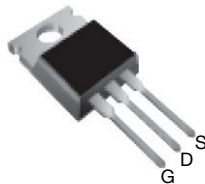


## Power MOSFET

**TO-220AB**


N-Channel MOSFET

### FEATURES

- Low gate charge  $Q_g$  results in simple drive requirement
- Improved gate, avalanche and dynamic  $dV/dt$  ruggedness
- Fully characterized capacitance and avalanche voltage and current
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS\***  
Available

### APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptible power supply
- High speed power switching

### APPLICABLE OFF LINE SMPS TOPOLOGIES

- Active clamped forward
- Main switch

### PRODUCT SUMMARY

|                           |                        |      |
|---------------------------|------------------------|------|
| $V_{DS}$ (V)              | 600                    |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.75 |
| $Q_g$ max. (nC)           | 49                     |      |
| $Q_{gs}$ (nC)             | 13                     |      |
| $Q_{gd}$ (nC)             | 20                     |      |
| Configuration             | Single                 |      |

### ORDERING INFORMATION

|                                 |                  |
|---------------------------------|------------------|
| Package                         | TO-220AB         |
| Lead (Pb)-free                  | IRFB9N60APbF     |
| Lead (Pb)-free and halogen-free | IRFB9N60APbF-BE3 |

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

| PARAMETER                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT  |
|-----------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|-------|
| Drain-source voltage                                      |                         |                         | V <sub>DS</sub>                   | 600         | V     |
| Gate-source voltage                                       |                         |                         | V <sub>GS</sub>                   | ± 30        |       |
| Continuous drain current                                  | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 9.2         | A     |
|                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 5.8         |       |
| Pulsed drain current <sup>a</sup>                         |                         |                         | I <sub>DM</sub>                   | 37          |       |
| Linear derating factor                                    |                         |                         |                                   | 1.3         | W/°C  |
| Single pulse avalanche energy <sup>b</sup>                |                         |                         | E <sub>AS</sub>                   | 290         | mJ    |
| Repetitive avalanche current <sup>a</sup>                 |                         |                         | I <sub>AR</sub>                   | 9.2         | A     |
| Repetitive avalanche energy <sup>a</sup>                  |                         |                         | E <sub>AR</sub>                   | 17          | mJ    |
| Maximum power dissipation                                 | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>                    | 170         | W     |
| Peak diode recovery dV/dt <sup>c</sup>                    |                         |                         | dV/dt                             | 5.0         | V/ns  |
| Operating junction and storage temperature range          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C    |
| Soldering recommendations (peak temperature) <sup>d</sup> | For 10 s                |                         |                                   | 300         |       |
| Mounting torque                                           | 6-32 or M3 screw        |                         |                                   | 10          |       |
|                                                           |                         |                         |                                   | 1.1         | N · m |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 6.8\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 9.2\text{ A}$  (see fig. 12)
- $I_{SD} \leq 9.2\text{ A}$ ,  $dI/dt \leq 50\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

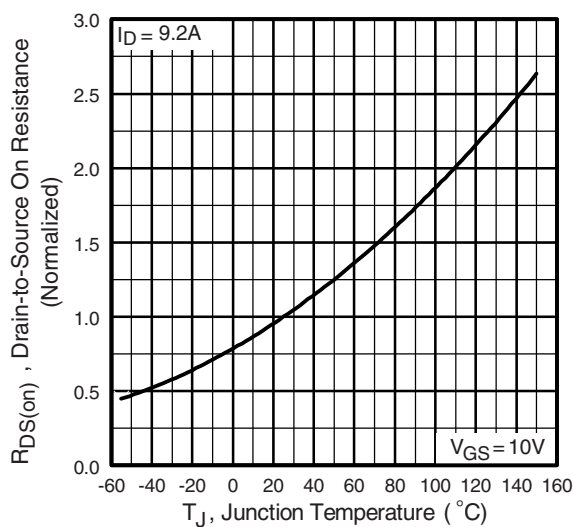
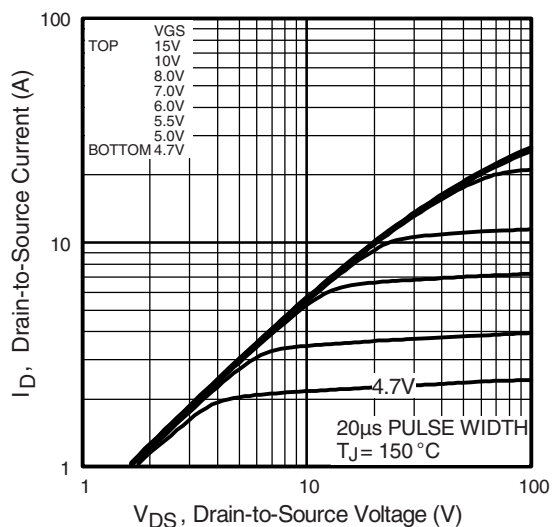
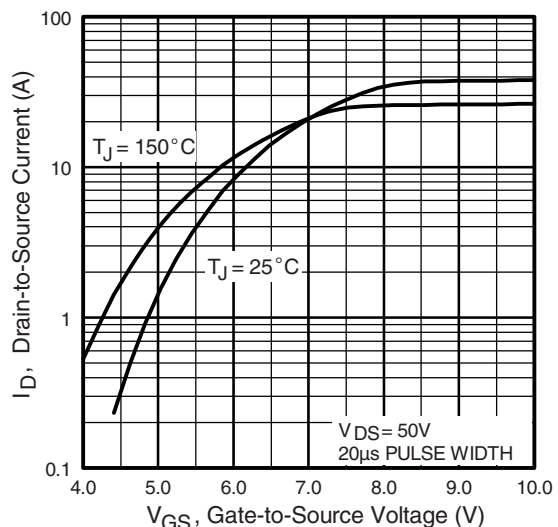
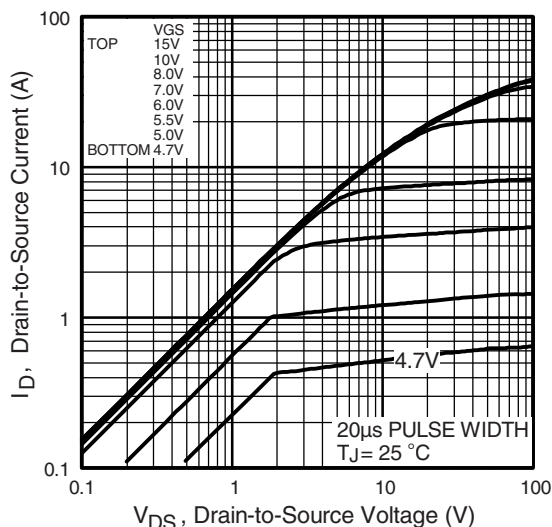
| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------|------------|------|------|------|
| Maximum junction-to-ambient         | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-sink, flat, greased surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum junction-to-case (drain)    | $R_{thJC}$ | -    | 0.75 |      |

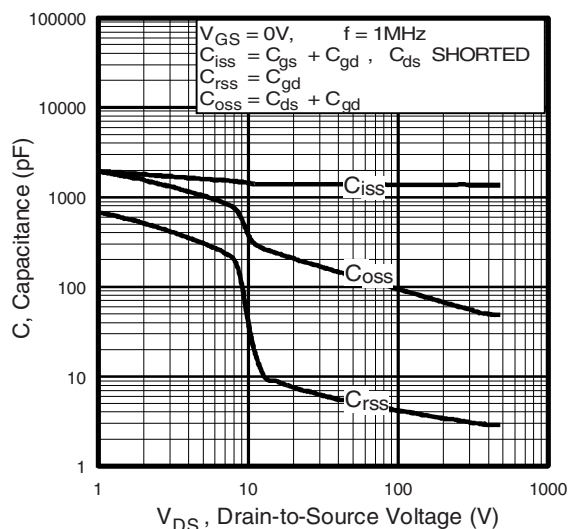
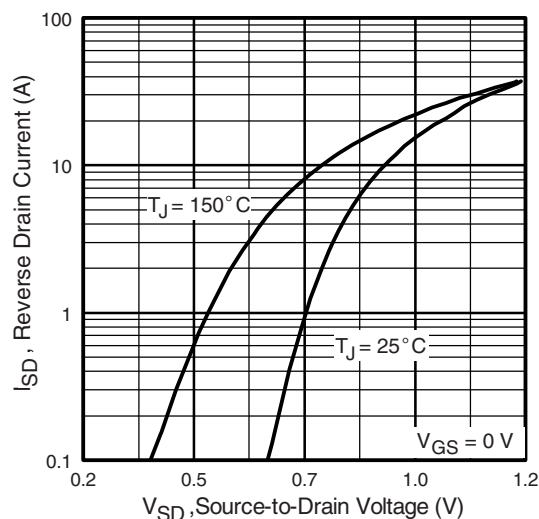
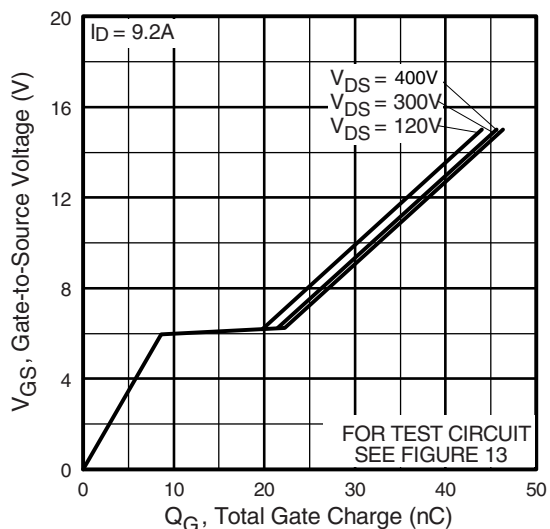
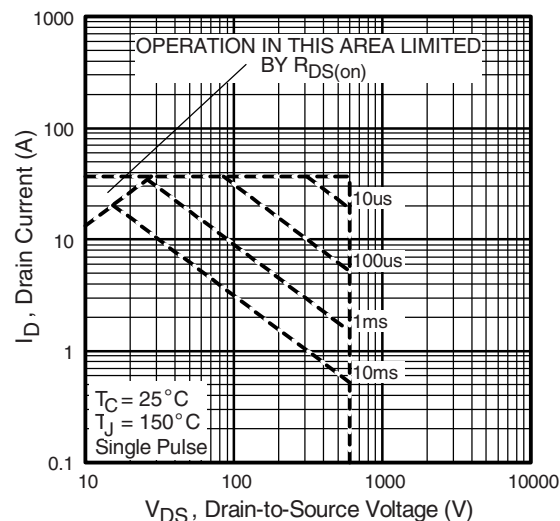
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

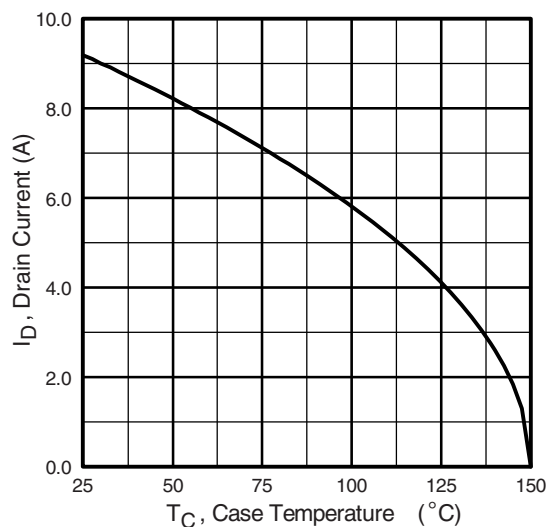
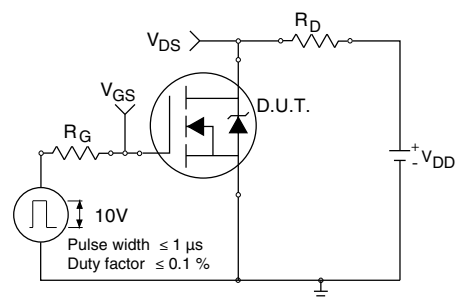
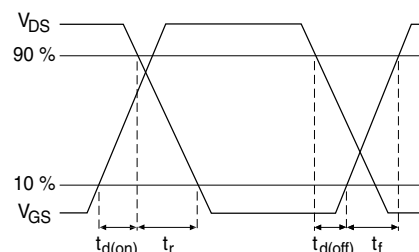
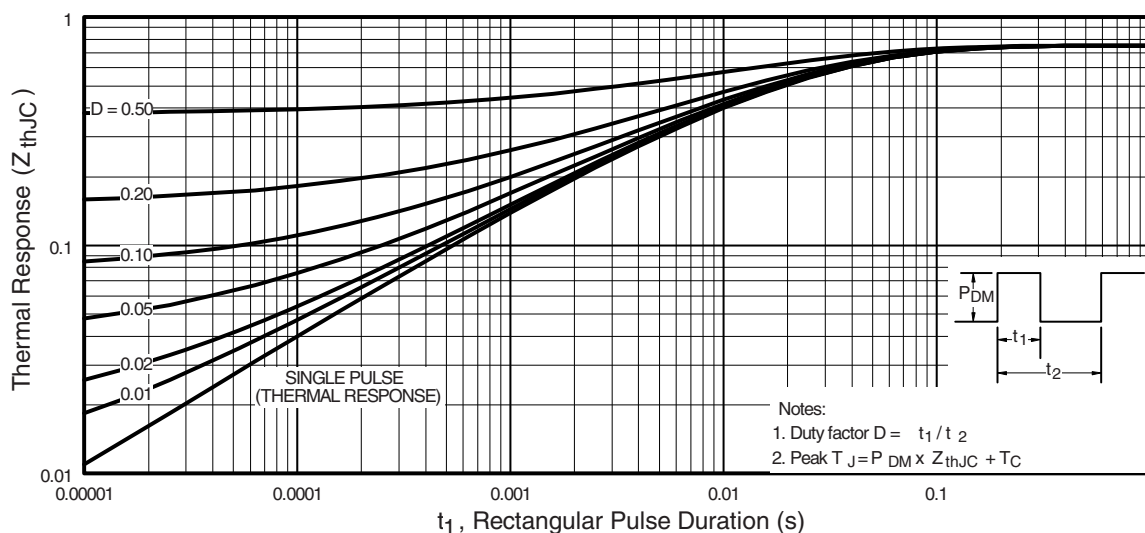
| PARAMETER                                      | SYMBOL                | TEST CONDITIONS                                                                                                                                          | MIN. | TYP. | MAX.      | UNIT          |
|------------------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-----------|---------------|
| <b>Static</b>                                  |                       |                                                                                                                                                          |      |      |           |               |
| Drain-source breakdown voltage                 | $V_{DS}$              | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                   | 600  | -    | -         | V             |
| $V_{DS}$ temperature coefficient               | $\Delta V_{DS}/T_J$   | Reference to $25\text{ }^{\circ}\text{C}$ , $I_D = 1\text{ mA}$                                                                                          | -    | 660  | -         | mV/°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                            | $I_{GSS}$             | $V_{GS} = \pm 30\text{ V}$                                                                                                                               | -    | -    | $\pm 100$ | nA            |
| Zero gate voltage drain current                | $I_{DSS}$             | $V_{DS} = 600\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                          | -    | -    | 25        | $\mu\text{A}$ |
|                                                |                       | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$                                                                    | -    | -    | 250       |               |
| Drain-source on-state resistance               | $R_{DS(on)}$          | $V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}^b$                                                                                                          | -    | -    | 0.75      | $\Omega$      |
| Forward transconductance                       | $g_{fs}$              | $V_{DS} = 50\text{ V}$ , $I_D = 5.5\text{ A}$                                                                                                            | 5.5  | -    | -         | 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                                                                 | -    | 1400 | -         | pF            |
| Output capacitance                             | $C_{oss}$             |                                                                                                                                                          | -    | 180  | -         |               |
| Reverse transfer capacitance                   | $C_{rss}$             |                                                                                                                                                          | -    | 7.1  | -         |               |
| Output capacitance                             | $C_{oss}$             | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 1.0\text{ V}$ , $f = 1.0\text{ MHz}$                                                                                | -    | 1957 | -         |               |
| Effective output capacitance                   | $C_{oss\text{ eff.}}$ | $V_{DS} = 480\text{ V}$ , $f = 1.0\text{ MHz}$                                                                                                           | -    | 49   | -         | nC            |
| Total gate charge                              | $Q_g$                 | $V_{GS} = 10\text{ V}$ ,<br>$I_D = 9.2\text{ A}$ , $V_{DS} = 400\text{ V}$<br>see fig. 6 and 13 <sup>b</sup>                                             | -    | -    | 49        |               |
| Gate-source charge                             | $Q_{gs}$              |                                                                                                                                                          | -    | -    | 13        |               |
| Gate-drain charge                              | $Q_{gd}$              |                                                                                                                                                          | -    | -    | 20        |               |
| Turn-on delay time                             | $t_{d(on)}$           | $V_{DD} = 300\text{ V}$ , $I_D = 9.2\text{ A}$<br>$R_g = 9.1\text{ }\Omega$ , $R_D = 35.5\text{ }\Omega$ , see fig. 10 <sup>b</sup>                      | -    | 13   | -         | ns            |
| Rise time                                      | $t_r$                 |                                                                                                                                                          | -    | 25   | -         |               |
| Turn-off delay time                            | $t_{d(off)}$          |                                                                                                                                                          | -    | 30   | -         |               |
| Fall time                                      | $t_f$                 |                                                                                                                                                          | -    | 22   | -         |               |
| Gate input resistance                          | $R_g$                 | $f = 1\text{ MHz}$ , open drain                                                                                                                          | 0.5  | -    | 3.2       | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b> |                       |                                                                                                                                                          |      |      |           |               |
| Continuous source-drain diode current          | $I_S$                 | MOSFET symbol showing the integral reverse p - n junction diode<br> | -    | -    | 9.2       | A             |
| Pulsed diode forward current <sup>a</sup>      | $I_{SM}$              |                                                                                                                                                          | -    | -    | 37        |               |
| Body diode voltage                             | $V_{SD}$              | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_S = 9.2\text{ A}$ , $V_{GS} = 0\text{ V}^b$                                                                      | -    | -    | 1.5       | V             |
| Body diode reverse recovery time               | $t_{rr}$              | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_F = 9.2\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$                                                         | -    | 530  | 800       | ns            |
| Body diode reverse recovery charge             | $Q_{rr}$              |                                                                                                                                                          | -    | 3.0  | 4.4       | $\mu\text{C}$ |
| Forward turn-on time                           | $t_{on}$              | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )                                                                          |      |      |           |               |

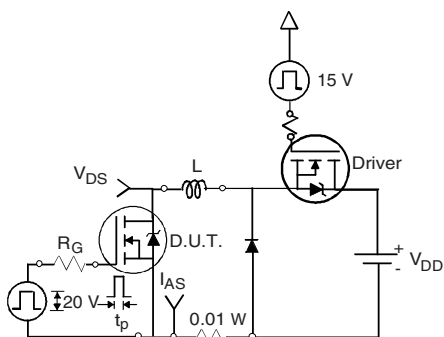
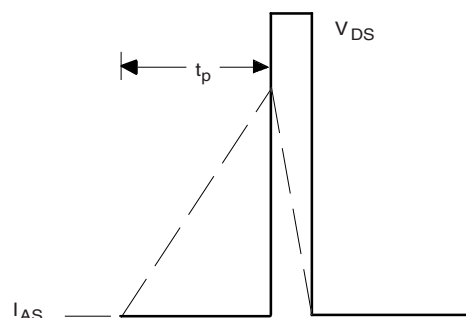
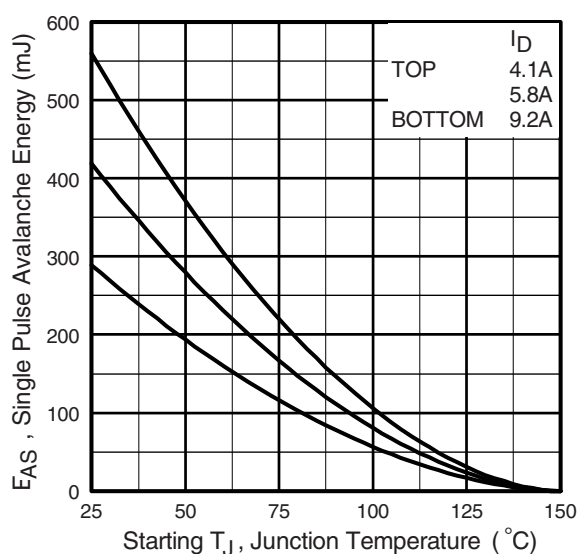
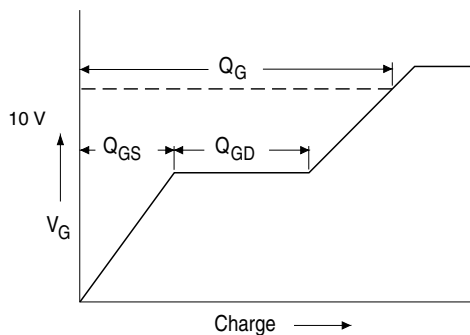
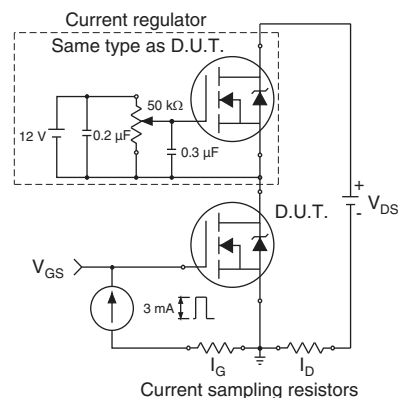
**Notes**

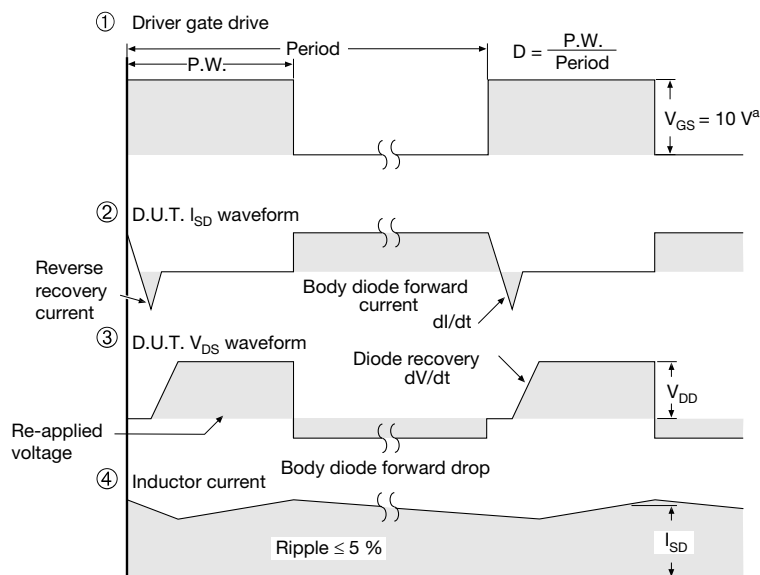
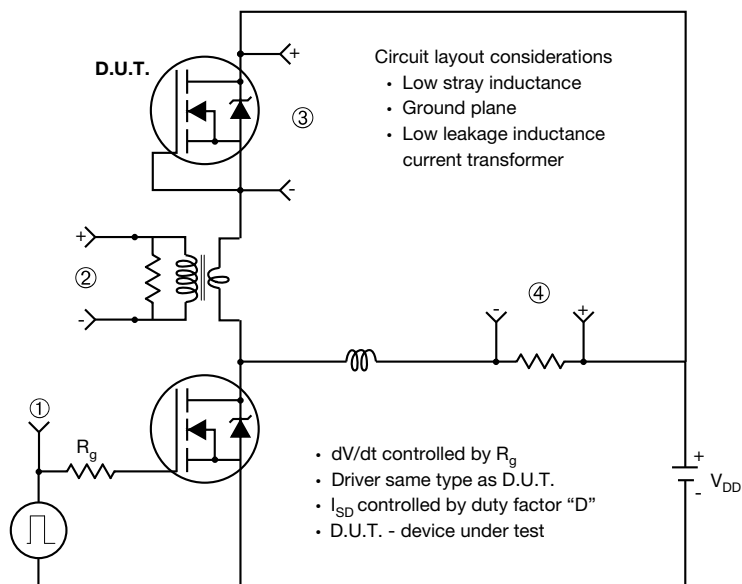
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\text{ }\%$
- $C_{oss}$  effective is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$

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

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

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