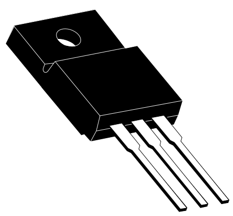
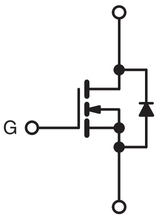
# Power MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) | 400 | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = 10 V | 1.8 |
| $Q_g$ (Max.) (nC) | 20 | |
| $Q_{gs}$ (nC) | 3.3 | |
| $Q_{gd}$ (nC) | 11 | |
| Configuration | Single | |

TO-220 FULLPAK



N-Channel MOSFET

## FEATURES

- Isolated package
- High voltage isolation = 2.5 $kV_{RMS}$ (t = 60 s; f = 60 Hz)
- Sink to lead creepage distance = 4.8 mm
- Dynamic dV/dt rating
- Low thermal resistance
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb Available
RoHS* Available

**Note**

* This datasheet provides information about parts that are RoHS-compliant and/or parts that are non-RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information/tables in this datasheet for details.

## DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220 FULLPAK eliminates the need for additional insulating hardware in commercial-industrial applications. The molding compound used provides a high isolation capability and a low thermal resistance between the tab and external heatsink. This isolation is equivalent to using a 100 micron mica barrier with standard TO-220 product. The FULLPAK is mounted to a heatsink using a single clip or by a single screw fixing.

| ORDERING INFORMATION | |
|---|---|
| Package | TO-220 FULLPAK |
| Lead (Pb)-free | IRFI720GPbF |
| | SiHFI720G-E3 |
| SnPb | IRFI720G |
| | SiHFI720G |

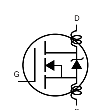
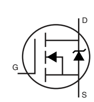
**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25 °C, unless otherwise noted)

| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DS}$ | 400 | V |
| Gate-Source Voltage | | | $V_{GS}$ | ± 20 | |
| Continuous Drain Current | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 2.6 | A |
| | | $T_C$ = 100 °C | | 1.7 | |
| Pulsed Drain Current [a] | | | $I_{DM}$ | 10 | |
| Linear Derating Factor | | | | 0.24 | W/°C |
| Single Pulse Avalanche Energy [b] | | | $E_{AS}$ | 150 | mJ |
| Repetitive Avalanche Current [a] | | | $I_{AR}$ | 2.6 | A |
| Repetitive Avalanche Energy [a] | | | $E_{AR}$ | 3.0 | mJ |
| Maximum Power Dissipation | $T_C$ = 25 °C | | $P_D$ | 30 | W |
| Peak Diode Recovery dV/dt [c] | | | dV/dt | 4.0 | V/ns |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | -55 to +150 | °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**

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. $V_{DD}$ = 50 V, starting $T_J$ = 25 °C, L = 38 mH, $R_G$ = 25 Ω, $I_{AS}$ = 2.6 A (see fig. 12).
c. $I_{SD} \leq$ 3.3 A, dI/dt $\leq$ 65 A/μs, $V_{DD} \leq V_{DS}$, $T_J \leq$ 150 °C.
d. 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) | $R_{thJC}$ | - | 4.1 | |

| **SPECIFICATIONS** ($T_J$ = 25 °C, unless otherwise noted) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Static** | | | | | | | |
| Drain-Source Breakdown Voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 μA | | 400 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | | - | 0.51 | - | V/°C |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | | 2.0 | - | 4.0 | V |
| Gate-Source Leakage | $I_{GSS}$ | $V_{GS}$ = ± 20 V | | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | | - | - | 25 | μA |
| | | $V_{DS}$ = 320 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | | - | - | 250 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V | $I_D$ = 1.6 A [b] | - | - | 1.8 | Ω |
| Forward Transconductance | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 1.6 A [b] | | 1.5 | - | - | S |
| **Dynamic** | | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1.0 MHz, see fig. 5 | | - | 410 | - | pF |
| Output Capacitance | $C_{oss}$ | | | - | 120 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | | - | 47 | - | |
| Drain to Sink Capacitance | C | f = 1.0 MHz | | - | 12 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = 10 V | $I_D$ = 3.3 A, $V_{DS}$ = 320 V, see fig. 6 and 13 [b] | - | - | 20 | nC |
| Gate-Source Charge | $Q_{gs}$ | | | - | - | 3.3 | |
| Gate-Drain Charge | $Q_{gd}$ | | | - | - | 11 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 200 V, $I_D$ = 3.3 A, $R_G$ = 18 Ω, $R_D$= 56 Ω, see fig. 10 [b] | | - | 10 | - | ns |
| Rise Time | $t_r$ | | | - | 14 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | - | 30 | - | |
| Fall Time | $t_f$ | | | - | 13 | - | |
| 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 | - | |
| **Drain-Source Body Diode Characteristics** | | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode |  | - | - | 2.6 | A |
| Pulsed Diode Forward Current[a] | $I_{SM}$ | | | - | - | 10 | |
| Body Diode Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 2.6 A, $V_{GS}$ = 0 V [b] | | - | - | 1.6 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 3.3 A, dI/dt = 100 A/μs [b] | | - | 300 | 600 | ns |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | | | - | 1.5 | 3.0 | μC |
| 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 ≤ 300 μs; duty cycle ≤ 2 %.

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

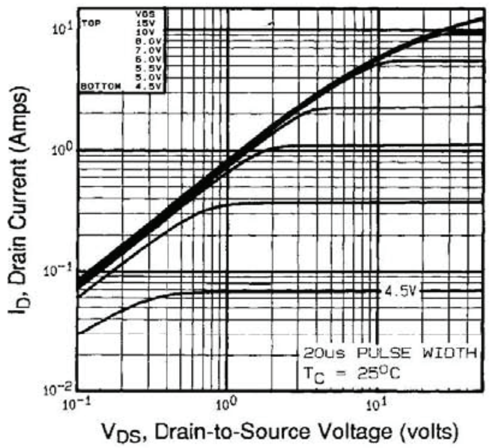



**Fig. 1 - Typical Output Characteristics, $T_C$ = 25 °C**

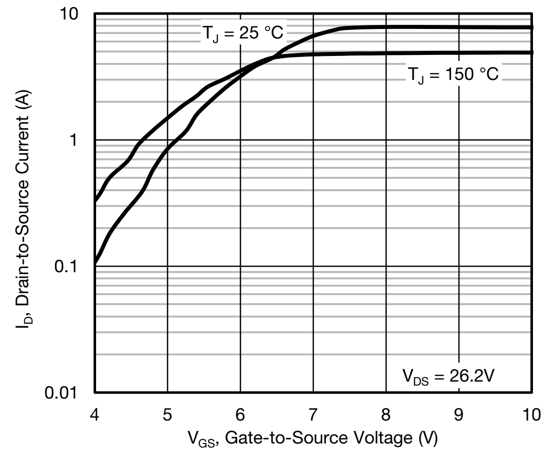



**Fig. 3 - Typical Transfer Characteristics**

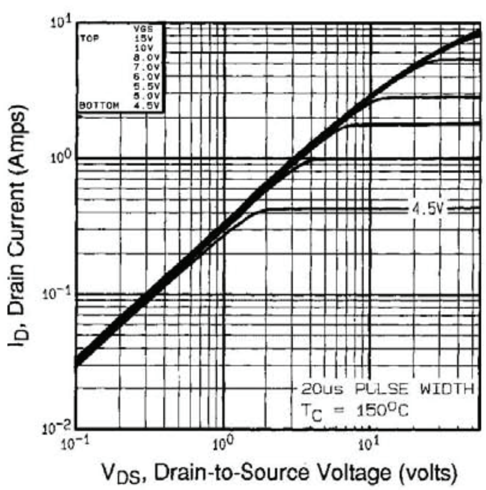



**Fig. 2 - Typical Output Characteristics, $T_C$ = 150 °C**

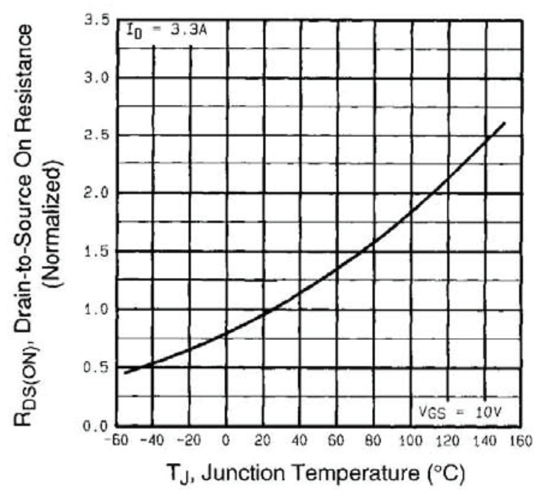



**Fig. 4 - Normalized On-Resistance vs. Temperature**

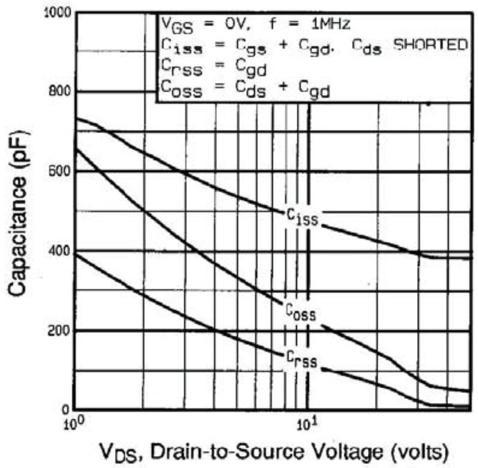



Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

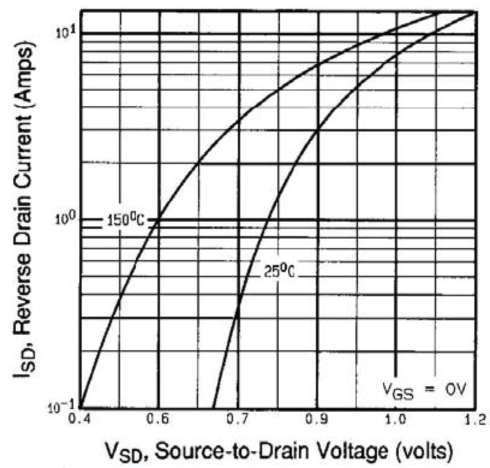



Fig. 7 - Typical Source-Drain Diode Forward Voltage

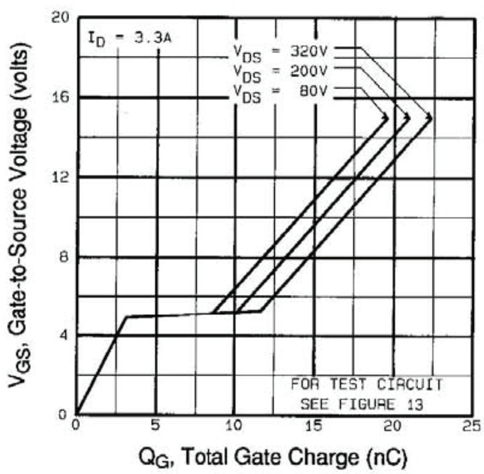



Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

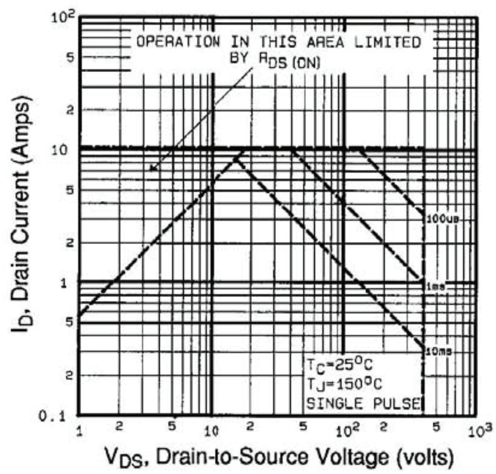



Fig. 8 - Maximum Safe Operating Area

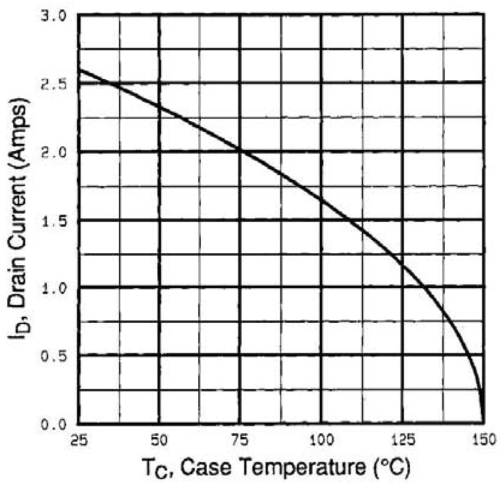



Fig. 9 - Maximum Drain Current vs. Case Temperature

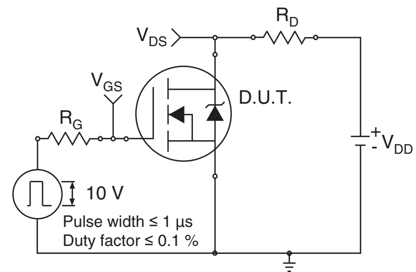



Fig. 10a - Switching Time Test Circuit

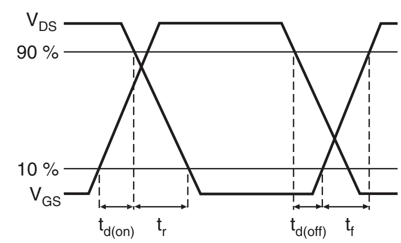



Fig. 10b - Switching Time Waveforms

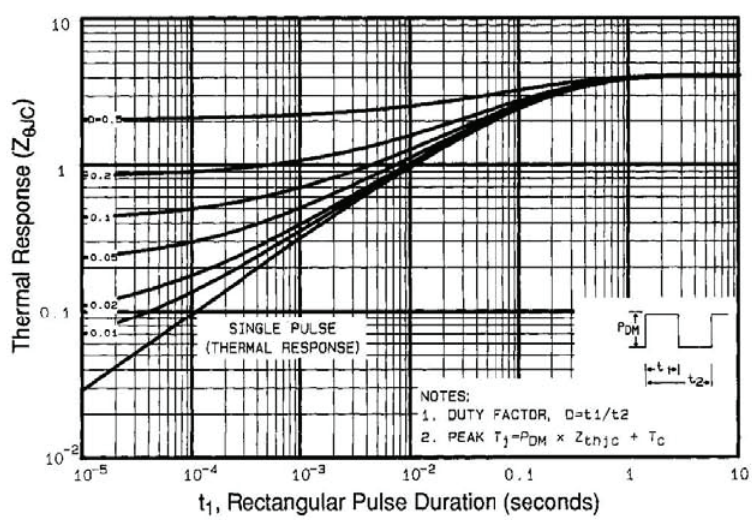



Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

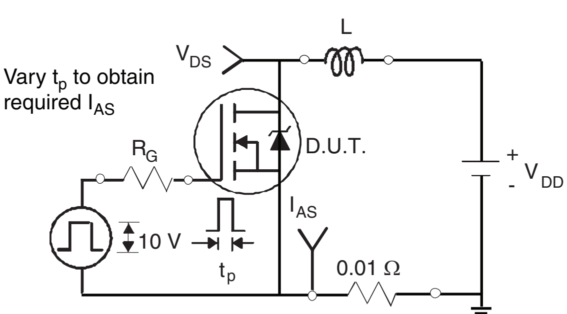



Fig. 12a - Unclamped Inductive Test Circuit

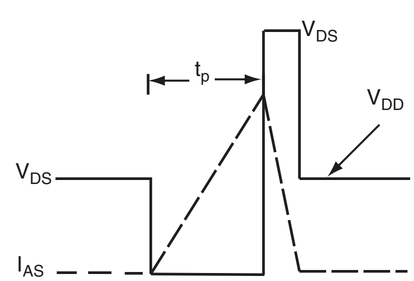



Fig. 12b - Unclamped Inductive Waveforms

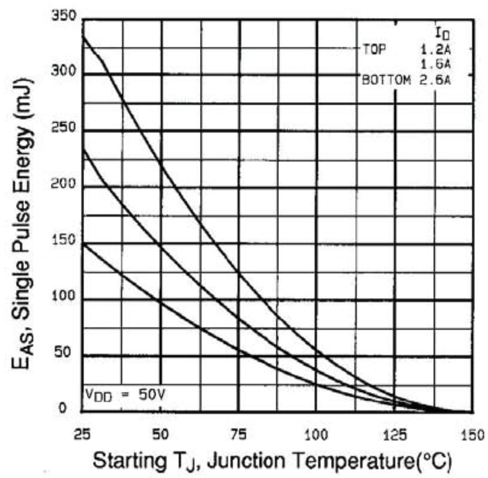



**Fig. 12c - Maximum Avalanche Energy vs. Drain Current**

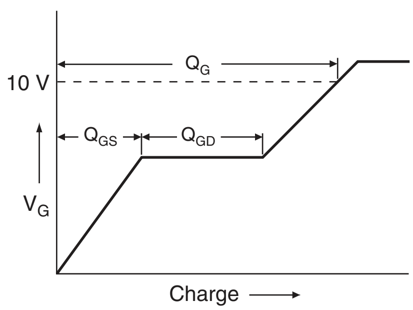



**Fig. 13a - Basic Gate Charge Waveform**

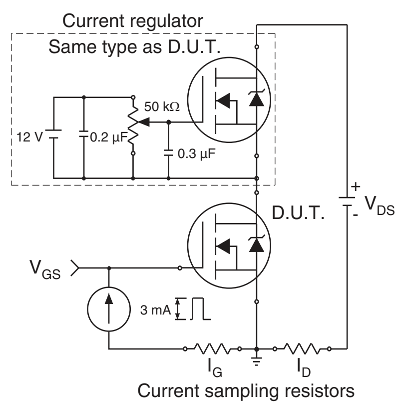
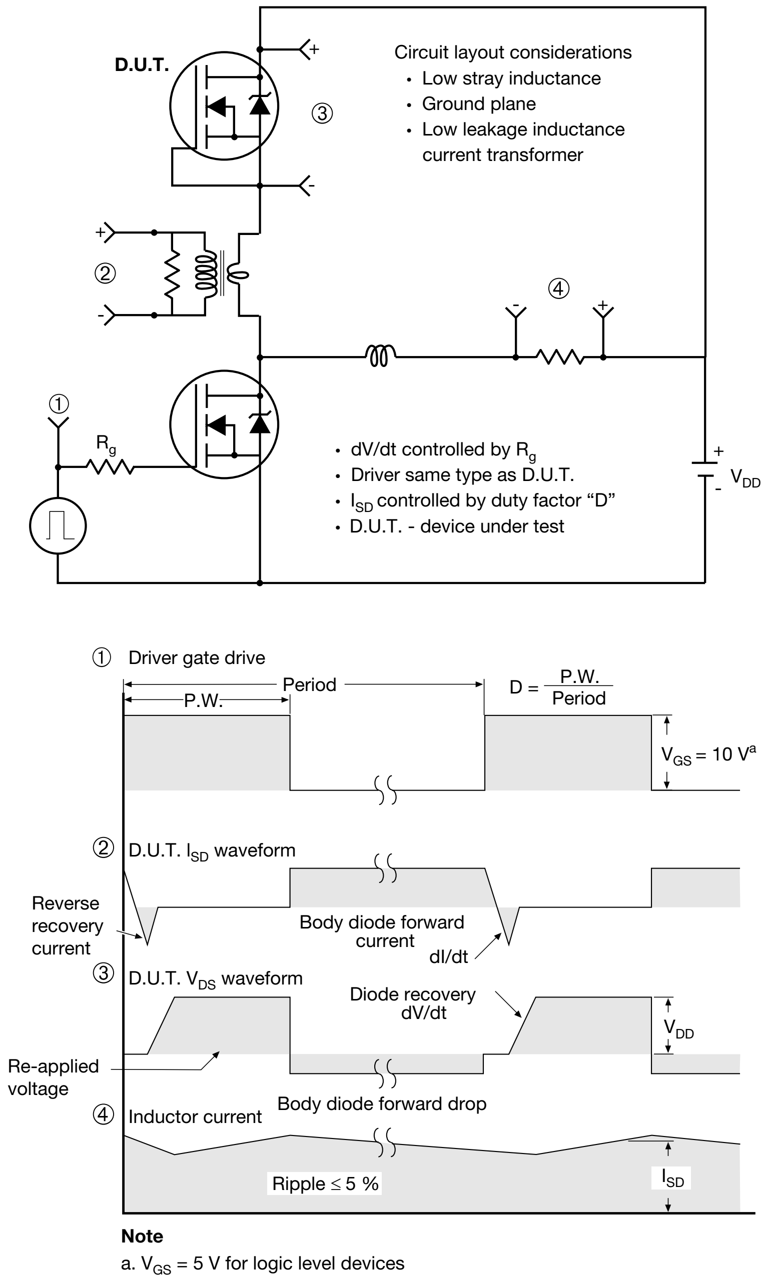



**Fig. 13b - Gate Charge Test Circuit**

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




**Note**

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

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

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