

Power MOSFET



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


 Available
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 |
| $R_{DS(on)}$ (Ω) | $V_{GS} = 10\text{ V}$ 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_{DS} | 600 | V | |
| Gate-source voltage | | V_{GS} | ± 30 | | |
| Continuous drain current | V_{GS} at 10 V | I_D | $T_C = 25\text{ }^\circ\text{C}$ | 9.2 | A |
| | | | $T_C = 100\text{ }^\circ\text{C}$ | 5.8 | |
| Pulsed drain current ^a | | I_{DM} | 37 | | |
| Linear derating factor | | | 1.3 | W/ $^\circ\text{C}$ | |
| Single pulse avalanche energy ^b | | E_{AS} | 290 | mJ | |
| Repetitive avalanche current ^a | | I_{AR} | 9.2 | A | |
| Repetitive avalanche energy ^a | | E_{AR} | 17 | mJ | |
| Maximum power dissipation | $T_C = 25\text{ }^\circ\text{C}$ | P_D | 170 | W | |
| Peak diode recovery dV/dt ^c | | 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) ^d | For 10 s | | 300 | | |
| 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)
- Starting $T_J = 25\text{ }^\circ\text{C}$, $L = 6.8\text{ mH}$, $R_g = 25\text{ }^\circ\Omega$, $I_{AS} = 9.2\text{ A}$ (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 |
| Static | | | | | | | |
| 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} | $V_{GS} = \pm 30\text{ V}$ | | - | - | ± 100 | nA |
| Zero gate voltage drain current | I_{DSS} | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$ | | - | - | 25 | μA |
| | | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | | - | - | 250 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$ | $I_D = 5.5\text{ A}^b$ | - | - | 0.75 | Ω |
| Forward transconductance | g_{fs} | $V_{DS} = 50\text{ V}, I_D = 5.5\text{ A}$ | | 5.5 | - | - | S |
| Dynamic | | | | | | | |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{ V},$ $V_{DS} = 25\text{ V},$ $f = 1.0\text{ MHz}$, see fig. 5 | | - | 1400 | - | pF |
| Output capacitance | C_{oss} | | | - | 180 | - | |
| Reverse transfer capacitance | C_{rss} | | | - | 7.1 | - | |
| Output capacitance | C_{oss} | $V_{GS} = 0\text{ V}$ | $V_{DS} = 1.0\text{ V}, f = 1.0\text{ MHz}$ | - | 1957 | - | pF |
| Effective output capacitance | $C_{oss\text{ eff.}}$ | | $V_{DS} = 480\text{ V}, f = 1.0\text{ MHz}$ | - | 49 | - | |
| Total gate charge | Q_g | $V_{GS} = 10\text{ V}$ | $I_D = 9.2\text{ A}, V_{DS} = 400\text{ V}$ see fig. 6 and 13 ^b | - | - | 49 | nC |
| Gate-source charge | Q_{gs} | | | - | - | 13 | |
| Gate-drain charge | Q_{gd} | | | - | - | 20 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 300\text{ V}, I_D = 9.2\text{ A}$ $R_g = 9.1\text{ }\Omega, R_D = 35.5\text{ }\Omega$, see fig. 10 ^b | | - | 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 | Ω |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous source-drain diode current | I_S | MOSFET symbol showing the integral reverse p-n junction diode  | | - | - | 9.2 | A |
| Pulsed diode forward current ^a | 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 | μC |
| 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 $\leq 2\%$
- 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)

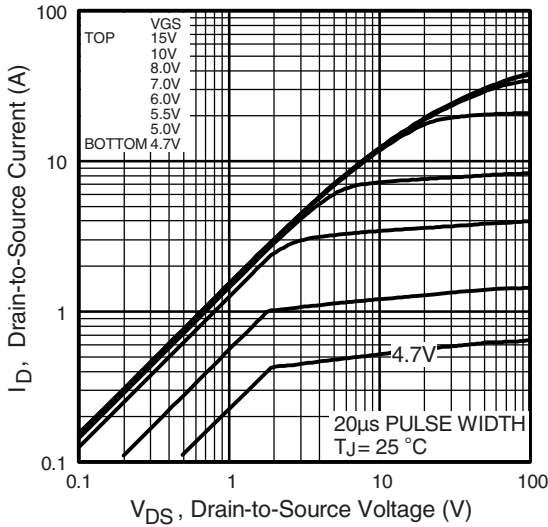


Fig. 1 - Typical Output Characteristics

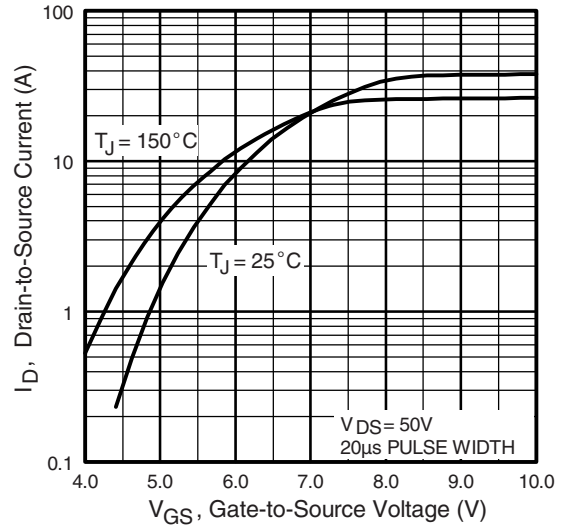


Fig. 3 - Typical Transfer Characteristics

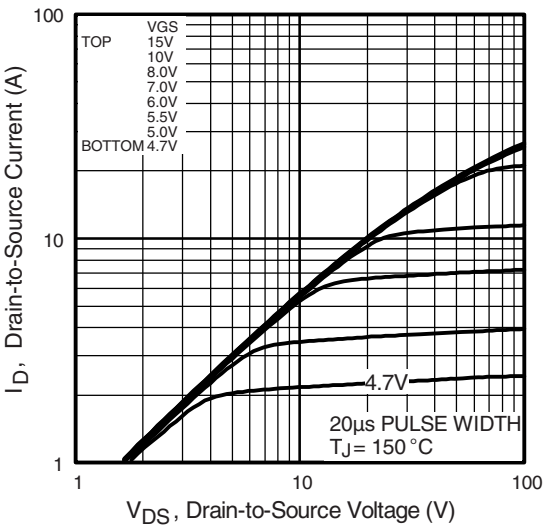


Fig. 2 - Typical Output Characteristics

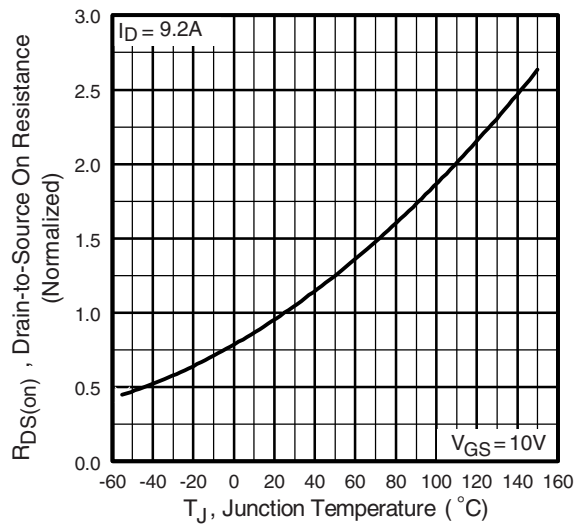


Fig. 4 - Normalized On-Resistance vs. Temperature

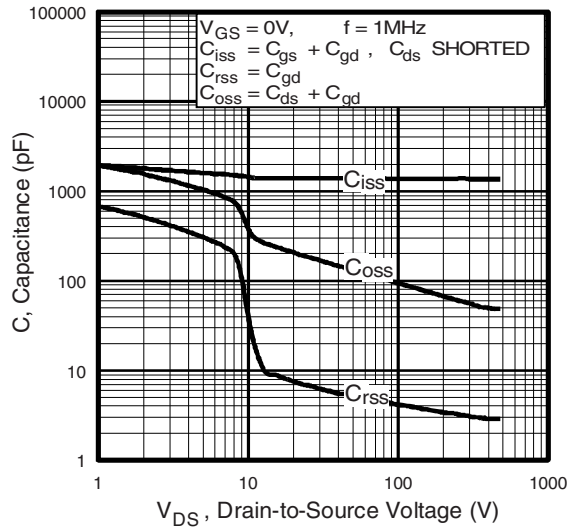


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

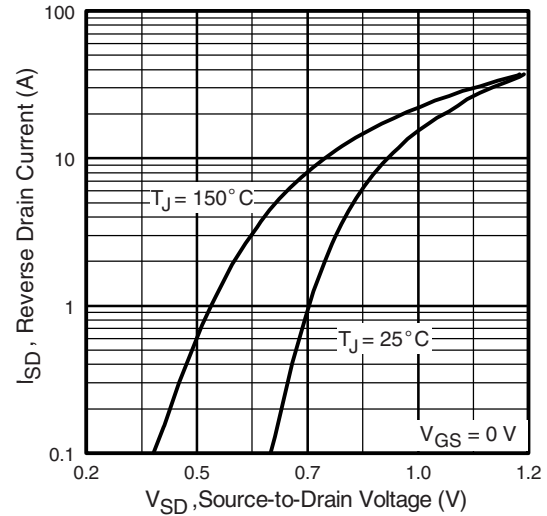


Fig. 7 - Typical Source-Drain Diode Forward Voltage

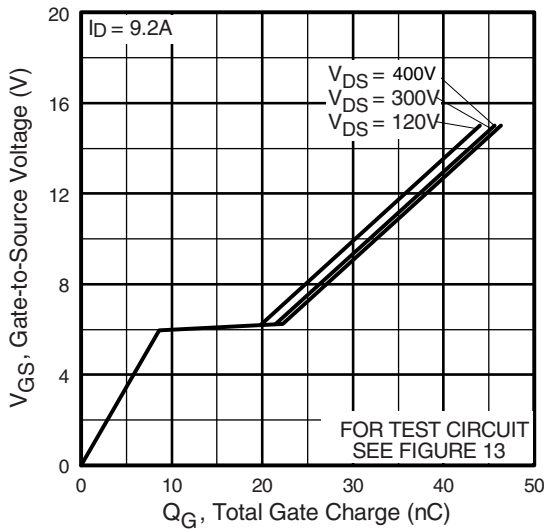


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

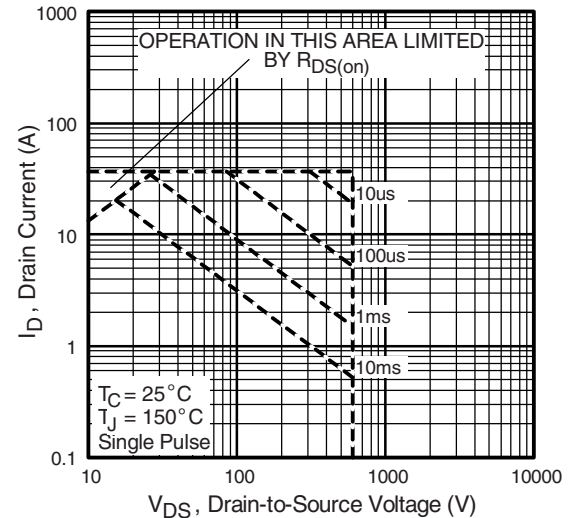


Fig. 8 - Maximum Safe Operating Area

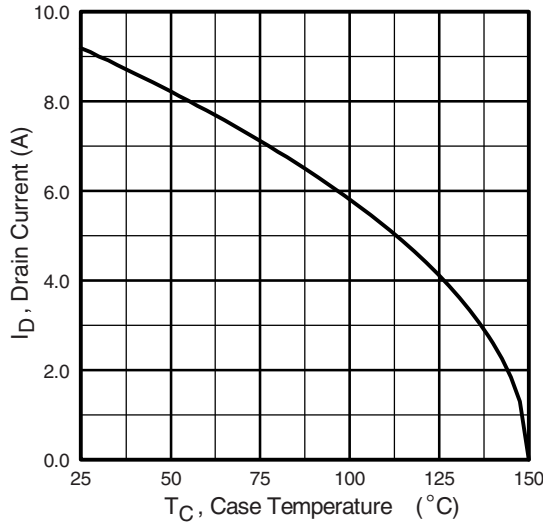


Fig. 9 - Maximum Drain Current vs. Case Temperature

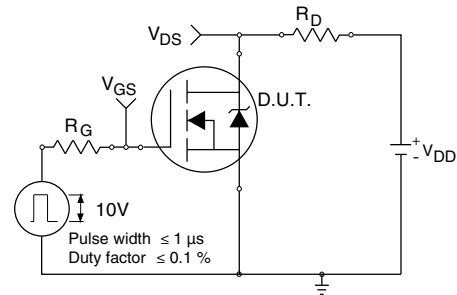


Fig. 10a - Switching Time Test Circuit

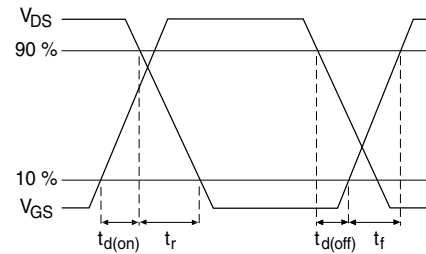


Fig. 10b - Switching Time Waveforms

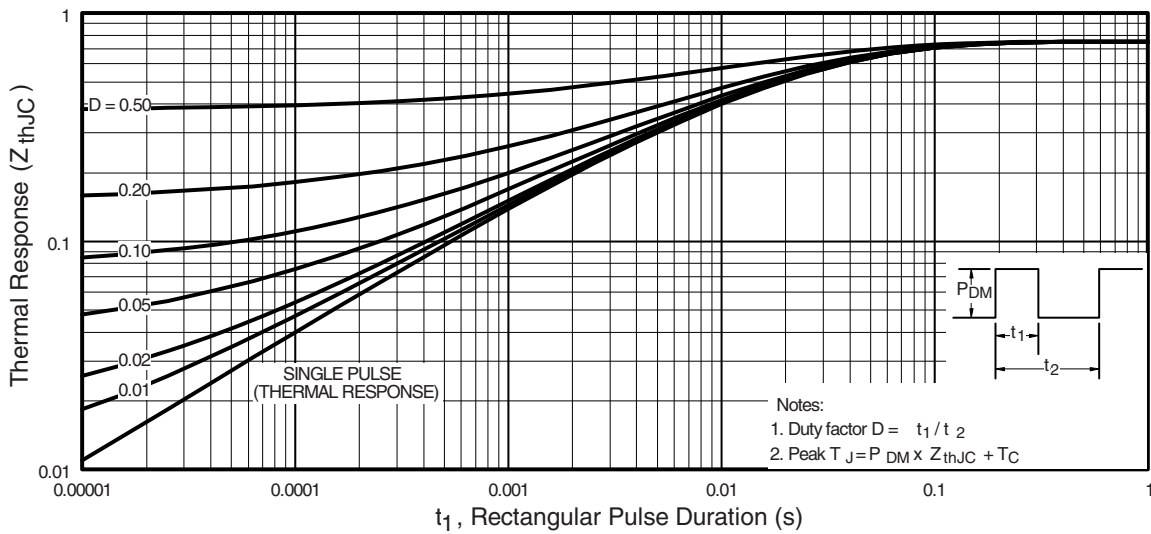


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

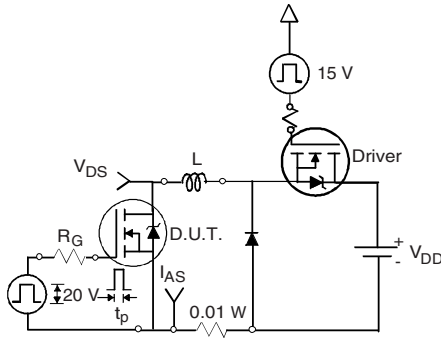


Fig. 12a - Unclamped Inductive Test Circuit

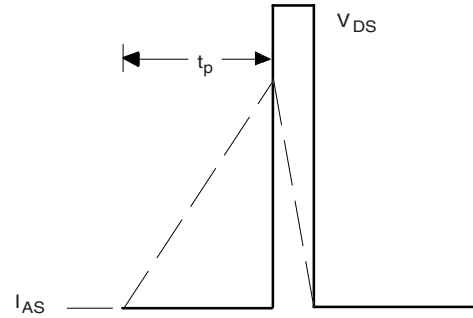


Fig. 12b - Unclamped Inductive Waveforms

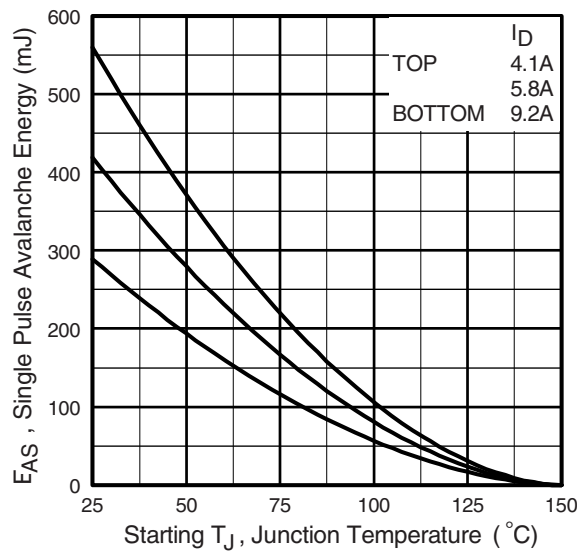


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

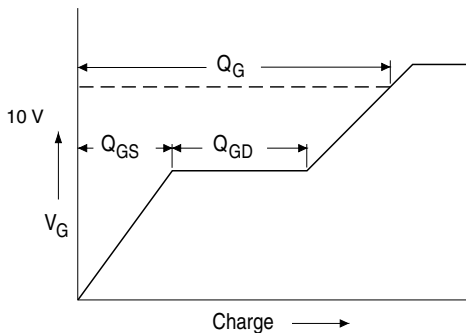


Fig. 13a - Basic Gate Charge Waveform

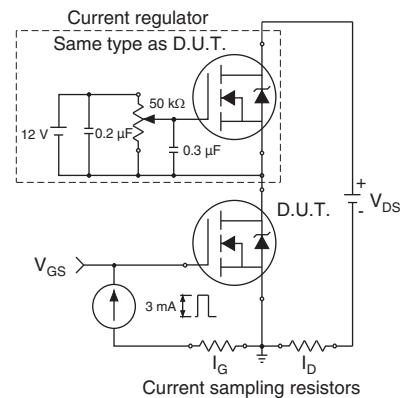
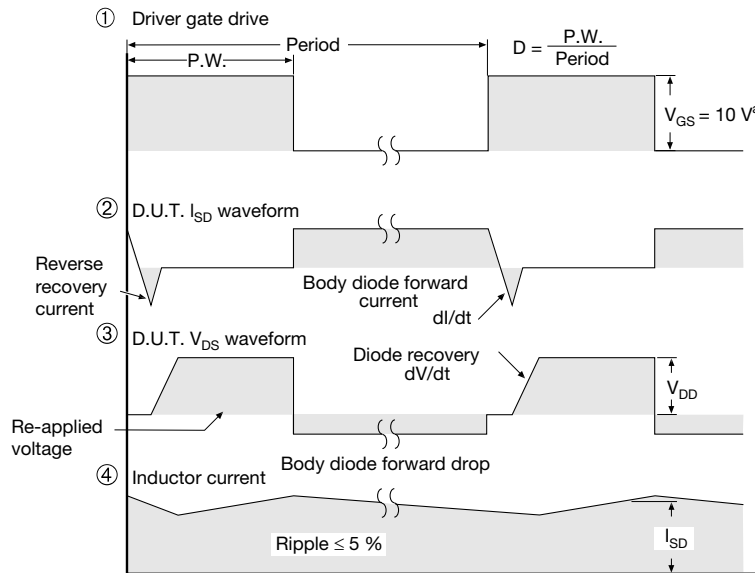
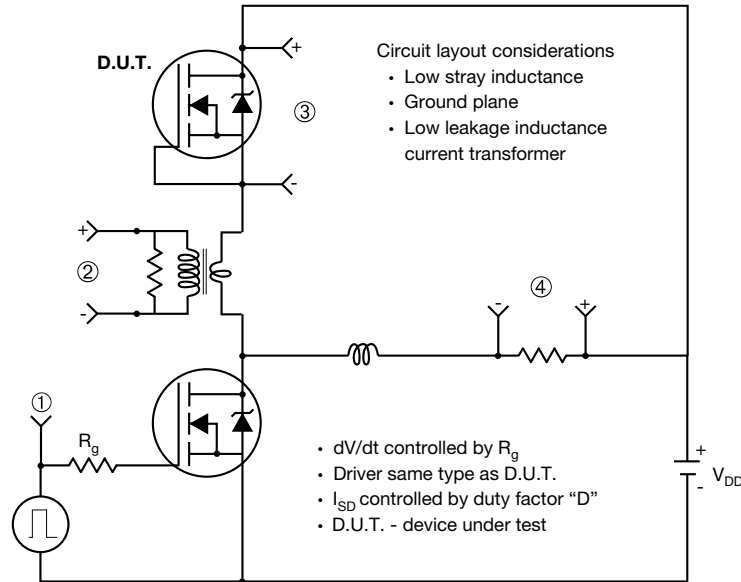


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



Note

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

Fig. 14 - For N-Channel

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