

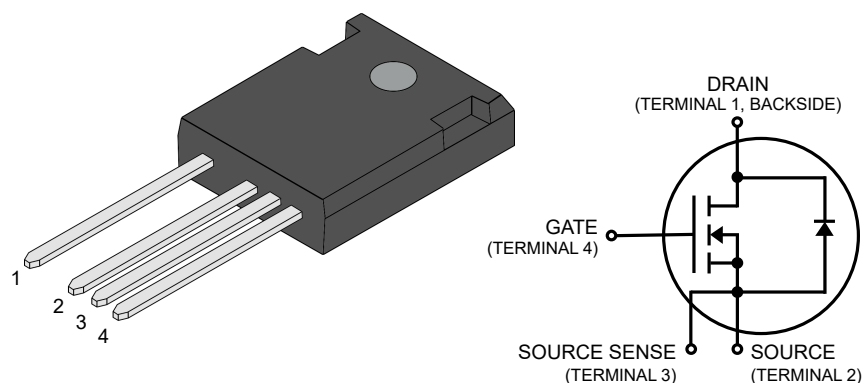
# 1200V, 80 mΩ N-Channel mSiC™ MOSFET

## MSC080SMA120B4



## Product Overview

1200V, 80 mΩ typical at  $V_{GS} = 20V$ , 90 mΩ typical at  $V_{GS} = 18V$ , Silicon Carbide (SiC) N-Channel MOSFET, TO-247 4-lead with a source sense.



## 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

## 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 $T_C = 25\text{ }^{\circ}\text{C}$	40	A
	Continuous drain current at $T_C = 100\text{ }^{\circ}\text{C}$	28	
$I_{DM}$	Pulsed drain current <sup>1</sup>	111	
$V_{GS}$	Gate-source voltage	23 to -10	V
	Transient gate-source voltage	25 to -12	
$P_D$	Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	231	W
	Linear derating factor	1.5	

**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	—	0.5	0.65	$^{\circ}\text{C}/\text{W}$
$T_J$	Operating junction temperature	-55	—	175	$^{\circ}\text{C}$
$T_{STG}$	Storage temperature	-55	—	150	
$T_L$	Lead temperature for 10 seconds	—	—	300	$^{\circ}\text{C}$
$\tau_M$	Mounting torque, M3 screw for heat sink attachment (requires 1, not included)	—	0.8	—	N·m
Wt	Package weight	—	6.2	—	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>	$V_{GS} = 20\text{V}, I_D = 15\text{A}$	—	80	100	$\text{m}\Omega$
		$V_{GS} = 18\text{V}, I_D = 15\text{A}$	—	90	—	
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}, I_D = 1\text{ mA}$	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	—	
$I_{GSS}$	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	$V_{GS} = 0\text{V}$	—	1031	—	pF
$C_{rss}$	Reverse transfer capacitance	$V_{DD} = 1000\text{V}$	—	6	—	
$C_{oss}$	Output capacitance	$V_{AC} = 25\text{ mV}$ $f = 200\text{ kHz}$	—	92	—	
$Q_G$	Total gate charge	$V_{GS} = -5\text{V}/20\text{V}$	—	64	—	nC
$Q_{GS}$	Gate-source charge	$V_{DD} = 800\text{V}$	—	12	—	
$Q_{GD}$	Gate-drain charge	$I_D = 15\text{A}$	—	19	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 850\text{V}$	—	13	—	ns
$t_r$	Voltage rise time	$V_{GS} = -5\text{V}/20\text{V}$	—	10	—	
$t_{d(off)}$	Turn-off delay time	$I_D = 20\text{A}$	—	22	—	
$t_f$	Voltage fall time	$R_{G(ext)} = 8\Omega$	—	12	—	
$E_{on}$	Turn-on switching energy	Freewheeling diode = MSC080SMA120B4 ( $V_{GS} = -5\text{V}$ ); reference <a href="#">Figure 1-19</a>	—	469	—	$\mu$ J
$E_{off}$	Turn-off switching energy		—	51	—	
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}$ , 25 mV, drain short	—	1.9	—	$\Omega$
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	$I_D = 15\text{A}$	—	1300	—	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.

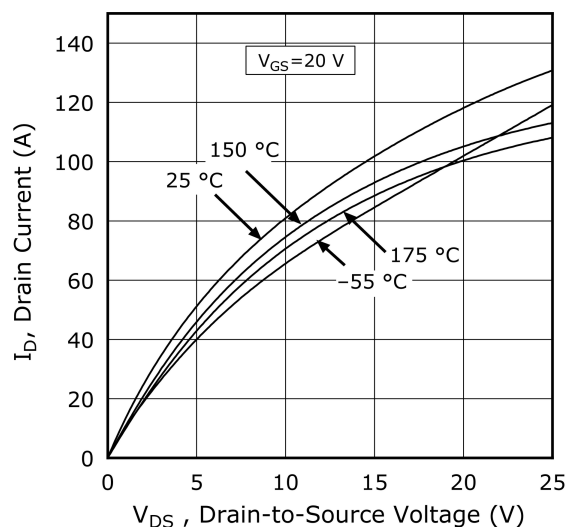
**Table 1-5. Body Diode Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 15\text{A}$ , $V_{GS} = 0\text{V}$	—	3.7	—	V
		$I_{SD} = 15\text{A}$ , $V_{GS} = -5\text{V}$	—	3.9	5.0	
$t_{rr}$	Reverse recovery time	$I_{SD} = 20\text{A}$ , $V_{GS} = -5\text{V}$ , Drive $R_G = 8\Omega$ , $V_{DD} = 850\text{V}$ , $dI/dt = -10100\text{ A}/\mu\text{s}$	—	12	—	ns
$Q_{rr}$	Reverse recovery charge		—	416	—	nC
$I_{RRM}$	Reverse recovery current		—	59	—	A

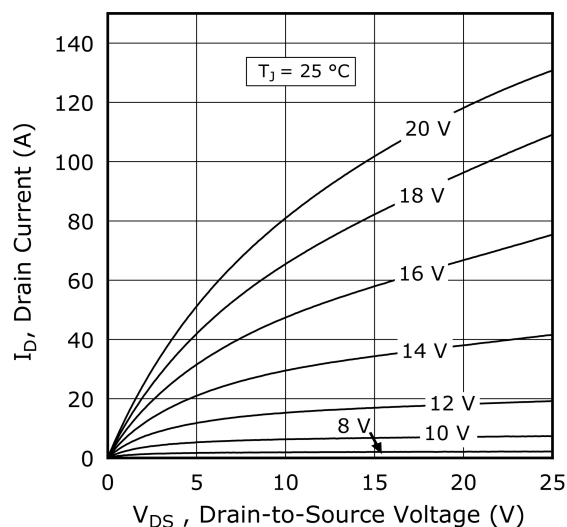
## 1.3 Typical Performance Curves

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

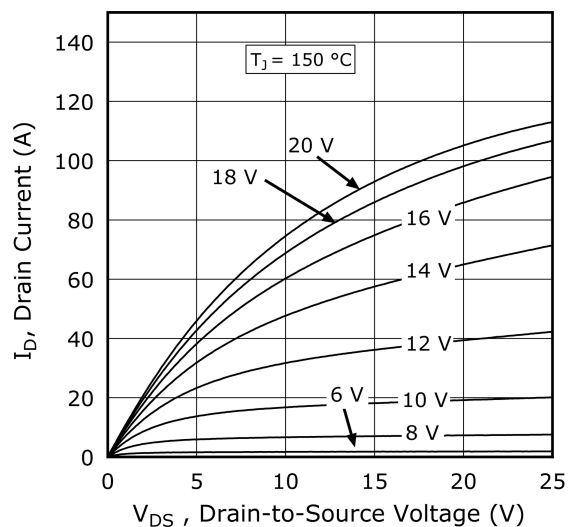
**Figure 1-1.** Drain Current vs.  $V_{DS}$  at  $T_J$



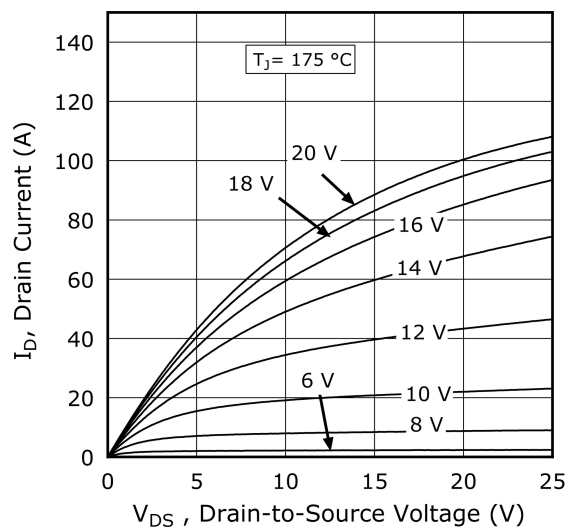
**Figure 1-2.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



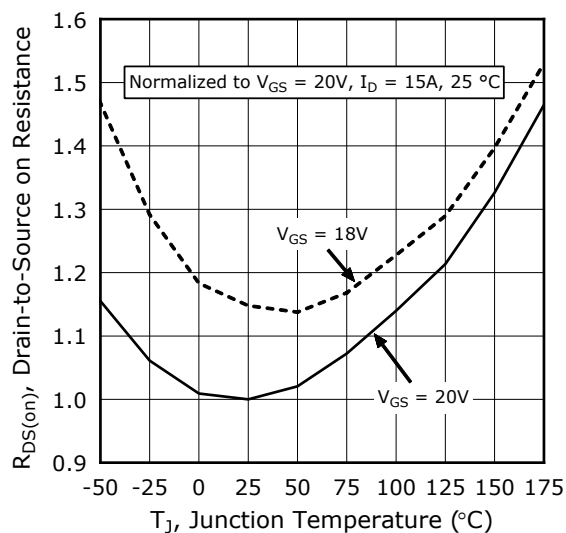
**Figure 1-3.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



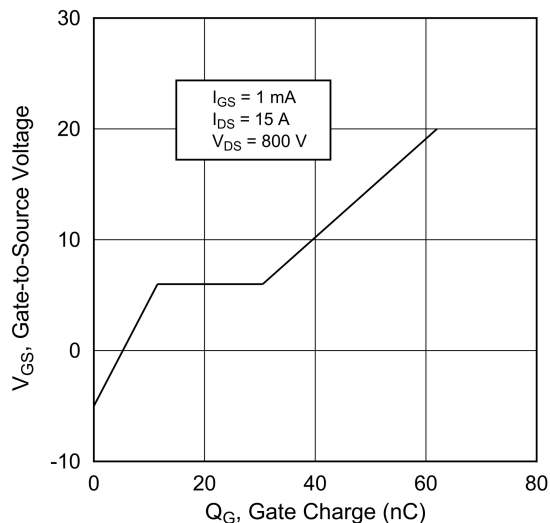
**Figure 1-4.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



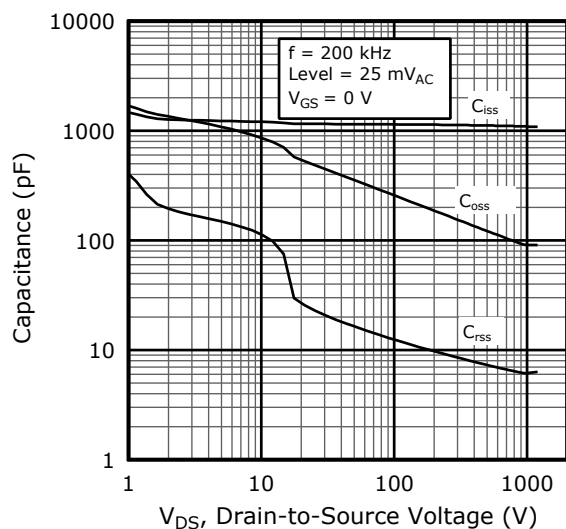
**Figure 1-5.**  $R_{DS(on)}$  vs. Junction Temperature



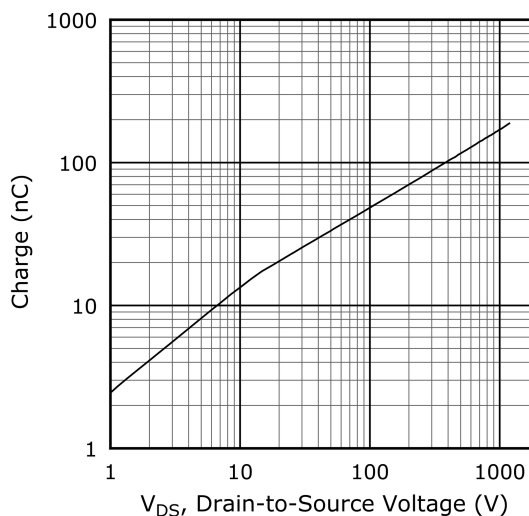
**Figure 1-6.** Gate Charge Characteristics



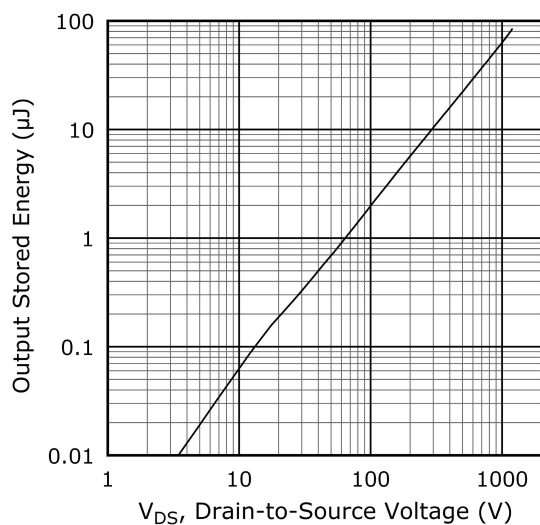
**Figure 1-7.** Capacitance vs. Drain-to-Source Voltage



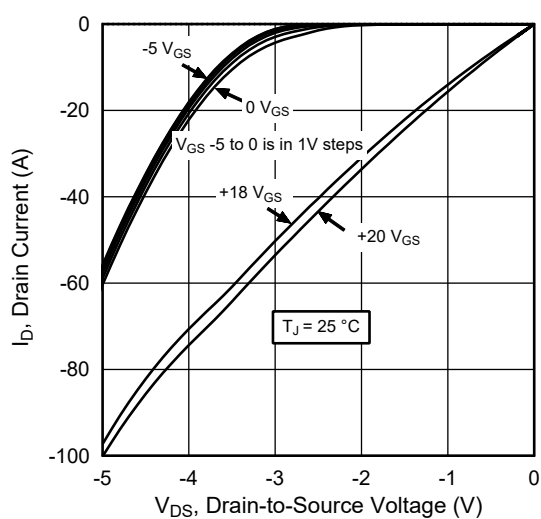
**Figure 1-8.** Output Charge vs. Drain-to-Source Voltage



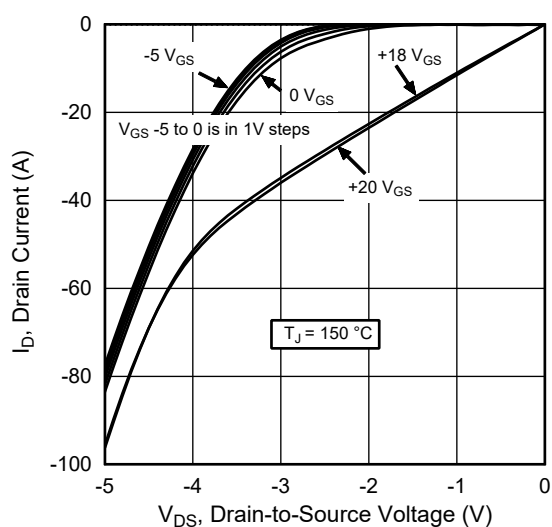
**Figure 1-9.** Output Stored Energy vs.  $V_{DS}$



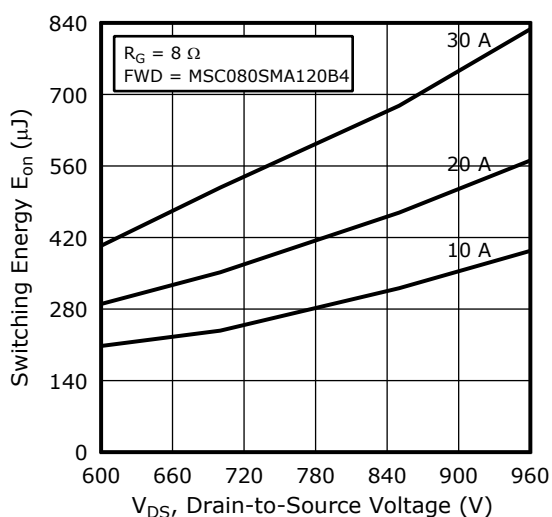
**Figure 1-10.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



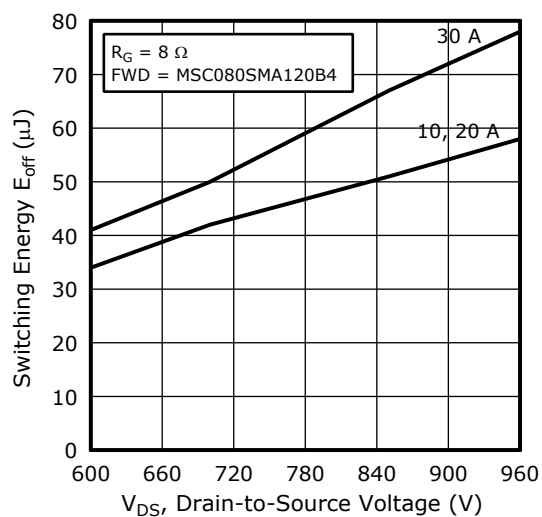
**Figure 1-11.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



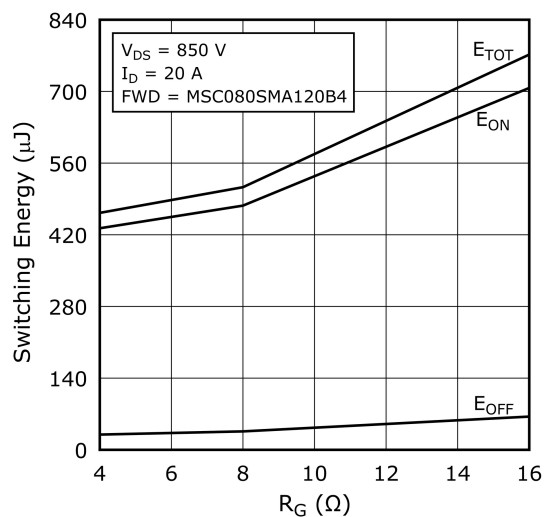
**Figure 1-12.** Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$



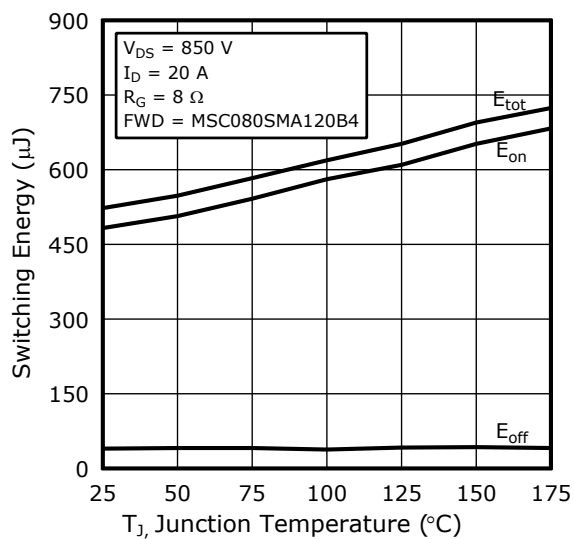
**Figure 1-13. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$**



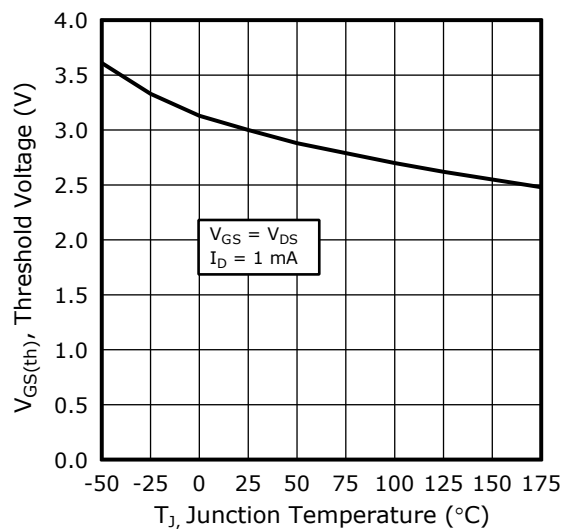
**Figure 1-14. Switching Energy vs.  $R_G$**



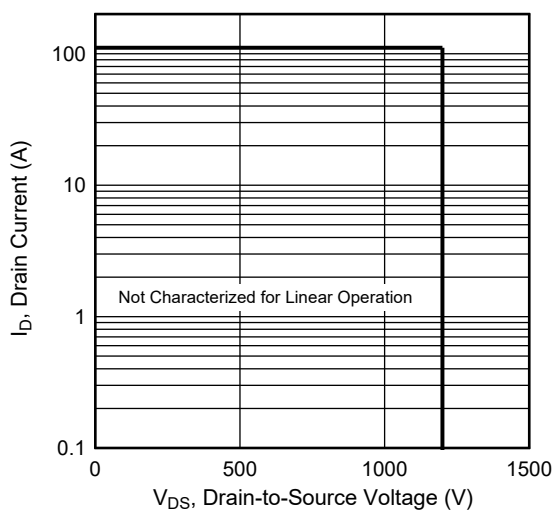
**Figure 1-15. Switching Energy vs. Junction Temperature**



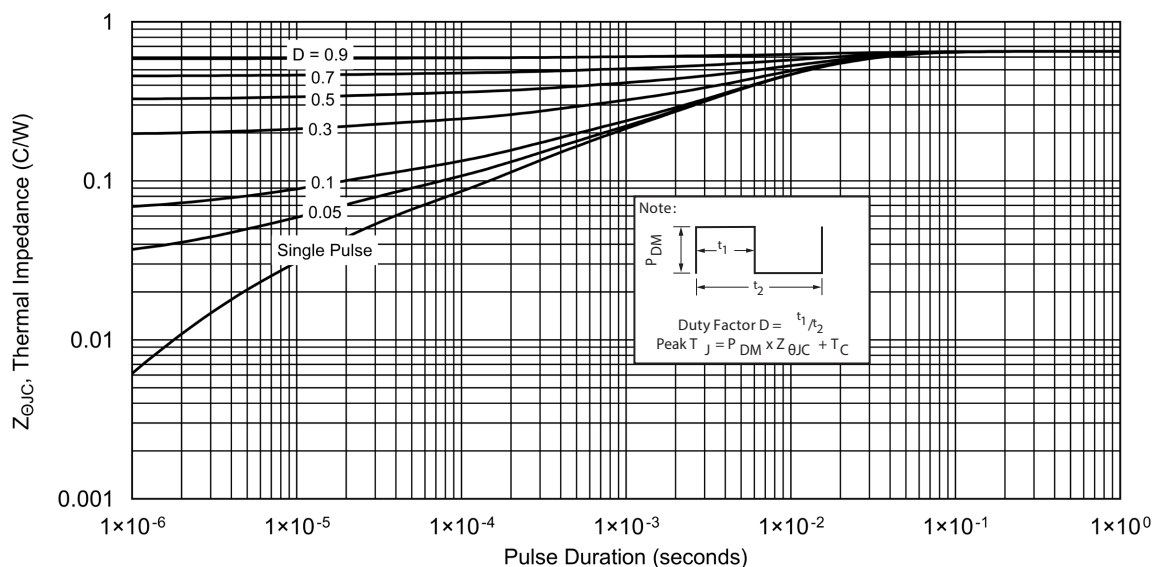
**Figure 1-16. Threshold Voltage vs. Junction Temperature**



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

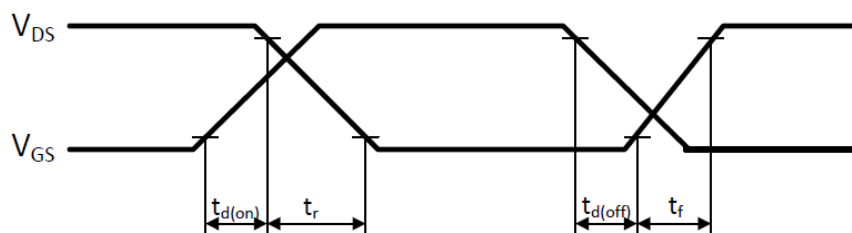


**Figure 1-18. Maximum Transient Thermal Impedance**



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

**Figure 1-19. Switching Waveform**



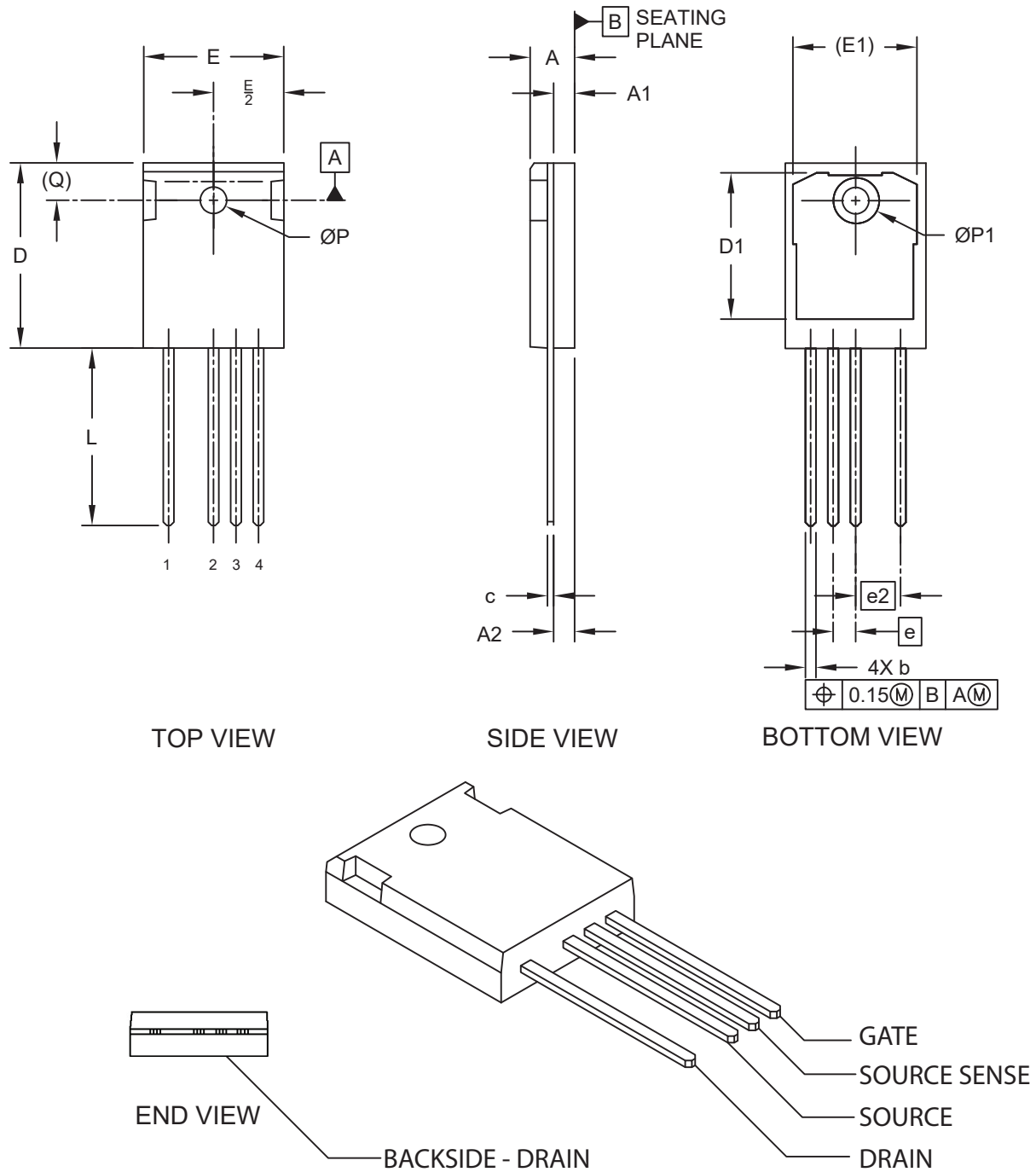
## 2. Package Specification

This section shows the package specification of this device.

### 2.1 Package Outline Drawing

The following figure illustrates the TO-247-4L package outline of this device.

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



The following table shows the TO-247-4L dimensions and should be used in conjunction with the package outline drawing.

**Table 2-1. TO-247-4L Dimensions**

Symbol	Description	Min. (mm)	Max. (mm)
N	Number of leads	4	
e	Pitch	2.54 BSC	
e2	Pitch	5.08 BSC	
A	Overall height	4.90	5.18
A1	Tab height	1.85	2.10
A2	Seating plane to lead	2.26	2.51
b	Lead width	1.06	1.32
c	Lead thickness	0.55	0.68
L	Lead length	19.81	20.32
D	Molded body length	20.82	21.08
D1	Thermal pad length	16.25	16.84
E	Total width	15.77	16.02
E1	Thermal pad width	13.89	14.14
Q	Hole center to tab edge	6.14 REF	
ØP	Hole diameter	3.55	3.65
ØP1	Thermal pad hole diameter	7.11	7.49

**Notes:**

Dimensioning and tolerancing per ASME Y14.5M.

- BSC: Basic dimension. Theoretically exact value shown without tolerances.
- REF: Reference dimension, usually without tolerance, for information purposes only.

### 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	<p>The following changes are made in this revision of the document:</p> <ul style="list-style-type: none"> <li>• Updated <a href="#">1.1. Absolute Maximum Ratings</a></li> <li>• Added <a href="#">Figure 1-9</a></li> <li>• Updated <a href="#">2.1. Package Outline Drawing</a></li> <li>• Added <math>\tau_M</math> symbol for mounting torque in <a href="#">Table 1-2</a></li> </ul>
C	08/2022	<p>The following changes are made in this revision of the document:</p> <ul style="list-style-type: none"> <li>• Updated typical value for zero gate voltage drain current in <a href="#">Table 1-3</a>.</li> <li>• Updated typical values for diode forward voltage in <a href="#">Table 1-5</a>.</li> <li>• Updated <a href="#">Figure 1-7</a>.</li> </ul>
B	12/2022	<p>The following changes are made in this revision of the document:</p> <ul style="list-style-type: none"> <li>• Updated Values in <a href="#">Table 1-3</a></li> <li>• Updated values in <a href="#">Table 1-4</a></li> <li>• Updated an image in <a href="#">1.3. Typical Performance Curves</a></li> </ul>
A	08/2022	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00004673A, which replaces the previous Microsemi literature number 050-7755.
Initial release (Microsemi Revision A)	09/2019	Document created.

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