

## N-Channel 60 V (D-S) MOSFET

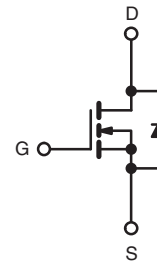
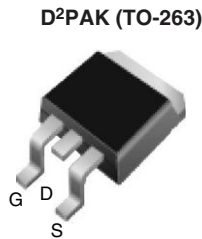
| PRODUCT SUMMARY     |                                  |                                    |                      |
|---------------------|----------------------------------|------------------------------------|----------------------|
| V <sub>DS</sub> (V) | R <sub>DS(on)</sub> (Ω)          | I <sub>D</sub> (A) <sup>a, e</sup> | Q <sub>g</sub> (Max) |
| 60                  | 0.023 at V <sub>GS</sub> = 10 V  | 50                                 | 66 nC                |
|                     | 0.027 at V <sub>GS</sub> = 4.5 V | 40                                 |                      |

### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Surface Mount
- Available in Tape and Reel
- Dynamic dV/dt Rating
- Logic-Level Gate Drive
- Fast Switching
- Compliant to RoHS Directive 2002/95/EC



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



N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                                   |                         |      |
|---|-----------------------------------|-------------------------|------|
| PARAMETER   | SYMBOL                            | LIMIT                   | UNIT |
| Drain-Source Voltage  | V <sub>DS</sub>                   | 60                      | V    |
| Gate-Source Voltage   | V <sub>GS</sub>                   | ± 10                    |      |
| Continuous Drain Current <sup>f</sup>                                     | V <sub>GS</sub> at 10 V           | T <sub>C</sub> = 25 °C  | A    |
| Continuous Drain Current  |                                   | T <sub>C</sub> = 100 °C |      |
| Pulsed Drain Current <sup>a</sup>   | I <sub>DM</sub>                   | 200                     |      |
| Linear Derating Factor  |                                   | 1.0                     | W/°C |
| Linear Derating Factor (PCB Mount) <sup>e</sup>                           |                                   | 0.025                   |      |
| Single Pulse Avalanche Energy <sup>b</sup>                                | E <sub>AS</sub>                   | 400                     | mJ   |
| Maximum Power Dissipation   | P <sub>D</sub>                    | T <sub>C</sub> = 25 °C  | W    |
| Maximum Power Dissipation (PCB Mount) <sup>e</sup>                        |                                   | T <sub>A</sub> = 25 °C  |      |
| Peak Diode Recovery dV/dt <sup>c</sup>                                    | dV/dt                             | 4.5                     | V/ns |
| Operating Junction and Storage Temperature Range                          | T <sub>J</sub> , T <sub>stg</sub> | - 55 to + 175           | °C   |
| Soldering Recommendations (Peak Temperature) <sup>d</sup>                 | for 10 s                          | 300 <sup>d</sup>        |      |

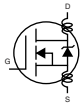
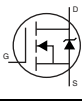
### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- V<sub>DD</sub> = 25 V, starting T<sub>J</sub> = 25 °C, L = 179 μH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = 51 A (see fig. 12).
- I<sub>SD</sub> ≤ 51 A, di/dt ≤ 250 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 175 °C.
- 1.6 mm from case.
- When mounted on 1" square PCB (FR-4 or G-10 material).
- Current limited by the package, (die current = 51 A).

| THERMAL RESISTANCE RATINGS                           |            |      |      |      |
|--|------------|------|------|------|
| PARAMETER  | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient                          | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Ambient (PCB Mount) <sup>a</sup> | $R_{thJA}$ | -    | 40   |      |
| Maximum Junction-to-Case (Drain)                     | $R_{thJC}$ | -    | 1.0  |      |

**Note**

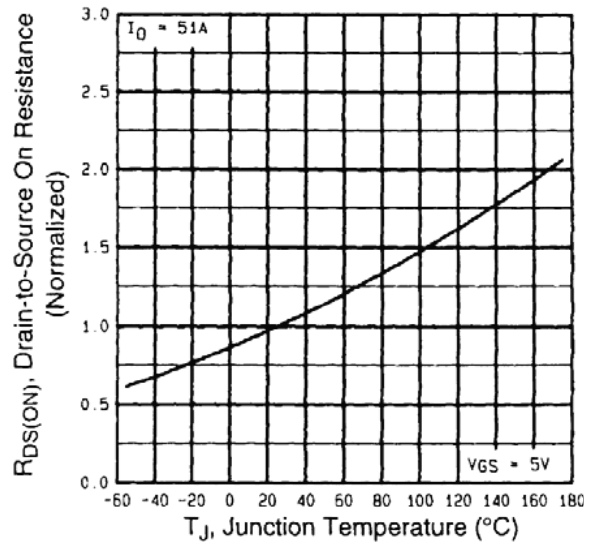
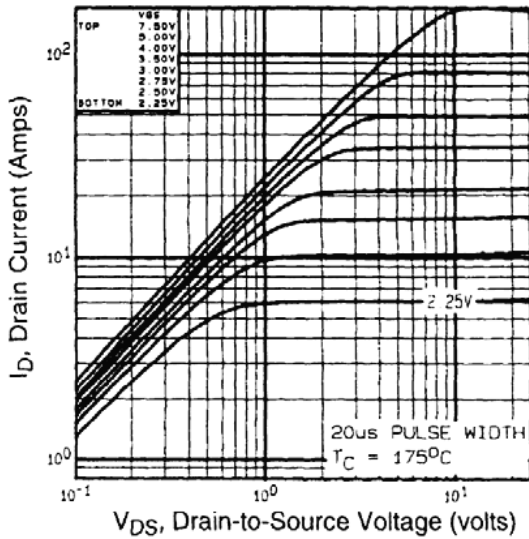
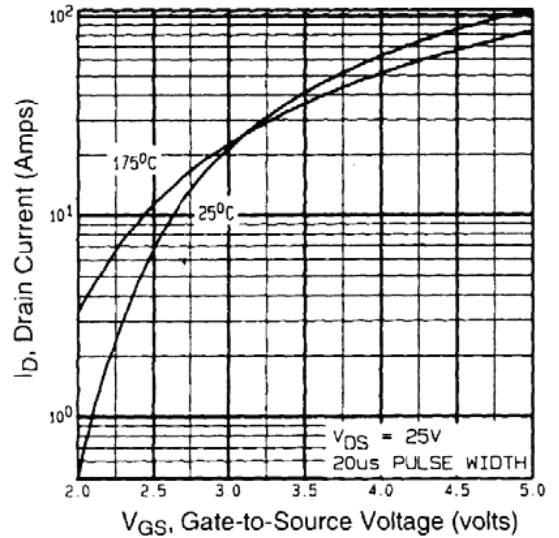
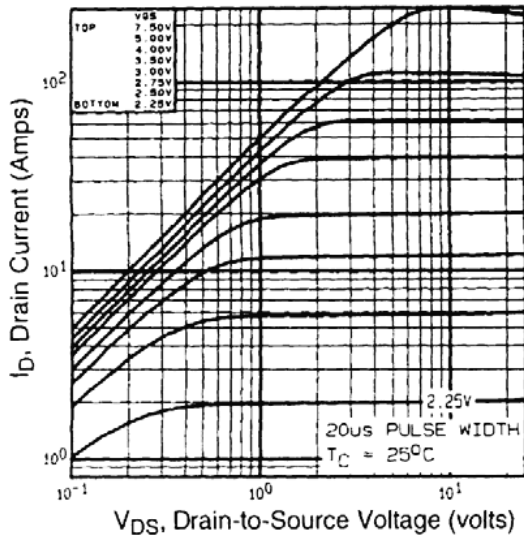
a. When mounted on 1" square PCB (FR-4 or G-10 material).

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |  |  |      |       |                 |               |
|---|---------------------|--|--|------|-------|-----------------|---------------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS  |  | MIN. | TYP.  | MAX.            | UNIT          |
| <b>Static</b>   |                     |  |  |      |       |                 |               |
| Drain-Source Breakdown Voltage  | $V_{DS}$            | $V_{GS} = 0, I_D = 250\text{ }\mu\text{A}$   |  | 60   | -     | -               | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$  |  | -    | 0.070 | -               | V/°C          |
| Gate-Source Threshold Voltage   | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$  |  | 1.0  | -     | 3.0             | V             |
| Gate-Source Leakage   | $I_{GSS}$           | $V_{GS} = \pm 10\text{ V}$   |  | -    | -     | $\pm 100$       | nA            |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$  |  | -    | -     | 25              | $\mu\text{A}$ |
|   |                     | $V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$   |  | -    | -     | 250             |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$   | $I_D = 21\text{ A}^b$  | -    | 23    | -               | $\Omega$      |
|   |                     | $V_{GS} = 4.5\text{ V}$  | $I_D = 15\text{ A}^b$  | -    | 27    | -               |               |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = 25\text{ V}, I_D = 21\text{ A}^b$  |  | 23   | -     | -               | S             |
| <b>Dynamic</b>  |                     |  |  |      |       |                 |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = 25\text{ V}, f = 1.0\text{ MHz}$ , see fig. 5   |  | -    | 3000  | -               | pF            |
| Output Capacitance  | $C_{oss}$           |  |  | -    | 1000  | -               |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |  |  | -    | 200   | -               |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = 5.0\text{ V}$  | $I_D = 51\text{ A}, V_{DS} = 48\text{ V}$ , see fig. 6 and 13 <sup>b</sup> | -    | 60    | -               | nC            |
| Gate-Source Charge  | $Q_{gs}$            |  |  | -    | 10    | -               |               |
| Gate-Drain Charge   | $Q_{gd}$            |  |  | -    | 40    | -               |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = 30\text{ V}, I_D = 51\text{ A}, R_g = 4.6\text{ }\Omega, R_D = 0.56\text{ }\Omega$ , see fig. 10 <sup>b</sup>                                |  | -    | 17    | -               | ns            |
| Rise Time   | $t_r$               |  |  | -    | 230   | -               |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |  |  | -    | 42    | -               |               |
| Fall Time   | $t_f$               |  |  | -    | 110   | -               |               |
| Internal Drain Inductance   | $L_D$               | Between lead, 6 mm (0.25") from package and center of die contact  |  | -    | 4.5   | -               | nH            |
| Internal Source Inductance  | $L_S$               |  |  | -    | 7.5   | -               |               |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |  |  |      |       |                 |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode    |  | -    | -     | 50 <sup>c</sup> | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                   | $I_{SM}$            |  |  | -    | -     | 200             |               |
| Body Diode Voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 51\text{ A}, V_{GS} = 0\text{ V}^b$   |  | -    | -     | 2.5             | V             |
| Body Diode Reverse Recovery Time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = 51\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$  |  | -    | 130   | 180             | ns            |
| Body Diode Reverse Recovery Charge  | $Q_{rr}$            |  |  | -    | 0.84  | 1.3             | $\mu\text{C}$ |
| 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. Current limited by the package, (Die Current = 51 A).

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



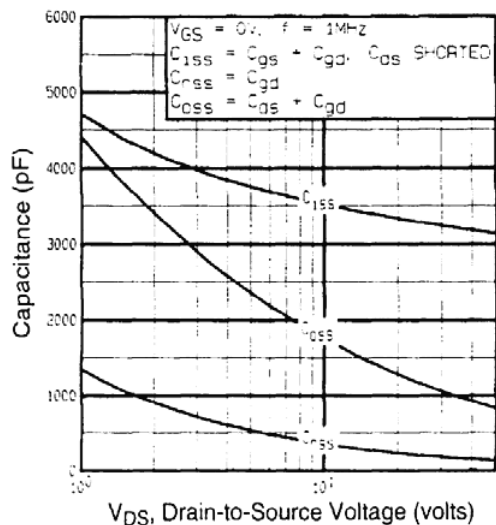


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

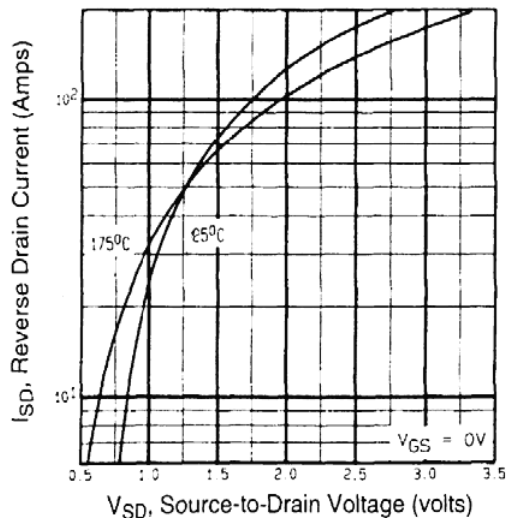


Fig. 7 - Typical Source-Drain Diode Forward Voltage

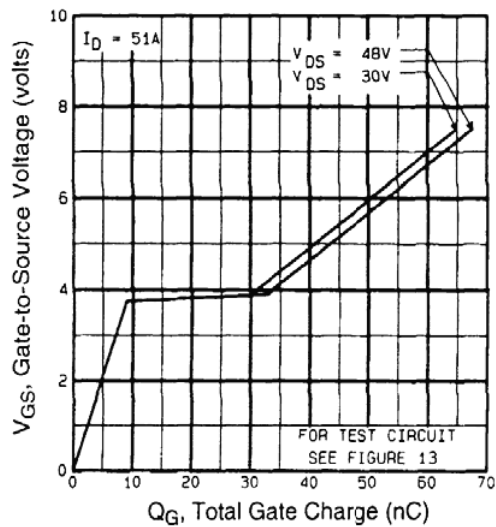


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

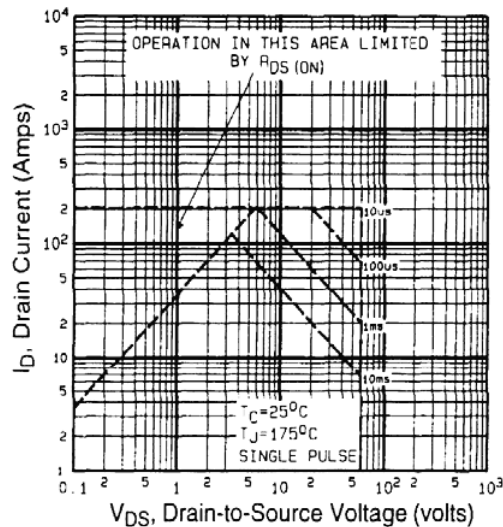


Fig. 8 - Maximum Safe Operating Area

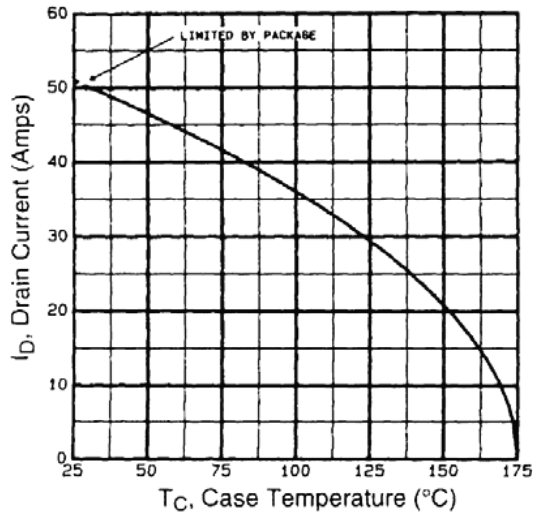


Fig. 9 - Maximum Drain Current vs. Case Temperature

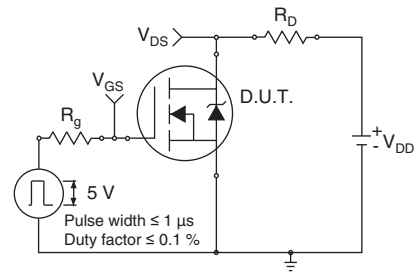


Fig. 10a - Switching Time Test Circuit

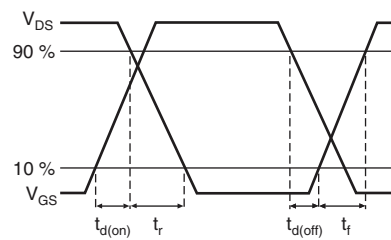


Fig. 10b - Switching Time Waveforms

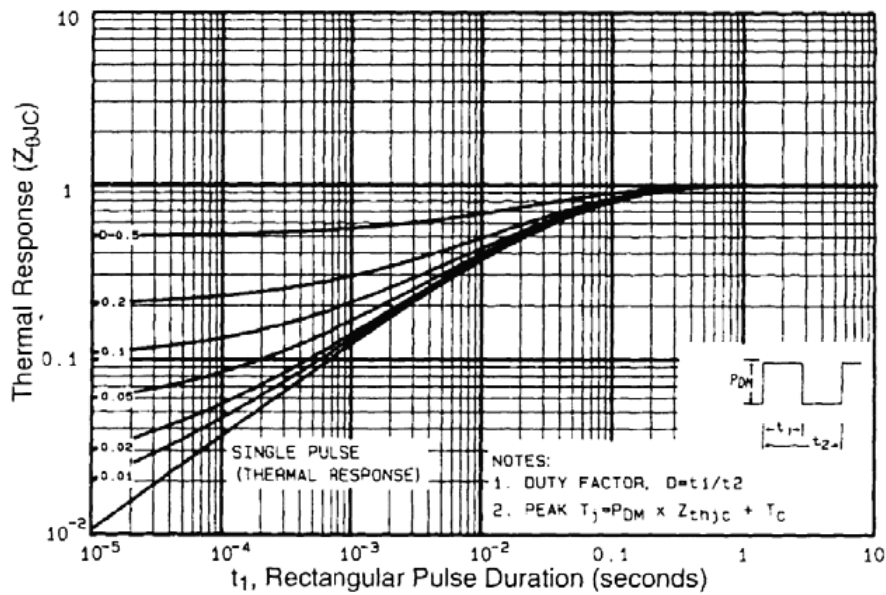


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

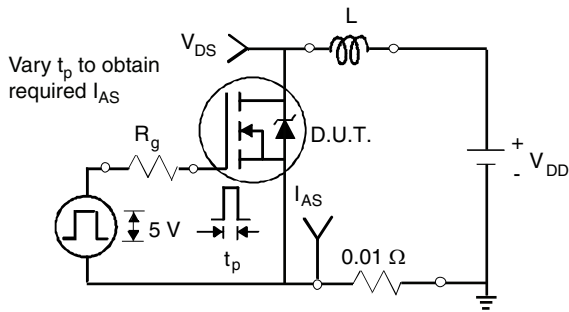


Fig. 12a - Unclamped Inductive Test Circuit

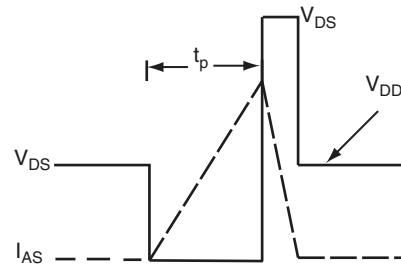


Fig. 12b - Unclamped Inductive Waveforms

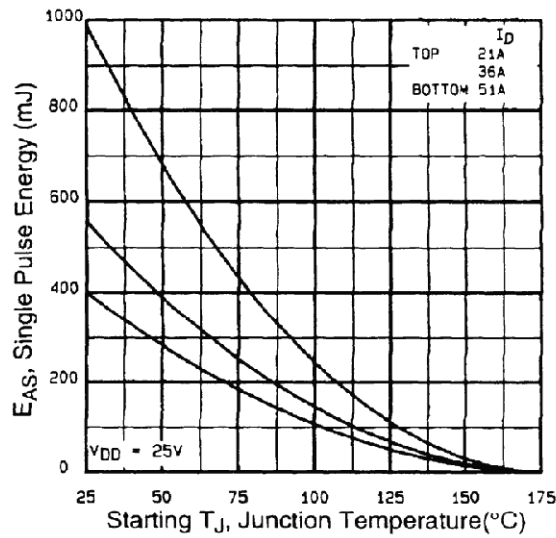


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

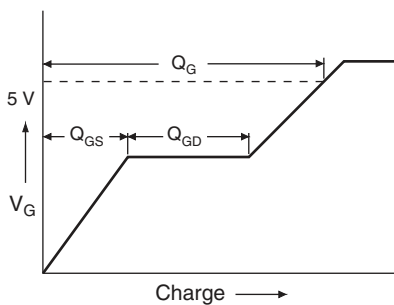


Fig. 13a - Basic Gate Charge Waveform

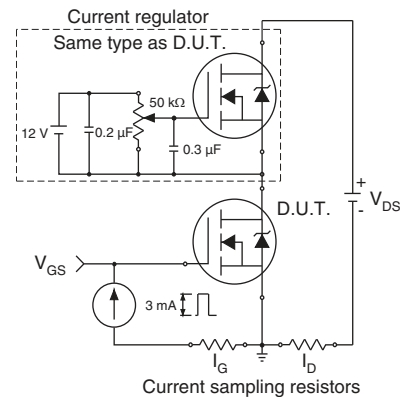
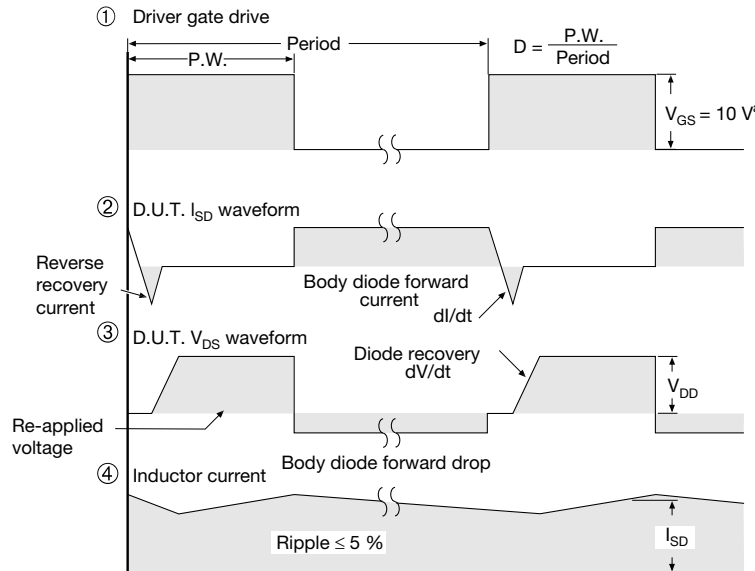
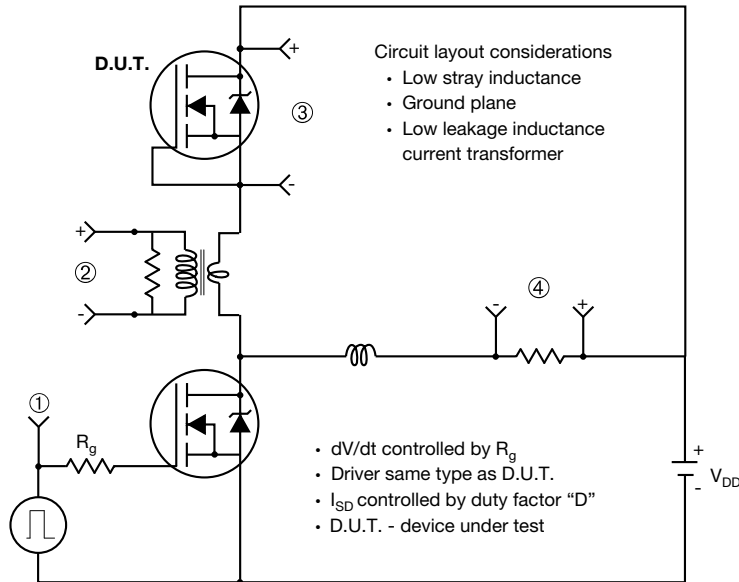


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit

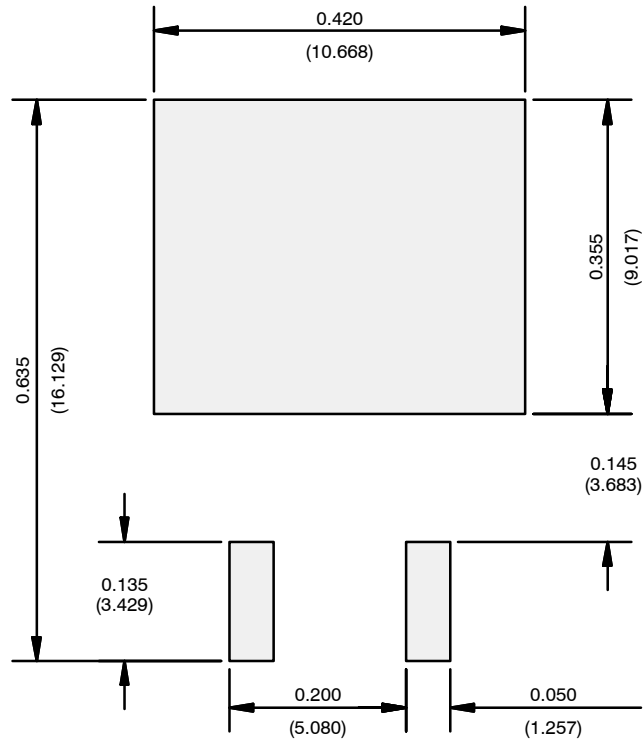


Note

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

Fig. 14 - For N-Channel

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



Recommended Minimum Pads  
Dimensions in Inches/(mm)



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