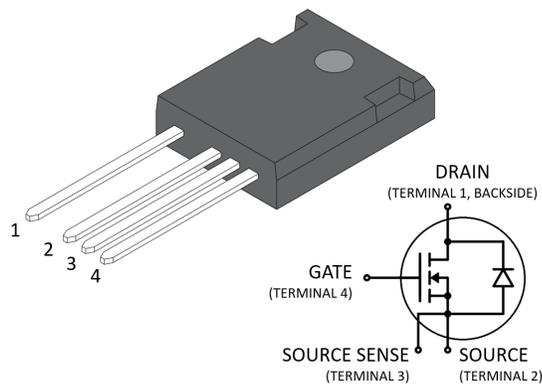


# MSC017SMA120B4 Silicon Carbide N-Channel Power MOSFET

## Product Overview

The silicon carbide (SiC) power MOSFET product line from Microsemi increases the performance over silicon MOSFET and silicon IGBT solutions while lowering the total cost of ownership for high-voltage applications. The MSC017SMA120B4 device is a 1200 V, 17 mΩ SiC MOSFET in a TO-247 package with a source sense.



### Features

The following are key features of the MSC017SMA120B4 device:

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

### Benefits

The following are benefits of the MSC017SMA120B4 device:

- High efficiency to enable lighter, 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

The MSC017SMA120B4 device is designed for the following applications:

- PV inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- H/EV powertrain and EV charger
- Power supply and distribution

## Device Specifications

This section shows the specifications of the MSC017SMA120B4 device.

### Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC017SMA120B4 device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Parameter	Ratings	Unit
V <sub>DSS</sub>	Drain source voltage	1200	V
I <sub>D</sub>	Continuous drain current at T <sub>C</sub> = 25 °C	113	A
	Continuous drain current at T <sub>C</sub> = 100 °C	80	
I <sub>DM</sub>	Pulsed drain current <sup>1</sup>	280	
V <sub>GS</sub>	Gate-source voltage	23 to -10	V
P <sub>D</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	455	W
	Linear derating factor	3.33	W/°C

**Note:**

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

The following table shows the thermal and mechanical characteristics of the MSC017SMA120B4 device.

**Table 2 • Thermal and Mechanical Characteristics**

Symbol	Characteristic	Min	Typ	Max	Unit
R <sub>θJC</sub>	Junction-to-case thermal resistance		0.22	0.33	°C/W
T <sub>J</sub>	Operating junction temperature	-55		175	°C
T <sub>STG</sub>	Storage temperature	-55		150	
T <sub>L</sub>	Soldering temperature for 10 seconds (1.6 mm from case)			300	
	Mounting torque, 6-32 or M3 screw			10	lbf-in
				1.1	N-m
Wt	Package weight		0.22		oz
			6.2		g

## Electrical Performance

The following table shows the static characteristics of the MSC017SMA120B4 device.  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

**Table 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>	$V_{GS} = 20\text{ V}, I_D = 40\text{ A}$		17.6	22	m $\Omega$
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}, I_D = 4.5\text{ mA}$	1.9	2.7		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}, I_D = 4.5\text{ mA}$		-4.6		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$			100	$\mu\text{A}$
		$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$			500	
$I_{GSS}$	Gate-source leakage current	$V_{GS} = 20\text{ V}/-10\text{ V}$			$\pm 100$	nA

**Note:**

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

The following table shows the dynamic characteristics of the MSC017SMA120B4 device.  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

**Table 4 • Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}, V_{DD} = 1000\text{ V}$ $V_{AC} = 25\text{ mV}, f = 1\text{ MHz}$		5280		pF
$C_{rss}$	Reverse transfer capacitance			12		
$C_{oss}$	Output capacitance			265		
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}, V_{DD} = 800\text{ V}$ $I_D = 40\text{ A}$		249		nC
$Q_{gs}$	Gate-source charge			63		
$Q_{gd}$	Gate-drain charge			32		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{ V}, V_{GS} = -5\text{ V}/20\text{ V},$ $I_D = 50\text{ A}, R_{g(ext)} = 4.0\text{ }\Omega,$ Freewheeling diode = MSC017SMA120B4		29		ns
$t_f$	Voltage fall time			18		
$t_{d(off)}$	Turn-off delay time			51		
$t_r$	Voltage rise time			13		
$E_{on}$	Turn-on switching energy			684		
$E_{off}$	Turn-off switching energy		195			
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{ V}, V_{GS} = -5\text{ V}/20\text{ V},$ $I_D = 50\text{ A}, R_{g(ext)} = 4.0\text{ }\Omega$ Freewheeling diode = MSC050SDA120B		29		ns
$t_f$	Voltage fall time			15		
$t_{d(off)}$	Turn-off delay time			51		
$t_r$	Voltage rise time			12		
$E_{on}$	Turn-on switching energy			509		
$E_{off}$	Turn-off switching energy		211			
ESR	Equivalent series resistance	$f = 1\text{ MHz}, 25\text{ mV}, \text{ drain short}$		0.71		$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 960\text{ V}, V_{GS} = 20\text{ V}$		3		$\mu\text{s}$
$E_{AS}$	Avalanche energy, single pulse	$V_{DS} = 150\text{ V}, I_D = 30\text{ A}$		3500		mJ

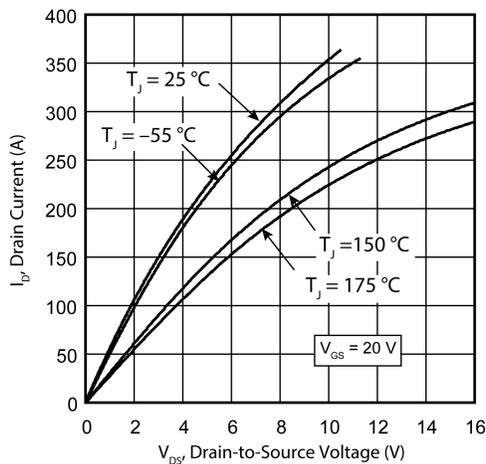
The following table shows the body diode characteristics of the MSC017SMA120B4 device.  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

**Table 5 • Body Diode Characteristics**

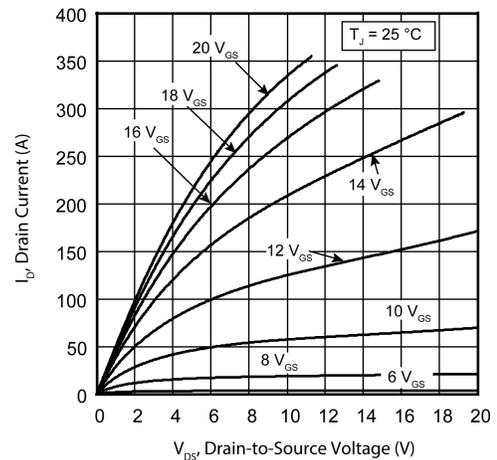
Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 40\text{ A}, V_{GS} = 0\text{ V}$		3.5		V
		$I_{SD} = 40\text{ A}, V_{GS} = -5\text{ V}$		3.9		V
$t_{rr}$	Reverse recovery time	$I_{SD} = 60\text{ A}, V_{GS} = -5\text{ V}$ $V_{DD} = 800\text{ V}, dI/dt = -8000\text{ A}/\mu\text{s}$ , Drive $R_g = 4.0\ \Omega$		17		ns
$Q_{rr}$	Reverse recovery charge			678		nC
$I_{RRM}$	Reverse recovery current				64	

### Typical Performance Curves

This section shows the typical performance curves of the MSC017SMA120B4 device.



**Figure 1 • Drain Current vs.  $V_{DS}$**



**Figure 2 • Drain Current vs.  $V_{DS}$**

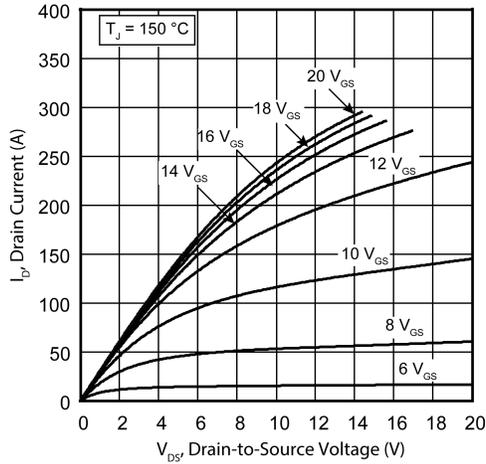


Figure 3 • Drain Current vs.  $V_{DS}$

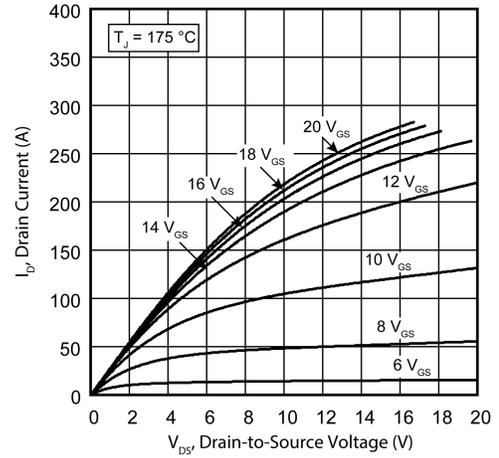


Figure 4 • Drain Current vs.  $V_{DS}$

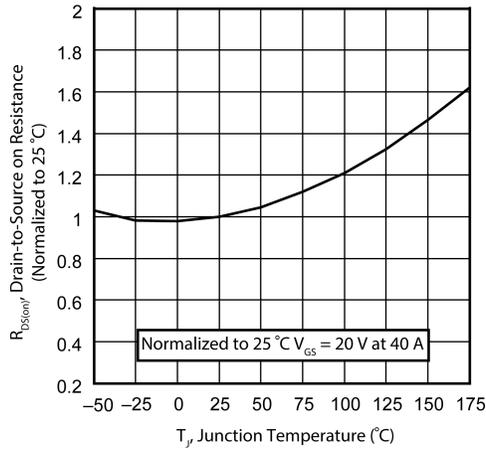


Figure 5 •  $R_{DS(on)}$  vs. Junction Temperature

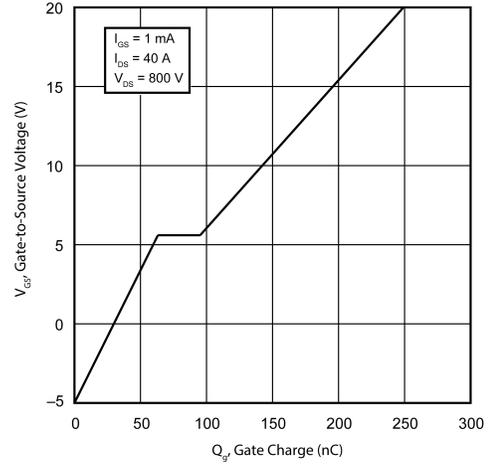


Figure 6 • Gate Charge Characteristics

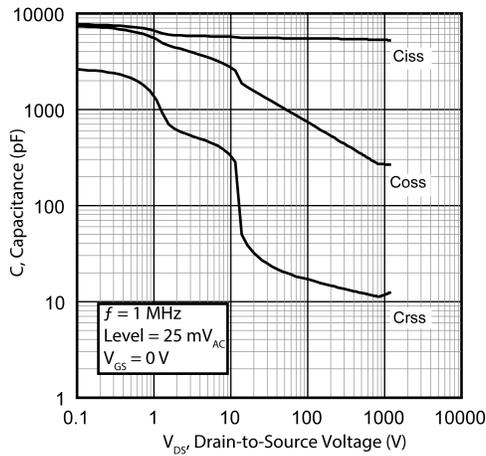


Figure 7 • Capacitance vs. Drain-to-Source Voltage

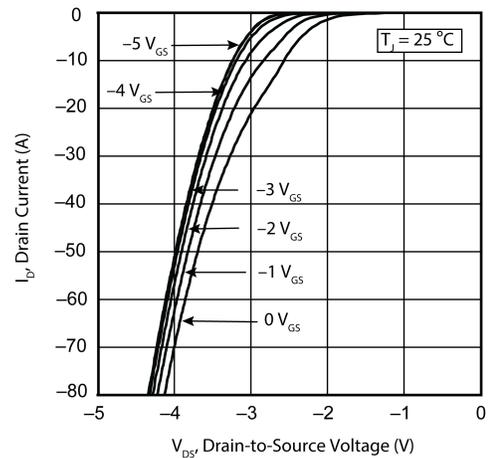


Figure 8 •  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

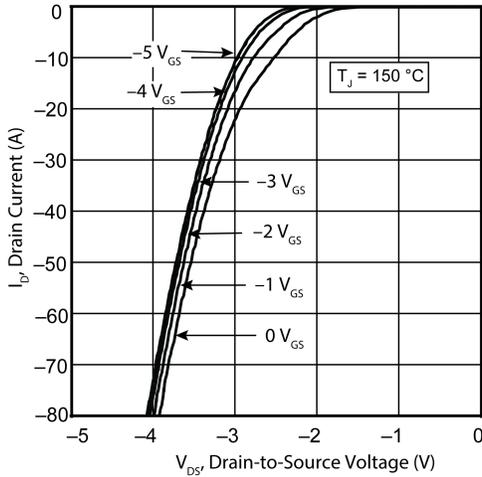


Figure 9 •  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

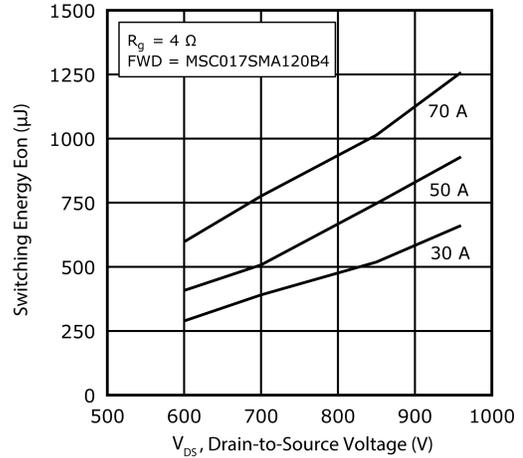


Figure 10 • Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$

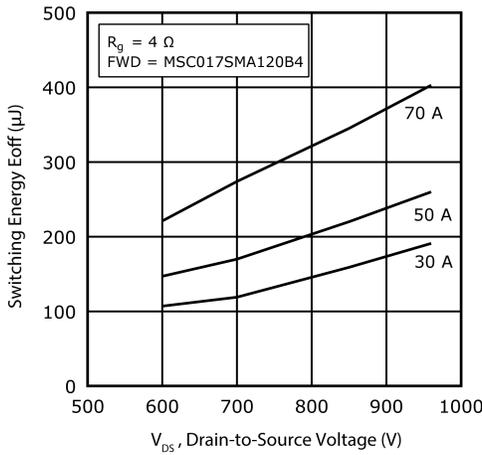


Figure 11 • Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$

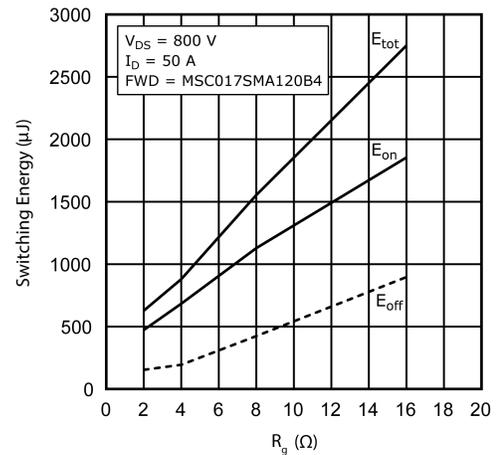


Figure 12 • Switching Energy vs.  $R_g$

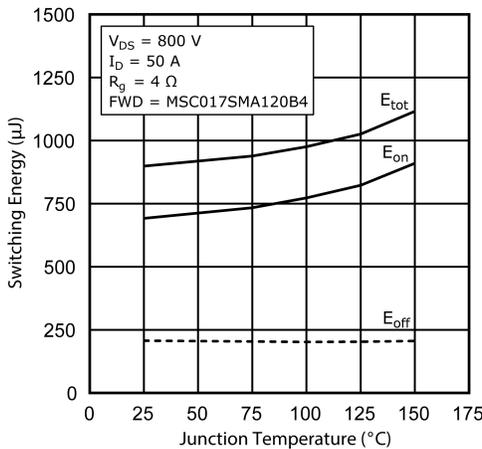


Figure 13 • Switching Energy vs. Temperature

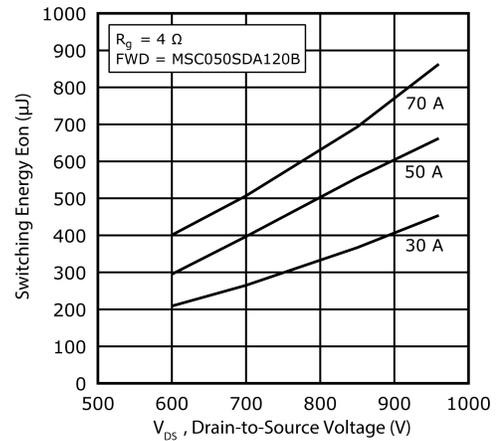


Figure 14 • Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$

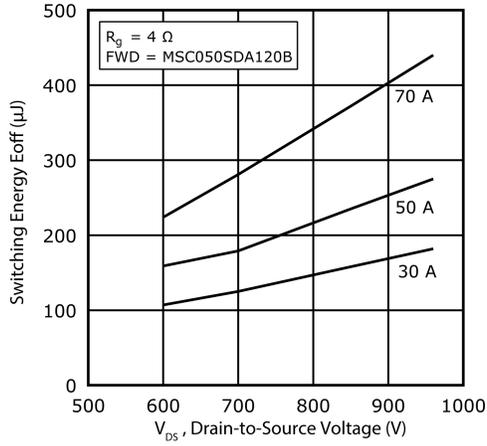


Figure 15 • Switching Energy Eoff vs.  $V_{DS}$  &  $I_D$

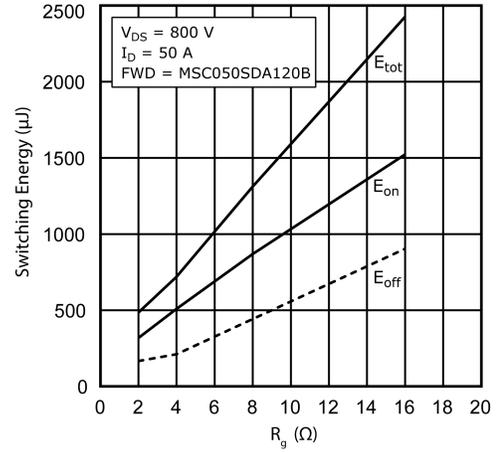


Figure 16 • Switching Energy vs.  $R_g$

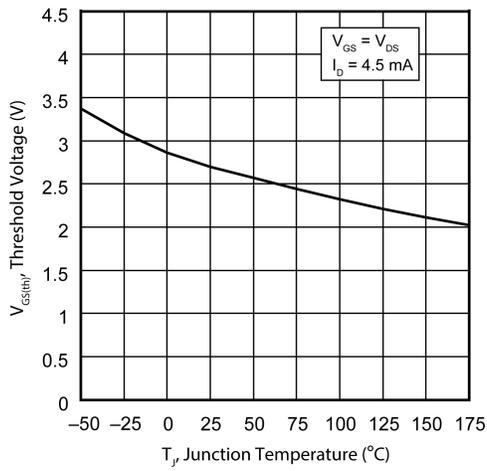


Figure 17 • Threshold Voltage vs. Junction Temp.

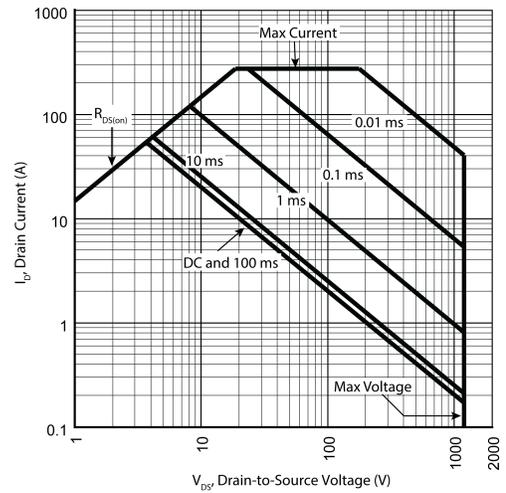


Figure 18 • Forward Safe Operating Area

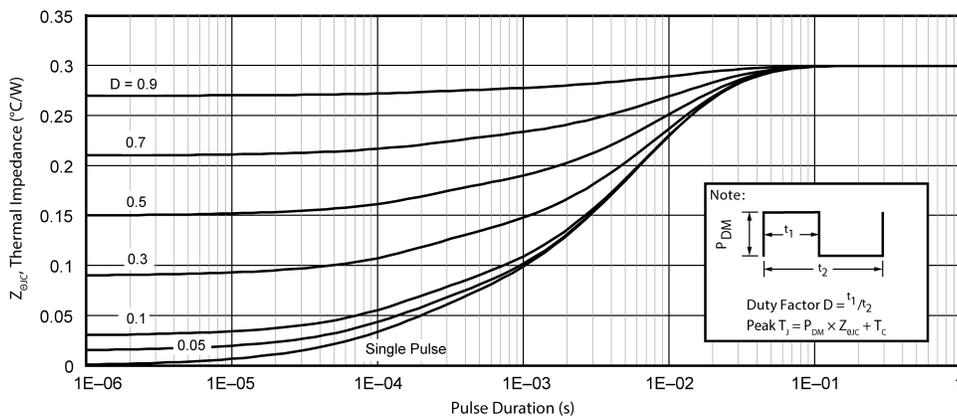


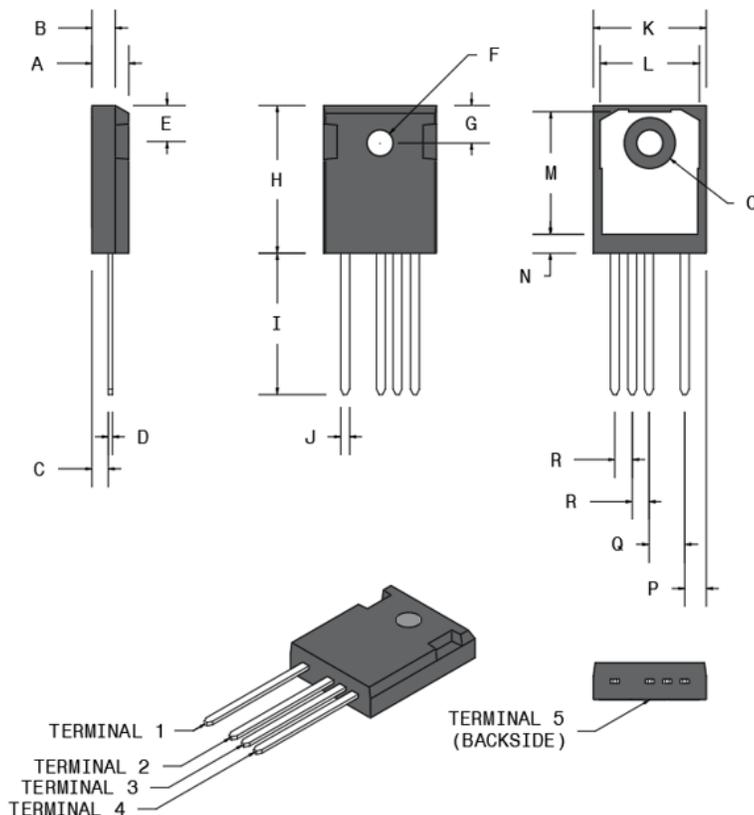
Figure 19 • Maximum Transient Thermal Impedance

## Package Specification

This section shows the package specification of the MSC017SMA120B4 device.

### Package Outline Drawing

The following figure illustrates the TO-247 4-lead package outline of the MSC017SMA120B4 device.



**Figure 20 • Package Outline Drawing**

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

**Table 6 • TO-247-4L Dimensions**

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
A	4.90	5.17	0.193	0.204
B	1.85	2.11	0.073	0.083
C	2.25	2.51	0.089	0.099
D	0.55	0.68	0.022	0.027
E	5.49	5.74	0.216	0.226

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
F	3.56	3.66	0.140	0.144
G	6.15 BSC		0.242 BSC	
H	20.83	21.08	0.820	0.830
I	19.81	20.32	0.780	0.800
J	1.07	1.33	0.042	0.052
K	15.77	16.03	0.621	0.631
L	13.89	14.15	0.547	0.557
M	16.25	16.85	0.640	0.663
N	2.00	2.75	0.079	0.108
O	7.10	7.50	0.280	0.295
P	2.87 BSC		0.113 BSC	
Q	5.08 BSC		0.200 BSC	
R	2.54 BSC		0.100 BSC	
Terminal 1	Drain			
Terminal 2	Source			
Terminal 3	Source sense			
Terminal 4	Gate			
Terminal 5	Drain			

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