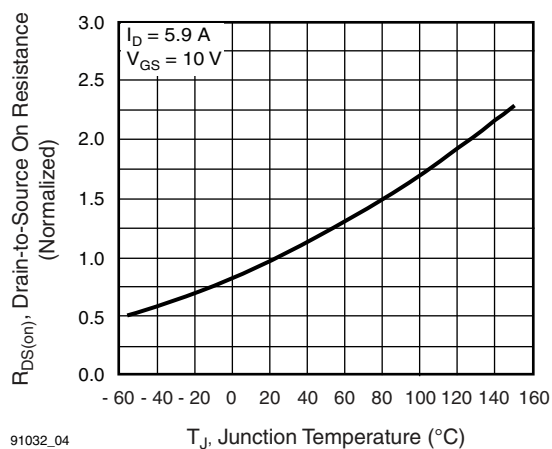


Fig. 4 - Normalized On-Resistance vs. Temperature

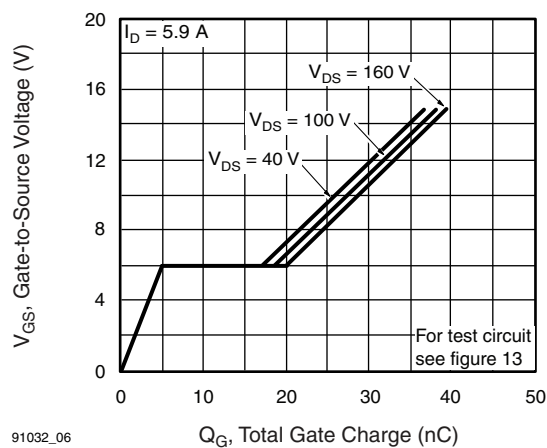


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

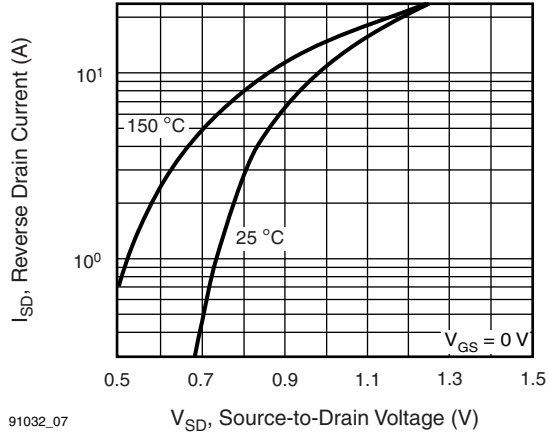


Fig. 7 - Typical Source-Drain Diode Forward Voltage

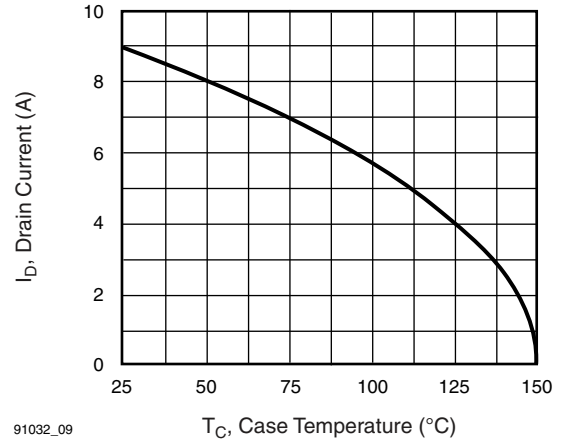


Fig. 9 - Maximum Drain Current vs. Case Temperature

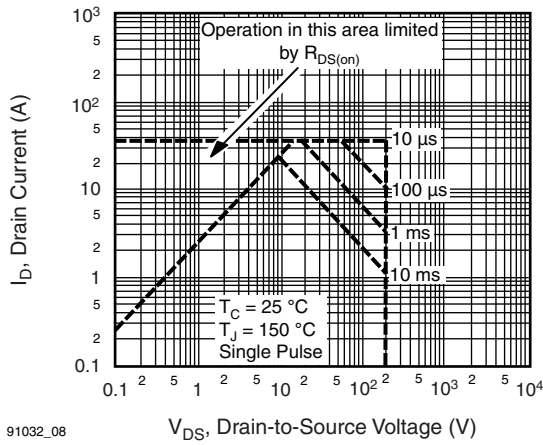


Fig. 8 - Maximum Safe Operating Area

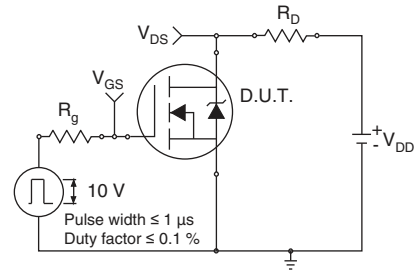


Fig. 10a - Switching Time Test Circuit

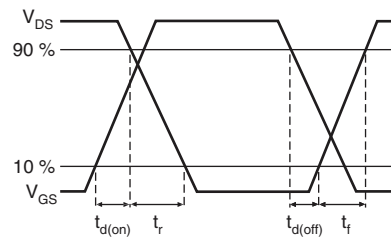


Fig. 10b - Switching Time Waveforms

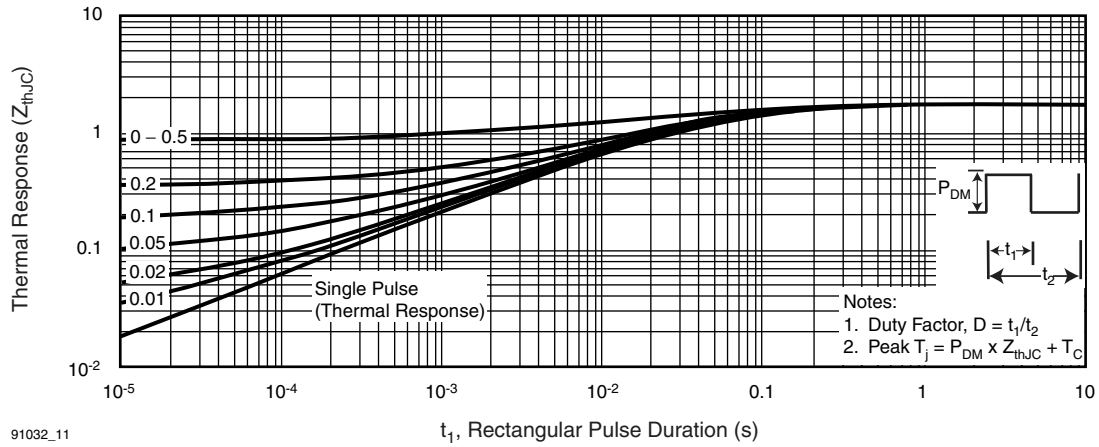


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

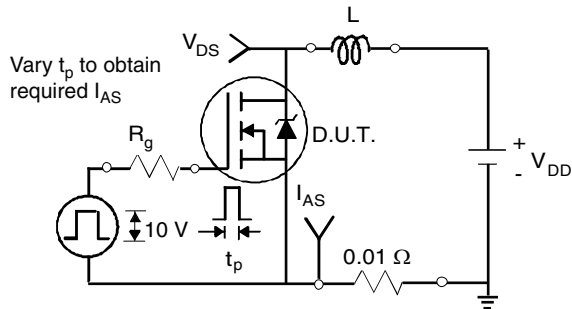


Fig. 12a - Unclamped Inductive Test Circuit

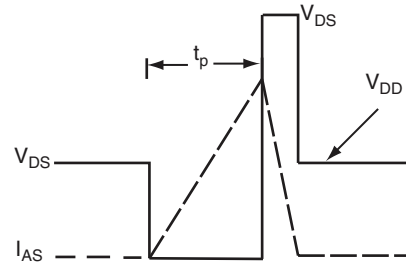


Fig. 12b - Unclamped Inductive Waveforms

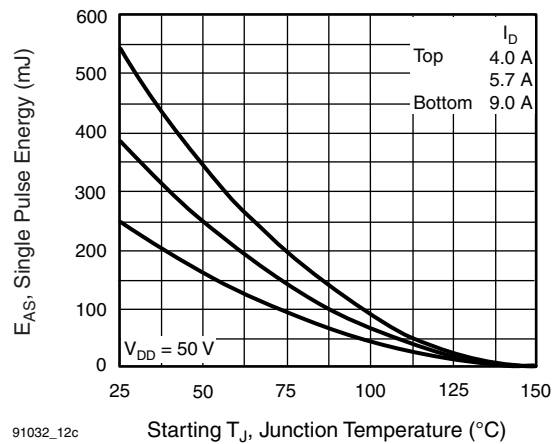


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

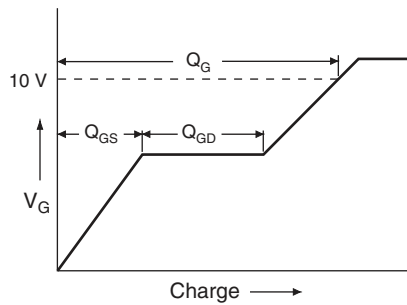


Fig. 13a - Basic Gate Charge Waveform

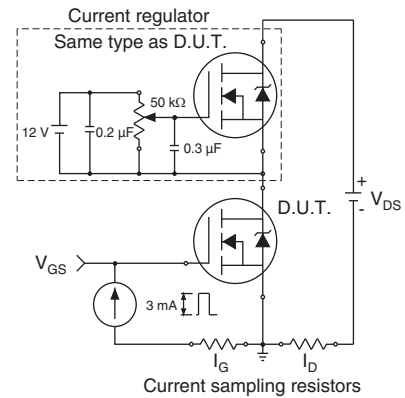
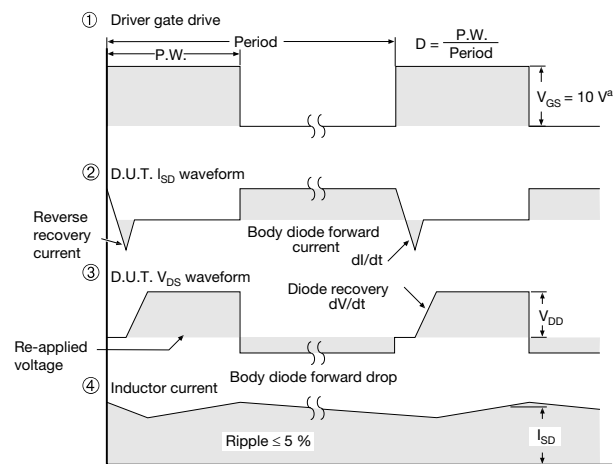
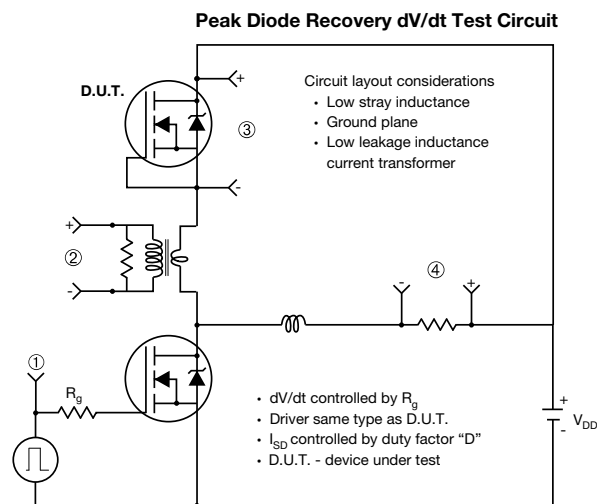


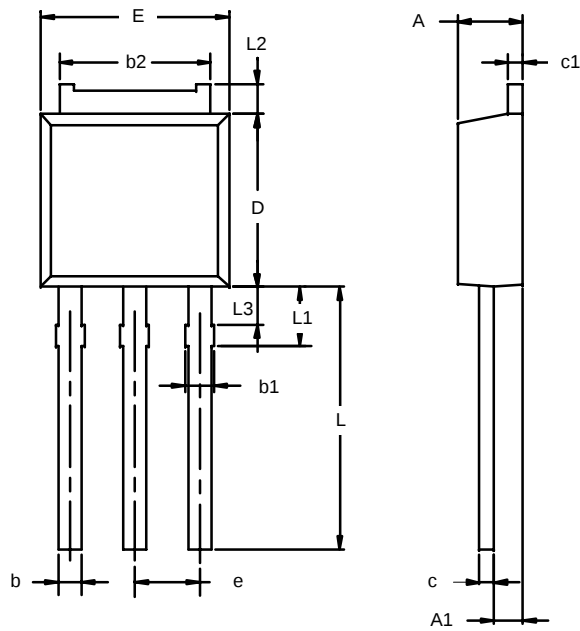
Fig. 13b - Gate Charge Test Circuit



**Note**

a.  $V_{GS} = 5 \text{ V}$  for logic level devices

TO-251AA



Note: Dimension L3 is for reference only.

| Dim                                         | MILLIMETERS |      | INCHES    |       |
|---------------------------------------------|-------------|------|-----------|-------|
|                                             | Min         | Max  | Min       | Max   |
| A                                           | 2.21        | 2.38 | 0.087     | 0.094 |
| A1                                          | 0.89        | 1.14 | 0.035     | 0.045 |
| b                                           | 0.71        | 0.89 | 0.028     | 0.035 |
| b1                                          | 0.76        | 1.14 | 0.030     | 0.045 |
| b2                                          | 5.23        | 5.43 | 0.206     | 0.214 |
| c                                           | 0.46        | 0.58 | 0.018     | 0.023 |
| c1                                          | 0.46        | 0.58 | 0.018     | 0.023 |
| D                                           | 5.97        | 6.22 | 0.235     | 0.245 |
| E                                           | 6.48        | 6.73 | 0.255     | 0.265 |
| e                                           | 2.28 BSC    |      | 0.090 BSC |       |
| L                                           | 3.89        | 9.53 | 0.153     | 0.375 |
| L1                                          | 1.91        | 2.28 | 0.075     | 0.090 |
| L2                                          | 0.89        | 1.27 | 0.035     | 0.050 |
| L3                                          | 1.15        | 1.52 | 0.045     | 0.060 |
| ECN: S-03946—Rev. E, 09-Jul-01<br>DWG: 5346 |             |      |           |       |

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