

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

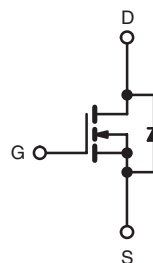
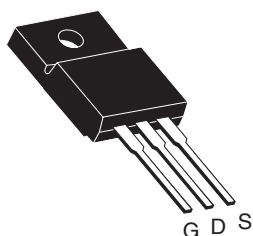
| PRODUCT SUMMARY           |                 |       |
|---------------------------|-----------------|-------|
| $V_{DS}$ (V)              | 60              |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10$ V | 0.027 |
| $Q_g$ (Max.) (nC)         | 95              |       |
| $Q_{gs}$ (nC)             | 27              |       |
| $Q_{gd}$ (nC)             | 46              |       |
| Configuration             | Single          |       |

### FEATURES

- Isolated Package
- High Voltage Isolation = 2.5 kV<sub>RMS</sub> (t = 60 s; f = 60 Hz)
- Sink to Lead Creepage Distance = 4.8 mm
- 175 °C Operating Temperature
- Dynamic dV/dt Rating
- Low Thermal Resistance
- Lead (Pb)-free Available



TO-220 FULLPAK



N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS $T_C = 25$ °C, unless otherwise noted |                  |                                   |       |          |
|--|------------------|-----------------------------------|-------|----------|
| PARAMETER  | SYMBOL           | LIMIT                             | UNIT  |          |
| Drain-Source Voltage   | $V_{DS}$         | 60                                | V     |          |
| Gate-Source Voltage  | $V_{GS}$         | $\pm 20$                          |       |          |
| Continuous Drain Current                                       | $I_D$            | $V_{GS}$ at 10 V<br>$T_C = 25$ °C | 45    | A        |
|  |                  | $T_C = 100$ °C                    | 30    |          |
| Pulsed Drain Current <sup>a</sup>                              | $I_{DM}$         | 220                               |       |          |
| Linear Derating Factor   |                  | 0.32                              | W/°C  |          |
| Single Pulse Avalanche Energy <sup>b</sup>                     | $E_{AS}$         | 100                               | mJ    |          |
| Maximum Power Dissipation                                      | $P_D$            | 52                                | W     |          |
| Peak Diode Recovery dV/dt <sup>c</sup>                         | dV/dt            | 4.5                               | V/ns  |          |
| Operating Junction and Storage Temperature Range               | $T_J, T_{stg}$   | - 55 to + 175                     | °C    |          |
| Soldering Recommendations (Peak Temperature)                   | for 10 s         | 300 <sup>d</sup>                  |       |          |
| Mounting Torque  | 6-32 or M3 screw | 10                                |       | lbf · in |
|  |                  | 1.1                               | N · m |          |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = 25$  V, starting  $T_J = 25$  °C, L = 129  $\mu$ H,  $R_G = 25$   $\Omega$ ,  $I_{AS} = 30$  A (see fig. 12).
- $I_{SD} \leq 52$  A,  $dI/dt \leq 250$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175$  °C.
- 1.6 mm from case.

| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 65   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 3.1  |      |

| 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   | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$   |  | 60   | -     | -         | V             |
| $V_{DS}$ Temperature Coefficient   | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$   |  | -    | 0.060 | -         | 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  | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$  |  | -    | -     | $\pm 100$ | 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   | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$  | $I_D = 18\text{ A}^b$  | -    | 0.027 | -         | $\Omega$      |
| Forward Transconductance   | $g_{fs}$            | $V_{DS} = 25\text{ V}, I_D = 18\text{ A}^b$   |  | 15   | -     | -         | 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  |  | -    | 1500  | -         | pF            |
| Output Capacitance   | $C_{oss}$           |   |  | -    | 720   | -         |               |
| Reverse Transfer Capacitance   | $C_{riss}$          |   |  | -    | 100   | -         |               |
| Drain to Sink Capacitance  | $C$                 | $f = 1.0\text{ MHz}$  |  | -    | 12    | -         |               |
| Total Gate Charge  | $Q_g$               | $V_{GS} = 10\text{ V}$  | $I_D = 52\text{ A}, V_{DS} = 48\text{ V}$ , see fig. 6 and 13 <sup>b</sup> | -    | -     | 95        | nC            |
| Gate-Source Charge   | $Q_{GS}$            |   |  | -    | -     | 27        |               |
| Gate-Drain Charge  | $Q_{GD}$            |   |  | -    | -     | 46        |               |
| Turn-On Delay Time   | $t_{d(on)}$         | $V_{DD} = 30\text{ V}, I_D = 52\text{ A}, R_G = 9.1\text{ }\Omega, R_D = 0.54\text{ }\Omega$ , see fig. 10 <sup>b</sup> |  | -    | 19    | -         | ns            |
| Rise Time  | $t_r$               |   |  | -    | 120   | -         |               |
| Turn-Off Delay Time  | $t_{d(off)}$        |   |  | -    | 55    | -         |               |
| Fall Time  | $t_f$               |   |  | -    | 86    | -         |               |
| 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   |  | -    | -     | 45        | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                | $I_{SM}$            |   |  | -    | -     | 120       |               |
| Body Diode Voltage   | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 30\text{ A}, V_{GS} = 0\text{ V}^b$  |  | -    | -     | 2.5       | V             |
| Body Diode Reverse Recovery Time   | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = 52\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$                                 |  | -    | 140   | 300       | ns            |
| Body Diode Reverse Recovery Charge                                       | $Q_{rr}$            |   |  | -    | 1.2   | 2.8       | $\mu\text{C}$ |
| 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  $\leq 2\%$ .

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

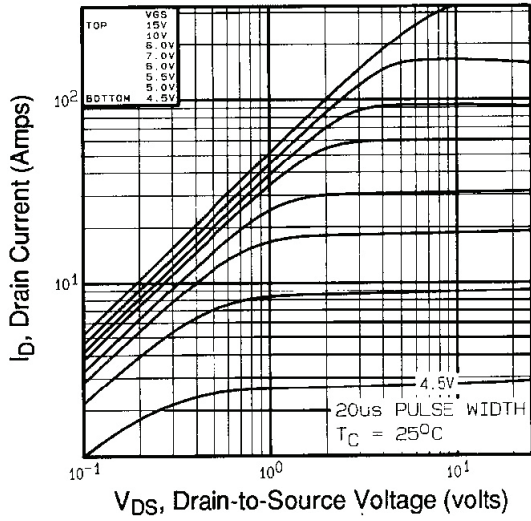


Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$

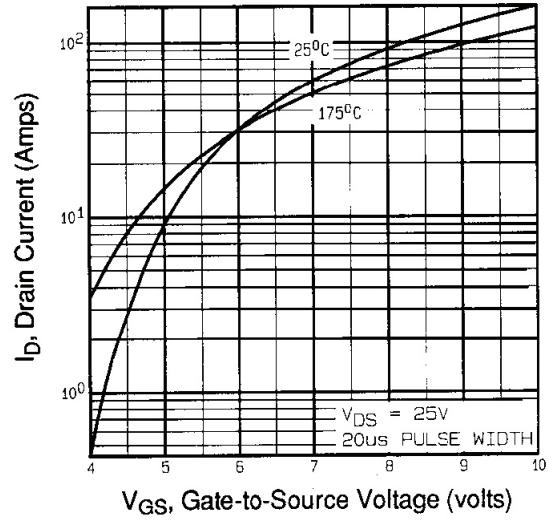


Fig. 3 - Typical Transfer Characteristics

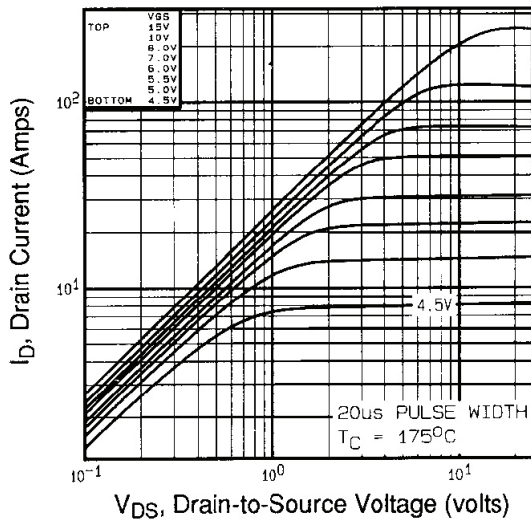


Fig. 2 - Typical Output Characteristics,  $T_C = 175\text{ }^\circ\text{C}$

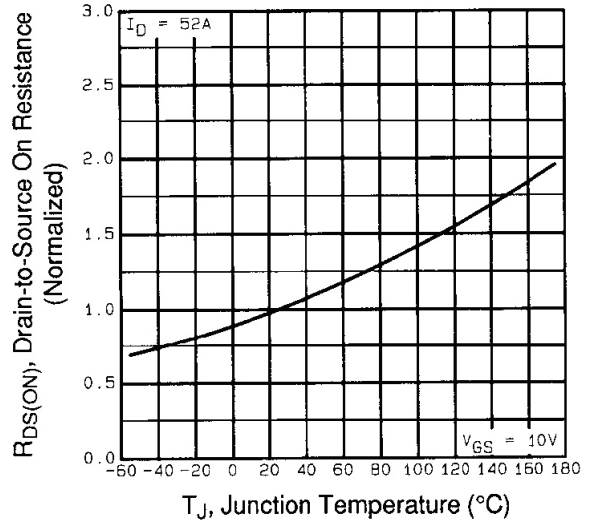


Fig. 4 - Normalized On-Resistance vs. Temperature

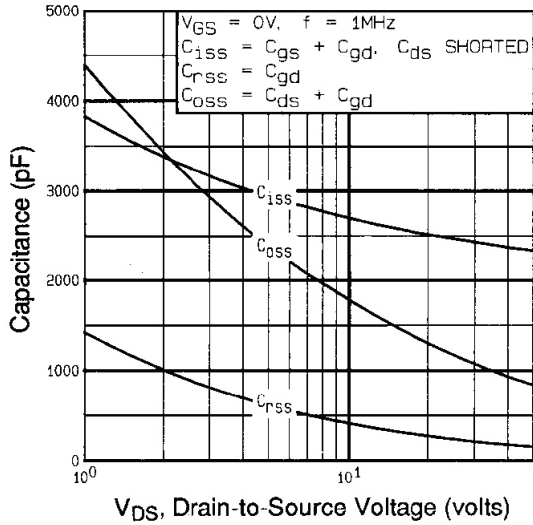


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

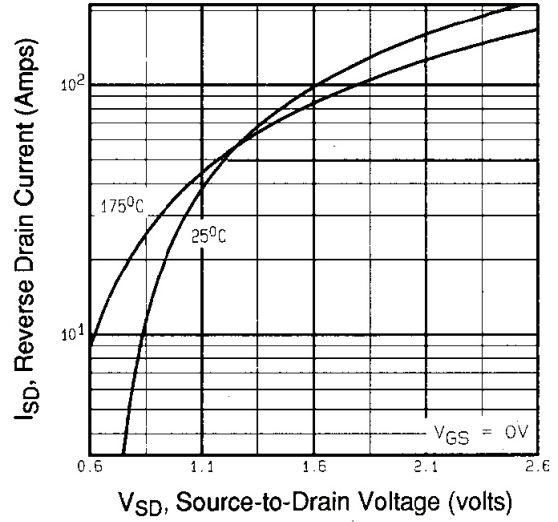


Fig. 7 - Typical Source-Drain Diode Forward Voltage

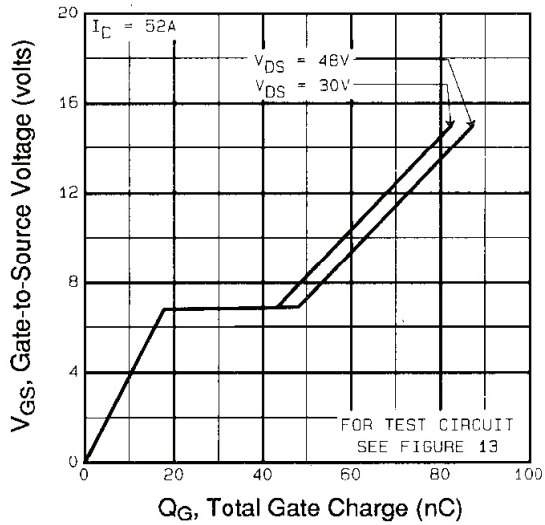


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

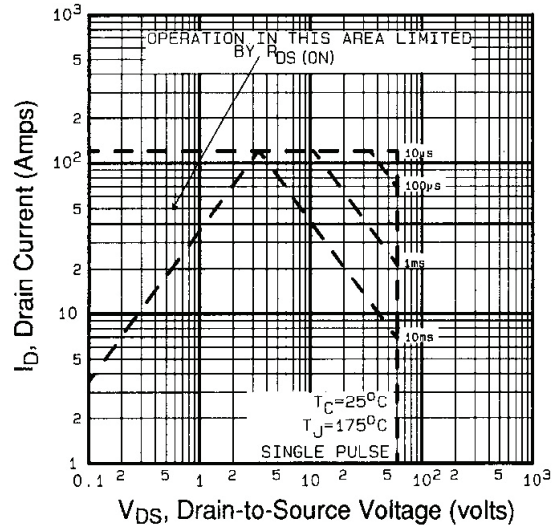


Fig. 8 - Maximum Safe Operating Area

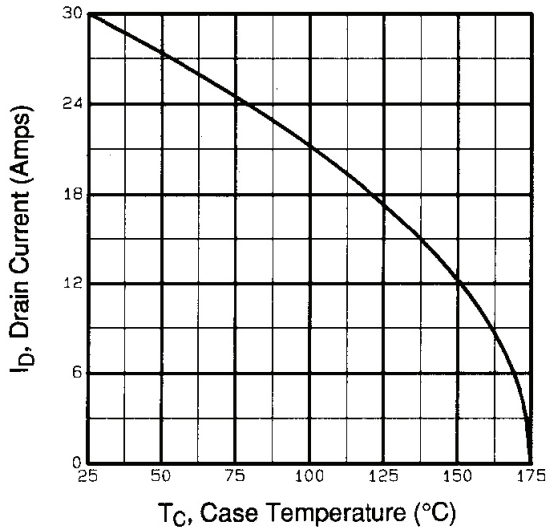


Fig. 9 - Maximum Drain Current vs. Case Temperature

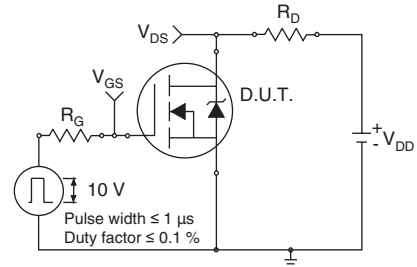


Fig. 10a - Switching Time Test Circuit

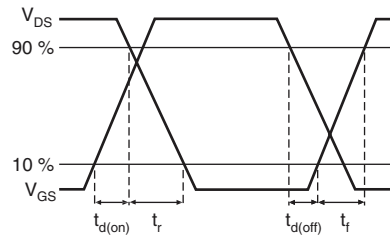


Fig. 10b - Switching Time Waveforms

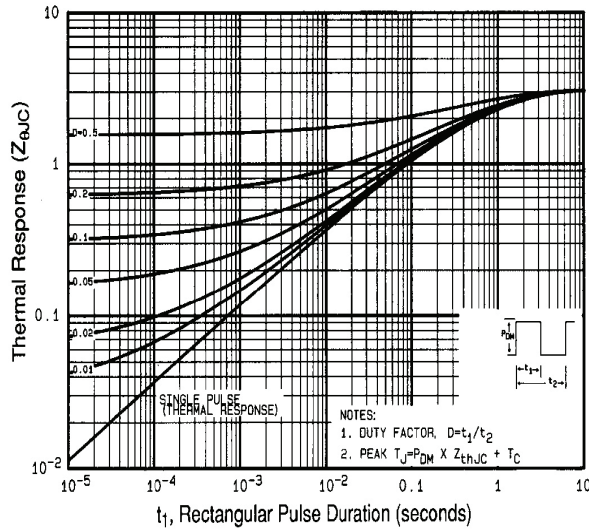


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

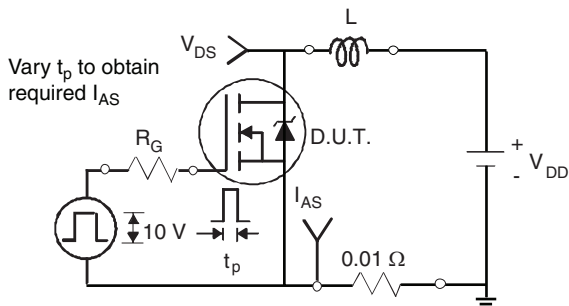


Fig. 12a - Unclamped Inductive Test Circuit

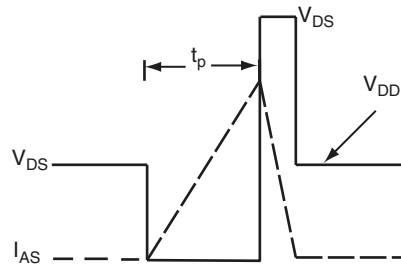


Fig. 12b - Unclamped Inductive Waveforms

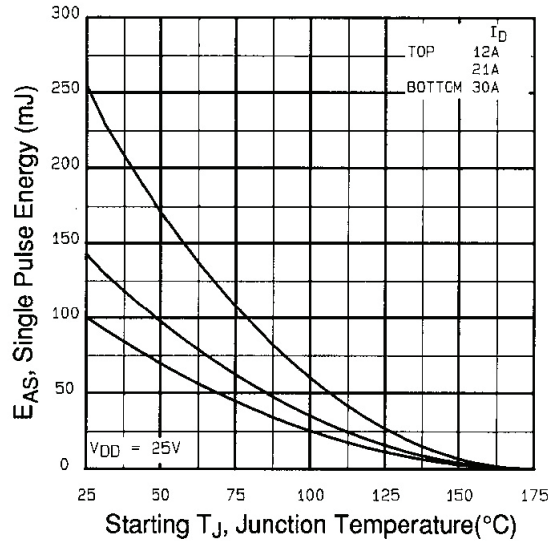


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

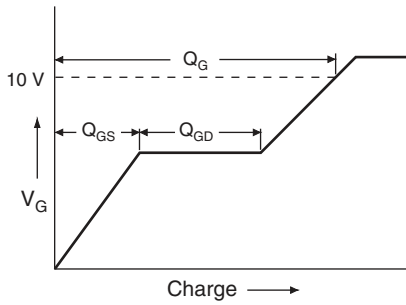


Fig. 13a - Basic Gate Charge Waveform

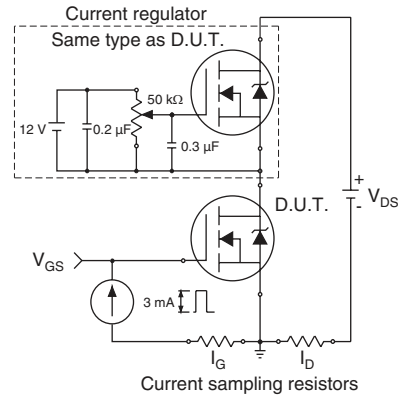
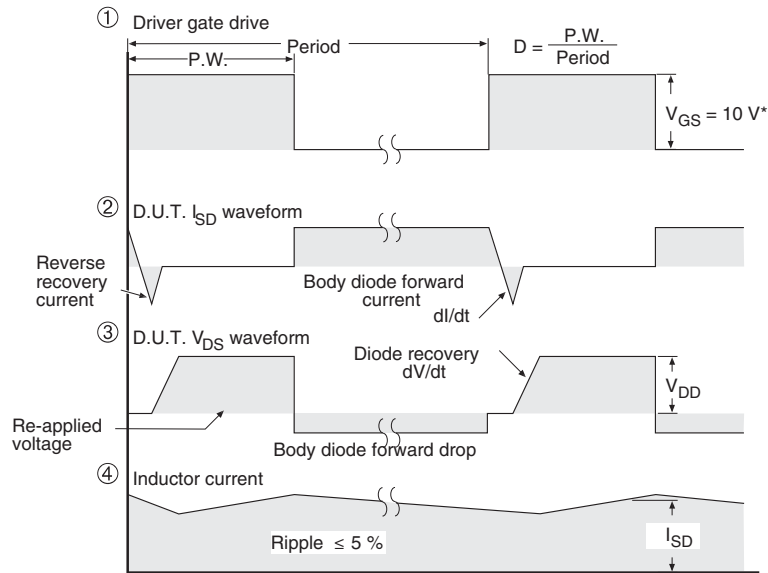
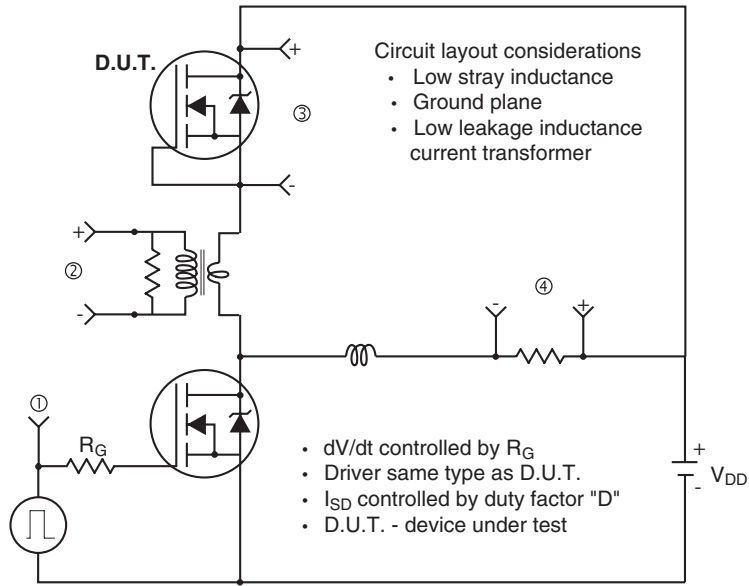


Fig. 13b - Gate Charge Test Circuit

**Peak Diode Recovery dV/dt Test Circuit**



\*  $V_{GS} = 5 V$  for logic level devices

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

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