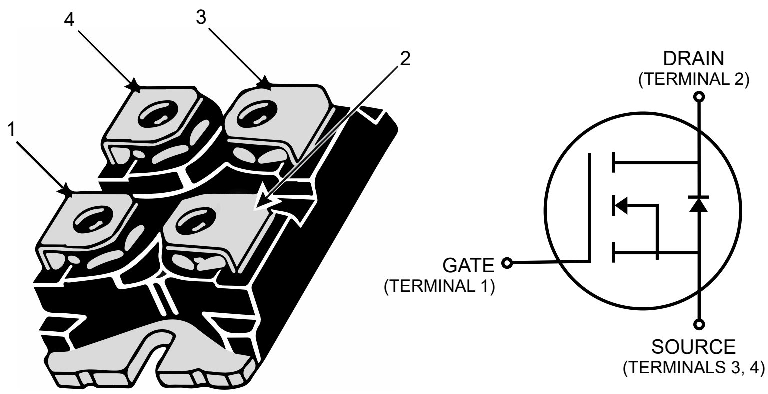
# 1200V, 80 mΩ N-Channel mSiC™ MOSFET

## MSC080SMA120J

## Product Overview

1200V, 80 mΩ typical at $V_{GS}$ = 20V, 90 mΩ typical at $V_{GS}$ = 18V, Silicon Carbide (SiC) N-Channel MOSFET, SOT-227.




### Features

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature, $T_{J(max)}$ = 175 °C
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant
- Isolated voltage to 2500V, UL certified file E145592

### Benefits

- High efficiency to enable lighter and more compact system
- Simple to drive and easy to parallel
- Improved thermal capabilities and lower switching losses
- Eliminates the need for external freewheeling diode
- Lower system cost of ownership

### Applications

- Photovoltaic (PV) inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- Hybrid Electric Vehicle (HEV) powertrain and Electric Vehicle (EV) charger
- Power supply and distribution

# 1. Device Specifications

This section shows the specifications of this device.

## 1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of this device.

**Table 1-1.** Absolute Maximum Ratings

| Symbol | Parameter | Ratings | Unit |
|---|---|---|---|
| $V_{DSS}$ | Drain source voltage | 1200 | V |
| $I_D$ | Continuous drain current at $T_C$ = 25 °C | 34 | A |
| | Continuous drain current at $T_C$ = 100 °C | 24 | |
| $I_{DM}$ | Pulsed drain current[1] | 111 | |
| $V_{GS}$ | Gate-source voltage | 23 to –10 | V |
| | Transient gate-source voltage | 25 to –12 | |
| $P_D$ | Total power dissipation at $T_C$ = 25 °C | 165 | W |
| | Linear derating factor | 1 | W/°C |

**Note:**

1. Repetitive rating: pulse width and case temperature are limited by the maximum junction temperature.

The following table shows the thermal and mechanical characteristics of this device.

**Table 1-2.** Thermal and Mechanical Characteristics

| Symbol | Characteristic/Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-case thermal resistance | — | 0.7 | 0.91 | °C/W |
| $T_J$ | Operating junction temperature | –55 | — | 175 | °C |
| $T_{STG}$ | Storage temperature | –55 | — | 150 | |
| $V_{ISOLATION}$ | RMS voltage (50 Hz–60 Hz sinusoidal waveform from terminals to mounting base for 1 minute) | 2500 | — | — | V |
| $\tau_M$ | Mounting torque, M3 screw for heat sink attachment (requires 2, not included) | — | 0.8 | — | N·m |
| $\tau_T$ | Terminal screw torque, M4 screw (4 included) | — | — | 1.1 | N·m |
| Wt | Package weight | — | 29.2 | — | g |

ESD practices should comply with JESD-625.

## 1.2 Electrical Performance

The following table shows the static characteristics of this device. $T_J$ = 25 °C unless otherwise specified.

**Table 1-3.** Static Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS}$ = 0V, $I_D$ = 100 µA | 1200 | — | — | V |
| $R_{DS(on)}$ | Drain-source on resistance[1] | $V_{GS}$ = 20V, $I_D$ = 15A | — | 80 | 100 | mΩ |
| | | $V_{GS}$ = 18V, $I_D$ = 15A | — | 90 | — | |
| $V_{GS(th)}$ | Gate-source threshold voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 1 mA | 1.9 | 3.0 | 5.0 | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{DS}$ = 1200V, $V_{GS}$ = 0V | — | 0.2 | 30 | µA |
| | | $V_{DS}$ = 1200V, $V_{GS}$ = 0V, $T_J$ = 175 °C | — | 2 | — | |
| $I_{GSS}$ | Gate-source leakage current | $V_{GS}$ = 20V/–10V | — | — | ±100 | nA |

**Note:**

1. Pulse test: pulse width < 380 μs, duty cycle < 2%.

The following table shows the dynamic characteristics of this device. $T_J$ = 25 °C unless otherwise specified. The dynamic characteristics are characterized, not 100% tested, at the recommended operating $V_{GS}$ = 20V/–5V.

**Table 1-4.** Dynamic Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{GS}$ = 0V<br>$V_{DD}$ = 1000V<br>$V_{AC}$ = 25 mV<br>$f$ = 200 kHz | — | 1031 | — | pF |
| $C_{rss}$ | Reverse transfer capacitance | | — | 6 | — | |
| $C_{oss}$ | Output capacitance | | — | 92 | — | |
| $Q_G$ | Total gate charge | $V_{GS}$ = –5V/20V<br>$V_{DD}$ = 800V<br>$I_D$ = 15A | — | 64 | — | nC |
| $Q_{GS}$ | Gate-source charge | | — | 12 | — | |
| $Q_{GD}$ | Gate-drain charge | | — | 19 | — | |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 850V<br>$V_{GS}$ = –5V/20V<br>$I_D$ = 20A<br>$R_{G(ext)}$ = 4Ω<br>Freewheeling diode = MSC080SMA120J ($V_{GS}$ = –5V); reference Figure 1-19 | — | 14 | — | ns |
| $t_r$ | Voltage rise time | | — | 13 | — | |
| $t_{d(off)}$ | Turn-off delay time | | — | 19 | — | |
| $t_f$ | Voltage fall time | | — | 13 | — | |
| $E_{on}$ | Turn-on switching energy | | — | 350 | — | μJ |
| $E_{off}$ | Turn-off switching energy | | — | 62 | — | |
| ESR | Gate equivalent series resistance | f = 1 MHz, 25 mV, drain short | — | 1.9 | — | Ω |
| SCWT | Short circuit withstand time | $V_{DS}$ = 960V, $V_{GS}$ = 20V | — | 3.0 | — | μs |
| $E_{AS}$ | Avalanche energy, single pulse | $I_D$ = 15A | — | 1300 | — | mJ |

The following table shows the body diode characteristics of this device. $T_J$ = 25 °C unless otherwise specified. The body diode reverse recovery is characterized, not 100% tested.

**Table 1-5.** Body Diode Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode forward voltage | $I_{SD}$ = 15A, $V_{GS}$ = 0V | — | 3.7 | — | V |
| | | $I_{SD}$ = 15A, $V_{GS}$ = –5V | — | 3.9 | 5.0 | |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 20A, $V_{GS}$ = –5V, Drive $R_G$ = 4Ω, $V_{DD}$ = 850V, dI/dt = –5200 A/μs | — | 22 | — | ns |
| $Q_{rr}$ | Reverse recovery charge | | — | 177 | — | nC |
| $I_{RRM}$ | Reverse recovery current | | — | 16 | — | A |

## 1.3 Typical Performance Curves

Data for performance curves are characterized, not 100% tested.

**Figure 1-1.** Drain Current vs. $V_{DS}$ at $T_J$

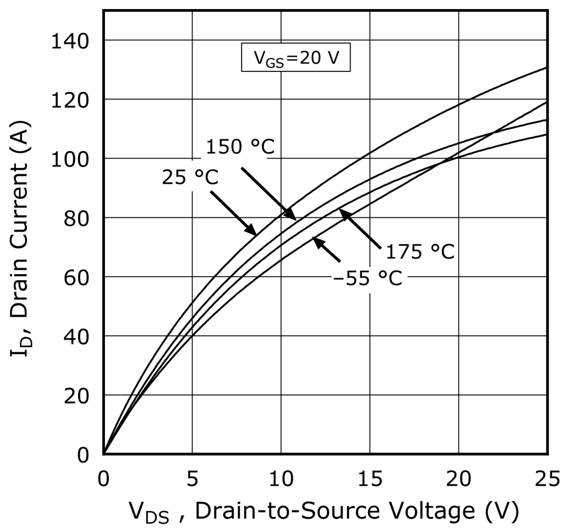



**Figure 1-2.** Drain Current vs. $V_{DS}$ at $V_{GS}$

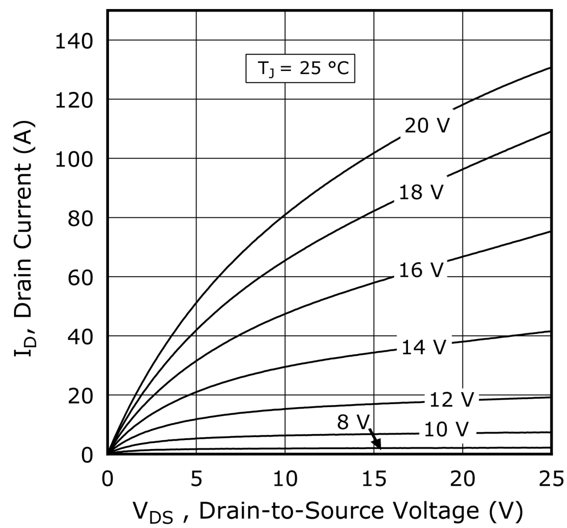



**Figure 1-3.** Drain Current vs. $V_{DS}$ at $V_{GS}$

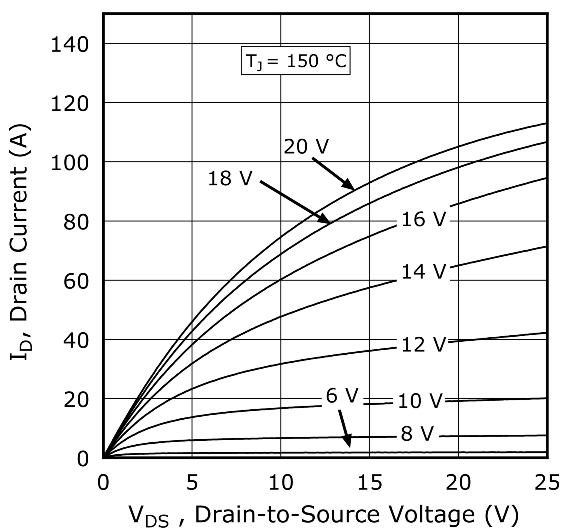



**Figure 1-4.** Drain Current vs. $V_{DS}$ at $V_{GS}$

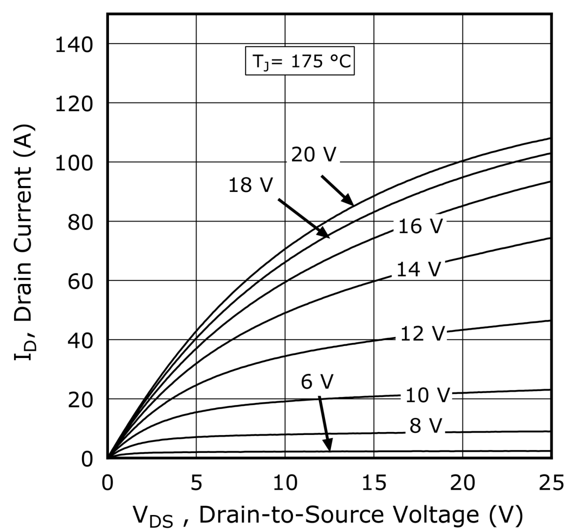


**Figure 1-5.** $R_{DS(on)}$ vs. Junction Temperature

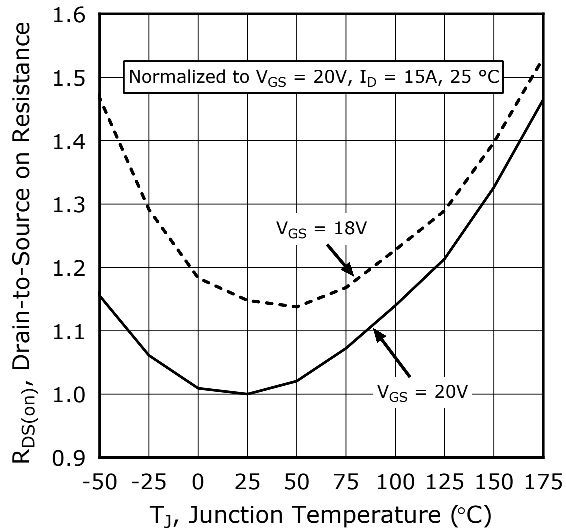



**Figure 1-6.** Gate Charge Characteristics

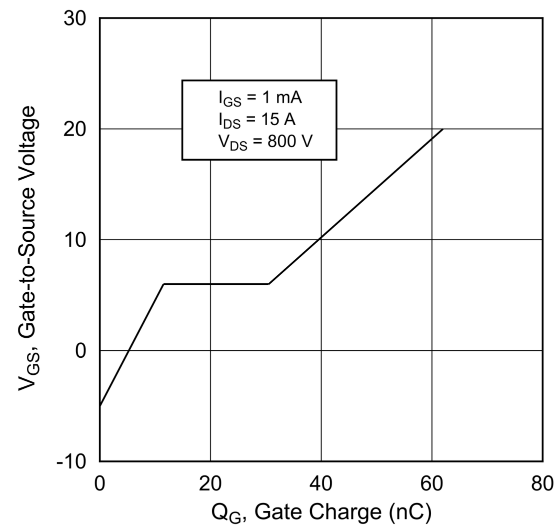



**Figure 1-7.** Capacitance vs. Drain-to-Source Voltage

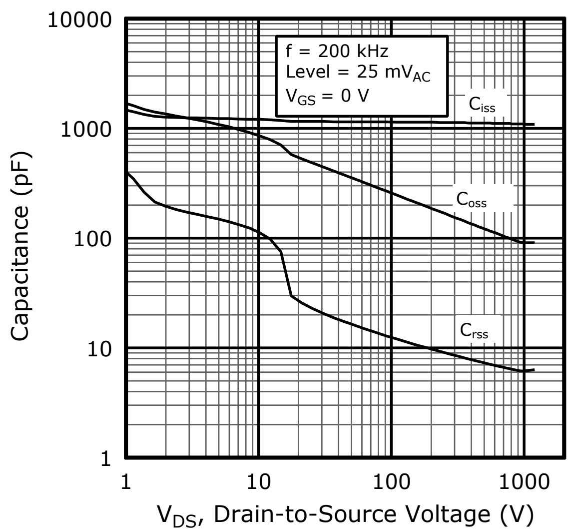



**Figure 1-8.** Output Charge vs. Drain-to-Source Voltage

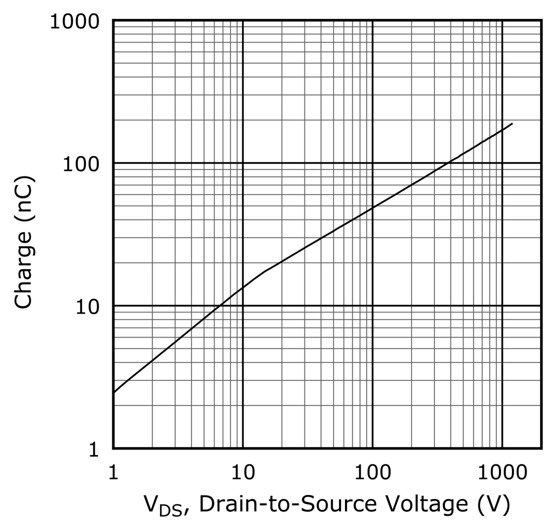


**Figure 1-9.** Output Stored Energy vs. $V_{DS}$

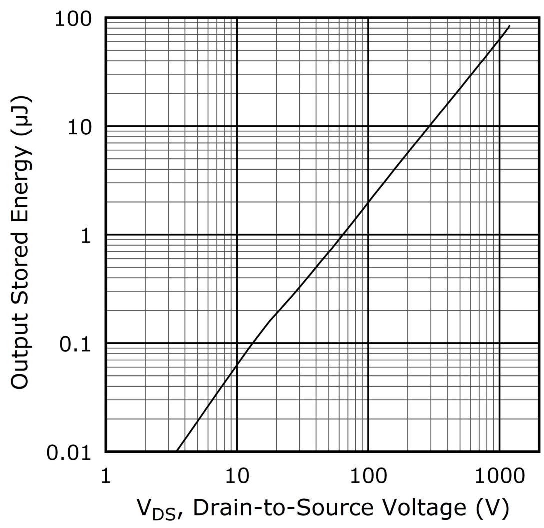



**Figure 1-10.** $I_D$ vs. $V_{DS}$ 3rd Quadrant Conduction

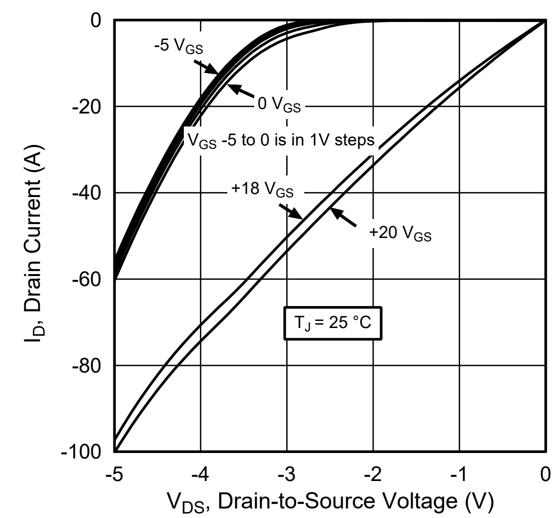



**Figure 1-11.** $I_D$ vs. $V_{DS}$ 3rd Quadrant Conduction

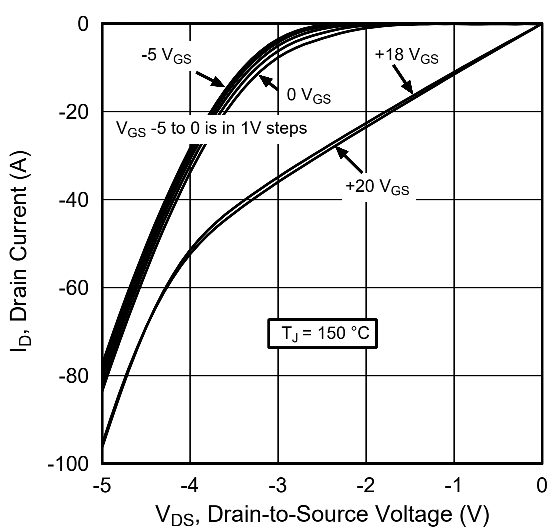



**Figure 1-12.** Switching Energy $E_{on}$ vs. $V_{DS}$ & $I_D$

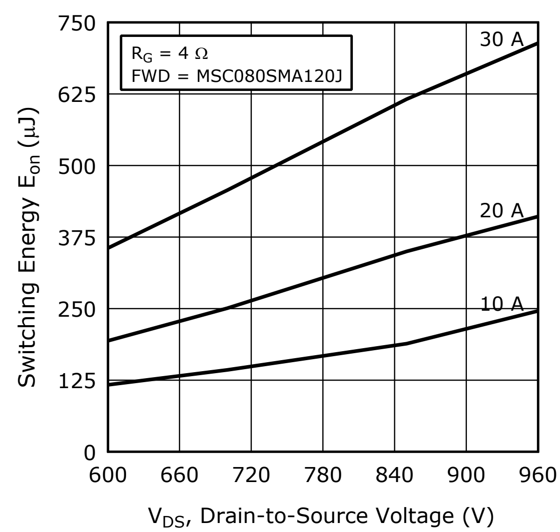


**Figure 1-13.** Switching Energy $E_{off}$ vs. $V_{DS}$ & $I_D$

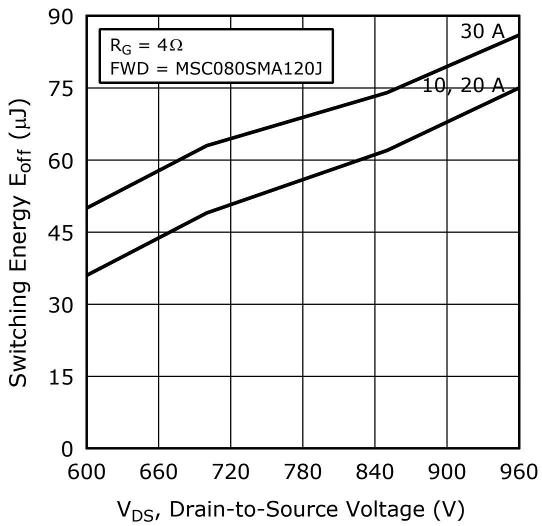



**Figure 1-14.** Switching Energy vs. $R_G$

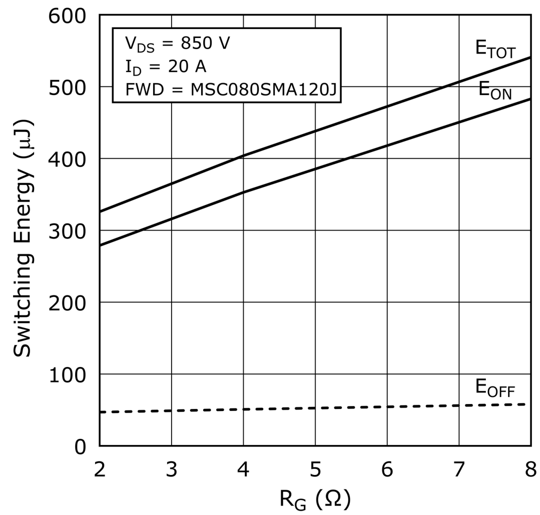



**Figure 1-15.** Switching Energy vs. Junction Temperature

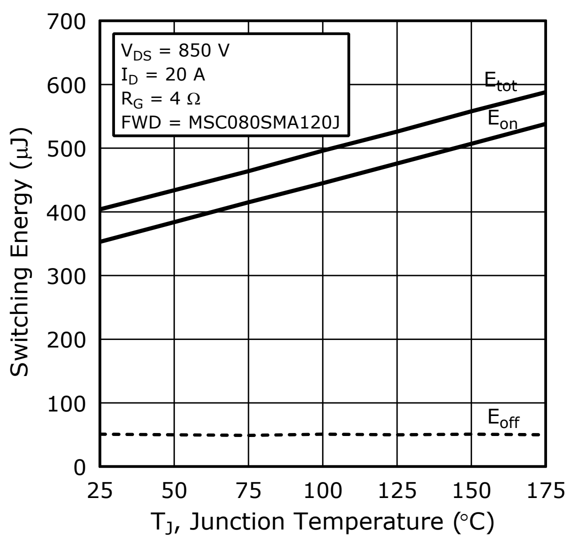



**Figure 1-16.** Threshold Voltage vs. Junction Temperature

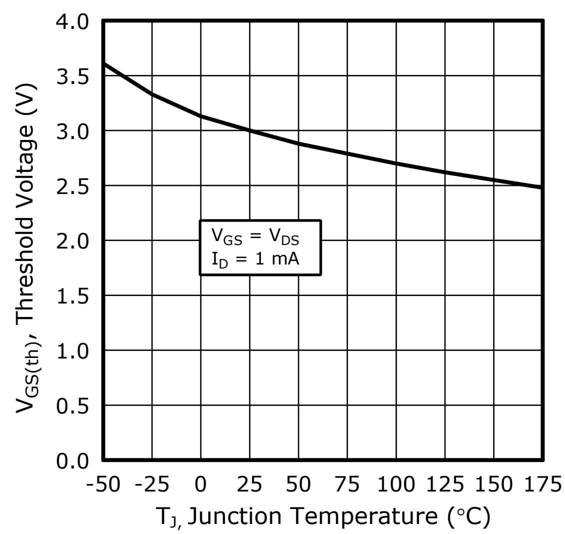


**Figure 1-17.** Forward Safe Operating Area

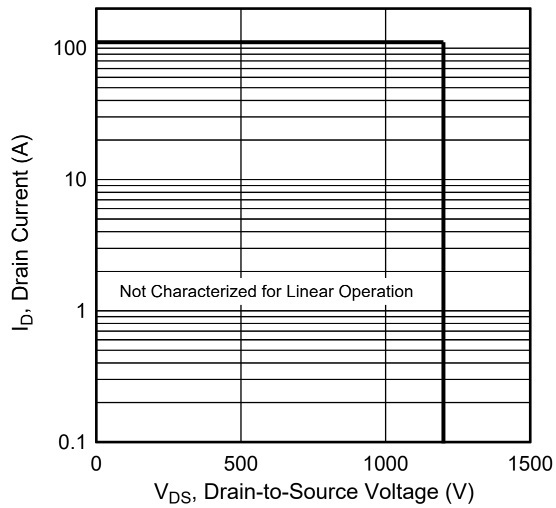
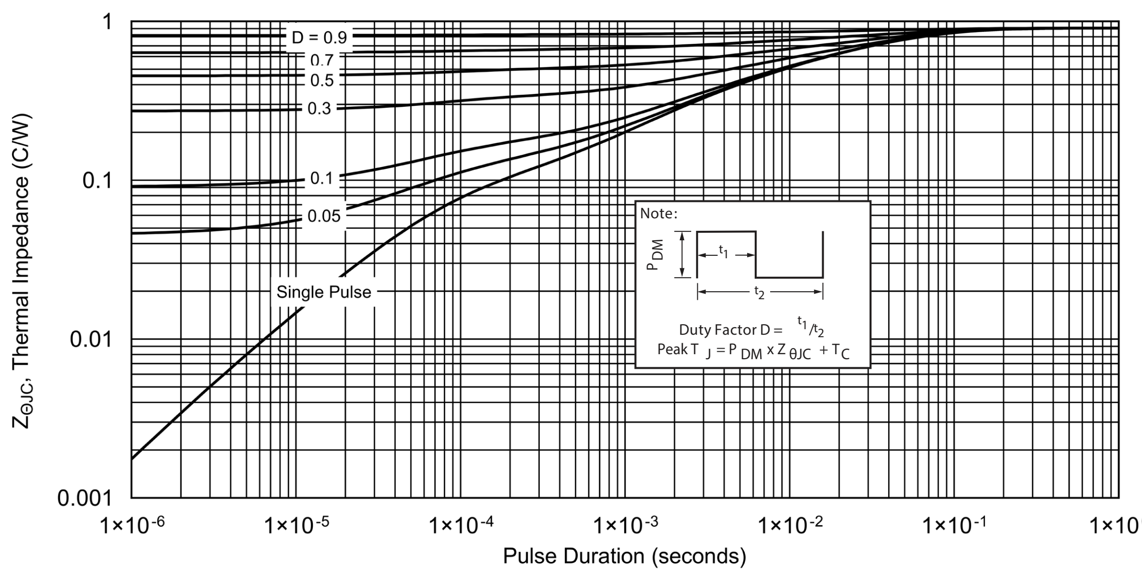
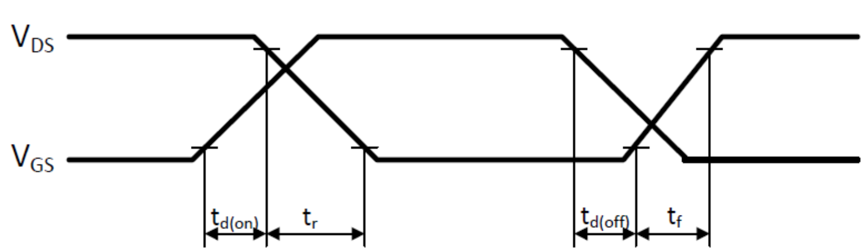



**Figure 1-18.** Maximum Transient Thermal Impedance




The following figure shows the switching waveform diagram of this device.

**Figure 1-19.** Switching Waveform



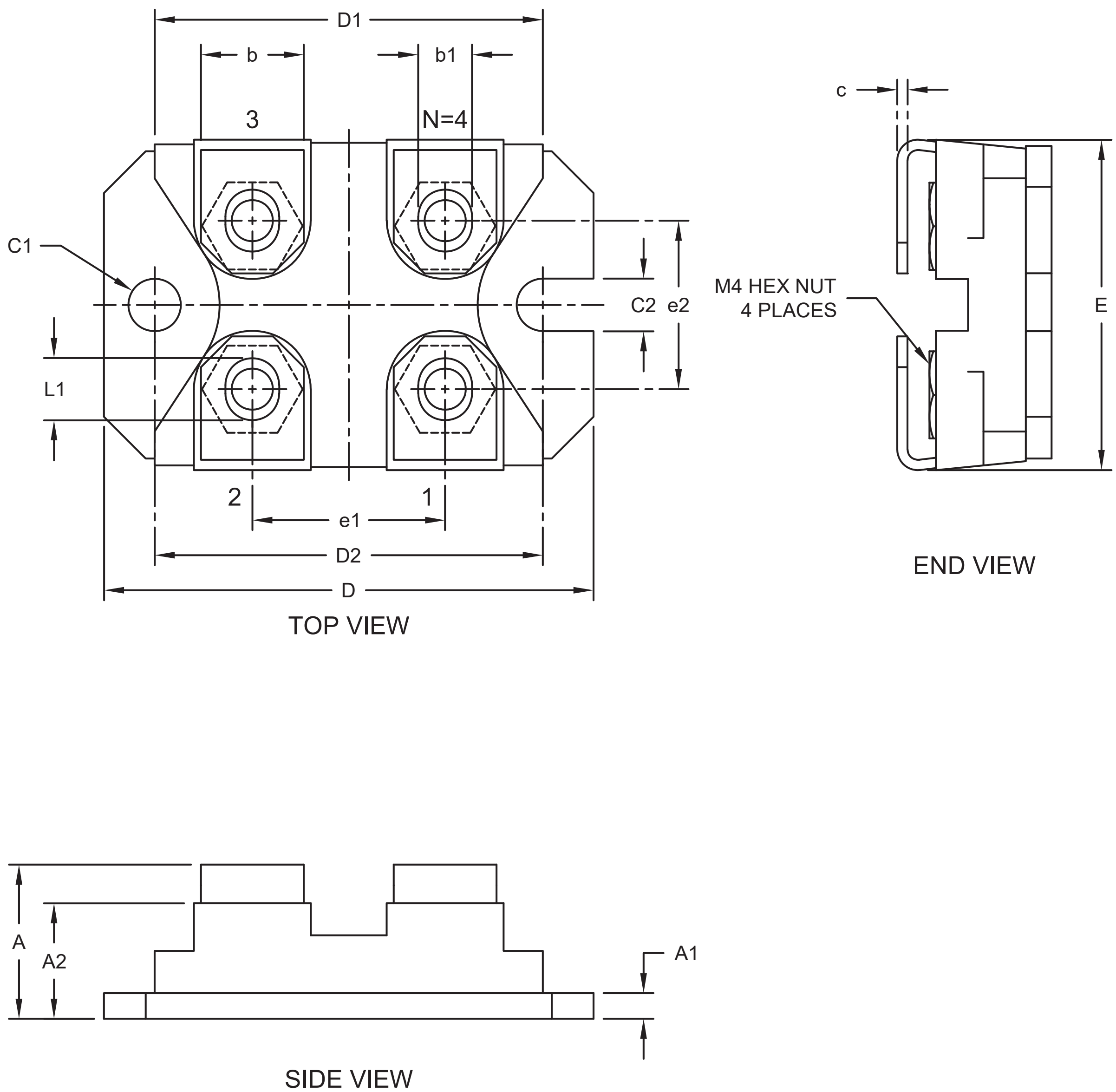
# 2. Package Specification

This section shows the package specification of this device.

## 2.1 Package Outline Drawing

The following figure illustrates the SOT-227 package outline of this device.

**Figure 2-1.** Package Outline Drawing




The following table shows the SOT-227 dimensions and should be used in conjunction with the package outline drawing.

**Table 2-1.** SOT-227 Dimensions

| Symbol | Description | Min. (mm) | Max. (mm) |
|---|---|---|---|
| N | Number of terminals | 4 | |
| e1 | Terminal pitch | 14.90 | 15.10 |

...........continued

| Symbol | Description | Min. (mm) | Max. (mm) |
|---|---|---|---|
| e2 | Terminal pitch | 12.60 | 12.88 |
| A | Overall height | 11.68 | 12.24 |
| A1 | Base plate thickness | 1.95 | 2.14 |
| A2 | Molded package thickness | 8.90 | 9.60 |
| D | Overall length | 37.95 | 38.20 |
| D1 | Molded package length | 31.50 | 31.90 |
| D2 | Mounting centers | 30.10 | 30.30 |
| E | Overall width | 25.15 | 25.40 |
| b | Terminal width | 7.80 | 8.20 |
| c | Terminal thickness | 0.75 | 0.85 |
| b1 | Terminal slot width | 4.10 | 4.30 |
| L1 | Terminal slot length | 4.72 | 4.90 |
| C1 | Mounting hole diameter | 4.00 | 4.29 |
| C2 | Mounting slot width | 4.00 | 4.29 |

# 3. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

**Table 3-1.** Revision History

| Revision | Date | Description |
|---|---|---|
| D | 07/2024 | The following changes are made in this revision of the document:<br>• Added $\tau_M$ and $\tau_T$ symbols for mounting torque in Table 1-2<br>• Updated Table 2-1 |
| C | 05/2024 | The following changes are made in this revision of the document:<br>• Added Figure 1-9. |
| B | 08/2023 | The following changes are made in this revision of the document:<br>• Updated values in Table 1-3<br>• Updated values in Table 1-5 |
| A | 06/2021 | Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00004138A, which replaces the previous Microsemi literature number 050-7767. |
| Initial release (Microsemi Revision A) | 02/2020 | Document created. |

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ISBN: 978-1-6683-0077-0

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