



# Power MOSFET

| PRODUCT SUMMARY            |                                |
|----------------------------|--------------------------------|
| V <sub>DS</sub> (V)        | -60                            |
| R <sub>DS(on)</sub> (Ω)    | V <sub>GS</sub> = -10 V   0.50 |
| Q <sub>g</sub> (Max.) (nC) | 12                             |
| Q <sub>gs</sub> (nC)       | 3.8                            |
| Q <sub>gd</sub> (nC)       | 5.1                            |
| Configuration              | Single                         |

## FEATURES

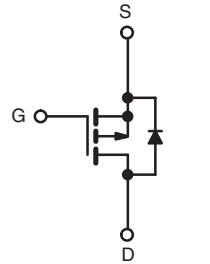
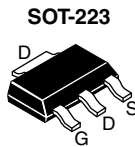
- Surface mount
- Available in tape and reel
- Dynamic dV/dt rating
- Repetitive avalanche rated
- P-channel
- Fast switching
- Ease of paralleling
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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.



P-Channel MOSFET

Marking code: FE

| 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 <sub>C</sub> = 25 °C, unless otherwise noted) |                                   |                         |      |
|---|-----------------------------------|-------------------------|------|
| PARAMETER   | SYMBOL                            | LIMIT                   | UNIT |
| Drain-Source Voltage  | V <sub>DS</sub>                   | -60                     | V    |
| Gate-Source Voltage   | V <sub>GS</sub>                   | ± 20                    |      |
| Continuous Drain Current  | V <sub>GS</sub> at - 10 V         | T <sub>C</sub> = 25 °C  | -1.8 |
|   |                                   | T <sub>C</sub> = 100 °C | -1.1 |
| Pulsed Drain Current <sup>a</sup>   | I <sub>DM</sub>                   | -14                     | A    |
| Linear Derating Factor  |                                   | 0.025                   |      |
| Linear Derating Factor (PCB Mount) <sup>e</sup>                           |                                   | 0.017                   |      |
| Single Pulse Avalanche Energy <sup>b</sup>                                | E <sub>AS</sub>                   | 140                     | mJ   |
| Repetitive Avalanche Current <sup>a</sup>                                 | I <sub>AR</sub>                   | -1.8                    | A    |
| Repetitive Avalanche Energy <sup>a</sup>                                  | E <sub>AR</sub>                   | 0.31                    | mJ   |
| Maximum Power Dissipation   | P <sub>D</sub>                    | T <sub>C</sub> = 25 °C  | 3.1  |
|   |                                   | T <sub>A</sub> = 25 °C  | 2.0  |
| Maximum Power Dissipation (PCB Mount) <sup>e</sup>                        |                                   |                         | W    |
| Peak Diode Recovery dV/dt <sup>c</sup>                                    | dV/dt                             | -4.5                    | V/ns |
| Operating Junction and Storage Temperature Range                          | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150             | °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<sub>DD</sub> = - 25 V, starting T<sub>J</sub> = 25 °C, L = 50 mH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = - 1.8 A (see fig. 12).
- I<sub>SD</sub> ≤ - 6.7 A, di/dt ≤ 90 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 150 °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 <sub>thJA</sub> | -    | 60   | °C/W |
| Maximum Junction-to-Case (Drain)                     | R <sub>thJC</sub> | -    | 40   |      |

**Note**

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

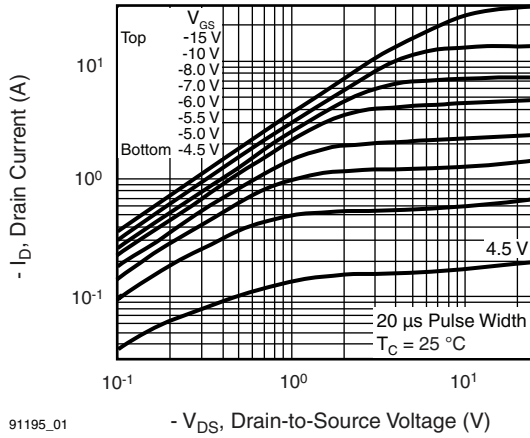
| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted) |                                  |  |   |      |        |       |      |
|---|----------------------------------|--|---|------|--------|-------|------|
| PARAMETER   | SYMBOL                           | TEST CONDITIONS  |   | MIN. | TYP.   | MAX.  | UNIT |
| <b>Static</b>   |                                  |  |   |      |        |       |      |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA   |   | -60  | -      | -     | V    |
| V <sub>DS</sub> Temperature Coefficient                         | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA  |   | -    | -0.059 | -     | V/°C |
| Gate-Source Threshold Voltage                                   | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA  |   | -2.0 | -      | -4.0  | V    |
| Gate-Source Leakage   | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V   |   | -    | -      | ± 100 | nA   |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>                 | V <sub>DS</sub> = -60 V, V <sub>GS</sub> = 0 V   |   | -    | -      | - 100 | μA   |
|   |                                  | V <sub>DS</sub> = -48 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C  |   | -    | -      | -500  |      |
| Drain-Source On-State Resistance                                | R <sub>DS(on)</sub>              | V <sub>GS</sub> = -10 V  | I <sub>D</sub> = 1.1 A <sup>b</sup>   | -    | -      | 0.50  | Ω    |
| Forward Transconductance  | g <sub>fs</sub>                  | V <sub>DS</sub> = - 25 V, I <sub>D</sub> = 1.1 A <sup>b</sup>  |   | 1.3  | -      | -     | S    |
| <b>Dynamic</b>  |                                  |  |   |      |        |       |      |
| Input Capacitance   | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 25 V,<br>f = 1.0 MHz, see fig. 5   |   | -    | 270    | -     | pF   |
| Output Capacitance  | C <sub>oss</sub>                 |  |   | -    | 170    | -     |      |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>                 |  |   | -    | 31     | -     |      |
| Total Gate Charge   | Q <sub>g</sub>                   | V <sub>GS</sub> = - 10 V   | I <sub>D</sub> = - 6.7 A, V <sub>DS</sub> = - 48 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | -      | 12    | nC   |
| Gate-Source Charge  | Q <sub>gs</sub>                  |  |   | -    | -      | 3.8   |      |
| Gate-Drain Charge   | Q <sub>gd</sub>                  |  |   | -    | -      | 5.1   |      |
| Turn-On Delay Time  | t <sub>d(on)</sub>               | V <sub>DD</sub> = - 30 V, I <sub>D</sub> = - 6.7 A,<br>R <sub>g</sub> = 24 Ω, R <sub>D</sub> = 4.0 Ω, see fig. 10 <sup>b</sup> |   | -    | 11     | -     | ns   |
| Rise Time   | t <sub>r</sub>                   |  |   | -    | 63     | -     |      |
| Turn-Off Delay Time   | t <sub>d(off)</sub>              |  |   | -    | 9.6    | -     |      |
| Fall Time   | t <sub>f</sub>                   |  |   | -    | 31     | -     |      |
| Internal Drain Inductance                                       | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact   |   | -    | 4.0    | -     | nH   |
| Internal Source Inductance                                      | L <sub>S</sub>                   |  |   | -    | 6.0    | -     |      |
| <b>Drain-Source Body Diode Characteristics</b>                  |                                  |  |   |      |        |       |      |
| Continuous Source-Drain Diode Current                           | I <sub>S</sub>                   | MOSFET symbol showing the<br>integral reverse<br>p - n junction diode  |   | -    | -      | - 1.8 | A    |
| Pulsed Diode Forward Current <sup>a</sup>                       | I <sub>SM</sub>                  |  |   | -    | -      | - 14  |      |
| Body Diode Voltage  | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = - 1.8 A, V <sub>GS</sub> = 0 V <sup>b</sup>   |   | -    | -      | - 5.5 | V    |
| Body Diode Reverse Recovery Time                                | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = - 6.7 A, di/dt = 100 A/μs <sup>b</sup>  |   | -    | 80     | 160   | ns   |
| Body Diode Reverse Recovery Charge                              | Q <sub>rr</sub>                  |  |   | -    | 0.096  | 0.19  | μC   |
| Forward Turn-On Time  | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                              |   |      |        |       |      |

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- b. Pulse width ≤ 300 μs; duty cycle ≤ 2 %.

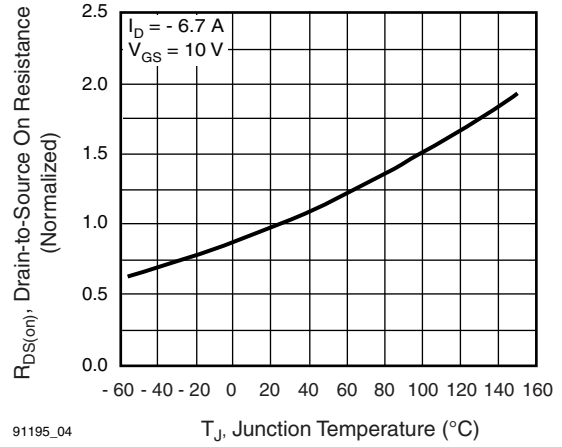


TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



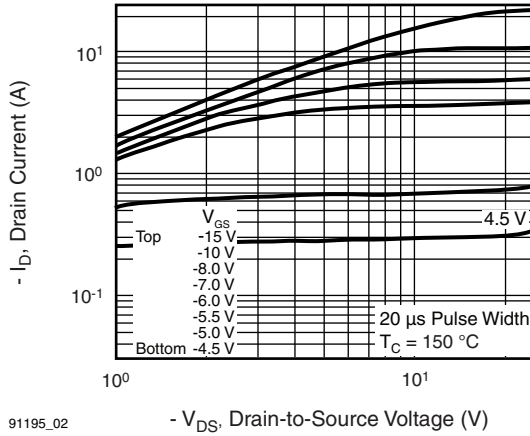
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Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$



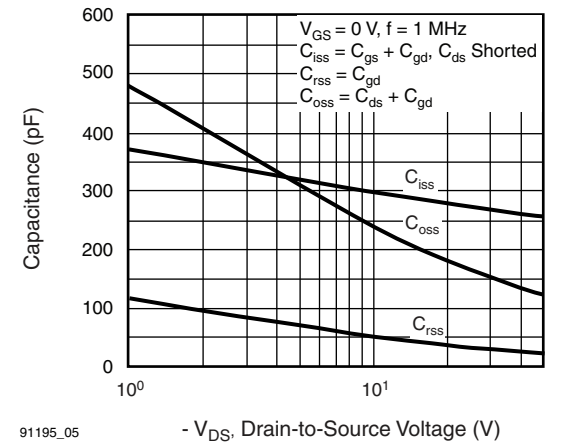
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Fig. 4 - Normalized On-Resistance vs. Temperature



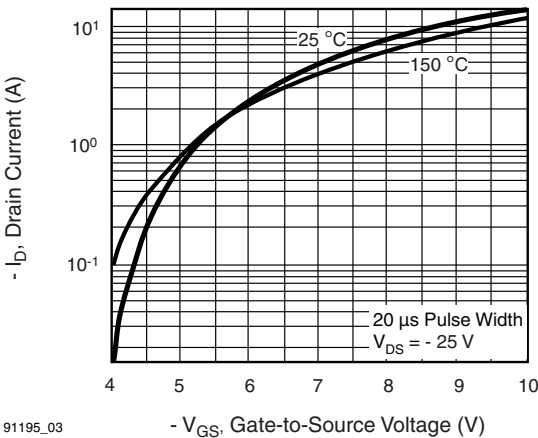
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Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^\circ\text{C}$



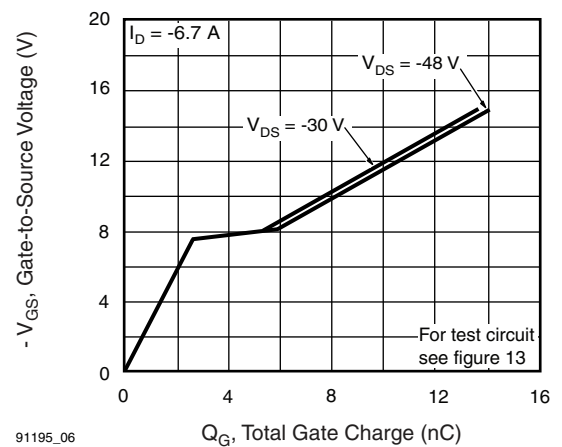
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Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



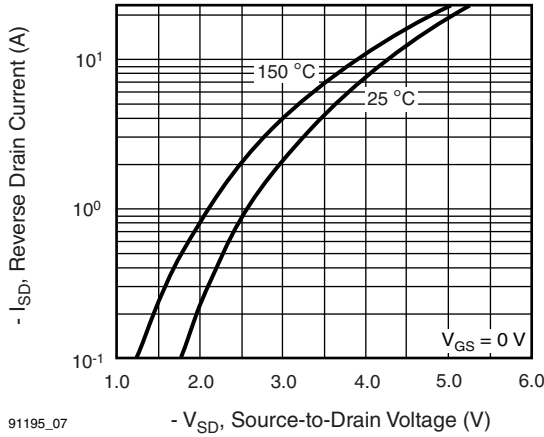
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Fig. 3 - Typical Transfer Characteristics



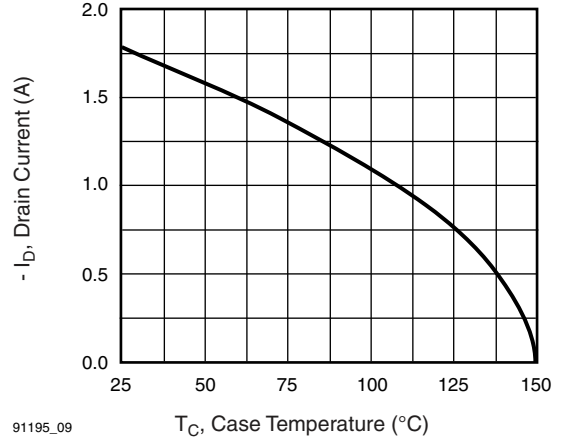
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Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage



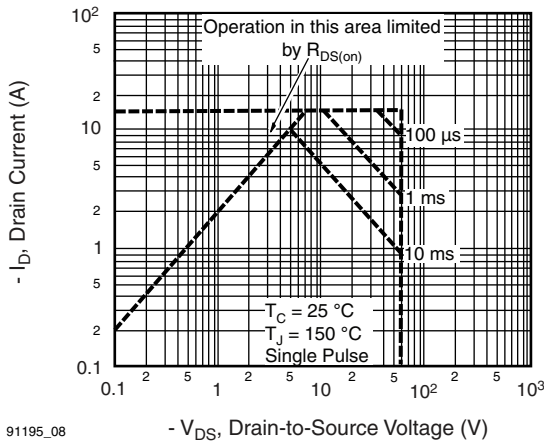
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Fig. 7 - Typical Source-Drain Diode Forward Voltage



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Fig. 9 - Maximum Drain Current vs. Case Temperature



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Fig. 8 - Maximum Safe Operating Area

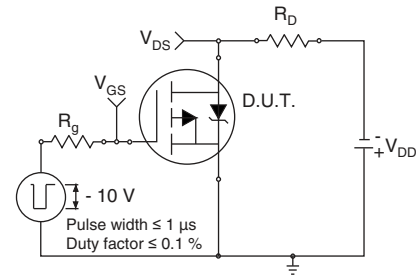


Fig. 10a - Switching Time Test Circuit

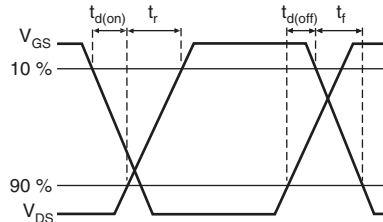
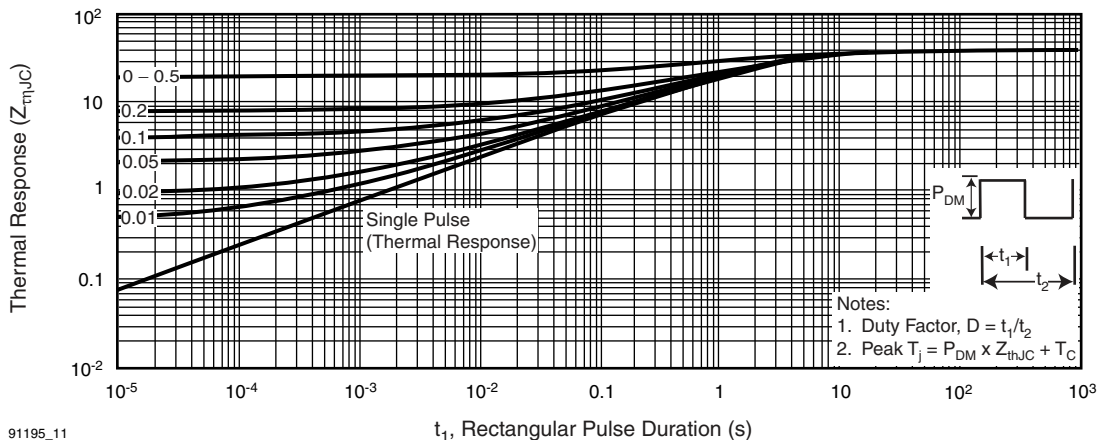


Fig. 10b - Switching Time Waveforms



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

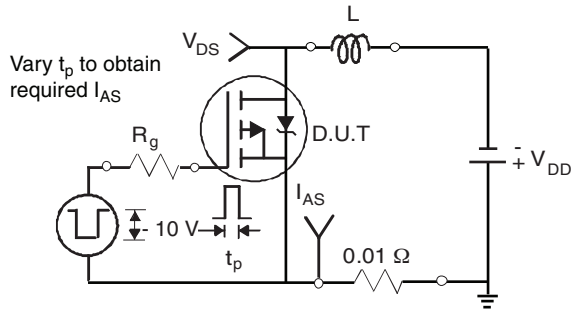


Fig. 12a - Unclamped Inductive Test Circuit

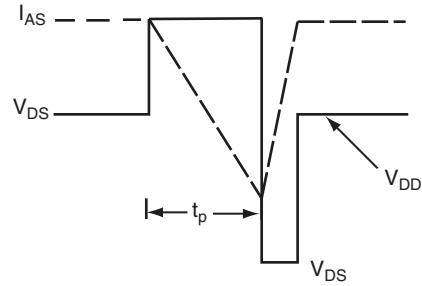


Fig. 12b - Unclamped Inductive Waveforms

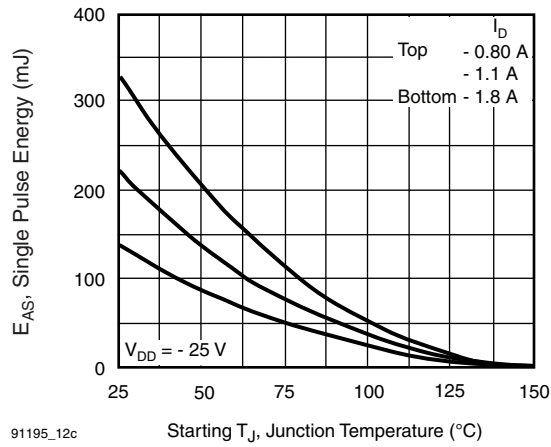


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

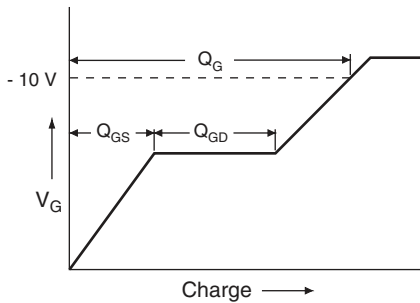


Fig. 13a - Basic Gate Charge Waveform

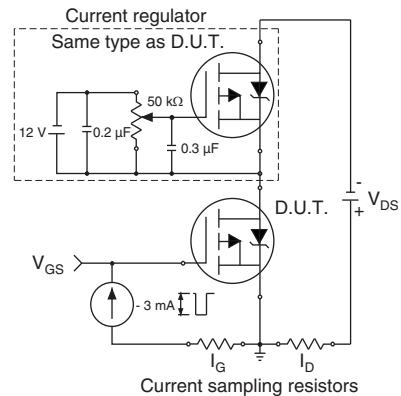
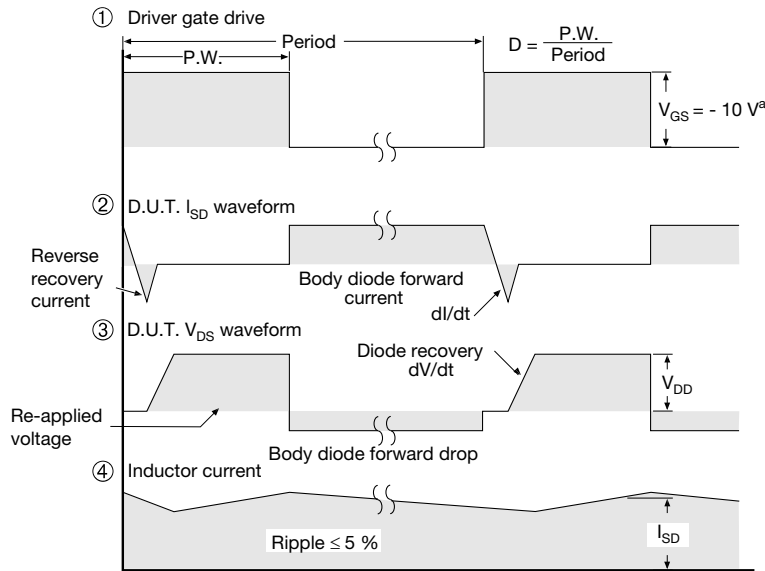


Fig. 13b - Gate Charge Test Circuit

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



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

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

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?91195](http://www.vishay.com/ppg?91195).

## 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 |       |
| 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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