# SOT-227 Power Module
# Single Switch - Power MOSFET, 220 A

SOT-227

## FEATURES

- Enhanced body diode dV/dt and $dI_F/dt$ capability
- Improved gate avalanche and dynamic dV/dt ruggedness
- Fully characterized capacitance and avalanche SOA
- Fully isolated package
- Easy to use and parallel
- Low on-resistance
- Simple drive requirements
- UL approved file E78996
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

## APPLICATIONS

- High efficiency synchronous rectification SMPS
- Uninterruptible power supply
- High speed power switching
- Hard switched and high frequency circuits

## DESCRIPTION

This generation of 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 400 W to 700 W. The low thermal resistance of the SOT-227 contribute to its wide acceptance throughout the industry.

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{DSS}$ | 200 V |
| $R_{DS(on)}$ | 4.8 mΩ |
| $I_D$ | 220 A |
| Type | Modules - MOSFET |
| Package | SOT-227 |

| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
| **MOSFET** | | | | |
| Drain to source voltage | $V_{DSS}$ | | 200 | V |
| Continuous drain current at $V_{GS}$ 10 V | $I_D$ (1) | $T_C$ = 25 °C | 220 | A |
| | | $T_C$ = 100 °C | 158 | |
| Pulsed drain current | $I_{DM}$ (2) | | 520 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 789 | W |
| | | $T_C$ = 100 °C | 395 | |
| Gate to source voltage | $V_{GS}$ | | ± 30 | V |
| Single pulse avalanche energy | $E_{AS}$ (3) | | 1200 | mJ |
| Avalanche current | $I_{AR}$ (4) | | 70 | A |
| Repetitive avalanche energy | $E_{AR}$ (4) | | 600 | mJ |
| **MODULE** | | | | |
| Operating junction temperature range | $T_J$ | | -55 to +175 | °C |
| Operating storage temperature range | $T_{Stg}$ | | -55 to +175 | |
| Insulation withstand voltage (AC-RMS) | $V_{ISOL}$ | | 2.5 | kV |

**Notes**

(1) Maximum continuous drain current at $V_{GS}$ 10 V must be limited to 100 A to do not exceed the maximum temperature of power terminals

(2) Repetitive rating; pulse width limited by maximum junction temperature

(3) Limited by $T_J$ max., starting $T_J$ = 25 °C, L = 0.23 mH, $R_g$ = 25 Ω, $I_{AS}$ = 102 A, $V_{GS}$ = 10 V. Part not recommended for use above this value

(4) Repetitive rating; pulse width limited by maximum junction temperature starting $T_J$ = 25 °C, L = 0.23 mH, $R_g$ = 25 Ω, $V_{GS}$ = 10 V, duty cycle 1 %

| THERMAL - MECHANICAL SPECIFICATIONS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Junction and storage temperature range | $T_J$, $T_{Stg}$ | | -55 | - | 175 | °C |
| Junction to case | $R_{thJC}$ | | - | - | 0.19 | °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 specified) | | | | | | |
|---|---|---|---|---|---|---|
| **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 | 200 | - | - | V |
| Breakdown voltage temperature coefficient | $\Delta V_{(BR)DSS}/\Delta T_J$ | Reference to 25 °C, $I_D$ = 1.0 mA | - | 0.21 | - | V/°C |
| Static drain to source on-resistance | $R_{DS(on)}$ (1) | $V_{GS}$ = 10 V, $I_D$ = 150 A | - | 4.8 | 7.0 | mΩ |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 500 µA | 3 | 4 | 5.1 | V |
| | | $V_{DS}$ = $V_{GS}$, $I_D$ = 500 µA, $T_J$ = 125 °C | - | 2.5 | - | |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 20 V, $I_D$ = 150 A | - | 385 | - | S |
| Gate resistance, internal | $R_g$ | | - | 2 | - | Ω |
| Drain to source leakage current | $I_{DSS}$ | $V_{DS}$ = 200 V, $V_{GS}$ = 0 V | - | 1 | 50 | µA |
| | | $V_{DS}$ = 200 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | 40 | 1000 | |
| | | $V_{DS}$ = 200 V, $V_{GS}$ = 0 V, $T_J$ = 175 °C | - | 2 | 10 | mA |
| Gate to source forward leakage | $I_{GSS}$ | $V_{GS}$ = 20 V | - | - | 250 | nA |
| Gate to source reverse leakage | | $V_{GS}$ = -20 V | - | - | -250 | |
| Total gate charge | $Q_g$ | $I_D$ = 150 A, $V_{DS}$ = 100 V, $V_{GS}$ = 10 V, see fig.15 and fig.19 (1) | - | 350 | - | nC |
| Gate to source charge | $Q_{gs}$ | | - | 120 | - | |
| Gate to drain (“Miller”) charge | $Q_{gd}$ | | - | 110 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 120 V, $I_D$ = 150 A, $R_g$ = 5 Ω, L = 500 µH, diode used: 20CZU02 | - | 360 | - | ns |
| Rise time | $t_r$ | | - | 245 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 205 | - | |
| Fall time | $t_f$ | | - | 220 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 120 V, $I_D$ = 150 A, $R_g$ = 5 Ω, L = 500 µH, $T_J$ = 125 °C, diode used: 20CZU02 | - | 350 | - | ns |
| Rise time | $t_r$ | | - | 243 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 210 | - | |
| Fall time | $t_f$ | | - | 175 | - | |
| Internal source inductance | $L_S$ | Between lead, and center of die contact | - | 5 | - | nH |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 50 V, f = 1.0 MHz, see fig.14 | - | 21 000 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 1600 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 320 | - | |
| Drain to case capacitance | $C_{d-cs}$ | $V_{GS}$ = 0 V, (G-S shortened); f = 1 MHz | - | 43 | - | |

| SOURCE-DRAIN RATINGS AND CHARACTERISTICS ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| 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 | - | - | 220 | A |
| Pulsed source current (body diode) | $I_{SM}$ (1) | | - | - | 520 | |
| Diode forward voltage | $V_{SD}$ (2) | $T_J$ = 25 °C, $I_S$ = 150 A, $V_{GS}$ = 0 V | - | 0.87 | 1.0 | V |
| | | $T_J$ = 125 °C, $I_S$ = 150 A, $V_{GS}$ = 0 V | - | 0.75 | - | |
| | | $T_J$ = 175 °C, $I_S$ = 150 A, $V_{GS}$ = 0 V | - | 0.70 | - | |
| Reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 50 A, $dI_F/dt$ = 100 A/µs, $V_R$ = 100 V (2) | - | 170 | - | ns |
| Reverse recovery current | $I_{rr}$ | | - | 12 | - | A |
| Reverse recovery charge | $Q_{rr}$ | | - | 1060 | - | nC |
| Reverse recovery time | $t_{rr}$ | $T_J$ = 125 °C, $I_F$ = 50 A, $dI_F/dt$ = 100 A/µs, $V_R$ = 100 V (2) | - | 200 | - | ns |
| Reverse recovery current | $I_{rr}$ | | - | 15 | - | A |
| Reverse recovery charge | $Q_{rr}$ | | - | 1550 | - | nC |
| Forward turn-on time | $t_{on}$ | Intrinsic turn-on time is negligible (turn-on is dominated by LS + LD) | | | | |

**Notes**

(1) Repetitive rating; pulse width limited by maximum junction temperature

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

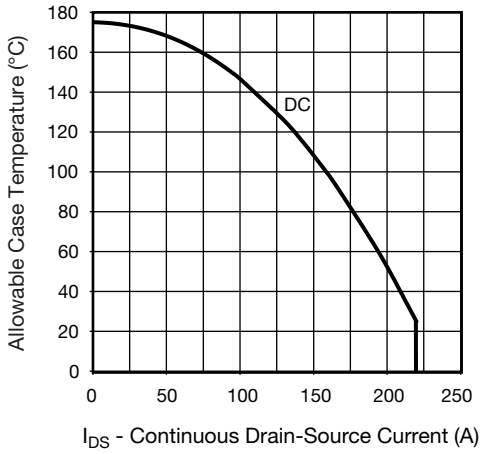



Fig. 1 - Maximum DC MOSFET Drain-Source Current vs. Case Temperature

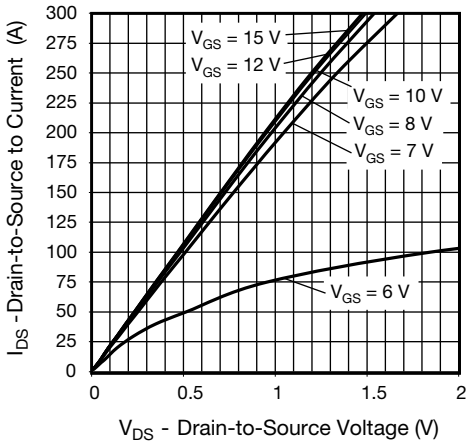



Fig. 3 - Typical Drain-to-Source Current Output Characteristics, at $T_J$ = 25 °C

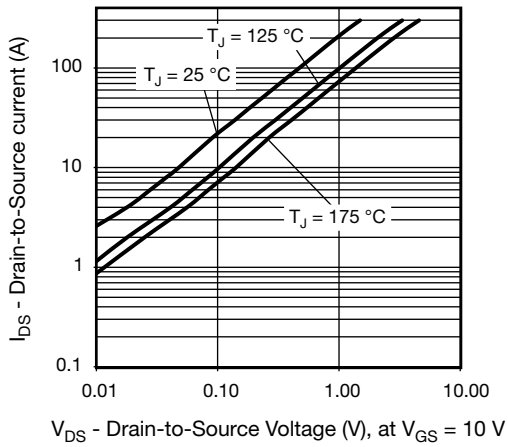



Fig. 2 - Typical Drain-to-Source Current Output Characteristics, $V_{GS}$ = 10 V

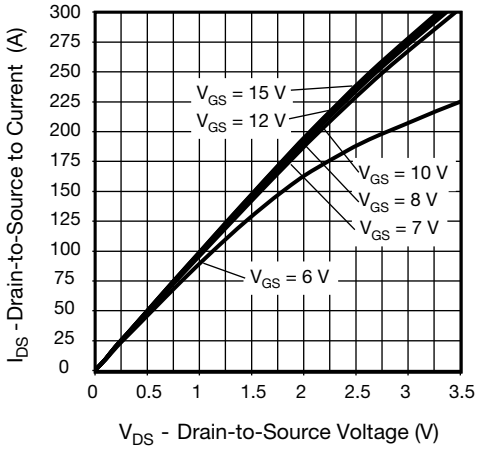



Fig. 4 - Typical Drain-to-Source Current Output Characteristics, at $T_J$ = 125 °C

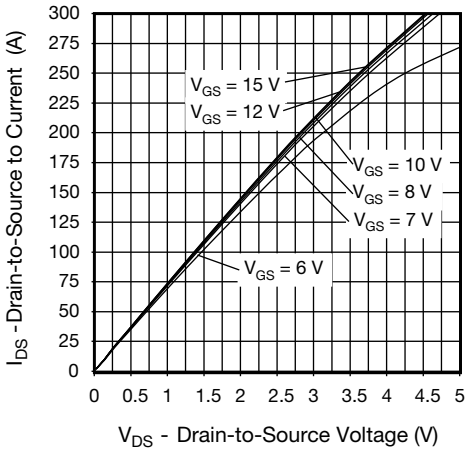



Fig. 5 - Typical Drain-to-Source Current Output Characteristics, at $T_J$ = 175 °C

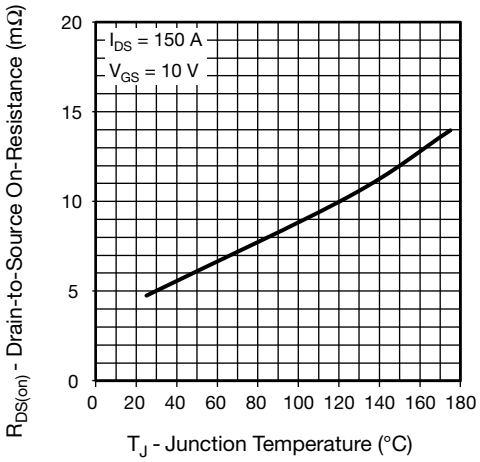



Fig. 6 - Typical Drain-to-Source On-Resistance vs. Temperature

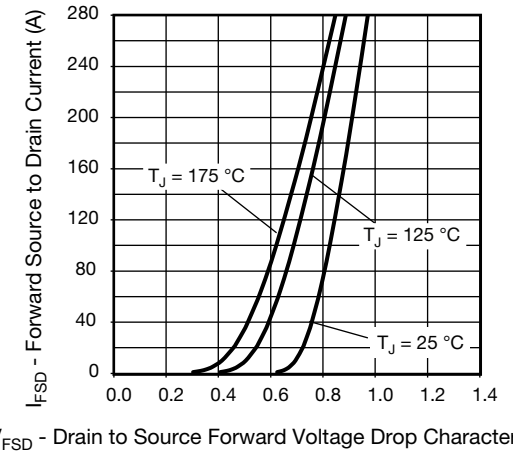



Fig. 7 - Typical Body Diode Forward Voltage Drop Characteristics

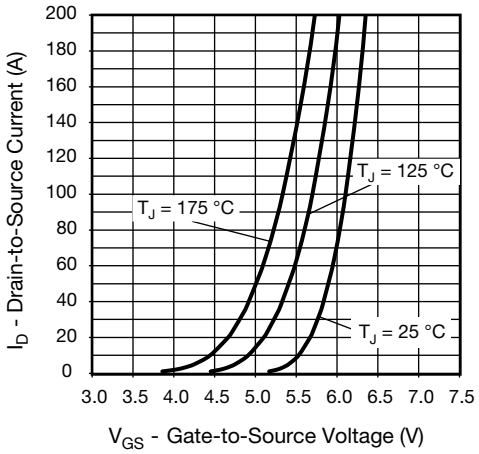



Fig. 8 - Typical MOSFET Transfer Characteristics

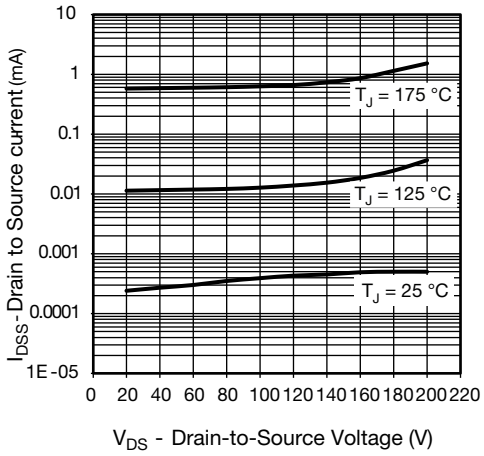



Fig. 9 - Typical MOSFET Zero Gate Voltage Drain Current

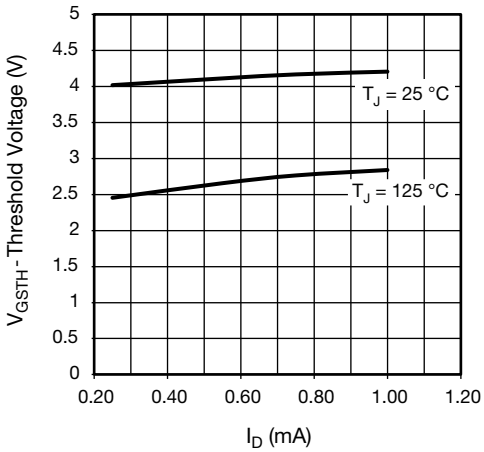



Fig. 10 - Typical MOSFET Threshold Voltage

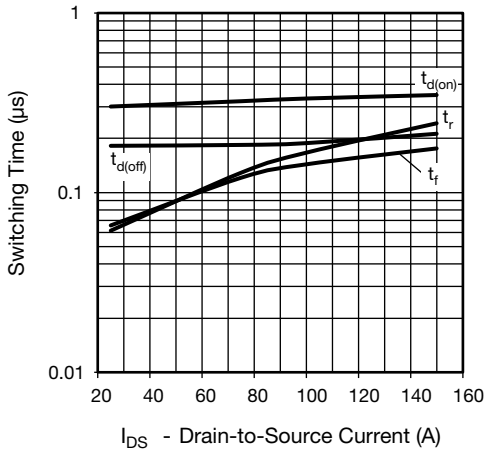



Fig. 11 - Typical MOSFET Switching Time vs. $I_{DS}$,
$T_J$ =125 °C, $V_{DD}$ = 120 V, $V_{GS}$ = 10 V, L = 500 µH, $R_g$ = 5 Ω
Diode Used: 20CZU02

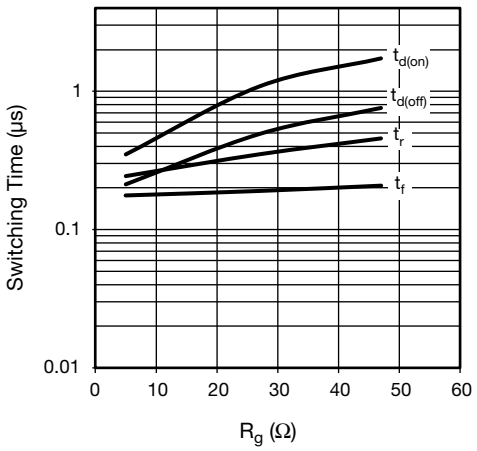



Fig. 12 - Typical MOSFET Switching Time vs. $R_g$,
$T_J$ =125 °C, $I_{DS}$ = 150 A, $V_{DD}$ = 120 V, $V_{GS}$ = 10 V, L = 500 µH
Diode Used: 20CZU02

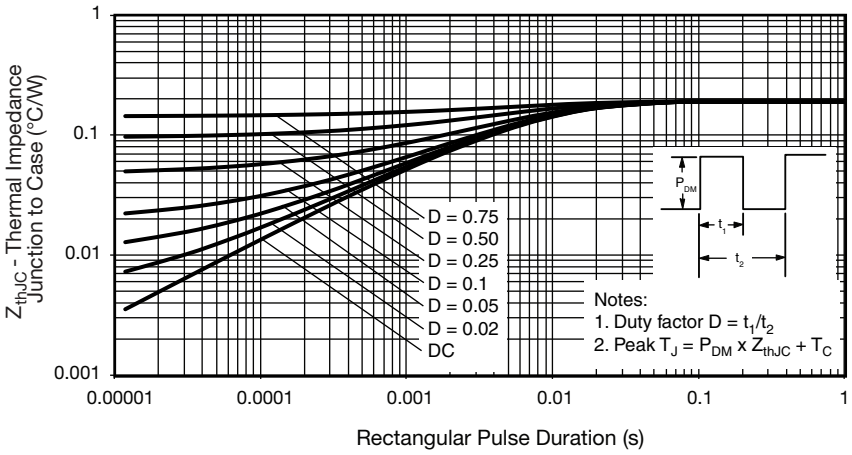



Fig. 13 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics, MOSFET

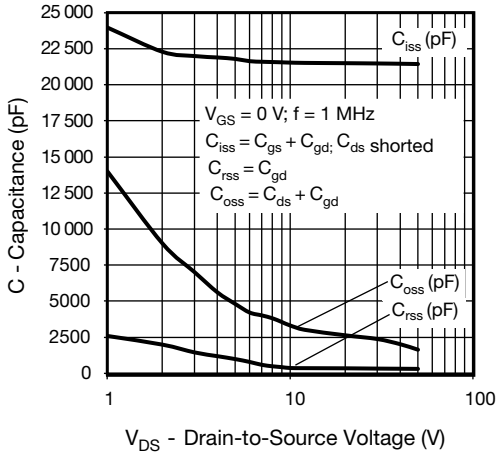



Fig. 14 - Typical Capacitance vs. Drain-to-Source Voltage

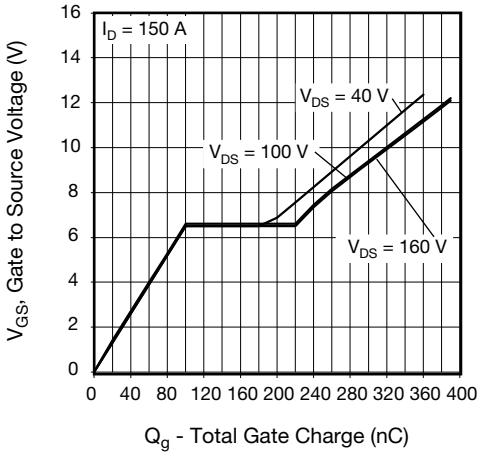



Fig. 15 - Typical Gate Charge vs. Gate-to-Source Voltage

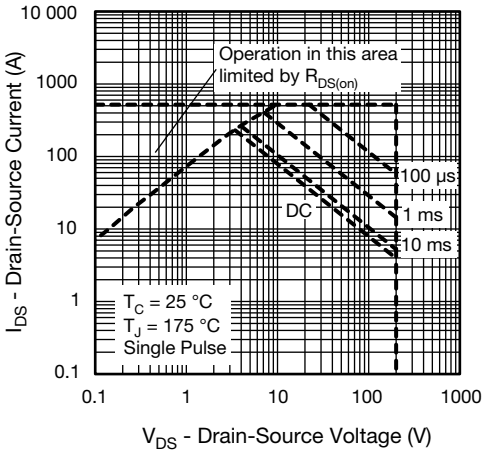



Fig. 16 - Maximum Safe Operating Area

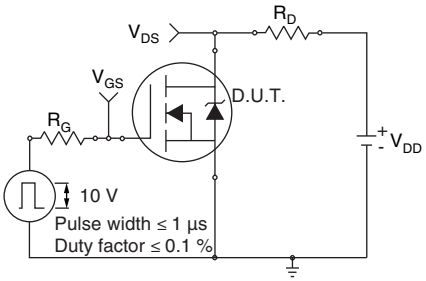



Fig. 17 - Switching Time Test Circuit

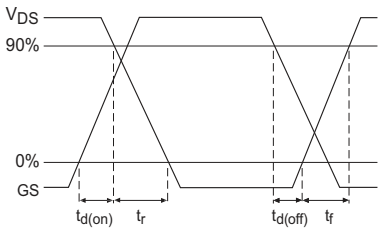



Fig. 18 - Switching Time Waveform

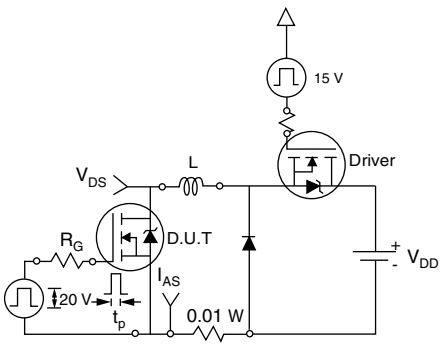



Fig. 19 - Unclamped Inductive Test Circuit

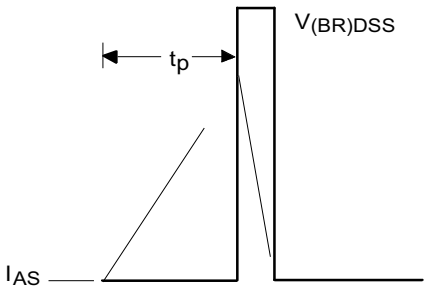



Fig. 20 - Unclamped Inductive Waveform

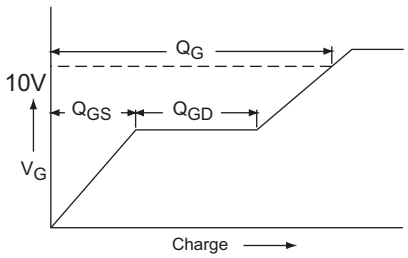



Fig. 21 - Basic Gate Charge Waveform

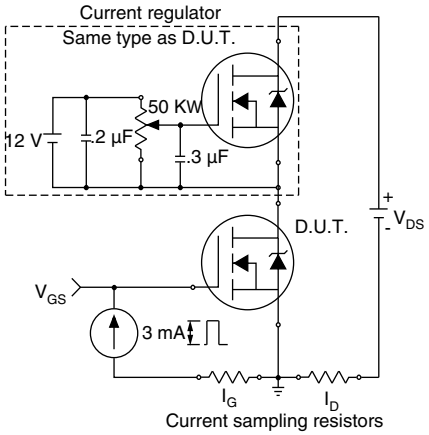



Fig. 22 - Gate Charge Test Circuit

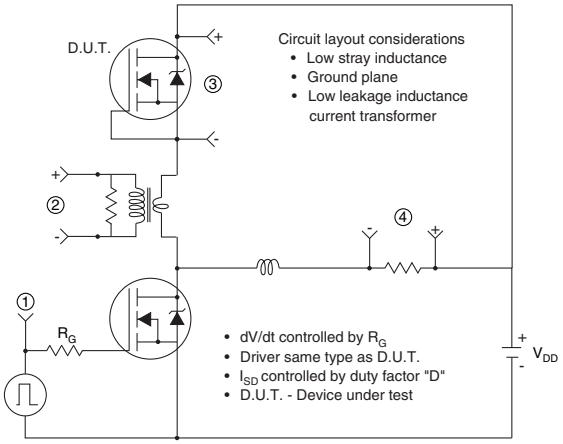
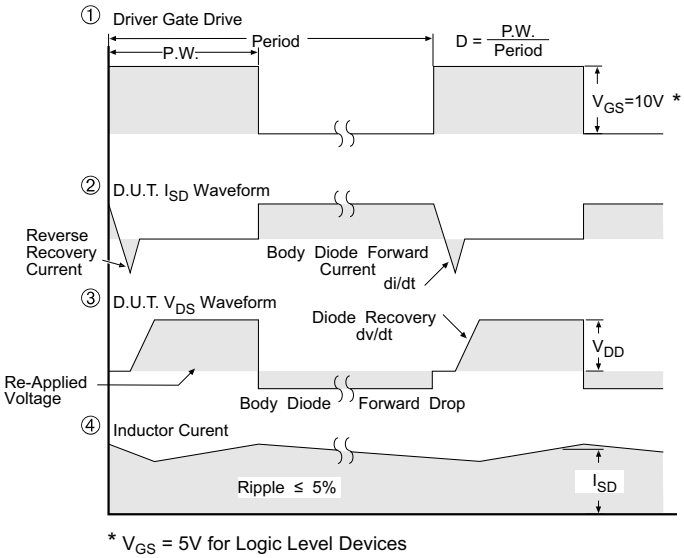



Fig. 23 - Peak Diode Recovery dV/dt Test Circuit




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

Fig. 24 - For N-Channel Power MOSFETs

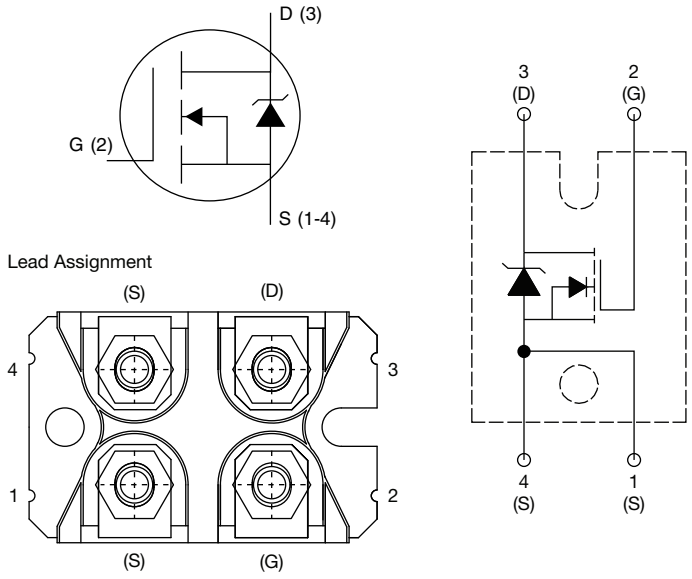
## ORDERING INFORMATION TABLE

Device code

| VS- | F | C | 220 | S | A | 20 |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- 1 - Vishay Semiconductors product
- 2 - MOSFET module
- 3 - MOSFET die generation
- 4 - Current rating (220 = 220 A)
- 5 - S = single switch
- 6 - Package indicator SOT-227
- 7 - Voltage rating (20 = 200 V)

## CIRCUIT CONFIGURATION

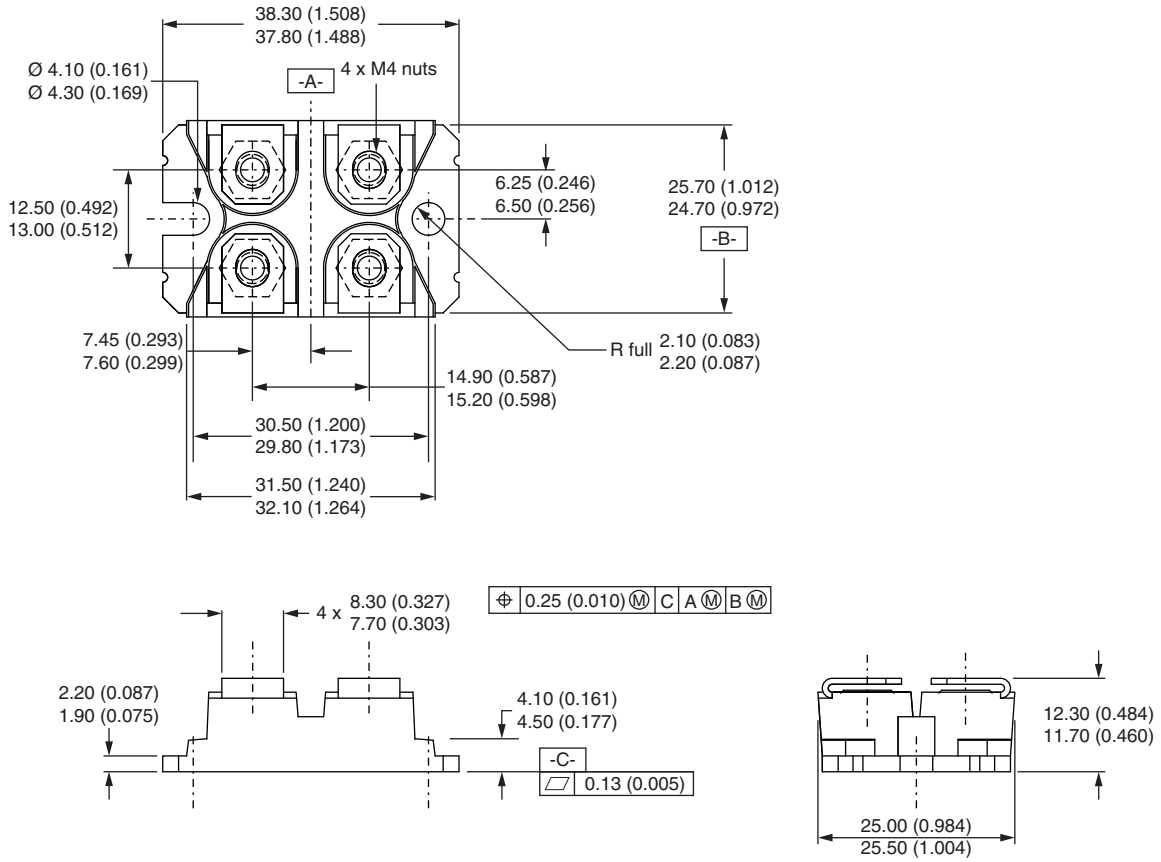
| CIRCUIT | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING |
|---|---|---|
| Single switch | S |  |



| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95423 |
| Packaging information | www.vishay.com/doc?95425 |

# SOT-227 Generation II

**DIMENSIONS** in millimeters (inches)




**Note**

- Controlling dimension: millimeter

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