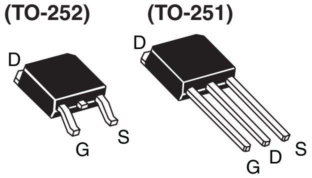
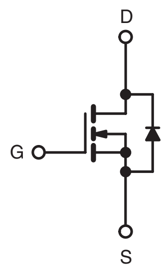
# Power MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) | 250 | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = 10 V | 1.1 |
| $Q_g$ (Max.) (nC) | 14 | |
| $Q_{gs}$ (nC) | 2.7 | |
| $Q_{gd}$ (nC) | 7.8 | |
| Configuration | Single | |

**DPAK (TO-252)** **IPAK (TO-251)**




N-Channel MOSFET

## FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- Surface Mount (IRFR224, SiHFR224)
- Straight Lead (IRFU224, SiHFU224)
- Available in Tape and Reel
- Fast Switching
- Ease of Paralleling
- Compliant to RoHS Directive 2002/95/EC

Pb Available
RoHS* COMPLIANT
HALOGEN FREE Available

## DESCRIPTION

Third generation Power MOSFETs form Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.
The DPAK is designed for surface mounting using vapor phase, infrared, or wave solderig techniques. The straight lead version (IRFU, SiHFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 W are possible in typical surface mount applications.

| ORDERING INFORMATION | | | | |
|---|---|---|---|---|
| Package | DPAK (TO-252) | DPAK (TO-252) | DPAK (TO-252) | IPAK (TO-251) |
| Lead (Pb)-free and Halogen-free | SiHFR224-GE3 | SiHFR224TR-GE3 | SiHFR224TRL-GE3 | SiHFU224-GE3 |
| Lead (Pb)-free | IRFR224PbF | IRFR224TRPbF[a] | IRFR224TRLPbF[a] | IRFU224PbF |
| | SiHFR224-E3 | SiHFR224T-E3[a] | SiHFR224TL-E3[a] | SiHFU224-E3 |
| SnPb | IRFR224 | IRFR224TR[a] | IRFR224TRL[a] | IRFU224 |
| | SiHFR224 | SiHFR224T[a] | SiHFR224TL[a] | SiHFU224 |

**Note**
a. See device orientation.

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

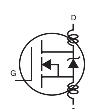
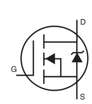
| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DS}$ | 250 | V |
| Gate-Source Voltage | | | $V_{GS}$ | ± 20 | |
| Continuous Drain Current | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 3.8 | A |
| | | $T_C$ = 100 °C | | 2.4 | |
| Pulsed Drain Current[a] | | | $I_{DM}$ | 15 | |
| Linear Derating Factor | | | | 0.33 | W/°C |
| Linear Derating Factor (PCB Mount)[e] | | | | 0.020 | |
| Single Pulse Avalanche Energy[b] | | | $E_{AS}$ | 130 | mJ |
| Repetitive Avalanche Current[a] | | | $I_{AR}$ | 3.8 | A |
| Repetitive Avalanche Energy[a] | | | $E_{AR}$ | 4.2 | mJ |
| Maximum Power Dissipation | $T_C$ = 25 °C | | $P_D$ | 42 | W |
| Maximum Power Dissipation (PCB Mount)[e] | $T_A$ = 25 °C | | | 2.5 | |
| Peak Diode Recovery dV/dt[c] | | | dV/dt | 4.8 | V/ns |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | - 55 to + 150 | °C |
| Soldering Recommendations (Peak Temperature) | for 10 s | | | 260[d] | |

**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 = 14 mH, $R_g$ = 25 Ω, $I_{AS}$ = 3.8 A (see fig. 12).
c. $I_{SD} \leq$ 3.8 A, dI/dt $\leq$ 90 A/μs, $V_{DD} \leq V_{DS}$, $T_J \leq$ 150 °C.
d. 1.6 mm from case.
e. When mounted on 1" square PCB (FR-4 or G-10 material).

* Pb containing terminations are not RoHS compliant, exemptions may apply

| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient (PCB Mount)[a] | $R_{thJA}$ | - | 50 | °C/W |
| Maximum Junction-to-Ambient | $R_{thJA}$ | - | 110 | |
| Maximum Junction-to-Case | $R_{thJC}$ | - | 3.0 | |

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

| **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 | 250 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 0.36 | - | 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 | $I_{DSS}$ | $V_{DS}$ = 250 V, $V_{GS}$ = 0 V | - | - | 25 | μA |
| | | $V_{DS}$ = 200 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 250 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V; $I_D$ = 2.3 A[b] | - | - | 1.1 | Ω |
| Forward Transconductance | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 2.3 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[c] | - | 260 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 77 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | - | 15 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = 10 V; $I_D$ = 4.4 A, $V_{DS}$ = 200 V, see fig. 6 and 13[b, c] | - | - | 14 | nC |
| Gate-Source Charge | $Q_{gs}$ | | - | - | 2.7 | |
| Gate-Drain Charge | $Q_{gd}$ | | - | - | 7.8 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 125 V, $I_D$ = 4.4 A, $R_G$ = 18 Ω, $R_D$ = 28 Ω, see fig. 10[b, c] | - | 7.0 | - | ns |
| Rise Time | $t_r$ | | - | 13 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 20 | - | |
| Fall Time | $t_f$ | | - | 12 | - | |
| 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  | - | - | 3.8 | A |
| Pulsed Diode Forward Current[a] | $I_{SM}$ | | - | - | 15 | |
| Body Diode Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 3.8 A, $V_{GS}$ = 0 V[b] | - | - | 1.8 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 4.4 A, dI/dt = 100 A/μs[b] | - | 200 | 400 | ns |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | | - | 0.93 | 1.9 | 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

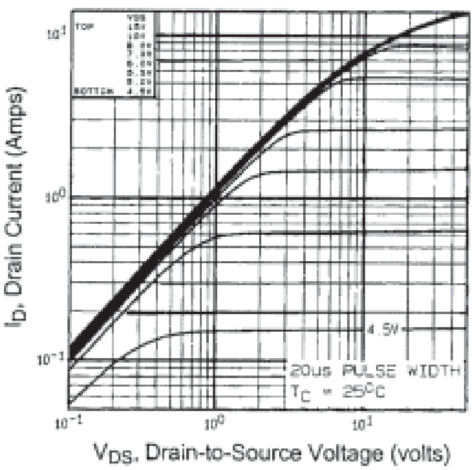



**Fig. 1 - Typical Output Characteristics, $T_C$ = 25 °C**

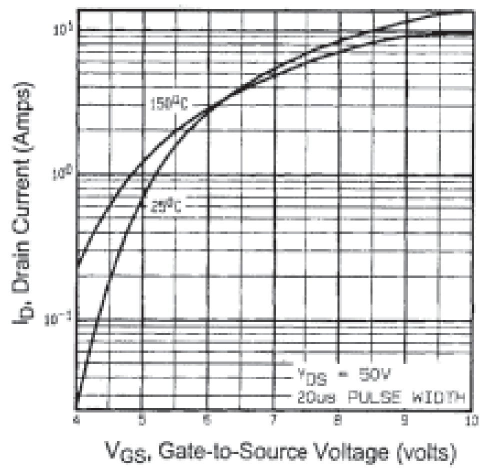



**Fig. 3 - Typical Transfer Characteristics**

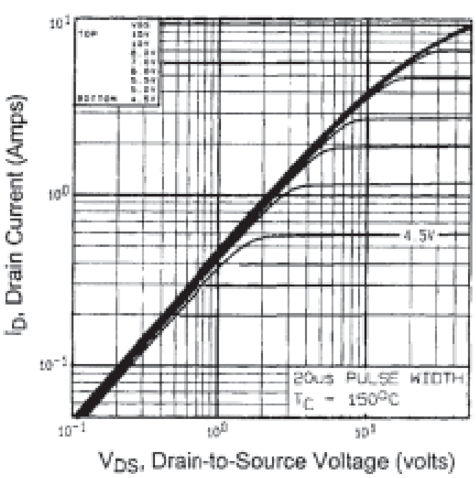



**Fig. 2 - Typical Output Characteristics, $T_C$ = 150 °C**

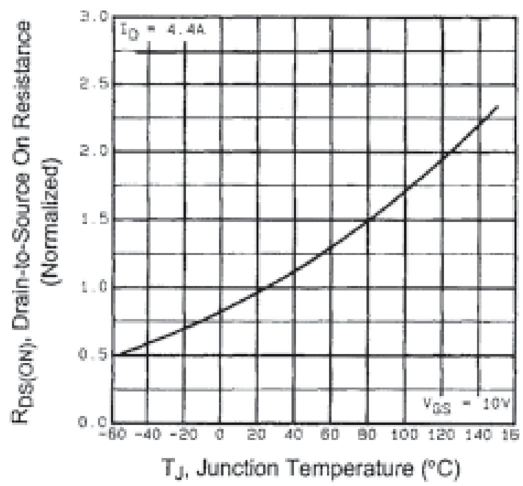



**Fig. 4 - Normalized On-Resistance vs. Temperature**

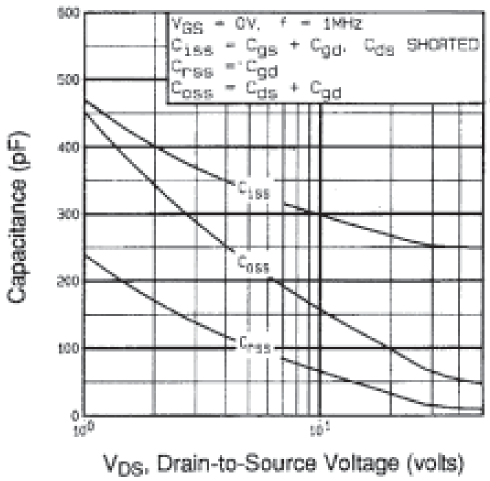



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

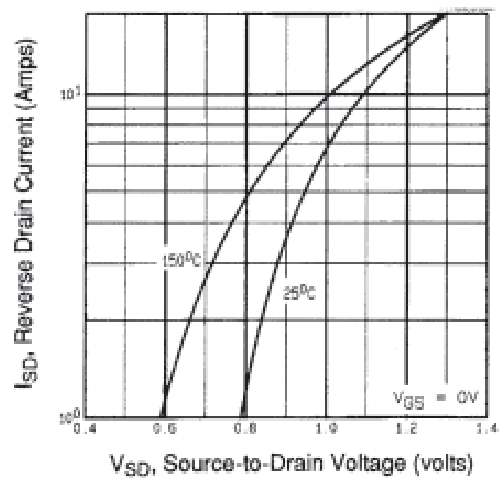



**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

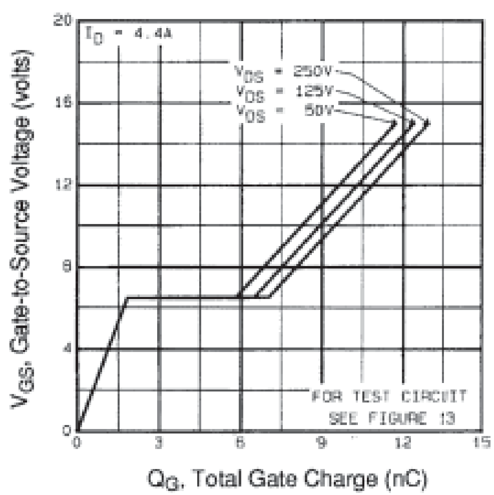



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

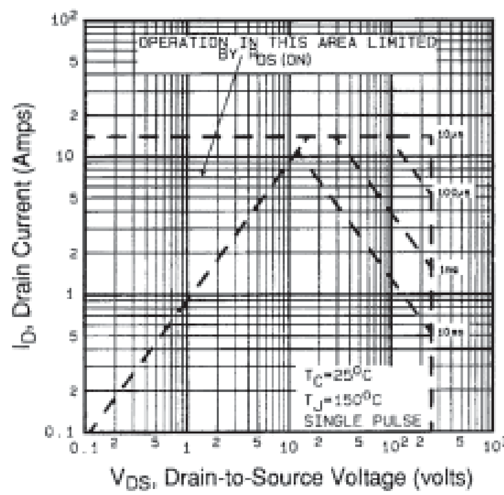



**Fig. 8 - Maximum Safe Operating Area**



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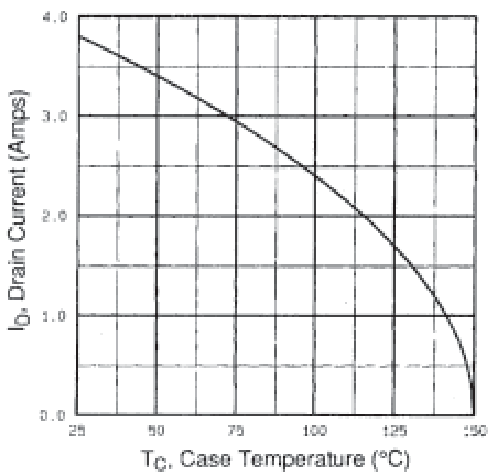



Fig. 9 - Maximum Drain Current vs. Case Temperature

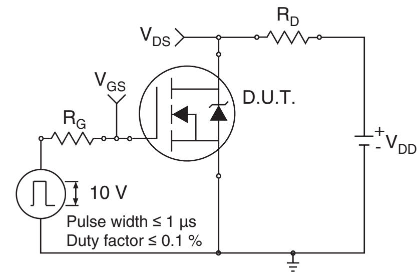



Fig. 10a - Switching Time Test Circuit

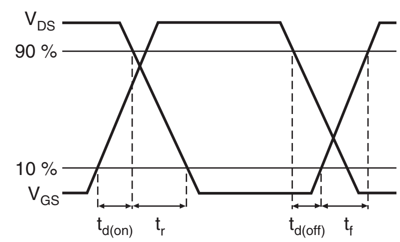



Fig. 10b - Switching Time Waveforms

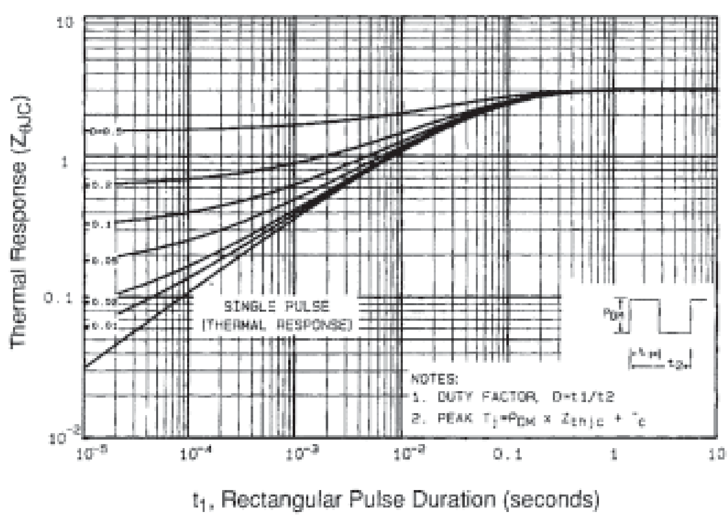



Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

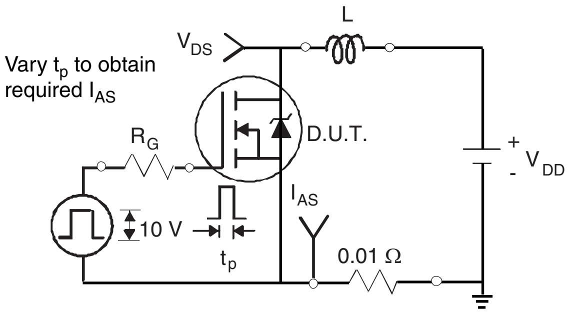



Fig. 12a - Unclamped Inductive Test Circuit

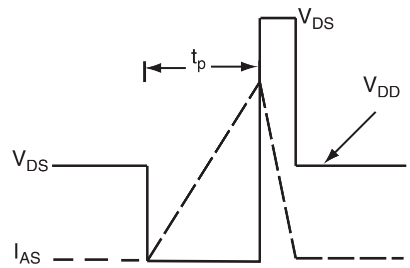



Fig. 12b - Unclamped Inductive Waveforms

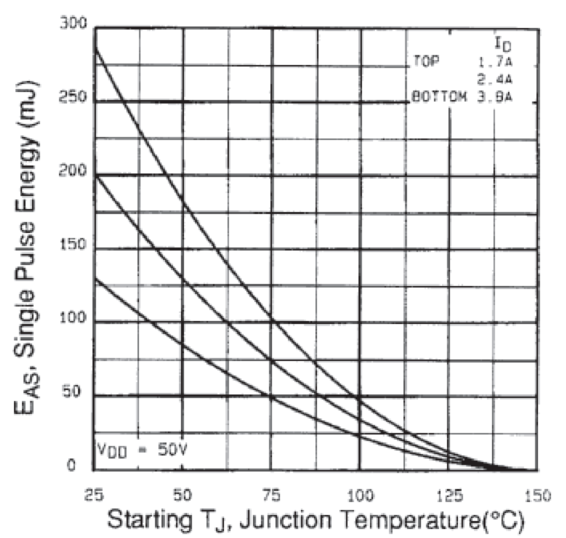



Fig. 12c - Maximum Avalanche Energy vs. Drain Current

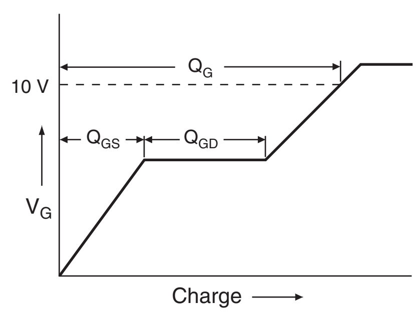



Fig. 13a - Basic Gate Charge Waveform

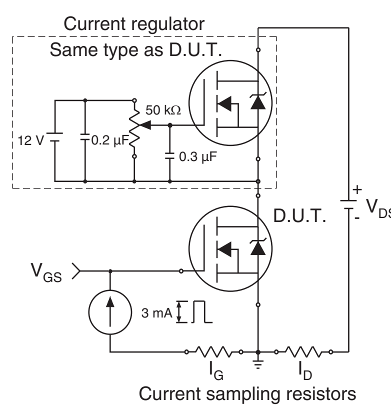
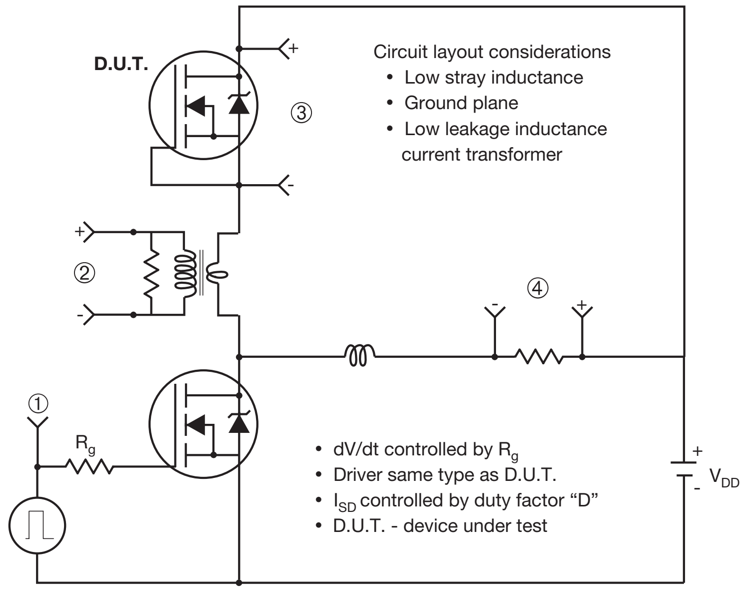
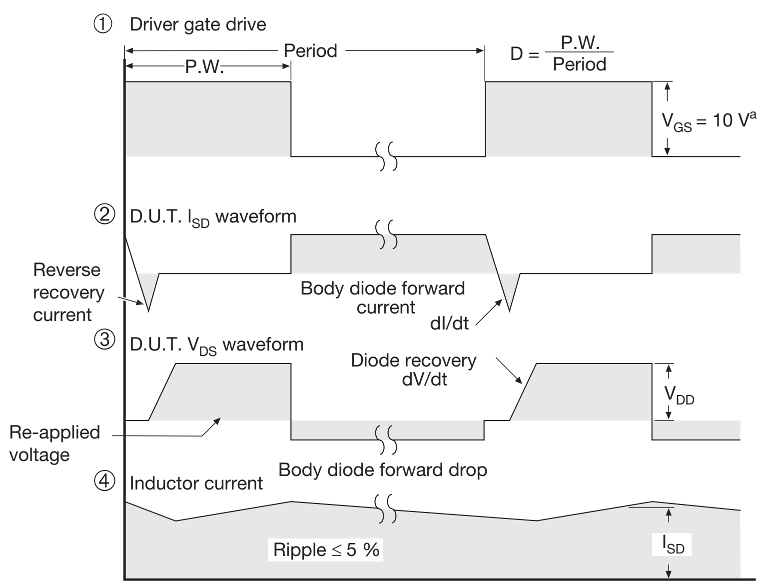



Fig. 13b - Gate Charge Test Circuit

**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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