

## FS59N10D-VB Datasheet

### Power MOSFET

#### PRODUCT SUMMARY

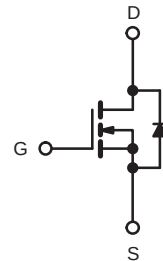
|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 100                    |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.020 |
| $Q_g$ (Max.) (nC)         | 70                     |       |
| $Q_{gs}$ (nC)             | 13                     |       |
| $Q_{gd}$ (nC)             | 39                     |       |
| Configuration             | Single                 |       |

#### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Surface Mount
- Low-Profile Through-Hole
- Available in Tape and Reel
- Dynamic  $dV/dt$  Rating
- 150 °C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Compliant to RoHS Directive 2002/95/EC



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



N-Channel MOSFET

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

| PARAMETER                                        | SYMBOL           | LIMIT                             | UNIT                |
|--------------------------------------------------|------------------|-----------------------------------|---------------------|
| Drain-Source Voltage                             | $V_{DS}$         | 100                               | V                   |
| Gate-Source Voltage                              | $V_{GS}$         | $\pm 20$                          |                     |
| Continuous Drain Current                         | $V_{GS}$ at 10 V | $T_C = 25\text{ }^\circ\text{C}$  | A                   |
|                                                  |                  | $T_C = 100\text{ }^\circ\text{C}$ |                     |
| Pulsed Drain Current <sup>a, e</sup>             | $I_{DM}$         | 250                               |                     |
| Linear Derating Factor                           |                  | 1.0                               | W/ $^\circ\text{C}$ |
| Single Pulse Avalanche Energy <sup>b, e</sup>    | $E_{AS}$         | 580                               | mJ                  |
| Avalanche Current <sup>a</sup>                   | $I_{AR}$         | 20                                | A                   |
| Repetitive Avalanche Energy <sup>a</sup>         | $E_{AR}$         | 13                                | mJ                  |
| Maximum Power Dissipation                        |                  | $T_C = 25\text{ }^\circ\text{C}$  | W                   |
|                                                  |                  | $T_A = 25\text{ }^\circ\text{C}$  |                     |
| Peak Diode Recovery $dV/dt$ <sup>c, e</sup>      | $dV/dt$          | 5.0                               | V/ns                |
| 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

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 2.7\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 18\text{ A}$  (see fig. 12).
- $I_{SD} \leq 20\text{ A}$ ,  $dI/dt \leq 150\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

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

**THERMAL RESISTANCE RATINGS**

| PARAMETER                                                               | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient<br>(PCB Mounted, Steady-State) <sup>a</sup> | $R_{thJA}$ | -    | 40   | °C/W |
| Maximum Junction-to-Case (Drain)                                        | $R_{thJC}$ | -    | 1.0  |      |

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material).

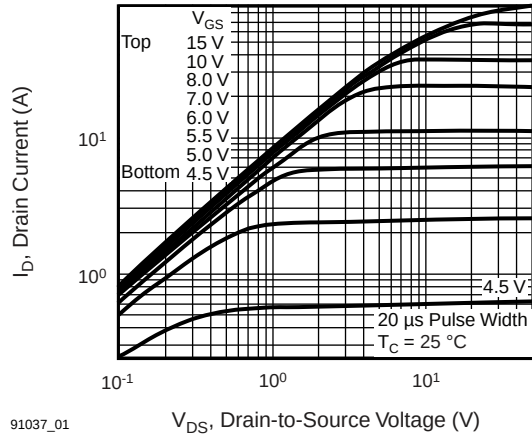
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                 | SYMBOL                           | TEST CONDITIONS                                                                                                                                         |                                                                                      | MIN. | TYP.  | MAX.  | UNIT |
|-------------------------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------|-------|-------|------|
| Static                                    |                                  |                                                                                                                                                         |                                                                                      |      |       |       |      |
| Drain-Source Breakdown Voltage            | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                          |                                                                                      | 100  | -     | -     | V    |
| V <sub>DS</sub> Temperature Coefficient   | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA <sup>c</sup>                                                                                                  |                                                                                      | -    | 0.29  | -     | V/°C |
| Gate-Source Threshold Voltage             | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                             |                                                                                      | 2.0  | -     | 4.0   | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V                                                                                                                                |                                                                                      | -    | -     | ± 100 | nA   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> =100 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                                                      | -    | -     | 25    | μA   |
|                                           |                                  | V <sub>DS</sub> = 80 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                                                                      | -    | -     | 250   |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                  | I <sub>D</sub> = 11 A <sup>b</sup>                                                   | -    | 0.020 | -     | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 11 A <sup>d</sup>                                                                                              |                                                                                      | 6.7  | -     | -     | S    |
| Dynamic                                   |                                  |                                                                                                                                                         |                                                                                      |      |       |       |      |
| Input Capacitance                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 25 V,<br>f = 1.0 MHz, see fig. 5 <sup>d</sup>                                                               |                                                                                      | -    | 1300  | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                         |                                                                                      | -    | 430   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                         |                                                                                      | -    | 130   | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                  | I <sub>D</sub> = 20 A, V <sub>DS</sub> = 160 V,<br>see fig. 6 and 13 <sup>b, c</sup> | -    | -     | 70    | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                         |                                                                                      | -    | -     | 13    |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                         |                                                                                      | -    | -     | 39    |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 50 V, I <sub>D</sub> = 20 A,<br>R <sub>g</sub> = 9.1 Ω, R <sub>D</sub> = 5.4 Ω, see fig. 10 <sup>b, c</sup>                           |                                                                                      | -    | 14    | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                                         |                                                                                      | -    | 51    | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                                         |                                                                                      | -    | 45    | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                                         |                                                                                      | -    | 36    | -     |      |
| Drain-Source Body Diode Characteristics   |                                  |                                                                                                                                                         |                                                                                      |      |       |       |      |
| Continuous Source-Drain Diode Current     | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                                                      | -    | -     | 20    | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                         |                                                                                      | -    | -     | 72    |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 20 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                       |                                                                                      | -    | -     | 2.0   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 20 A, dI/dt = 100 A/μs <sup>b, c</sup>                                                                         |                                                                                      | -    | 300   | 610   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                                         |                                                                                      | -    | 3.4   | 7.1   | μC   |
| Forward Turn-On Time                      | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                                                       |                                                                                      |      |       |       |      |

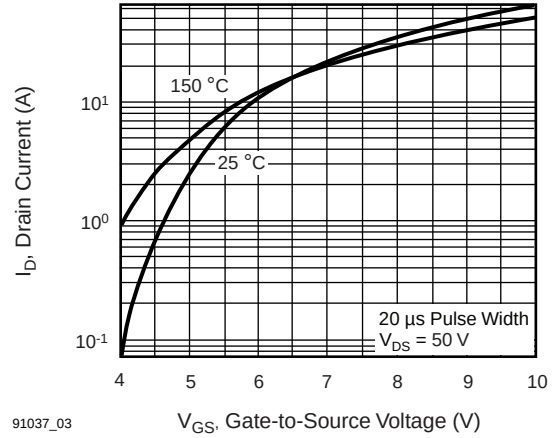
**Notes**

- 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. Uses IRF640/SiHF640 data and test conditions.

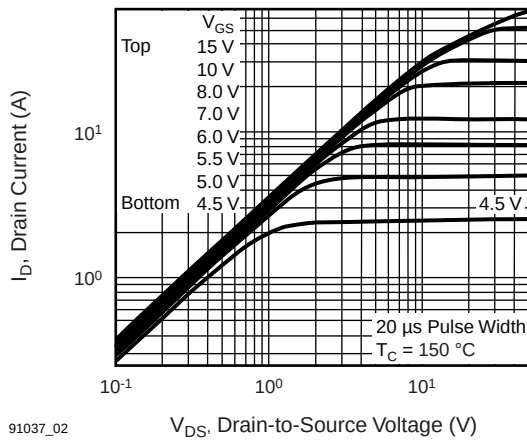
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



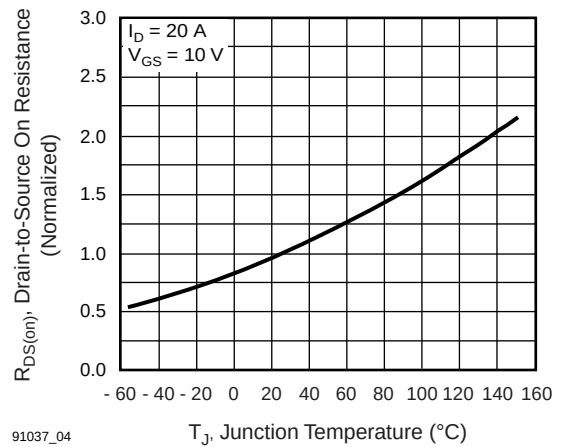
**Fig. 1 - Typical Output Characteristics,  $T_J = 25\text{ °C}$**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics,  $T_J = 175\text{ °C}$**



**Fig. 4 - Normalized On-Resistance vs. Temperature**

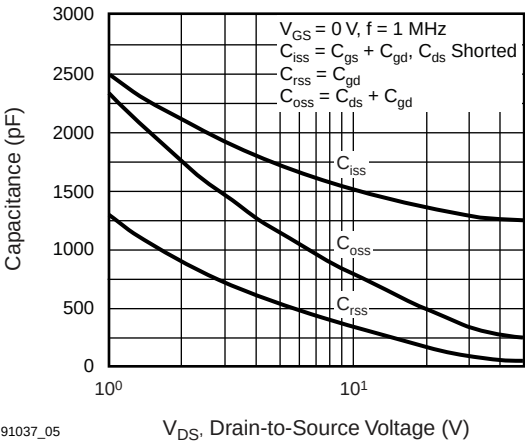


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

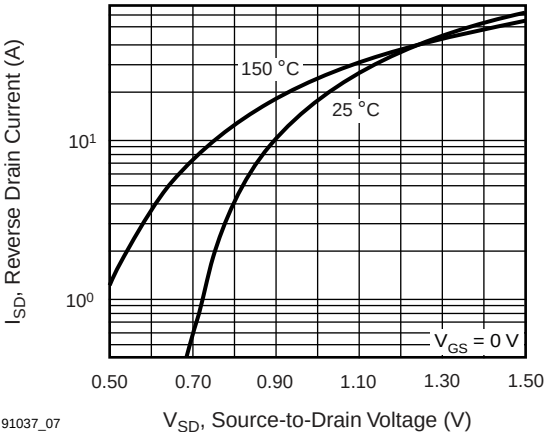


Fig. 7 - Typical Source-Drain Diode Forward Voltage

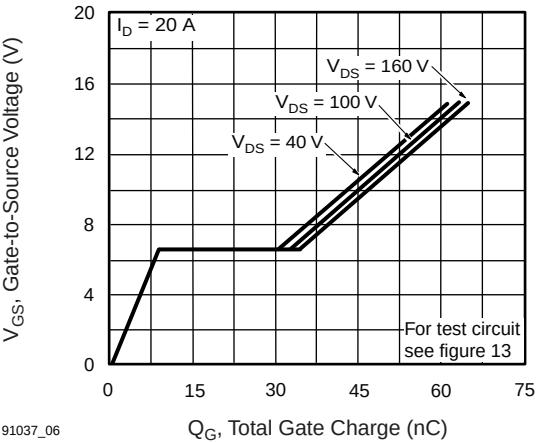


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

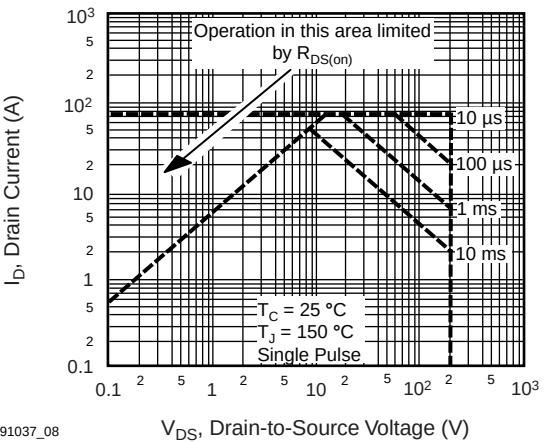
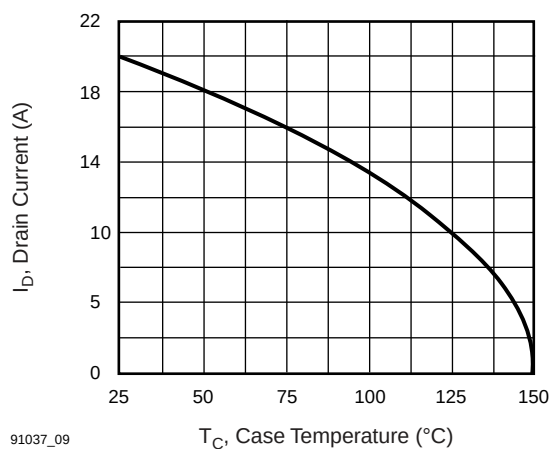
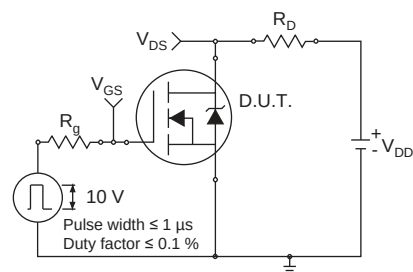


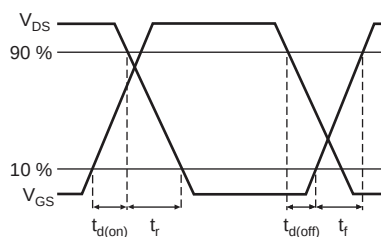
Fig. 8 - Maximum Safe Operating Area



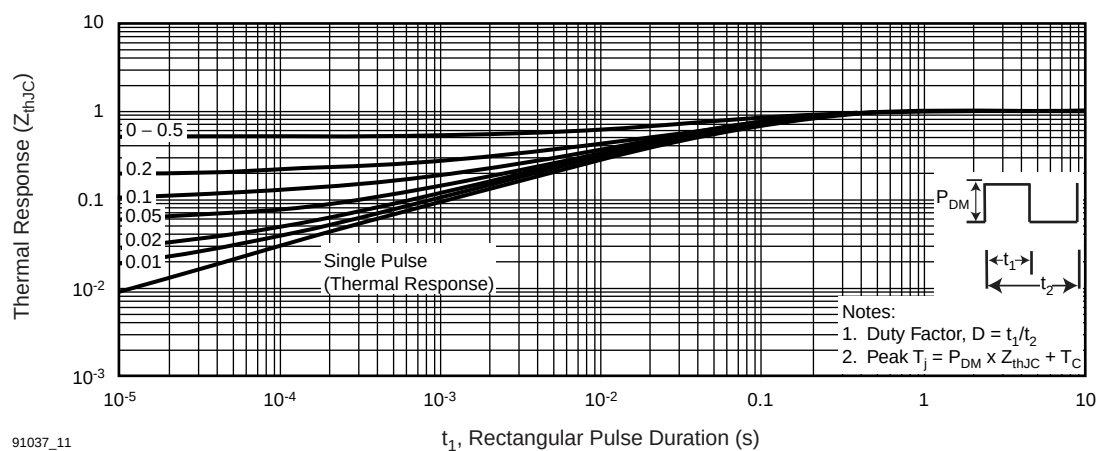
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



**Fig. 10a - Switching Time Test Circuit**



**Fig. 10b - Switching Time Waveforms**



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

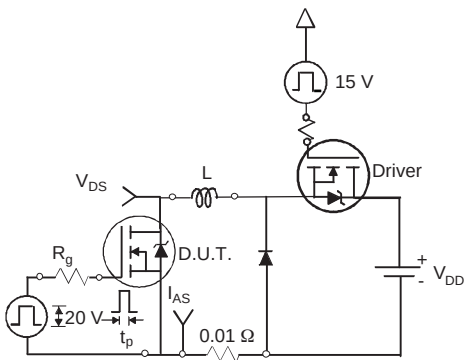


Fig. 12a - Unclamped Inductive Test Circuit

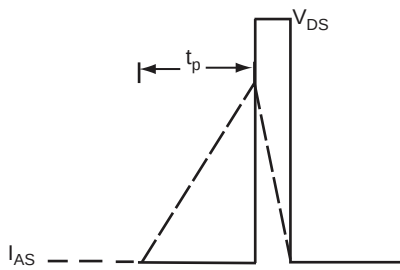


Fig. 12b - Unclamped Inductive Waveforms

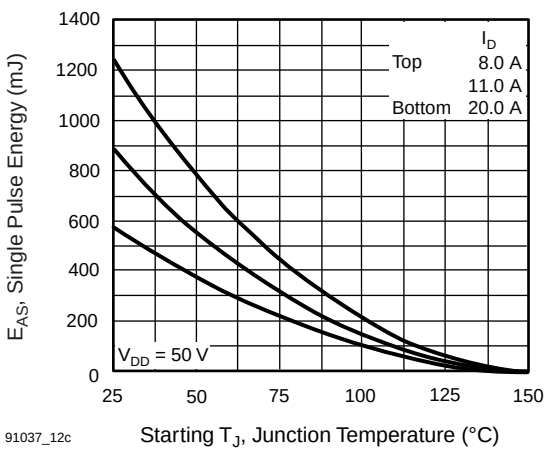


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

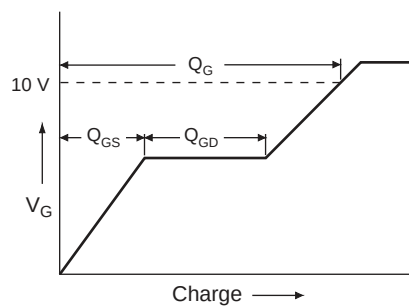


Fig. 13a - Basic Gate Charge Waveform

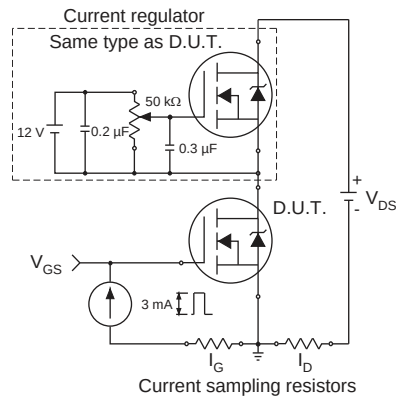
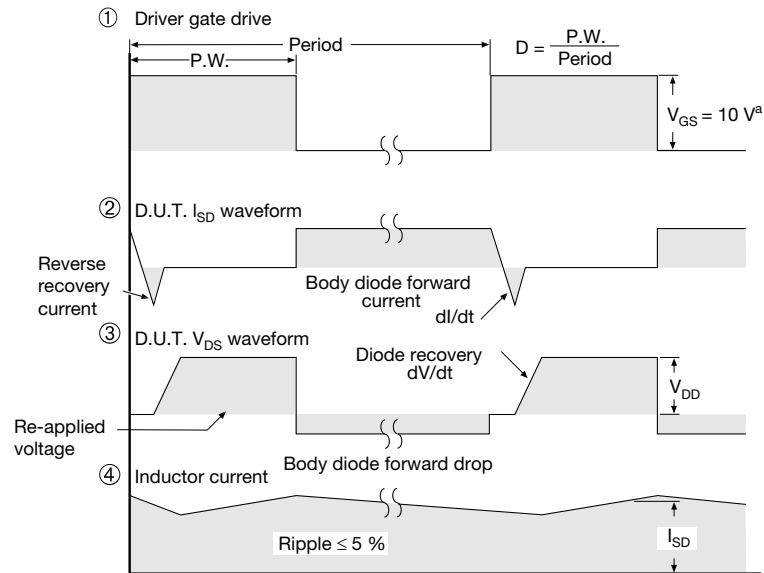
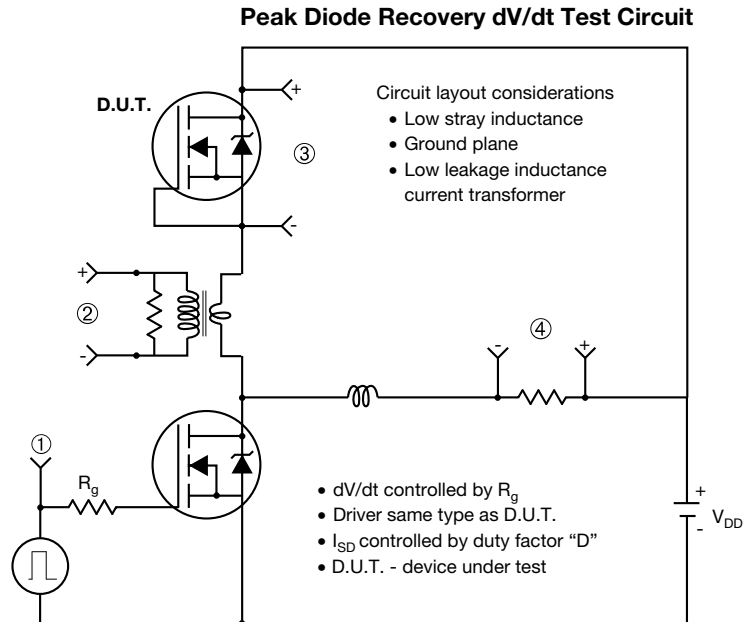


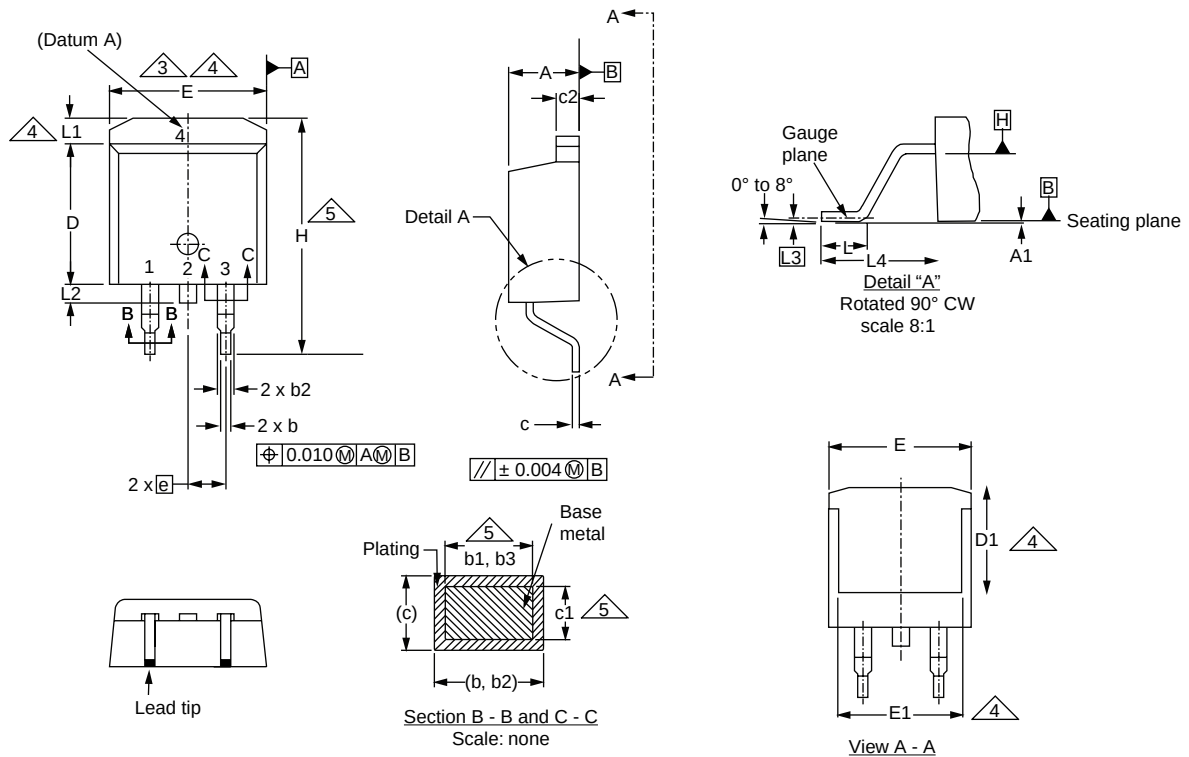
Fig. 13b - Gate Charge Test Circuit



**Note**

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

**Fig. 14 - For N-Channel**

**TO-263AB (HIGH VOLTAGE)**

| DIM. | MILLIMETERS |      | INCHES |       |
|------|-------------|------|--------|-------|
|      | MIN.        | MAX. | MIN.   | MAX.  |
| A    | 4.06        | 4.83 | 0.160  | 0.190 |
| A1   | 0.00        | 0.25 | 0.000  | 0.010 |
| b    | 0.51        | 0.99 | 0.020  | 0.039 |
| b1   | 0.51        | 0.89 | 0.020  | 0.035 |
| b2   | 1.14        | 1.78 | 0.045  | 0.070 |
| b3   | 1.14        | 1.73 | 0.045  | 0.068 |
| c    | 0.38        | 0.74 | 0.015  | 0.029 |
| c1   | 0.38        | 0.58 | 0.015  | 0.023 |
| c2   | 1.14        | 1.65 | 0.045  | 0.065 |
| D    | 8.38        | 9.65 | 0.330  | 0.380 |

| DIM. | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
|      | MIN.        | MAX.  | MIN.      | MAX.  |
| D1   | 6.86        | -     | 0.270     | -     |
| E    | 9.65        | 10.67 | 0.380     | 0.420 |
| E1   | 6.22        | -     | 0.245     | -     |
| e    | 2.54 BSC    |       | 0.100 BSC |       |
| H    | 14.61       | 15.88 | 0.575     | 0.625 |
| L    | 1.78        | 2.79  | 0.070     | 0.110 |
| L1   | -           | 1.65  | -         | 0.066 |
| L2   | -           | 1.78  | -         | 0.070 |
| L3   | 0.25 BSC    |       | 0.010 BSC |       |
| L4   | 4.78        | 5.28  | 0.188     | 0.208 |

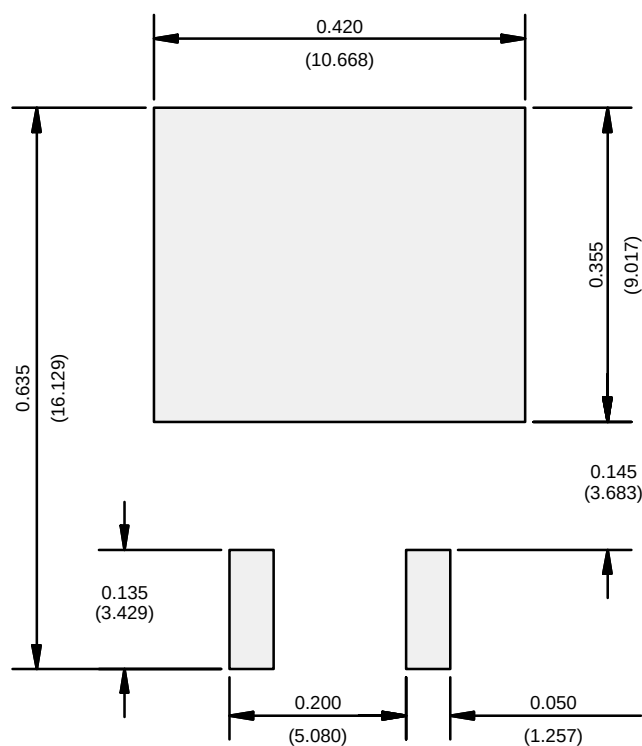
ECN: S-82110-Rev. A, 15-Sep-08  
 DWG: 5970

**Notes**

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimensions are shown in millimeters (inches).
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body at datum A.
4. Thermal PAD contour optional within dimension E, L1, D1 and E1.
5. Dimension b1 and c1 apply to base metal only.
6. Datum A and B to be determined at datum plane H.
7. Outline conforms to JEDEC outline to TO-263AB.



**RECOMMENDED MINIMUM PADS FOR D<sup>2</sup>PAK: 3-Lead**



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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