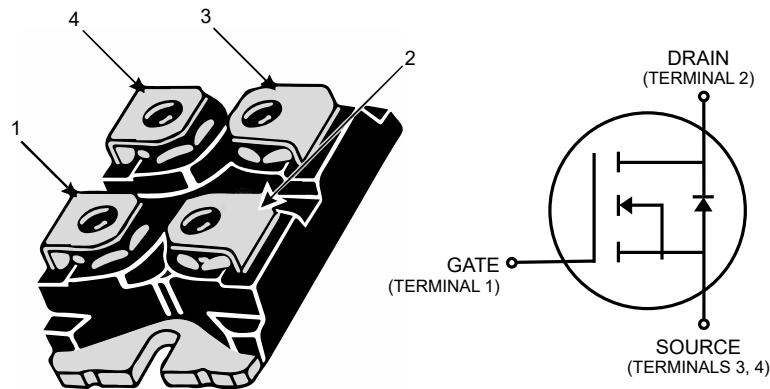



## Product Overview

1200V, 40 mΩ typical at  $V_{GS} = 20V$ , 45 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,  $T_{J(max)} = 175\text{ }^{\circ}\text{C}$
- 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 $T_C = 25\text{ }^{\circ}\text{C}$	57	A
	Continuous drain current at $T_C = 100\text{ }^{\circ}\text{C}$	41	
$I_{DM}$	Pulsed drain current <sup>1</sup>	215	
$V_{GS}$	Gate-source voltage	23 to -10	V
	Transient gate-source voltage	25 to -12	
$P_D$	Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	240	W
	Linear derating factor	1.6	

**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	—	0.48	0.62	$^{\circ}\text{C}/\text{W}$
$T_J$	Operating junction temperature	-55	—	175	$^{\circ}\text{C}$
$T_{STG}$	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.  $T_J = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

**Table 1-3.** Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{V}$ , $I_D = 100\text{ }\mu\text{A}$	1200	—	—	V
$R_{DS(on)}$	Drain-source on resistance <sup>1</sup>	$V_{GS} = 20\text{V}$ , $I_D = 40\text{A}$	—	40	50	$\text{m}\Omega$
		$V_{GS} = 18\text{V}$ , $I_D = 40\text{A}$	—	45	—	
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 2\text{ mA}$	1.9	3.0	5.0	V
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 1200\text{V}$ , $V_{GS} = 0\text{V}$	—	0.2	30	$\mu\text{A}$
		$V_{DS} = 1200\text{V}$ , $V_{GS} = 0\text{V}$ , $T_J = 175\text{ }^{\circ}\text{C}$	—	2.0	—	
$I_{GSS}$	Gate-source leakage current	$V_{GS} = 20\text{V}/-10\text{V}$	—	—	$\pm 100$	nA

**Note:**

1. Pulse test: pulse width < 380  $\mu$ s, duty cycle < 2%.

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

**Table 1-4. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{V}$	—	1962	—	pF
$C_{rss}$	Reverse transfer capacitance	$V_{DD} = 1000\text{V}$	—	11	—	
$C_{oss}$	Output capacitance	$V_{AC} = 25\text{ mV}$ $f = 200\text{ kHz}$	—	164	—	
$Q_G$	Total gate charge	$V_{GS} = -5\text{V}/20\text{V}$	—	137	—	nC
$Q_{GS}$	Gate-source charge	$V_{DD} = 800\text{V}$	—	29	—	
$Q_{GD}$	Gate-drain charge	$I_D = 40\text{A}$	—	31	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{V}$	—	30	—	ns
$t_r$	Voltage rise time	$V_{GS} = -5\text{V}/20\text{V}$	—	11	—	
$t_{d(off)}$	Turn-off delay time	$I_D = 30\text{A}$	—	29	—	
$t_f$	Voltage fall time	$R_{G(ext)} = 8\Omega$	—	16	—	
$E_{on}$	Turn-on switching energy	Freewheeling diode = MSC040SMA120J ( $V_{GS} = -5\text{V}$ ); reference <a href="#">Figure 1-19</a>	—	823	—	$\mu$ J
$E_{off}$	Turn-off switching energy		—	182	—	
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}$ , 25 mV, drain short	—	1.2	—	$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 960\text{V}$ , $V_{GS} = 20\text{V}$	—	3.0	—	$\mu$ s
$E_{AS}$	Avalanche energy, single pulse	$I_D = 40\text{A}$	—	2600	—	mJ

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

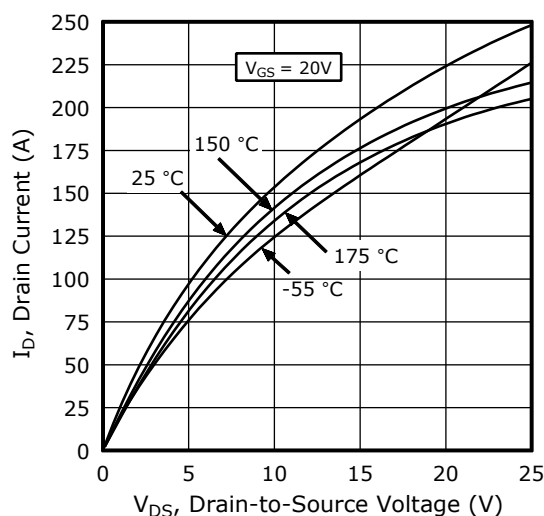
**Table 1-5. Body Diode Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 40\text{A}$ , $V_{GS} = 0\text{V}$	—	3.9	—	V
		$I_{SD} = 40\text{A}$ , $V_{GS} = -5\text{V}$	—	4.1	5.0	
$t_{rr}$	Reverse recovery time	$I_{SD} = 30\text{A}$ , $V_{GS} = -5\text{V}$ , Drive $R_G = 4\Omega$ , $V_{DD} = 800\text{V}$ , $dI/dt = -5300\text{ A}/\mu\text{s}$	—	32	—	ns
$Q_{rr}$	Reverse recovery charge		—	322	—	nC
$I_{RRM}$	Reverse recovery current		—	19	—	A

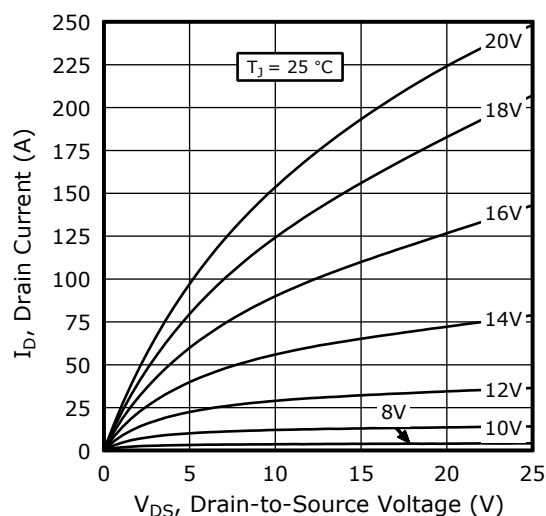
## 1.3 Typical Performance Curves

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

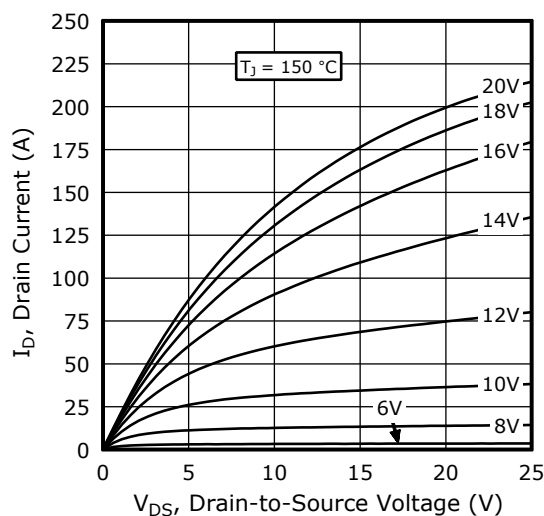
**Figure 1-1.** Drain Current vs.  $V_{DS}$  at  $T_J$



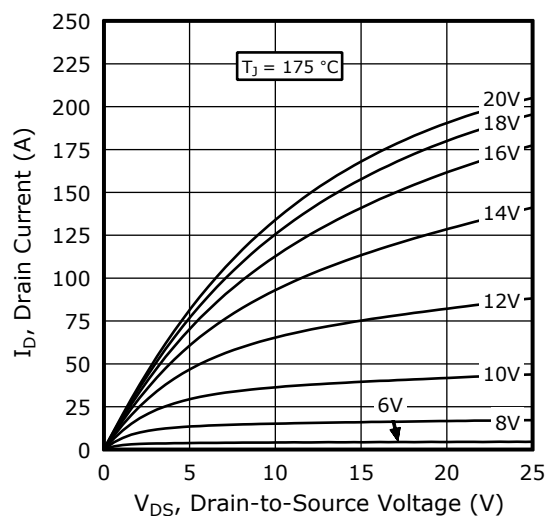
**Figure 1-2.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



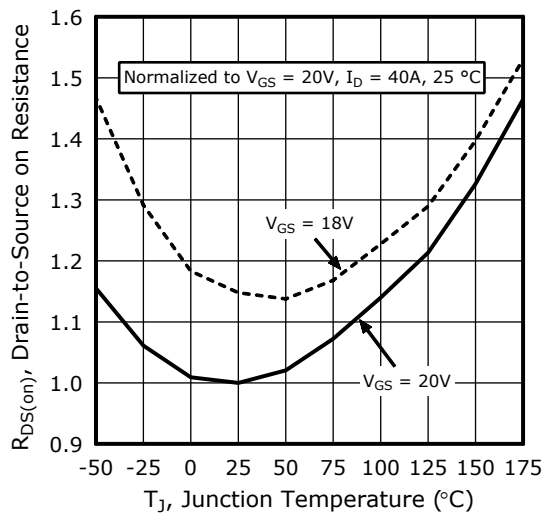
**Figure 1-3.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



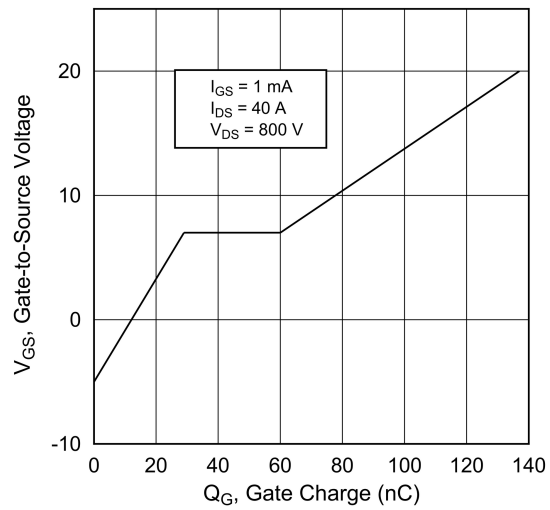
**Figure 1-4.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



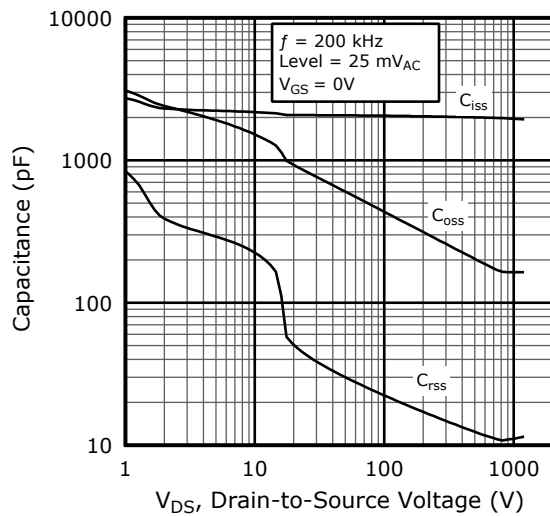
**Figure 1-5.**  $R_{DS(on)}$  vs. Junction Temperature



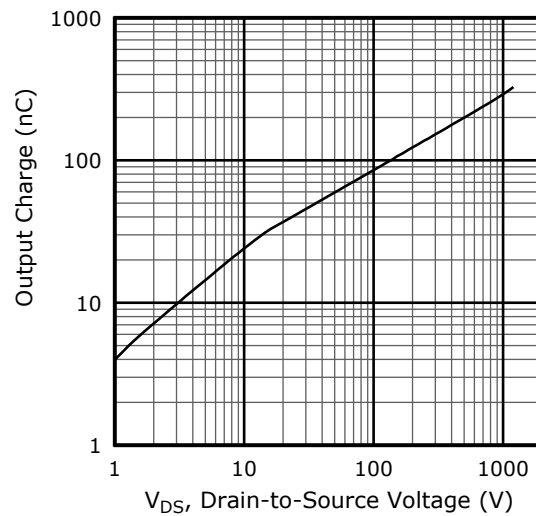
**Figure 1-6.** Gate Charge Characteristics



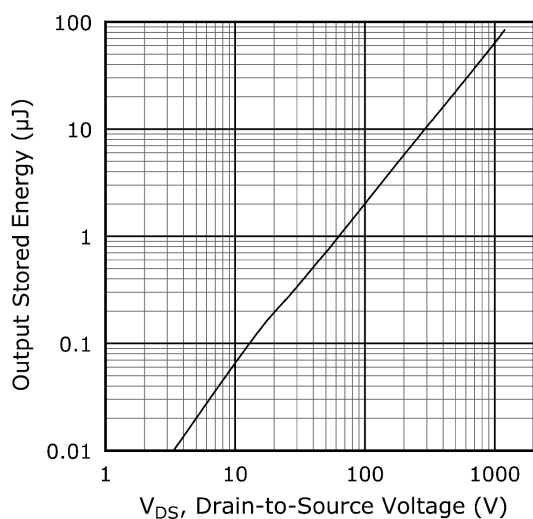
**Figure 1-7.** Capacitance vs. Drain-to-Source Voltage



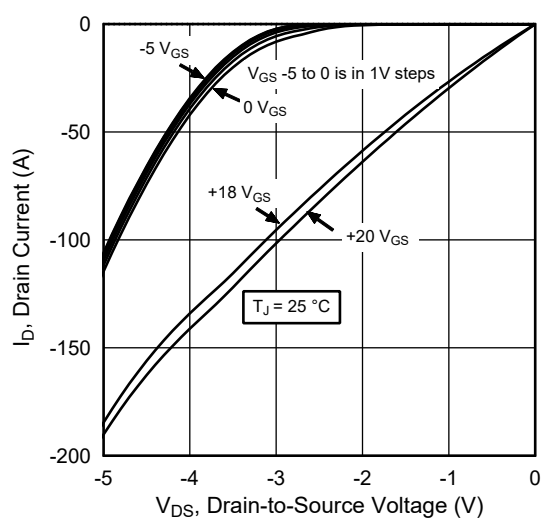
**Figure 1-8.** Output Charge vs. Drain-to-Source Voltage



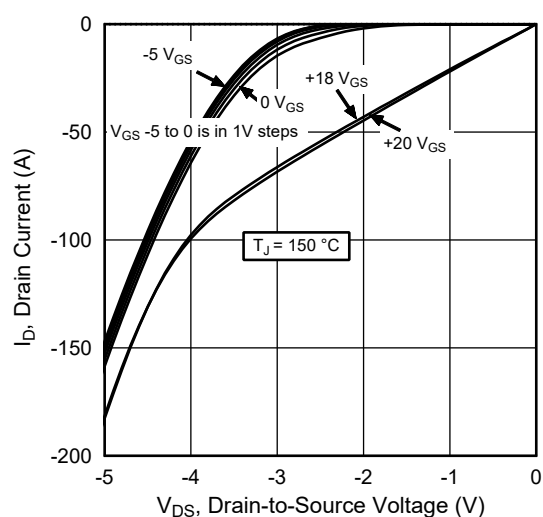
**Figure 1-9.** Output Stored Energy vs.  $V_{DS}$



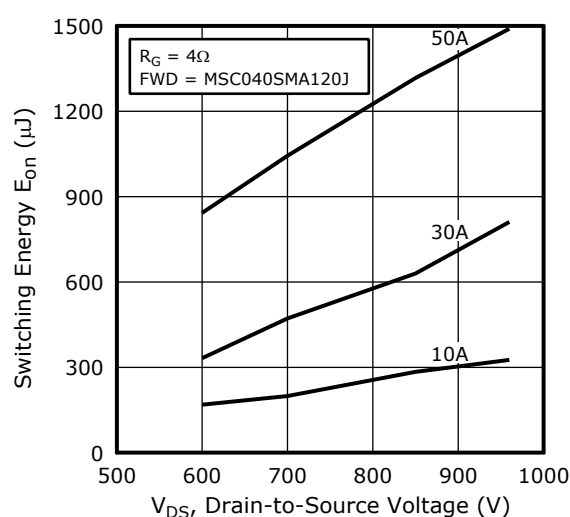
**Figure 1-10.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



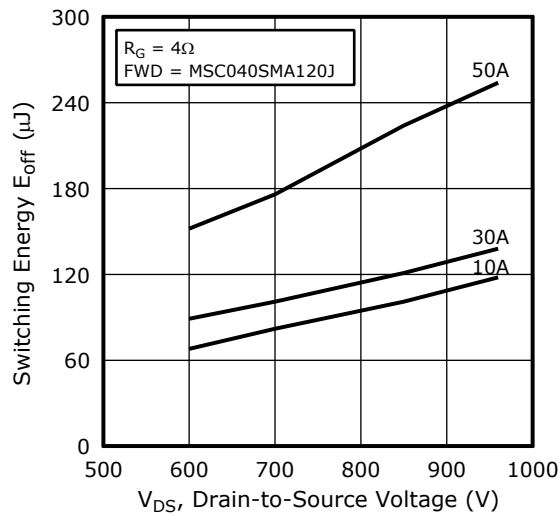
**Figure 1-11.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



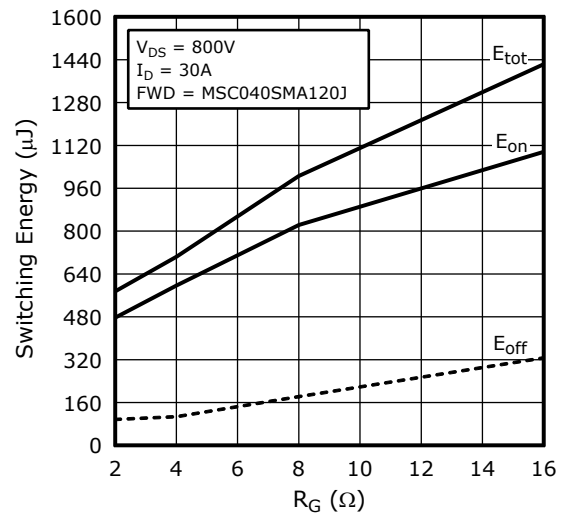
**Figure 1-12.** Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$



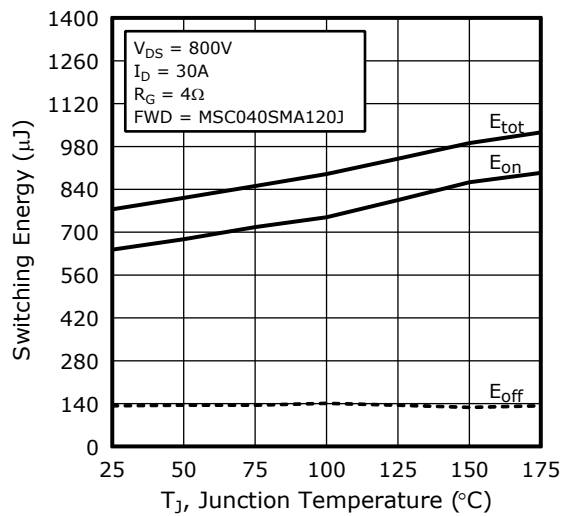
**Figure 1-13. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$**



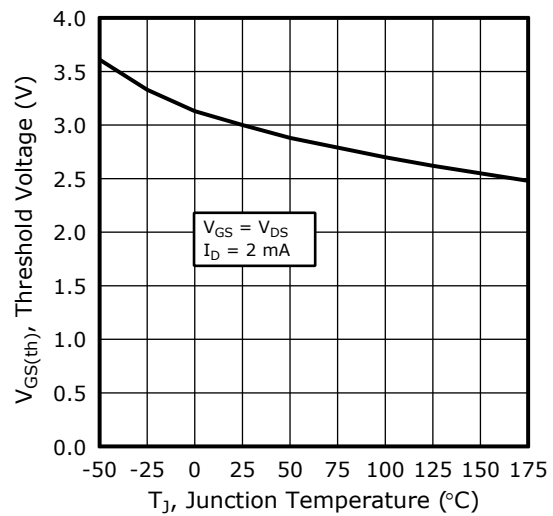
**Figure 1-14. Switching Energy vs.  $R_G$**



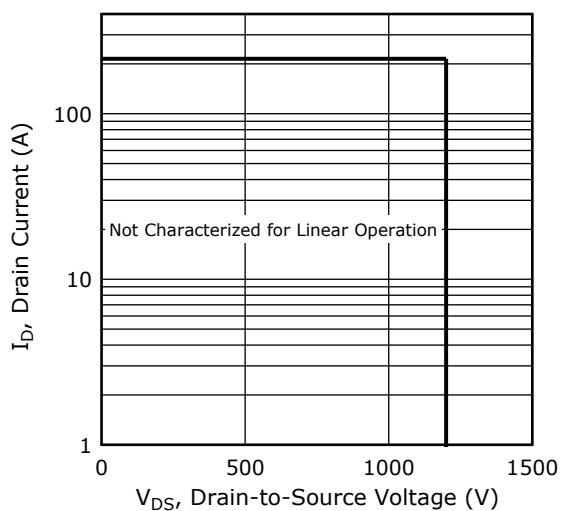
**Figure 1-15. Switching Energy vs. Junction Temperature**



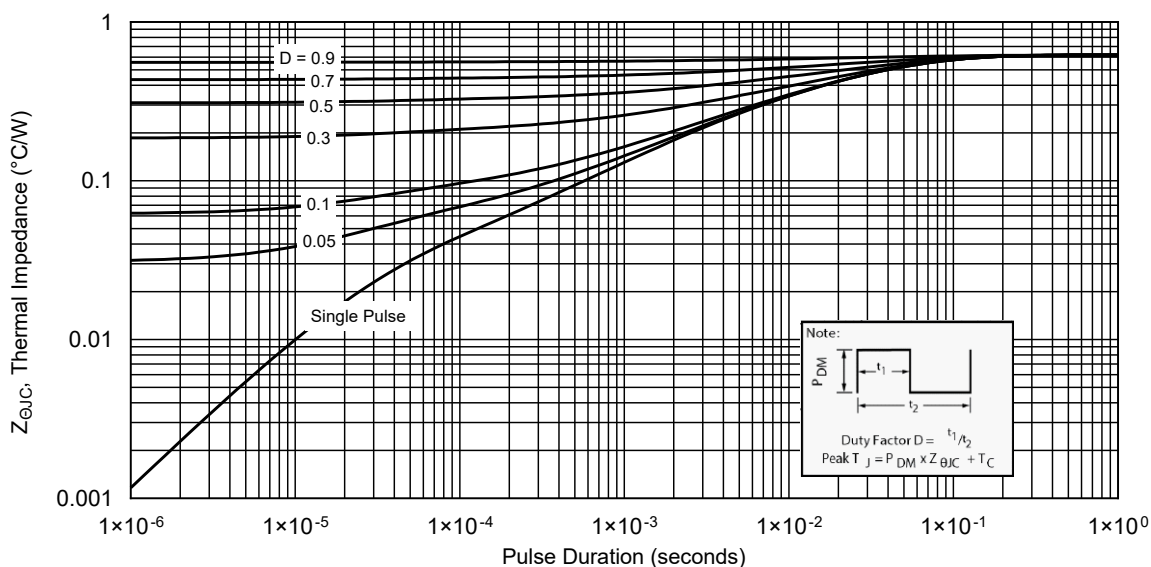
**Figure 1-16. Threshold Voltage vs. Junction Temperature**



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

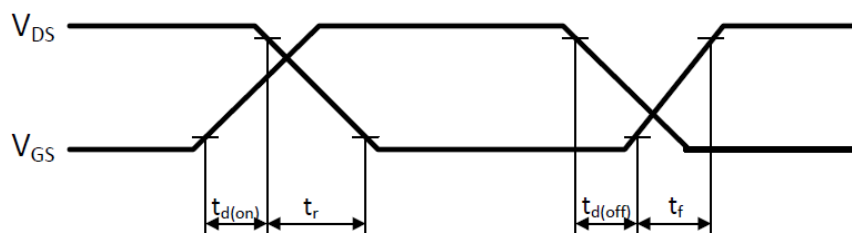


**Figure 1-18. Maximum Transient Thermal Impedance**



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

**Figure 1-19. Switching Waveform**





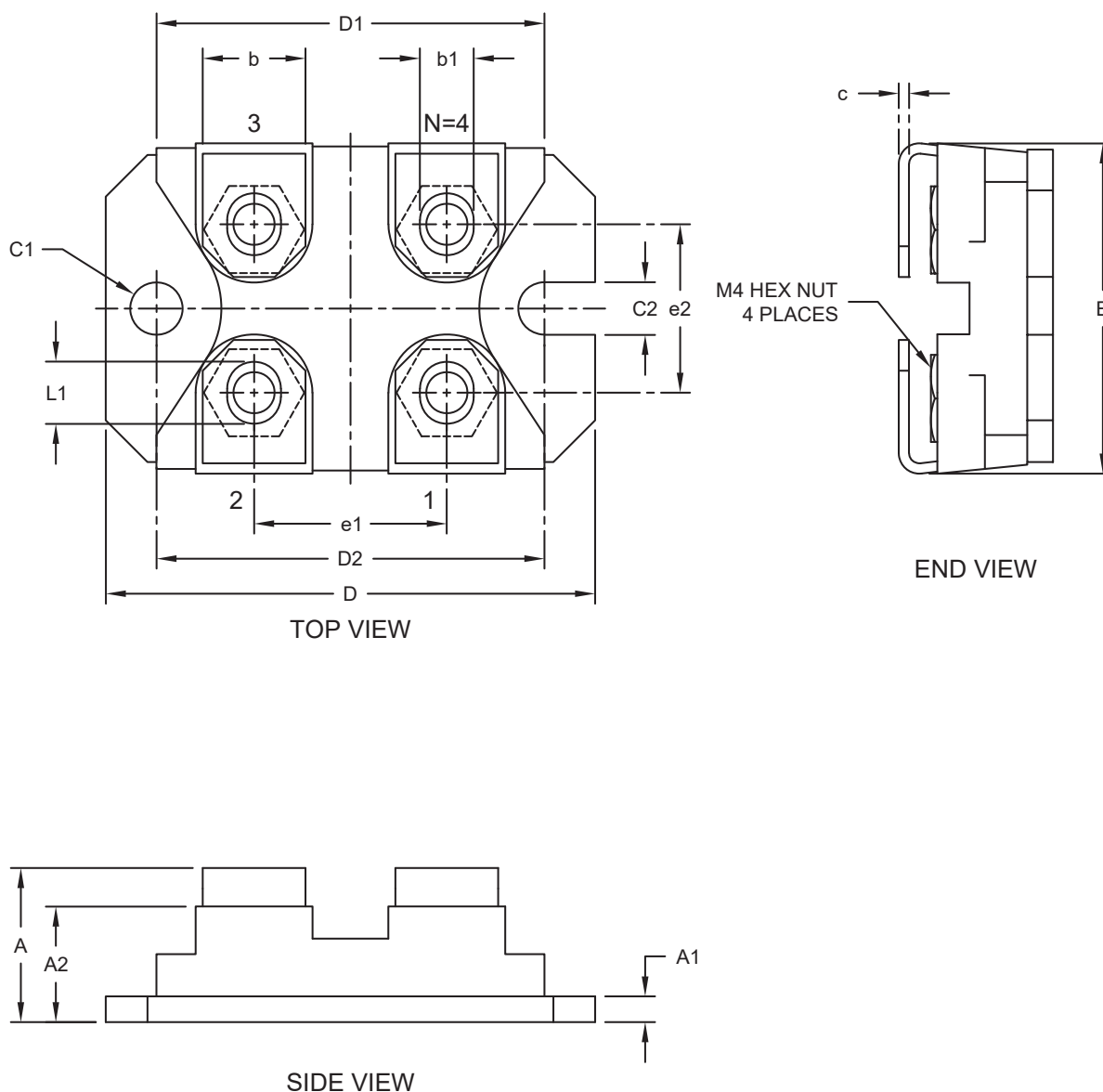
## 2. Package Specification

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
C	07/2024	The following are the list of updates in this revision. <ul style="list-style-type: none"> <li>Added <math>\tau_M</math> and <math>\tau_T</math> symbols for mounting torque in <a href="#">Table 1-2</a>.</li> <li>Updated <a href="#">2.1. Package Outline Drawing</a>.</li> </ul>
B	05/2024	Updated <a href="#">Figure 1-5</a> .
A	04/2024	The following changes are made in this revision of the document: <ul style="list-style-type: none"> <li>Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00005284A, which replaces the previous Microsemi literature number 050-7738.</li> <li>Added <a href="#">Figure 1-9</a>.</li> </ul>
Initial release (Microsemi Revision A and B)	10/2018–04/2019	Initial releases.

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