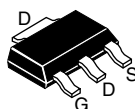


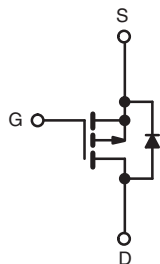
## Power MOSFET

### PRODUCT SUMMARY

|                           |                  |      |
|---------------------------|------------------|------|
| $V_{DS}$ (V)              | -60              |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = -10$ 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](http://www.vishay.com/doc?99912)

### 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.



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**  
Available

### ORDERING INFORMATION

| Package                         | SOT-223       | SOT-223                    |
|---------------------------------|---------------|----------------------------|
| Lead (Pb)-free and Halogen-free | SiHFL9014-GE3 | SiHFL9014TR-GE3            |
| Lead (Pb)-free                  | IRFL9014PbF   | IRFL9014TRPbF <sup>a</sup> |
|                                 | SiHFL9014-E3  | SiHFL9014T-E3 <sup>a</sup> |

#### Note

a. See device orientation.

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

| PARAMETER                                                 | SYMBOL            | LIMIT                     | UNIT                |
|-----------------------------------------------------------|-------------------|---------------------------|---------------------|
| Drain-Source Voltage                                      | $V_{DS}$          | -60                       | V                   |
| Gate-Source Voltage                                       | $V_{GS}$          | $\pm 20$                  |                     |
| Continuous Drain Current                                  | $V_{GS}$ at -10 V | $T_C = 25^\circ\text{C}$  | A                   |
|                                                           |                   | $T_C = 100^\circ\text{C}$ |                     |
| Pulsed Drain Current <sup>a</sup>                         | $I_{DM}$          | -14                       | W/ $^\circ\text{C}$ |
| Linear Derating Factor                                    |                   | 0.025                     |                     |
| Linear Derating Factor (PCB Mount) <sup>e</sup>           |                   | 0.017                     | mJ                  |
| Single Pulse Avalanche Energy <sup>b</sup>                | $E_{AS}$          | 140                       |                     |
| Repetitive Avalanche Current <sup>a</sup>                 | $I_{AR}$          | -1.8                      | A                   |
| Repetitive Avalanche Energy <sup>a</sup>                  | $E_{AR}$          | 0.31                      | mJ                  |
| Maximum Power Dissipation                                 | $P_D$             | $T_C = 25^\circ\text{C}$  | W                   |
| Maximum Power Dissipation (PCB Mount) <sup>e</sup>        |                   | $T_A = 25^\circ\text{C}$  |                     |
| Peak Diode Recovery dV/dt <sup>c</sup>                    | dV/dt             | -4.5                      | V/ns                |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$    | -55 to +150               | $^\circ\text{C}$    |
| Soldering Recommendations (Peak Temperature) <sup>d</sup> | for 10 s          | 300                       |                     |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = -25$  V, starting  $T_J = 25^\circ\text{C}$ ,  $L = 50$  mH,  $R_g = 25\ \Omega$ ,  $I_{AS} = -1.8$  A (see fig. 12).
- $I_{SP} \leq -6.7$  A,  $dI/dt \leq 90$  A/ $\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150^\circ\text{C}$ .
- 1.6 mm from case.
- 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) <sup>a</sup> | $R_{thJA}$ | -    | 60   | °C/W |
| Maximum Junction-to-Case (Drain)                     | $R_{thJC}$ | -    | 40   |      |

**Note**

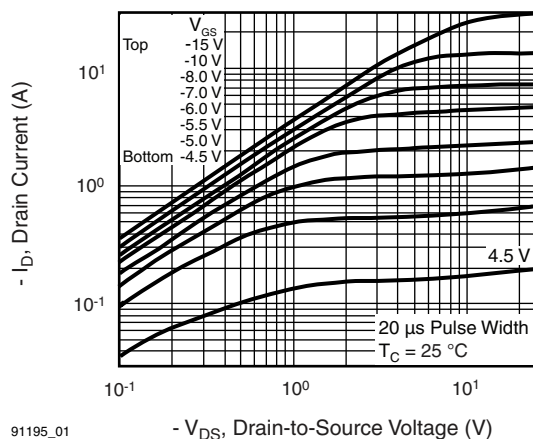
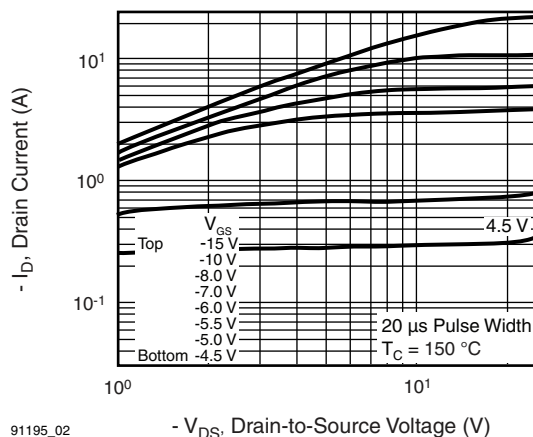
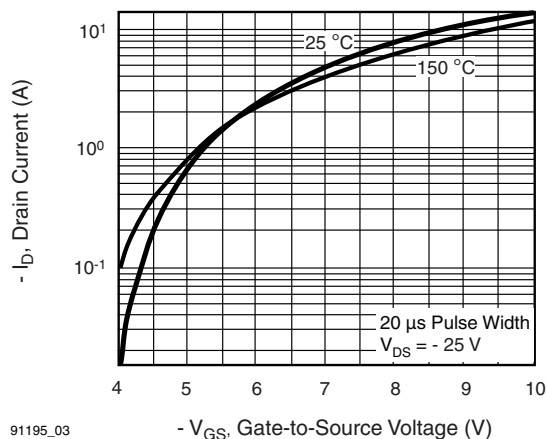
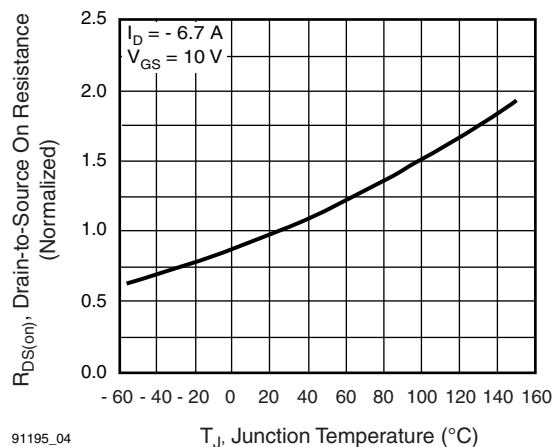
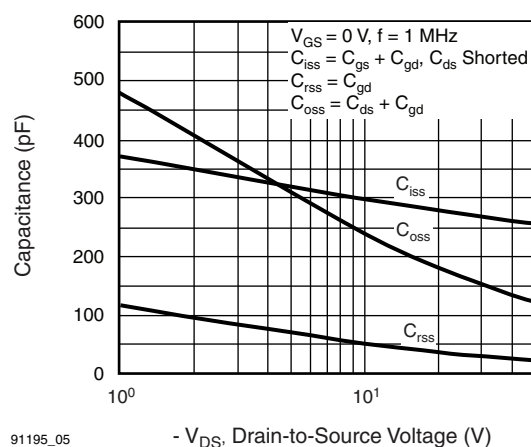
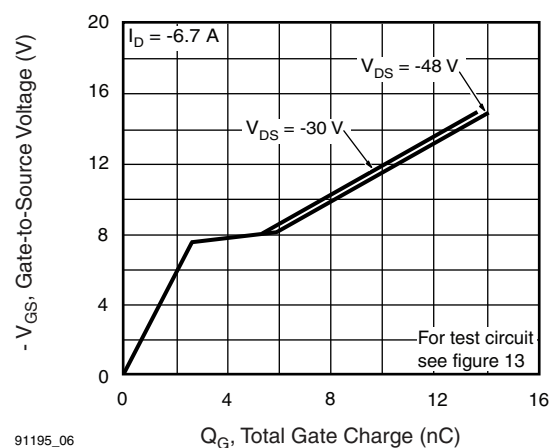
a. When mounted on 1" square PCB (FR-4 or G-10 material).

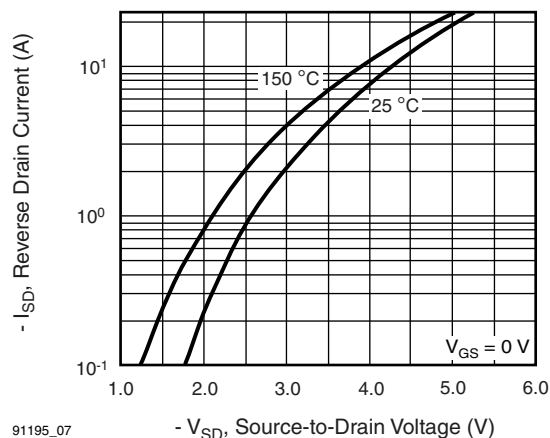
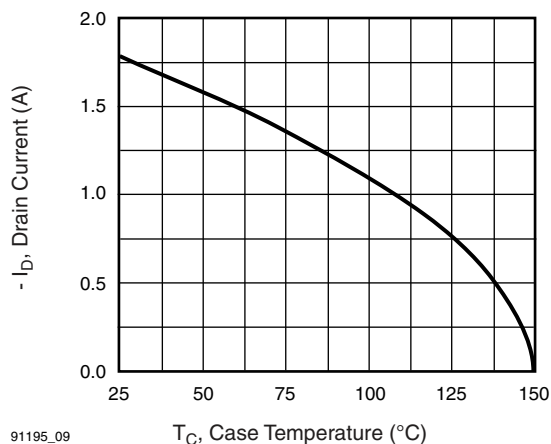
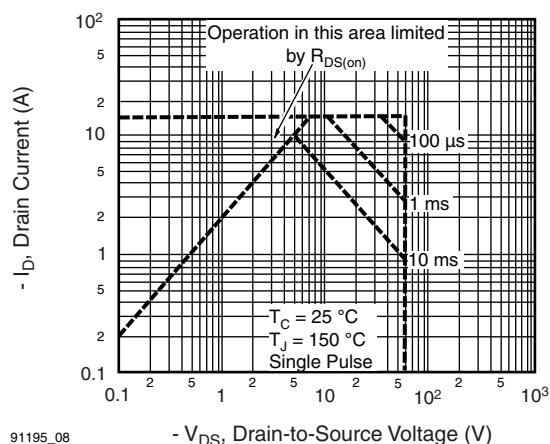
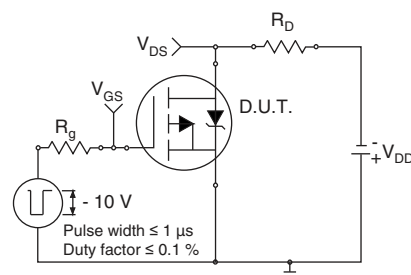
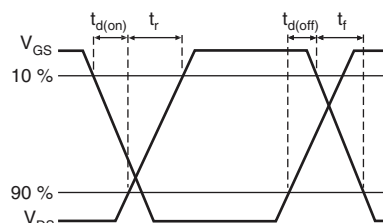
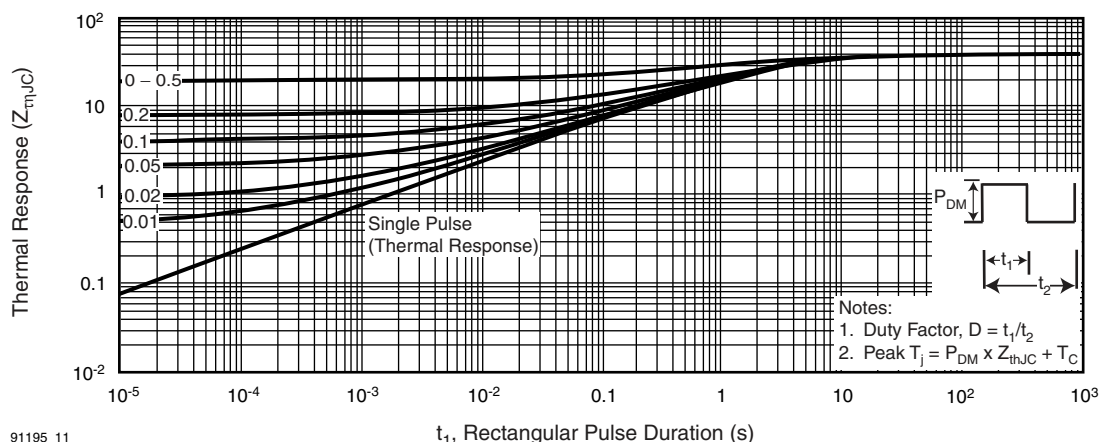
**SPECIFICATIONS** ( $T_J = 25^\circ\text{C}$ , unless otherwise noted)

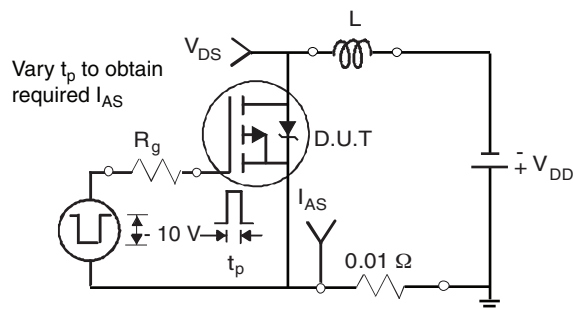
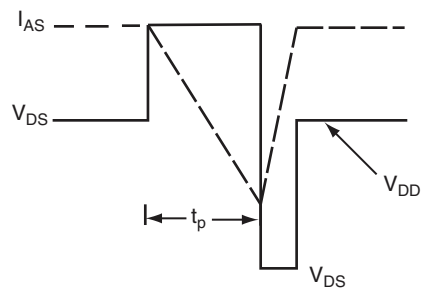
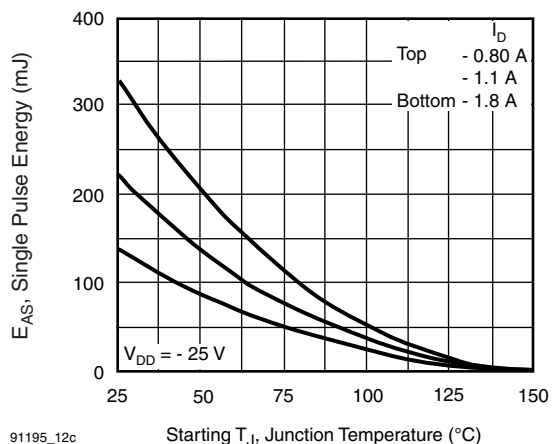
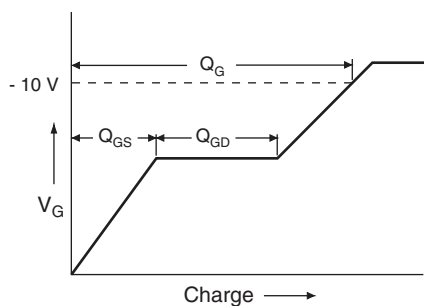
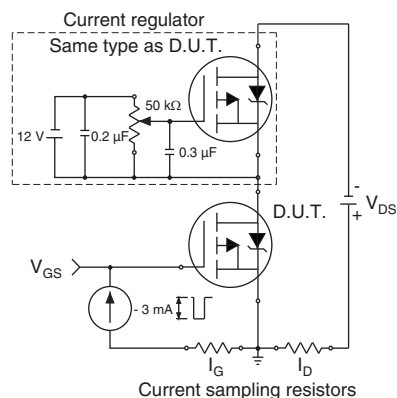
| PARAMETER                                 | SYMBOL              | TEST CONDITIONS                                                                                                                      |                                                                                     | MIN. | TYP.   | MAX.      | UNIT                |
|-------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|--------|-----------|---------------------|
| Static                                    |                     |                                                                                                                                      |                                                                                     |      |        |           |                     |
| Drain-Source Breakdown Voltage            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                               |                                                                                     | -60  | -      | -         | V                   |
| $V_{DS}$ Temperature Coefficient          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$                                                                        |                                                                                     | -    | -0.059 | -         | V/ $^\circ\text{C}$ |
| 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                       | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                           |                                                                                     | -    | -      | $\pm 100$ | nA                  |
| Zero Gate Voltage Drain Current           | $I_{DSS}$           | $V_{DS} = -60\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                      |                                                                                     | -    | -      | -100      | $\mu\text{A}$       |
|                                           |                     | $V_{DS} = -48\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$                                                  |                                                                                     | -    | -      | -500      |                     |
| Drain-Source On-State Resistance          | $R_{DS(on)}$        | $V_{GS} = -10\text{ V}$                                                                                                              | $I_D = 1.1\text{ A}^b$                                                              | -    | -      | 0.50      | $\Omega$            |
| Forward Transconductance                  | $g_{fs}$            | $V_{DS} = -25\text{ V}$ , $I_D = 1.1\text{ A}^b$                                                                                     |                                                                                     | 1.3  | -      | -         | S                   |
| Dynamic                                   |                     |                                                                                                                                      |                                                                                     |      |        |           |                     |
| Input Capacitance                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 25\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ , see fig. 5                                             |                                                                                     | -    | 270    | -         | pF                  |
| Output Capacitance                        | $C_{oss}$           |                                                                                                                                      |                                                                                     | -    | 170    | -         |                     |
| Reverse Transfer Capacitance              | $C_{rss}$           |                                                                                                                                      |                                                                                     | -    | 31     | -         |                     |
| Total Gate Charge                         | $Q_g$               | $V_{GS} = -10\text{ V}$                                                                                                              | $I_D = -6.7\text{ A}$ , $V_{DS} = -48\text{ V}$ ,<br>see fig. 6 and 13 <sup>b</sup> | -    | -      | 12        | nC                  |
| Gate-Source Charge                        | $Q_{gs}$            |                                                                                                                                      |                                                                                     | -    | -      | 3.8       |                     |
| Gate-Drain Charge                         | $Q_{gd}$            |                                                                                                                                      |                                                                                     | -    | -      | 5.1       |                     |
| Turn-On Delay Time                        | $t_{d(on)}$         | $V_{DD} = -30\text{ V}$ , $I_D = -6.7\text{ A}$ ,<br>$R_g = 24\text{ }\Omega$ , $R_D = 4.0\text{ }\Omega$ , see fig. 10 <sup>b</sup> |                                                                                     | -    | 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,<br>6 mm (0.25") from<br>package and center of<br>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<br>showing the<br>integral reverse<br>p - n junction diode                                                             |                                                                                     | -    | -      | -1.8      | A                   |
| Pulsed Diode Forward Current <sup>a</sup> | $I_{SM}$            |                                                                                                                                      |                                                                                     | -    | -      | -14       |                     |
| Body Diode Voltage                        | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = -1.8\text{ A}$ , $V_{GS} = 0\text{ V}^b$                                                   |                                                                                     | -    | -      | -5.5      | V                   |
| Body Diode Reverse Recovery Time          | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = -6.7\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$                                      |                                                                                     | -    | 80     | 160       | ns                  |
| Body Diode Reverse Recovery Charge        | $Q_{rr}$            |                                                                                                                                      |                                                                                     | -    | 0.096  | 0.19      | $\mu\text{C}$       |
| Forward Turn-On Time                      | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )                                                      |                                                                                     |      |        |           |                     |

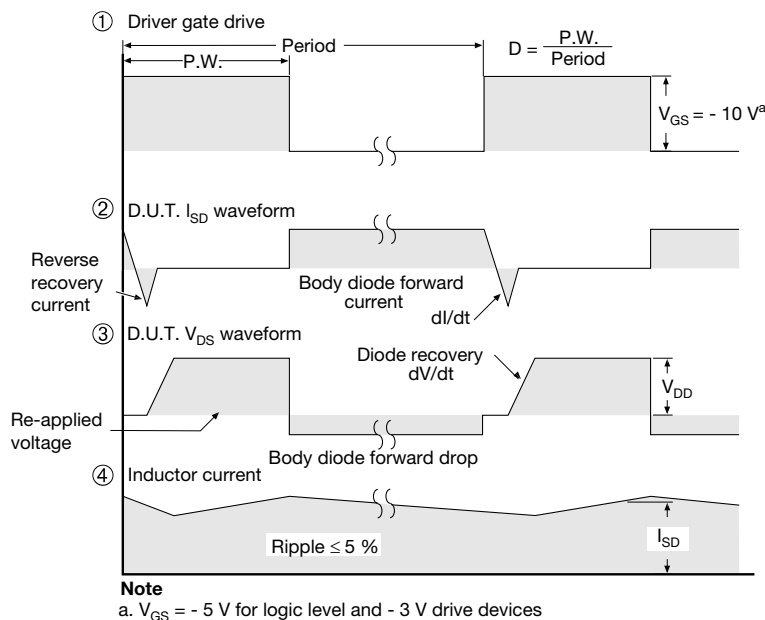
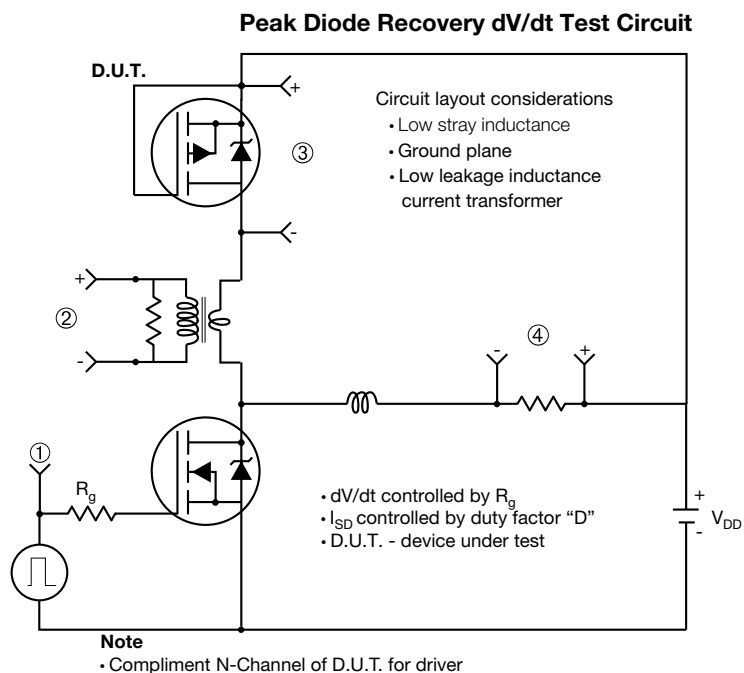
**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).  
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

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

**Fig. 1 - Typical Output Characteristics,  $T_C = 25^\circ\text{C}$** 

**Fig. 2 - Typical Output Characteristics,  $T_C = 150^\circ\text{C}$** 

**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**

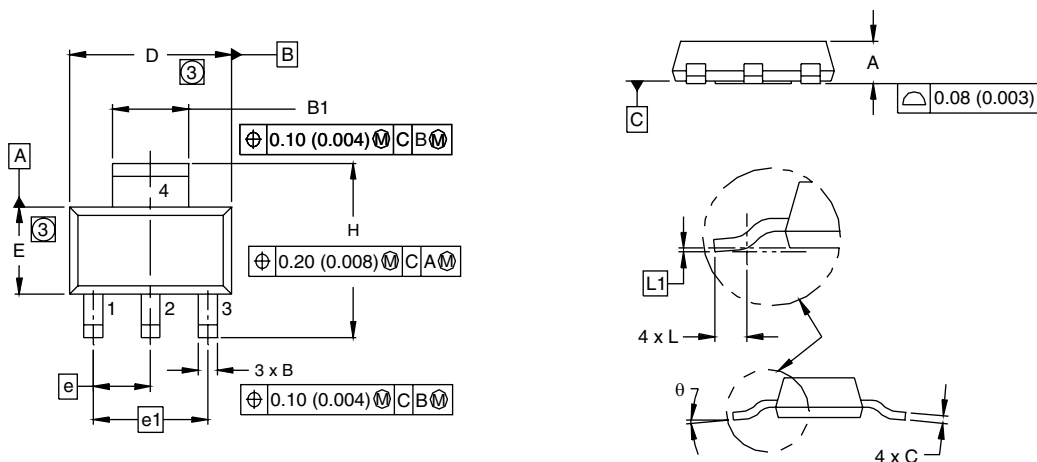

**Fig. 12a - Unclamped Inductive Test Circuit**

**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**



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

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## SOT-223 (HIGH VOLTAGE)



| DIM.                                        | MILLIMETERS |      | INCHES     |       |
|---------------------------------------------|-------------|------|------------|-------|
|                                             | 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 |       |
| $\theta$                                    | -           | 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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