# Power MOSFET, 40 A

SOT-227

## FEATURES

- Fully isolated package
- Easy to use and parallel
- Low on-resistance
- Dynamic dV/dt rating
- Fully avalanche rated
- Simple drive requirements
- Low drain to case capacitance
- Low internal inductance
- UL approved file E78996
- Designed for industrial level
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS COMPLIANT

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{DSS}$ | 500 V |
| $R_{DS(on)}$ | 106 mΩ |
| $I_D$ | 40 A |
| Type | Modules - MOSFET |
| Package | SOT-227 |

## DESCRIPTION

Third generation power MOSFETs from Vishay Semiconductors provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.
The SOT-227 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 500 W. The low thermal resistance of the SOT-227 contribute to its wide acceptance throughout the industry.

**ABSOLUTE MAXIMUM RATINGS**

| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
|---|---|---|---|---|
| Continuous drain current at $V_{GS}$ 10 V | $I_D$ | $T_C$ = 25 °C | 40 | A |
| | | $T_C$ = 90 °C | 29 | |
| Pulsed drain current | $I_{DM}$ (1) | | 150 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 543 | W |
| | | $T_C$ = 90 °C | 261 | |
| Gate to source voltage | $V_{GS}$ | | ± 20 | V |
| Single pulse avalanche energy | $E_{AS}$ (2) | | 400 | mJ |
| Repetitive avalanche current | $I_{AR}$ (1) | | 13 | A |
| Repetitive avalanche energy | $E_{AR}$ (1) | | 42 | mJ |
| Peak diode recovery dV/dt | dV/dt (3) | | 10 | V/ns |
| Operating junction and storage temperature range | $T_J$, $T_{Stg}$ | | -55 to +150 | °C |
| Insulation withstand voltage (AC-RMS) | $V_{ISO}$ | | 2.5 | kV |
| Mounting torque | | M4 screw, on terminals and heatsink | 1.3 | Nm |

**Notes**

(1) Repetitive rating; pulse width limited by maximum junction temperature (see fig. 18)
(2) Starting $T_J$ = 25 °C, L = 500 μH, $R_g$ = 2.4 Ω, $I_{AS}$ = 40 A (see fig. 18)
(3) $I_{SD} \leq$ 40 A, $dI_F/dt \leq$ 200 A/μs, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq$ 150 °C


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| THERMAL - MECHANICAL SPECIFICATIONS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Junction and storage temperature range | $T_J$, $T_{Stg}$ | | -55 | - | 150 | °C |
| Junction to case | $R_{thJC}$ | | - | - | 0.23 | °C/W |
| Case to heatsink | $R_{thCS}$ | Flat, greased surface | - | 0.05 | - | |
| Weight | | | - | 30 | - | g |
| Mounting torque | | Torque to terminal | - | - | 1.1 (9.7) | Nm (lbf.in) |
| | | Torque to heatsink | - | - | 1.8 (15.9) | Nm (lbf.in) |
| Case style | | | SOT-227 | | | |

| ELECTRICAL CHARACTERISTICS ($T_J$ = 25 °C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Drain to source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 1.0 mA | 500 | - | - | V |
| Breakdown voltage temperature coefficient | $\Delta V_{(BR)DSS}/\Delta T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 0.65 | - | V/°C |
| Static drain to source on-resistance | $R_{DS(on)}$ (1) | $V_{GS}$ = 10 V, $I_D$ = 23 A | - | 106 | 130 | mΩ |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | 2 | 3 | 4 | V |
| | | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA, $T_J$ = 125 °C | - | 1.9 | - | |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 23 A | - | 29 | - | S |
| Drain to source leakage current | $I_{DSS}$ | $V_{DS}$ = 500 V, $V_{GS}$ = 0 V | - | 0.5 | 50 | μA |
| | | $V_{DS}$ = 500 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | 30 | 500 | |
| | | $V_{DS}$ = 500 V, $V_{GS}$ = 0 V, $T_J$ = 150 °C | - | 0.2 | 3 | mA |
| Gate to source forward leakage | $I_{GSS}$ | $V_{GS}$ = 20 V | - | - | 200 | nA |
| Gate to source reverse leakage | | $V_{GS}$ = - 20 V | - | - | - 200 | |
| Total gate charge | $Q_g$ | $I_D$ = 38 A<br>$V_{DS}$ = 400 V<br>$V_{GS}$ = 10 V; see fig. 15 and 19 (1) | - | 280 | 420 | nC |
| Gate to source charge | $Q_{gs}$ | | - | 37 | 55 | |
| Gate to drain ("Miller") charge | $Q_{gd}$ | | - | 150 | 220 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 250 V, $I_D$ = 40 A, $R_g$ = 2.4 Ω,<br>L = 500 μH, diode used: 60APH06 | - | 143 | - | ns |
| Rise time | $t_r$ | | - | 33 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 107 | - | |
| Fall time | $t_f$ | | - | 36 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 250 V, $I_D$ = 40 A, $R_g$ = 2.4 Ω,<br>L = 500 μH, $T_J$ = 125 °C, diode used:<br>60APH06 | - | 145 | - | ns |
| Rise time | $t_r$ | | - | 35 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 110 | - | |
| Fall time | $t_f$ | | - | 40 | - | |
| Internal source inductance | $L_S$ | Between lead, and center of die contact | - | 5 | - | nH |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V<br>$V_{DS}$ = 25 V<br>f = 1.0 MHz, see fig. 14 | - | 6900 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 1600 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 580 | - | |

**Note**

(1) Pulse width ≤ 300 μs, duty cycle ≤ 2 %


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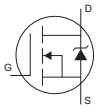
| SOURCE-DRAIN RATINGS AND CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Continuous source current (body diode) | $I_S$ | MOSFET symbol showing the integral reverse p-n junction diode.  | - | - | 38 | A |
| Pulsed source current (body diode) | $I_{SM}$ (1) | | - | - | 150 | |
| Diode forward voltage | $V_{SD}$ (2) | $T_J$ = 25 °C, $I_S$ = 38 A, $V_{GS}$ = 0 V | - | 0.9 | 1.31 | V |
| | | $T_J$ = 125 °C, $I_S$ = 38 A, $V_{GS}$ = 0 V | - | 0.75 | - | |
| Reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 40 A; $dI_F/dt$ = 100 A/μs (2) | - | 560 | - | ns |
| Reverse recovery current | $I_{rr}$ | | - | 40 | - | A |
| Reverse recovery charge | $Q_{rr}$ | | - | 11 | - | μC |
| Reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 40 A; $dI_F/dt$ = 100 A/μs (2) | - | 680 | - | ns |
| Reverse recovery current | $I_{rr}$ | | - | 47 | - | A |
| Reverse recovery charge | $Q_{rr}$ | | - | 16 | - | μC |
| Forward turn-on time | $t_{on}$ | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$) | | | | |

**Notes**

(1) Repetitive rating; pulse width limited by maximum junction temperature (see fig. 18)

(2) Pulse width ≤ 300 μs, duty cycle ≤ 2 %

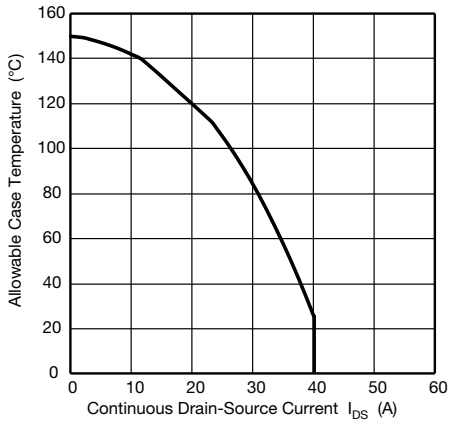



Fig. 1 - Maximum DC MOSFET Drain-Source Current vs. Case Temperature

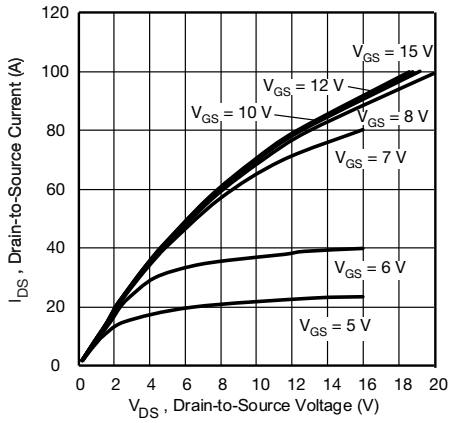



Fig. 3 - Typical Drain-to-Source Current Output Characteristics at $T_J$ = 25 °C

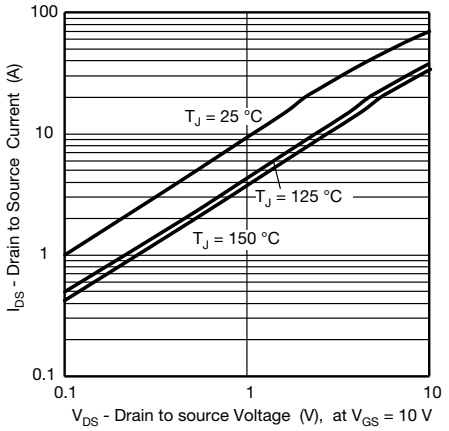



Fig. 2 - Typical Drain-to-Source Current Output Characteristics; $V_{GS}$ = 10 V

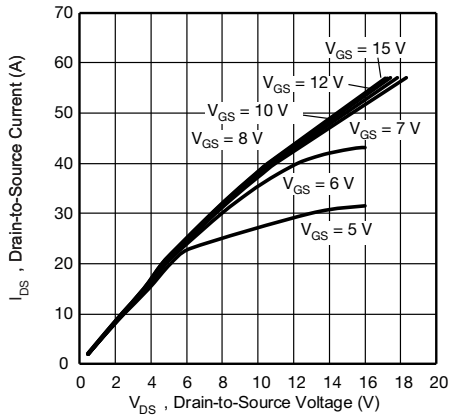



Fig. 4 - Typical Drain-to-Source Current Output Characteristics at $T_J$ = 125 °C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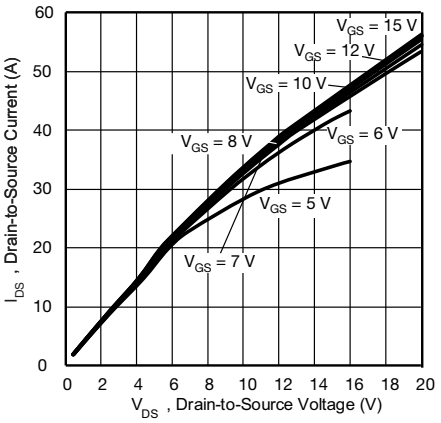


Fig. 5 - Typical Drain-to-Source Current Output Characteristics at $T_J$ = 150 °C

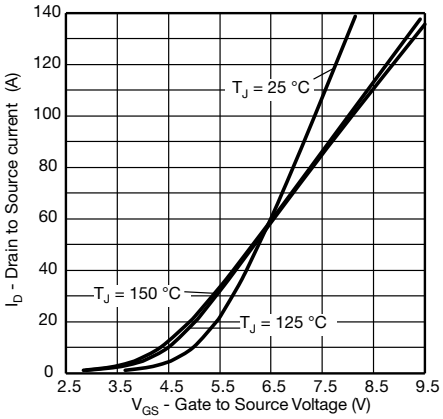


Fig. 8 - Typical MOSFET Transfer Characteristics

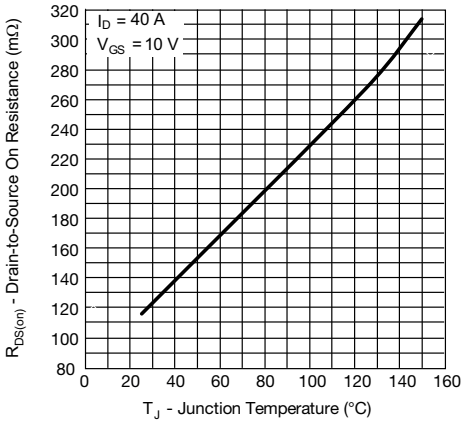


Fig. 6 - Normalized On-Resistance vs. Temperature

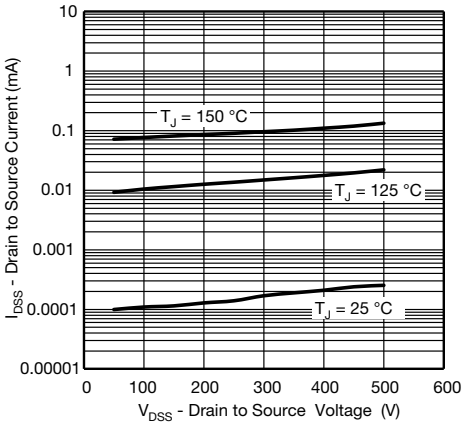


Fig. 9 - Typical MOSFET Zero Gate Voltage Drain Current

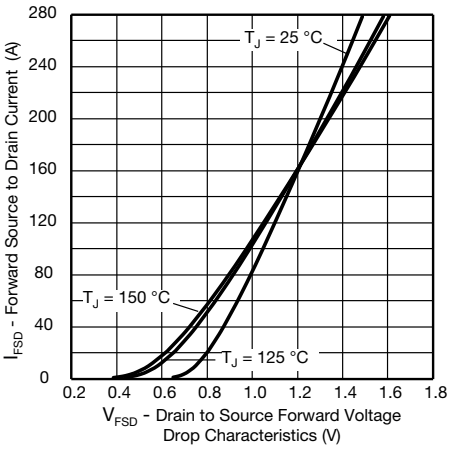


Fig. 7 - Typical Body Diode Forward Voltage Drop Characteristics

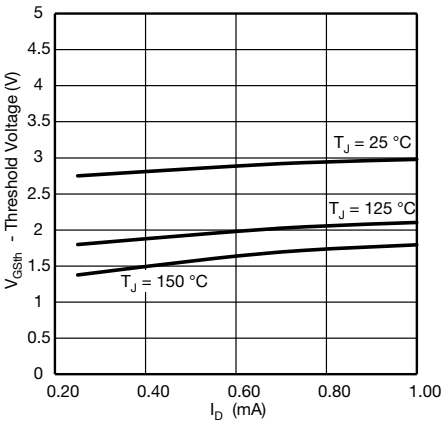


Fig. 10 - Typical MOSFET Threshold Voltage


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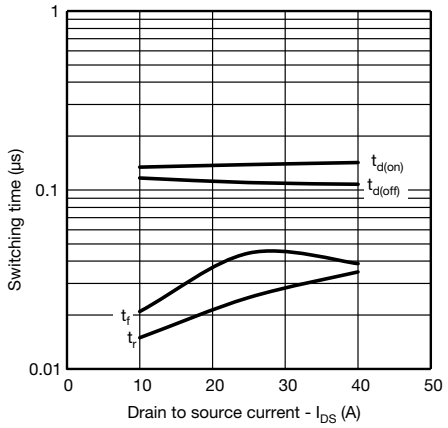


Fig. 11 - Typical MOSFET Switching Time vs. $I_{DS}$, $T_J$ = 125 °C, $V_{DD}$ = 250 V, $V_{GS}$ = 10 V, L = 500 µH, $R_G$ = 2.4 Ω
Diode used 60APH06

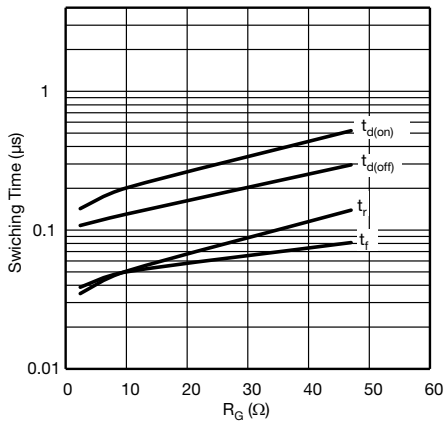


Fig. 12 - Typical MOSFET Switching Time vs. $R_G$, $T_J$ = 125 °C, $I_{DS}$ = 40 A, $V_{DD}$ = 250 V, $V_{GS}$ = 10 V, L = 500 µH
Diode used 60APH06

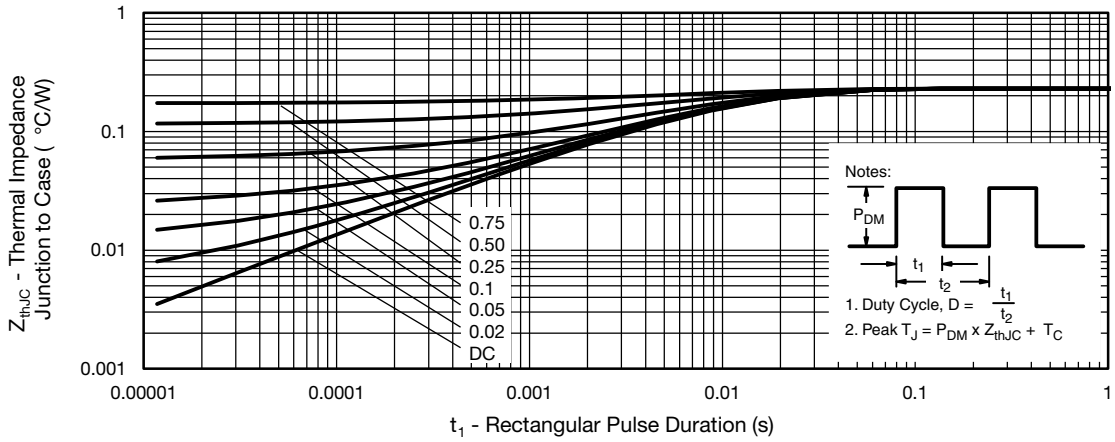


Fig. 13 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics, MOSFET

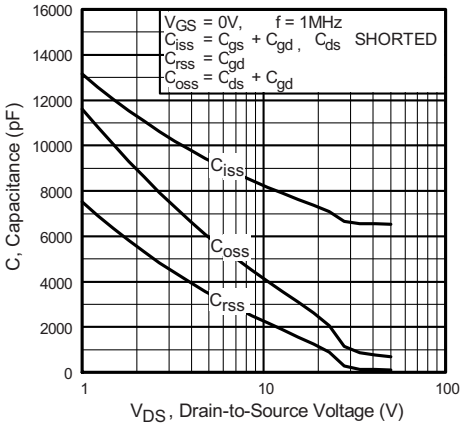


Fig. 14 - Typical Capacitance vs. Drain to Source Voltage

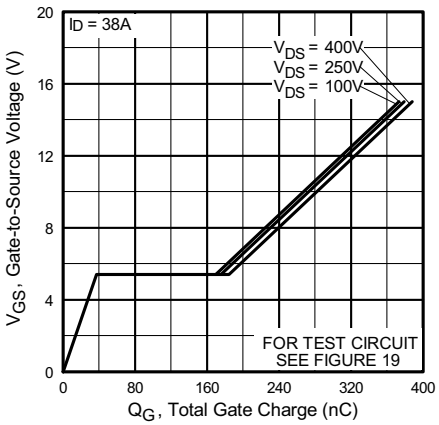


Fig. 15 - Typical Gate Charge vs. Gate to Source Voltage


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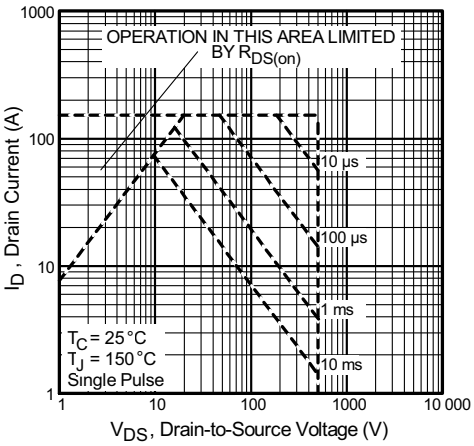


Fig. 16 - Maximum Safe Operating Area

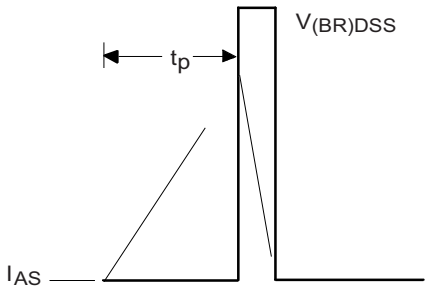


Fig. 20 - Unclamped Inductive Waveforms

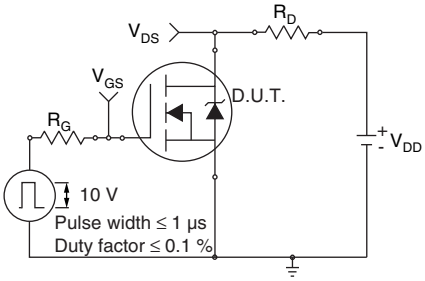


Fig. 17 - Switching Time Test Circuit

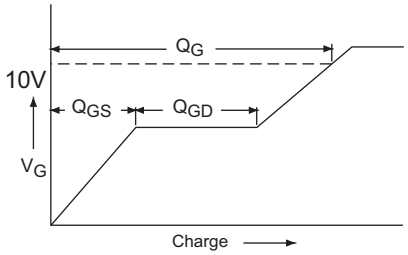


Fig. 21 - Basic Gate Charge Waveform

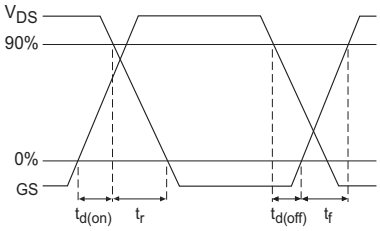


Fig. 18 - Switching Time Waveforms

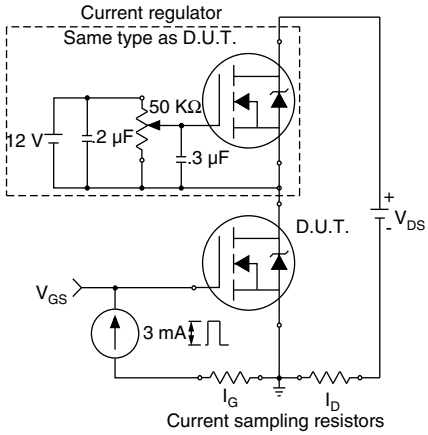


Fig. 22 - Gate Charge Test Circuit

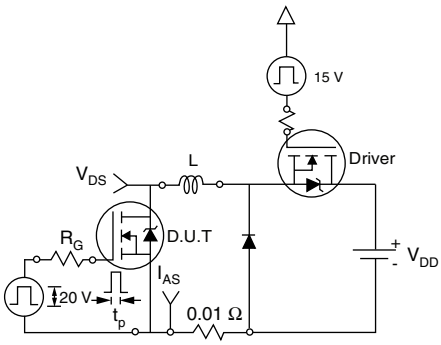


Fig. 19 - Unclamped Inductive Test Circuit


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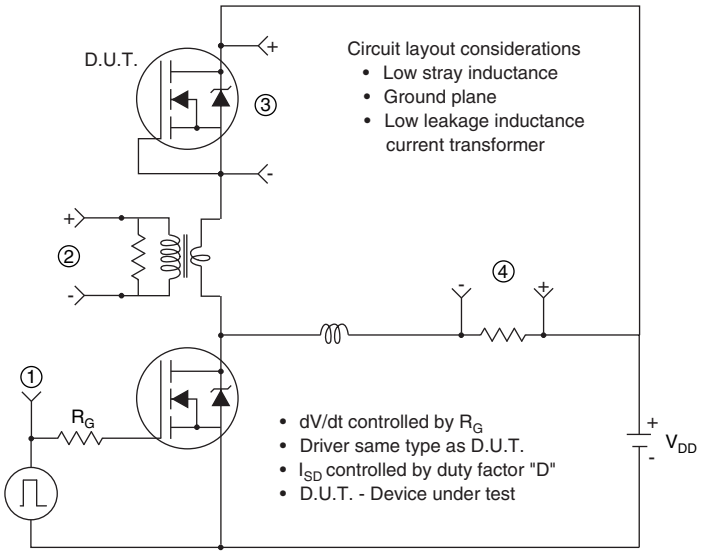
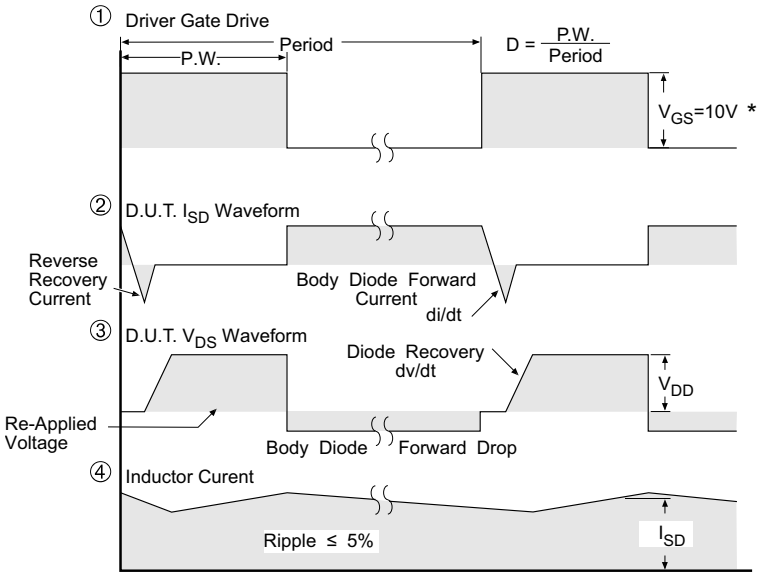



Fig. 23 - Peak Diode Recovery dV/dt Test Circuit




* $V_{GS}$ = 5V for Logic Level Devices

Fig. 24 - For N-Channel Power MOSFETs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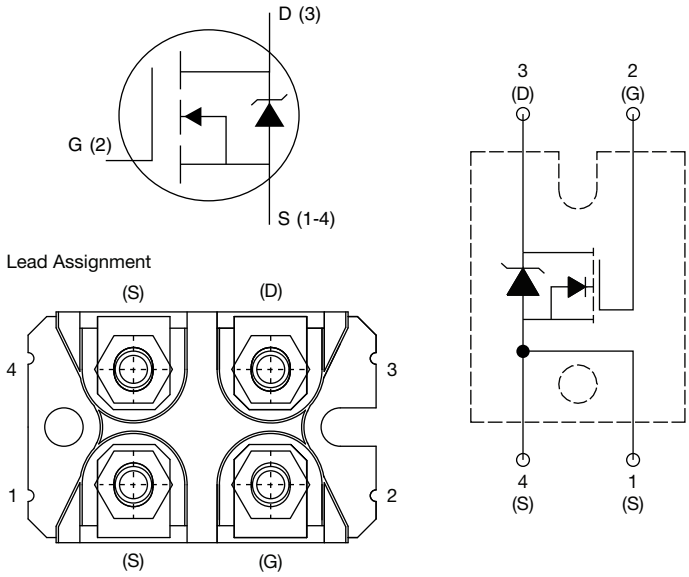
## ORDERING INFORMATION TABLE

| Device code | VS- | F | A | 40 | S | A | 50 | LC |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

1 - Vishay Semiconductors product
2 - Power MOSFET
3 - A = generation 3, MOSFET silicon die
4 - Current rating (40 = 40 A)
5 - Single switch
6 - Package indicator (SOT-227)
7 - Voltage rating (50 = 500 V)
8 - LC = low charge

| CIRCUIT CONFIGURATION | | |
|---|---|---|
| **CIRCUIT** | **CIRCUIT CONFIGURATION CODE** | **CIRCUIT DRAWING** |
| Single switch | S |   |

| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95423 |
| Packaging information | www.vishay.com/doc?95425 |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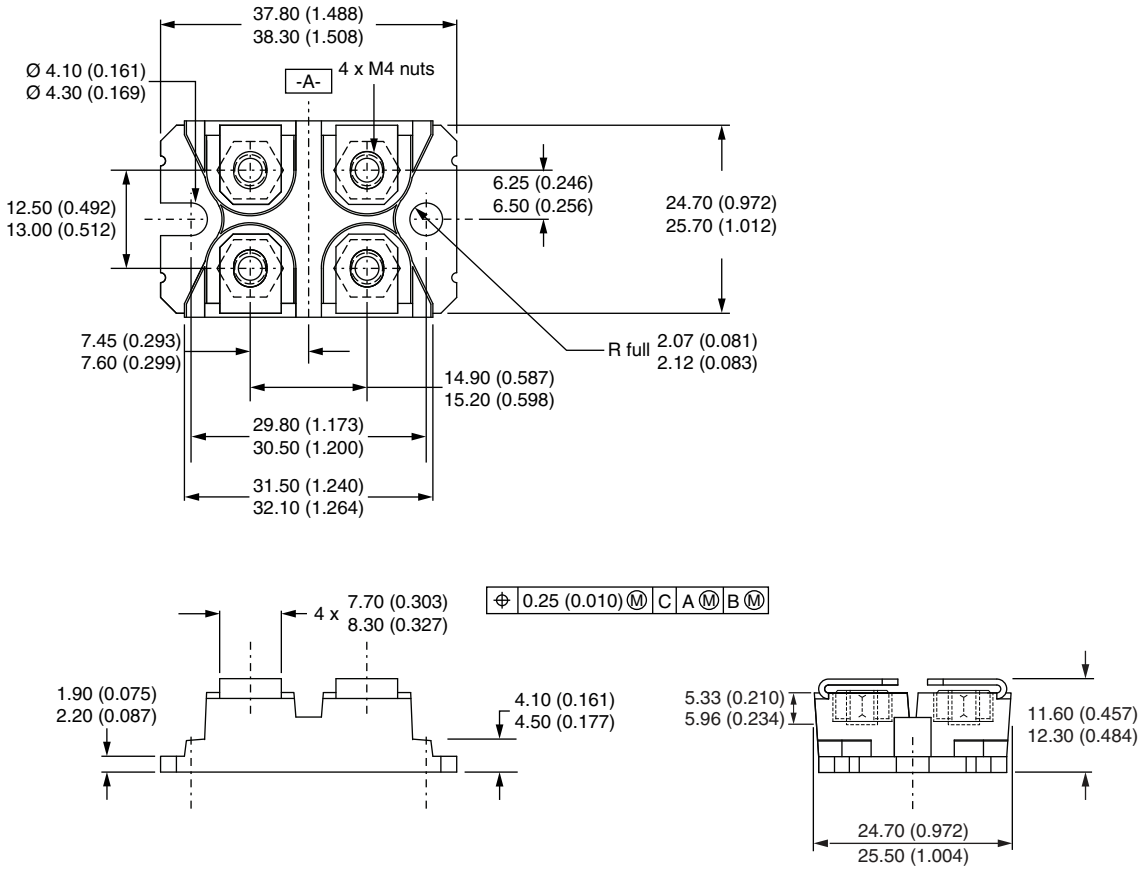
# SOT-227 Generation 2

**DIMENSIONS** in millimeters (inches)




**Note**

- Controlling dimension: millimeter



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