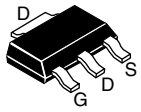
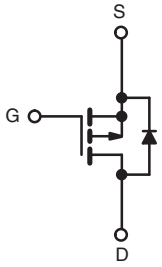
## Power MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) | -60 | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = -10 V | 0.50 |
| $Q_g$ (Max.) (nC) | 12 | |
| $Q_{gs}$ (nC) | 3.8 | |
| $Q_{gd}$ (nC) | 5.1 | |
| Configuration | Single | |

SOT-223




Marking code: FE




P-Channel MOSFET

### FEATURES

- Surface mount
- Available in tape and reel
- Dynamic dV/dt rating
- Repetitive avalanche rated
- P-channel
- Fast switching
- Ease of paralleling
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT
HALOGEN FREE Available

### 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 SOT-223 package is designed for surface-mounting using vapor phase, infrared, or wave soldering techniques. Its unique package design allows for easy automatic pick-and-place as with other SOT or SOIC packages but has the added advantage of improved thermal performance due to an enlarged tab for heatsinking. Power dissipation of greater than 1.25 W is possible in a typical surface mount application.

| ORDERING INFORMATION | | |
|---|---|---|
| Package | SOT-223 | SOT-223 |
| Lead (Pb)-free and Halogen-free | SiHFL9014-GE3 | SiHFL9014TR-GE3 |
| Lead (Pb)-free | IRFL9014PbF | IRFL9014TRPbF [a] |
| | SiHFL9014-E3 | SiHFL9014T-E3 [a] |

**Note**

a. See device orientation.

| ABSOLUTE MAXIMUM RATINGS ($T_C$ = 25 °C, unless otherwise noted) | | | | | |
|---|---|---|---|---|---|
| **PARAMETER** | | | **SYMBOL** | **LIMIT** | **UNIT** |
| Drain-Source Voltage | | | $V_{DS}$ | -60 | V |
| Gate-Source Voltage | | | $V_{GS}$ | ± 20 | |
| Continuous Drain Current | $V_{GS}$ at - 10 V | $T_C$ = 25 °C | $I_D$ | -1.8 | A |
| | | $T_C$ = 100 °C | | -1.1 | |
| Pulsed Drain Current [a] | | | $I_{DM}$ | -14 | |
| Linear Derating Factor | | | | 0.025 | W/°C |
| Linear Derating Factor (PCB Mount) [e] | | | | 0.017 | |
| Single Pulse Avalanche Energy [b] | | | $E_{AS}$ | 140 | mJ |
| Repetitive Avalanche Current [a] | | | $I_{AR}$ | -1.8 | A |
| Repetitive Avalanche Energy [a] | | | $E_{AR}$ | 0.31 | mJ |
| Maximum Power Dissipation | $T_C$ = 25 °C | | $P_D$ | 3.1 | W |
| Maximum Power Dissipation (PCB Mount) [e] | $T_A$ = 25 °C | | | 2.0 | |
| Peak Diode Recovery dV/dt [c] | | | dV/dt | -4.5 | 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 | |

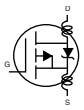
**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. $V_{DD}$ = - 25 V, starting $T_J$ = 25 °C, L = 50 mH, $R_g$ = 25 Ω, $I_{AS}$ = - 1.8 A (see fig. 12).
c. $I_{SD} \leq$ - 6.7 A, dI/dt ≤ 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).

| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TYP.** | **MAX.** | **UNIT** |
| Maximum Junction-to-Ambient (PCB Mount) [a] | $R_{thJA}$ | - | 60 | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | - | 40 | |

**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 | -60 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | -0.059 | - | 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 | $I_{DSS}$ | $V_{DS}$ = -60 V, $V_{GS}$ = 0 V | - | - | - 100 | µA |
| | | $V_{DS}$ = -48 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | -500 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS}$ = -10 V, $I_D$ = 1.1 A [b] | - | - | 0.50 | Ω |
| Forward Transconductance | $g_{fs}$ | $V_{DS}$ = - 25 V, $I_D$ = 1.1 A [b] | 1.3 | - | - | S |
| **Dynamic** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1.0 MHz, see fig. 5 | - | 270 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 170 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | - | 31 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = - 10 V, $I_D$ = - 6.7 A, $V_{DS}$ = - 48 V, see fig. 6 and 13 [b] | - | - | 12 | nC |
| Gate-Source Charge | $Q_{gs}$ | | - | - | 3.8 | |
| Gate-Drain Charge | $Q_{gd}$ | | - | - | 5.1 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = - 30 V, $I_D$ = - 6.7 A, $R_g$ = 24 Ω, $R_D$ = 4.0 Ω, see fig. 10 [b] | - | 11 | - | ns |
| Rise Time | $t_r$ | | - | 63 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 9.6 | - | |
| Fall Time | $t_f$ | | - | 31 | - | |
| Internal Drain Inductance | $L_D$ | Between lead, 6 mm (0.25") from package and center of die contact  | - | 4.0 | - | nH |
| Internal Source Inductance | $L_S$ | | - | 6.0 | - | |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | - 1.8 | A |
| Pulsed Diode Forward Current [a] | $I_{SM}$ | | - | - | - 14 | |
| Body Diode Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = - 1.8 A, $V_{GS}$ = 0 V [b] | - | - | - 5.5 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = - 6.7 A, dI/dt = 100 A/µs [b] | - | 80 | 160 | ns |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | | - | 0.096 | 0.19 | 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)

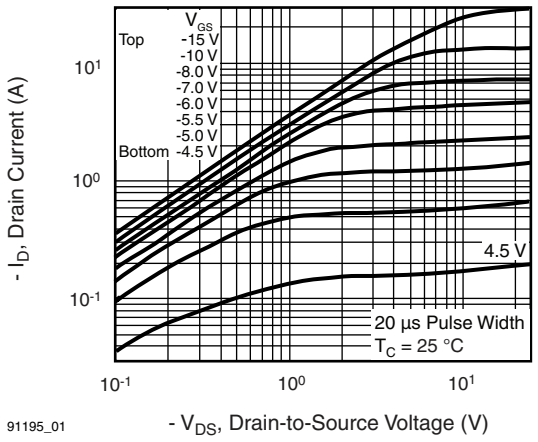



**Fig. 1 - Typical Output Characteristics, $T_C$ = 25 °C**

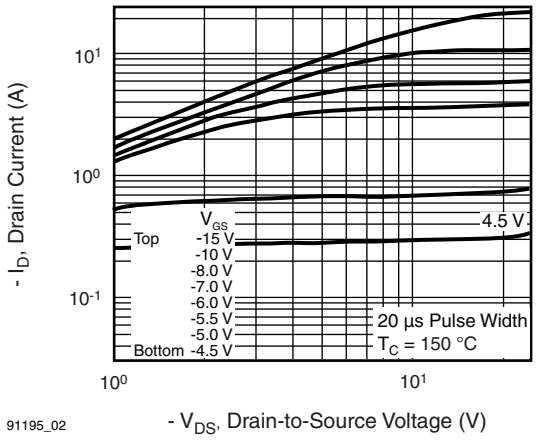



**Fig. 2 - Typical Output Characteristics, $T_C$ = 150 °C**

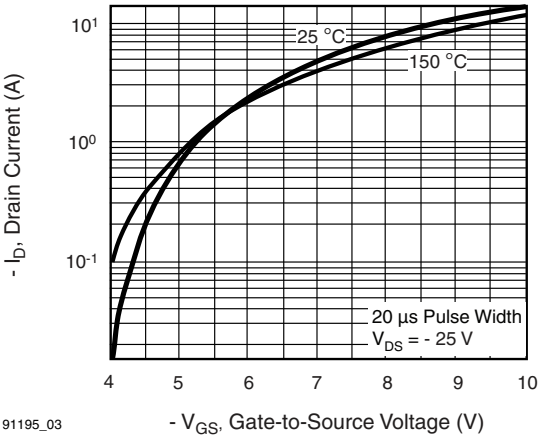



**Fig. 3 - Typical Transfer Characteristics**

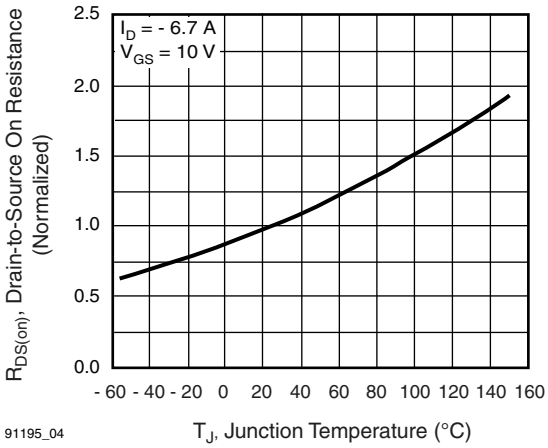



**Fig. 4 - Normalized On-Resistance vs. Temperature**

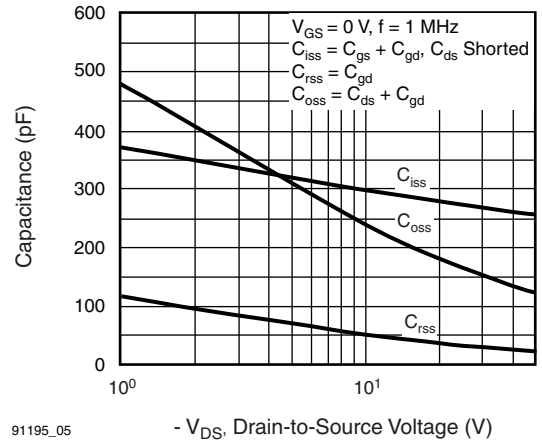



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

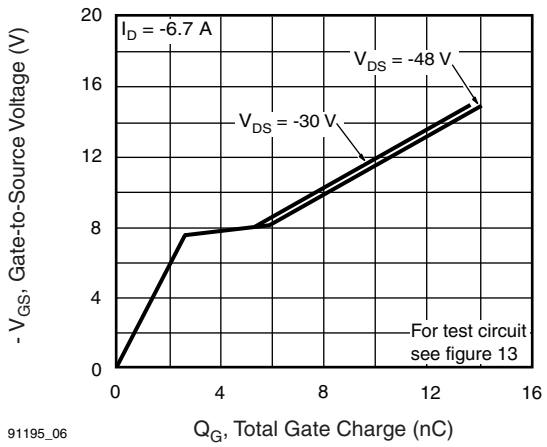



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

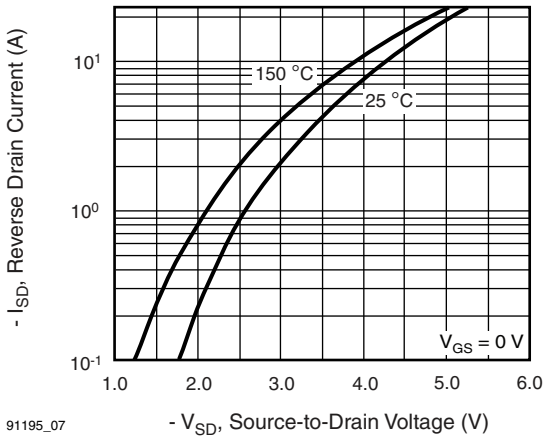



**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

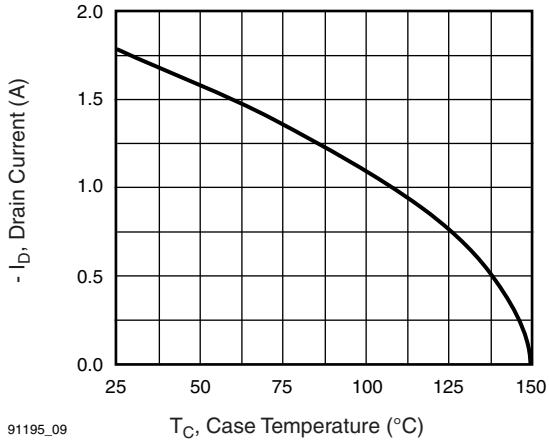



**Fig. 9 - Maximum Drain Current vs. Case Temperature**

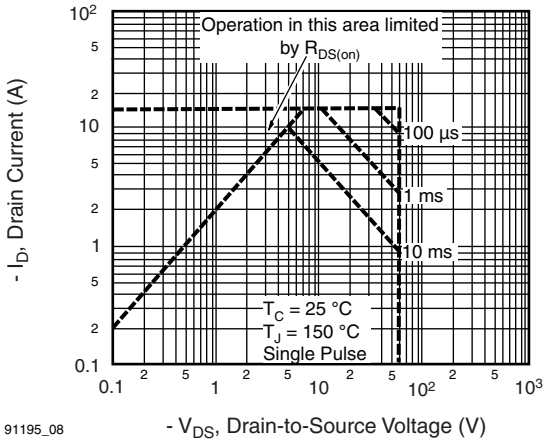



**Fig. 8 - Maximum Safe Operating Area**

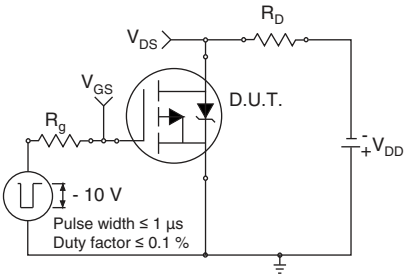



**Fig. 10a - Switching Time Test Circuit**

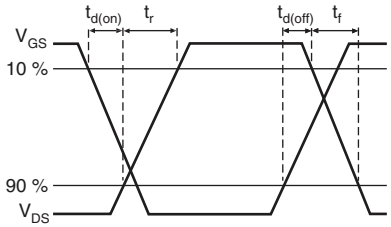



**Fig. 10b - Switching Time Waveforms**

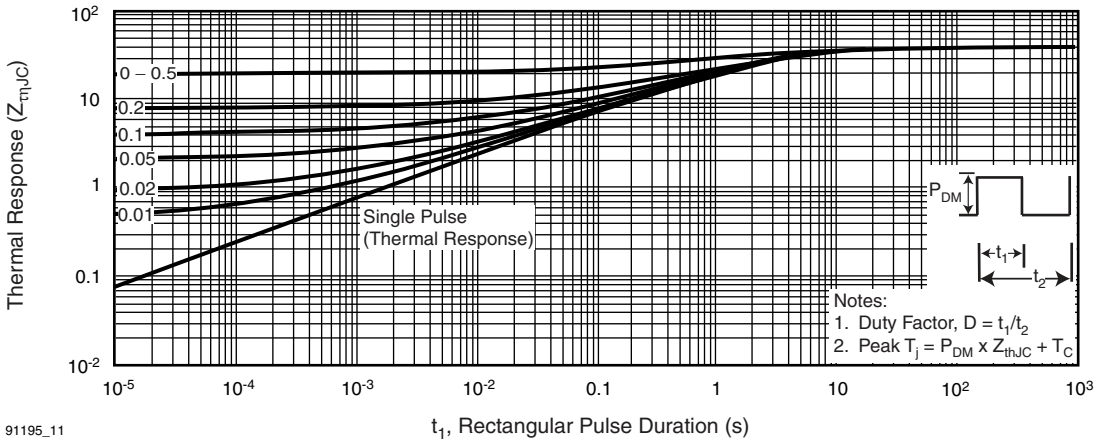



**Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

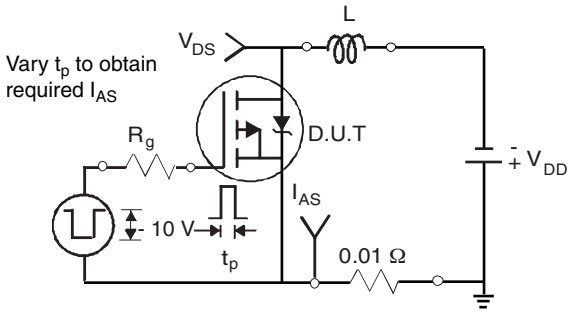



**Fig. 12a - Unclamped Inductive Test Circuit**

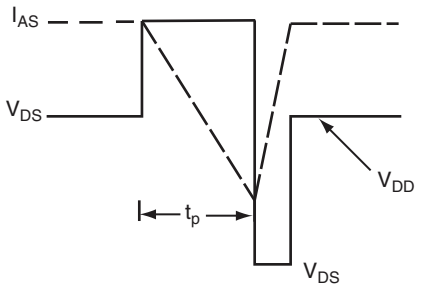



**Fig. 12b - Unclamped Inductive Waveforms**

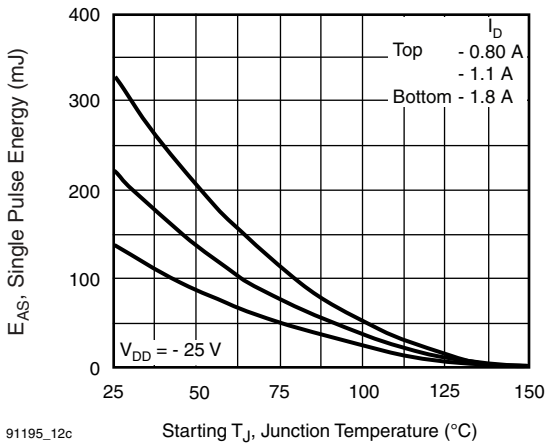



**Fig. 12c - Maximum Avalanche Energy vs. Drain Current**

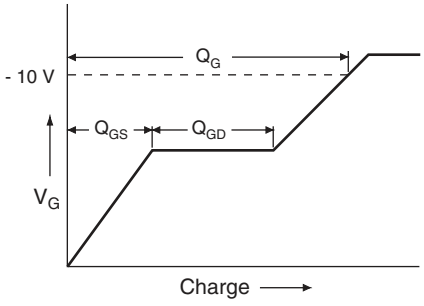



**Fig. 13a - Basic Gate Charge Waveform**

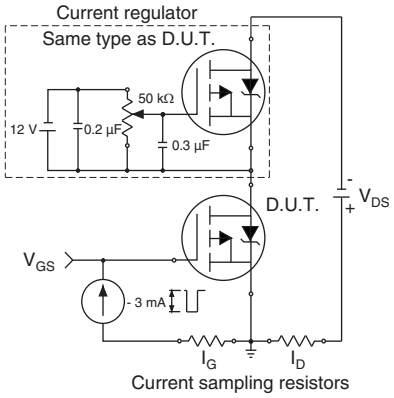
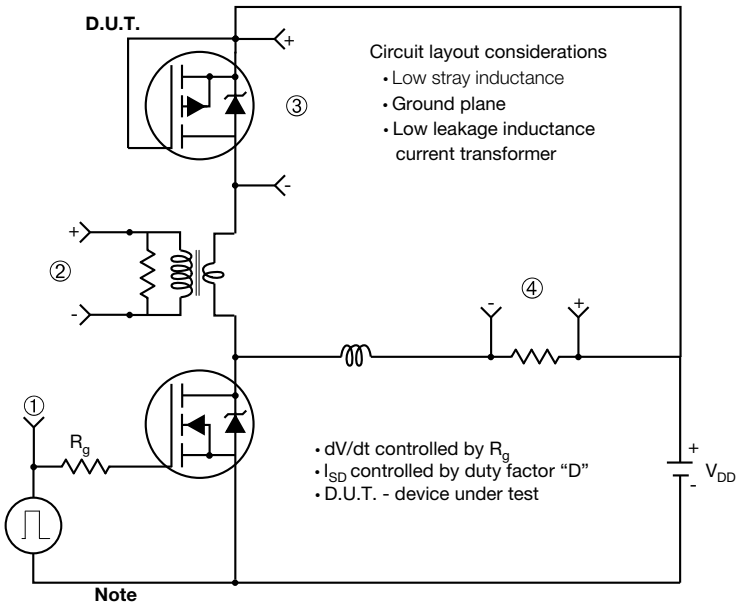
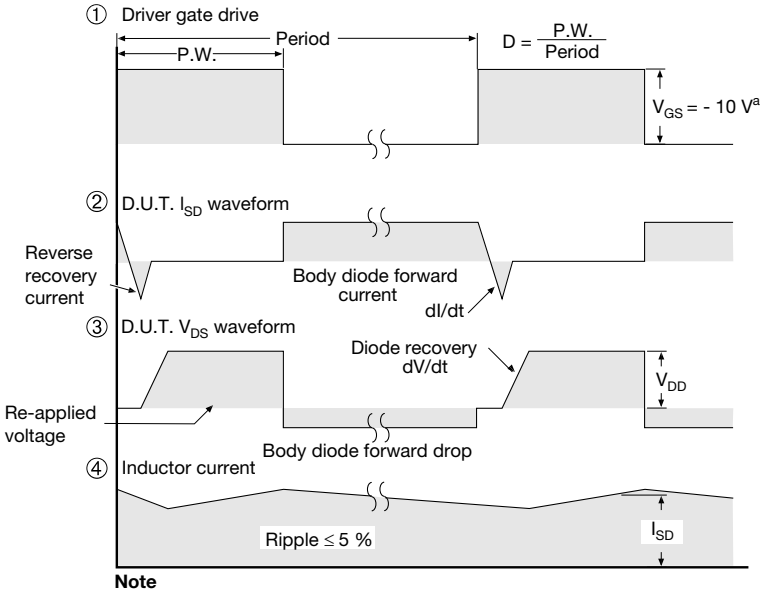



**Fig. 13b - Gate Charge Test Circuit**

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




**Note**
• Compliment N-Channel of D.U.T. for driver




**Note**
a. $V_{GS}$ = - 5 V for logic level and - 3 V drive devices

**Fig. 14 - For P-Channel**

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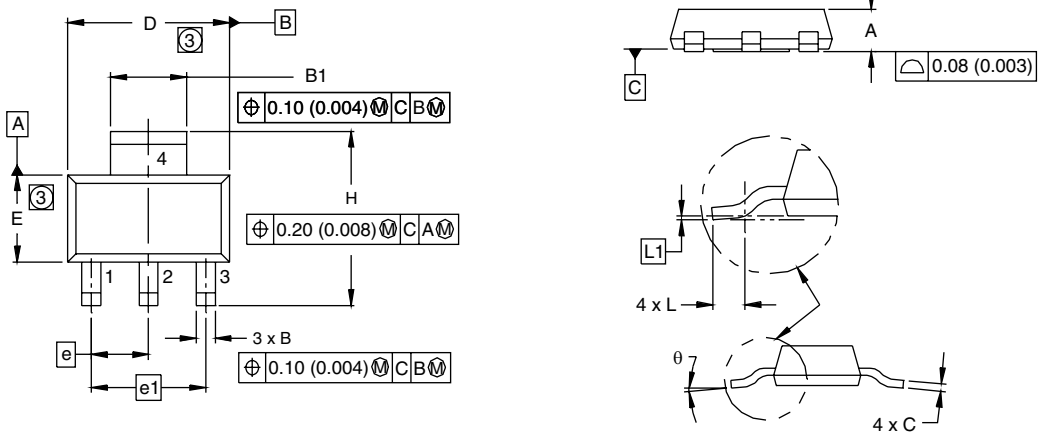
## SOT-223 (HIGH VOLTAGE)




| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| **DIM.** | **MIN.** | **MAX.** | **MIN.** | **MAX.** |
| A | 1.55 | 1.80 | 0.061 | 0.071 |
| B | 0.65 | 0.85 | 0.026 | 0.033 |
| B1 | 2.95 | 3.15 | 0.116 | 0.124 |
| C | 0.25 | 0.35 | 0.010 | 0.014 |
| D | 6.30 | 6.70 | 0.248 | 0.264 |
| E | 3.30 | 3.70 | 0.130 | 0.146 |
| e | 2.30 BSC | | 0.0905 BSC | |
| e1 | 4.60 BSC | | 0.181 BSC | |
| H | 6.71 | 7.29 | 0.264 | 0.287 |
| L | 0.91 | - | 0.036 | - |
| L1 | 0.061 BSC | | 0.0024 BSC | |
| θ | - | 10' | - | 10' |
| ECN: S-82109-Rev. A, 15-Sep-08<br>DWG: 5969 | | | | |

**Notes**

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimensions are shown in millimeters (inches).
3. Dimension do not include mold flash.
4. Outline conforms to JEDEC outline TO-261AA.

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