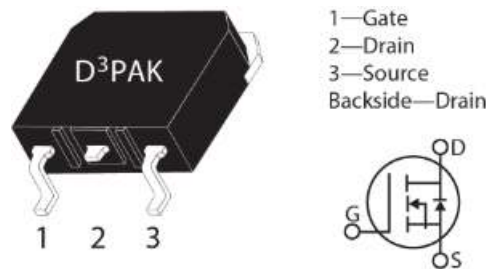


# MSC017SMA120S Silicon Carbide N-Channel Power MOSFET

## 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 MSC017SMA120S device is a 1200 V, 17 m $\Omega$  SiC MOSFET in a TO-268 (D<sup>3</sup>PAK) package.



### Features

The following are key features of the MSC017SMA120S device:

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

### Benefits

The following are benefits of the MSC017SMA120S 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 MSC017SMA120S 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 MSC017SMA120S device.

### Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC017SMA120S 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	100	A
	Continuous drain current at T <sub>C</sub> = 100 °C	71	
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	357	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 MSC017SMA120S device.

**Table 2 • Thermal and Mechanical Characteristics**

Symbol	Characteristic	Min	Typ	Max	Unit
R <sub>θJC</sub>	Junction-to-case thermal resistance		0.28	0.42	°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	
Wt	Package weight		0.14		oz
			4.0		g

## Electrical Performance

The following table shows the static characteristics of the MSC017SMA120S 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 MSC017SMA120S 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		$\mu\text{F}$
$C_{rss}$	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 = MSC017SMA120S ( $V_{GS} = -5\text{ V}$ )		52		ns
$t_f$	Voltage fall time			21		
$t_{d(off)}$	Turn-off delay time			49		

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit	
$t_r$	Voltage rise time			16			
$E_{on}$	Turn-on switching energy			1677		$\mu$ J	
$E_{off}$	Turn-off switching energy			395			
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{ V}$ , $V_{GS} = -5\text{ V}/20\text{ V}$ , $I_D = 50\text{ A}$ , $R_{g(ext)} = 4.0\ \Omega$ Freewheeling diode = MSC050SDA120B		49		ns	
$t_f$	Voltage fall time			19			
$t_{d(off)}$	Turn-off delay time			49			
$t_r$	Voltage rise time			14			
$E_{on}$	Turn-on switching energy				1329		$\mu$ J
$E_{off}$	Turn-off switching energy				429		
ESR	Equivalent series resistance		$f = 1\text{ MHz}$ , 25 mV, drain short		0.71		$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 960\text{ V}$ , $V_{GS} = 20\text{ V}$		3		$\mu$ 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 MSC017SMA120S 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	$I_{SD} = 50\text{ A}$ , $V_{GS} = -5\text{ V}$ , Drive $R_g = 4\ \Omega$ $V_{DD} = 800\text{ V}$ , $di/dt = -2500\text{ A}/\mu\text{s}$		40		ns
$Q_{rr}$	Reverse recovery charge			490		nC
$I_{RRM}$	Reverse recovery current				22	

## Typical Performance Curves

This section shows the typical performance curves of the MSC017SMA120S device.

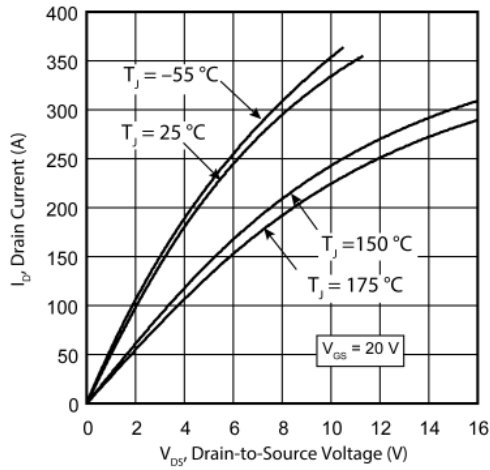


Figure 1 • Drain Current vs.  $V_{DS}$

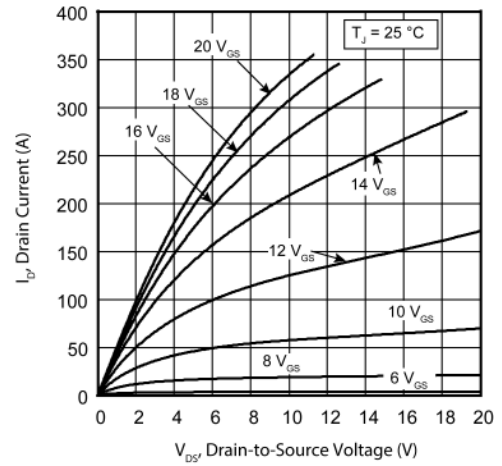


Figure 2 • Drain Current vs.  $V_{DS}$

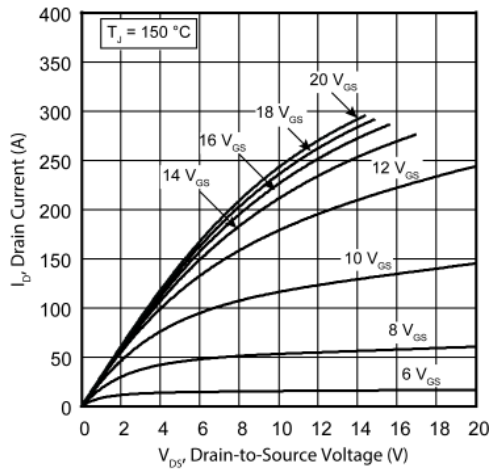


Figure 3 • Drain Current vs.  $V_{DS}$

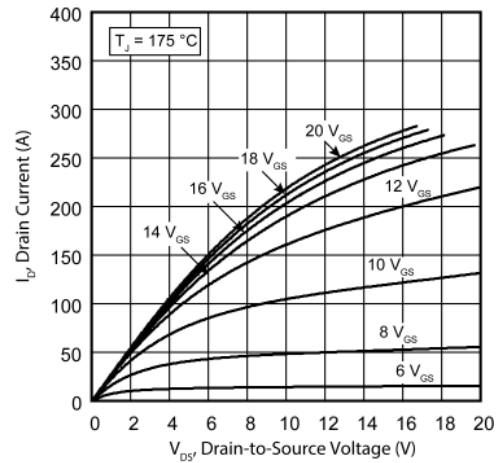


Figure 4 • Drain Current vs.  $V_{DS}$

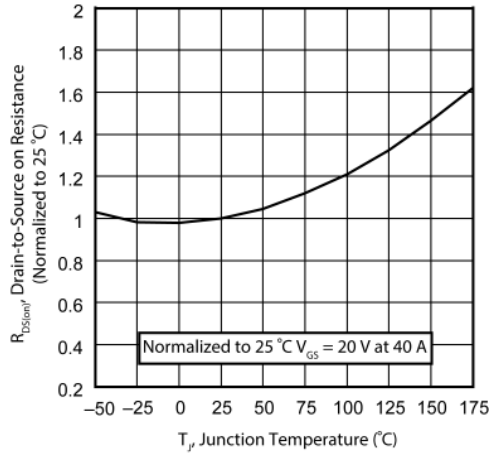


Figure 5 • RDS(on) vs. Junction Temperature

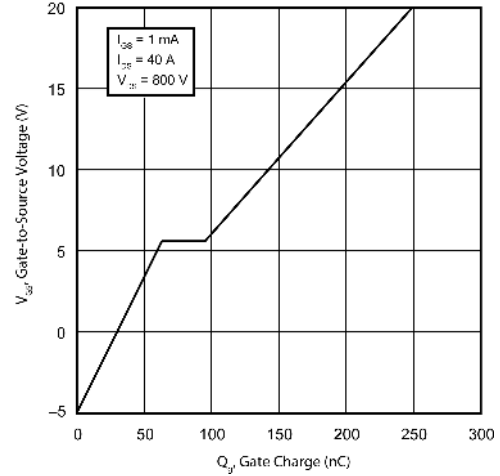


Figure 6 • Gate Charge Characteristics

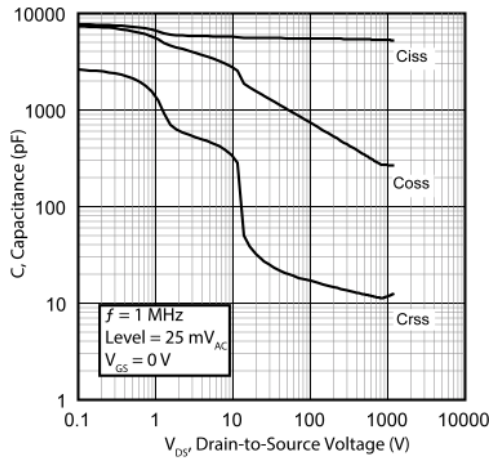


Figure 7 • Capacitance vs. Drain-to-Source Voltage

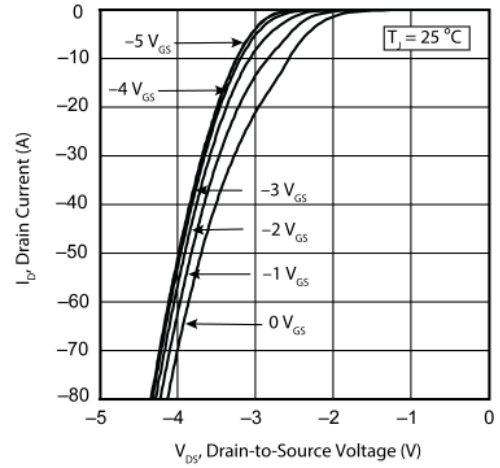


Figure 8 •  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

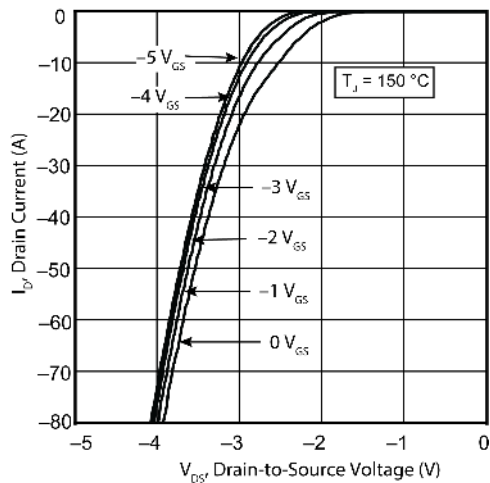


Figure 9 •  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

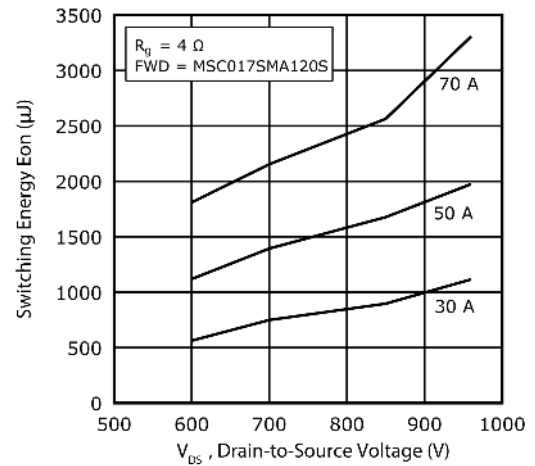


Figure 10 • Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$

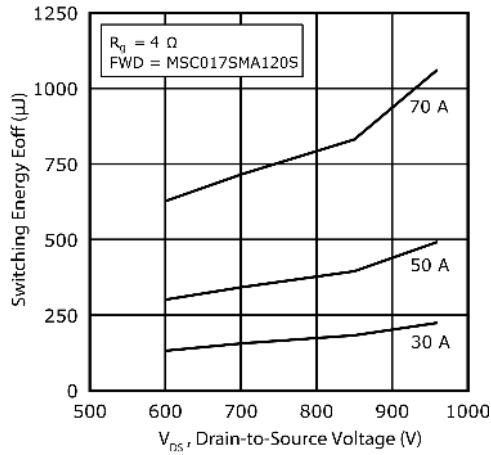


Figure 11 • Switching Energy Eoff vs.  $V_{DS}$  &  $I_D$

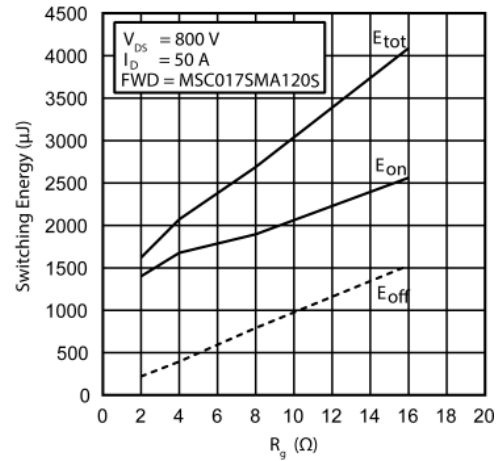


Figure 12 • Switching Energy vs.  $R_g$

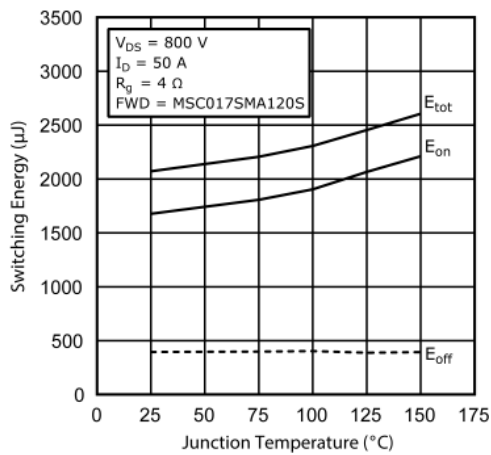


Figure 13 • Switching Energy vs. Temperature

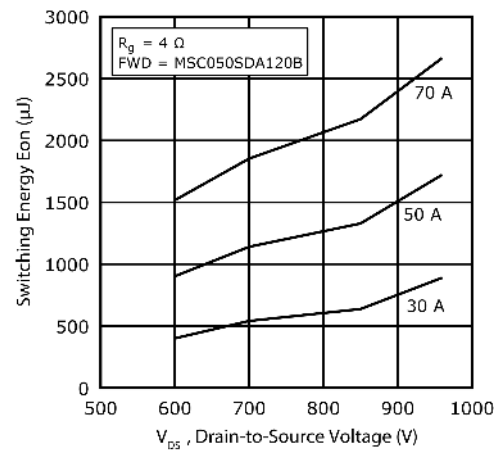


Figure 14 • Switching Energy Eon vs.  $V_{DS}$  &  $I_D$

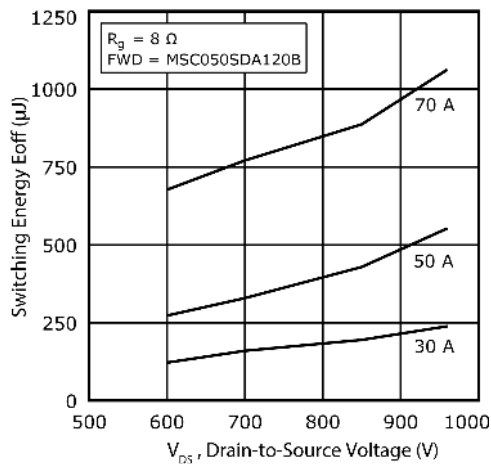


Figure 15 • Switching Energy Eoff vs.  $V_{DS}$  &  $I_D$

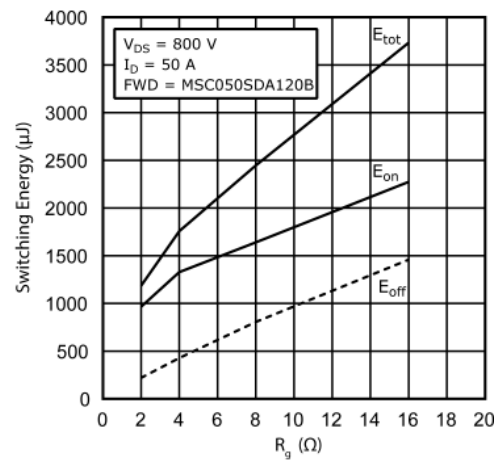


Figure 16 • Switching Energy vs.  $R_g$

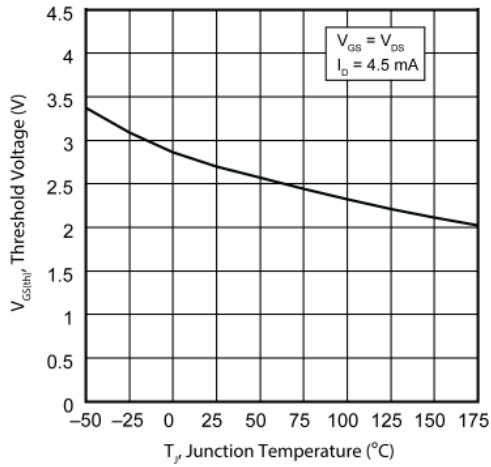


Figure 17 • Threshold Voltage vs. Junction Temp.

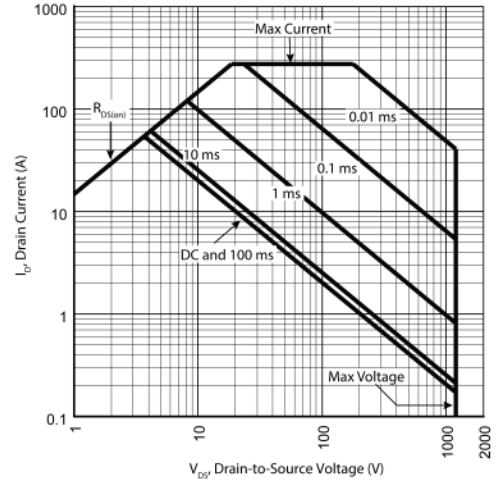


Figure 18 • Forward Safe Operating Area

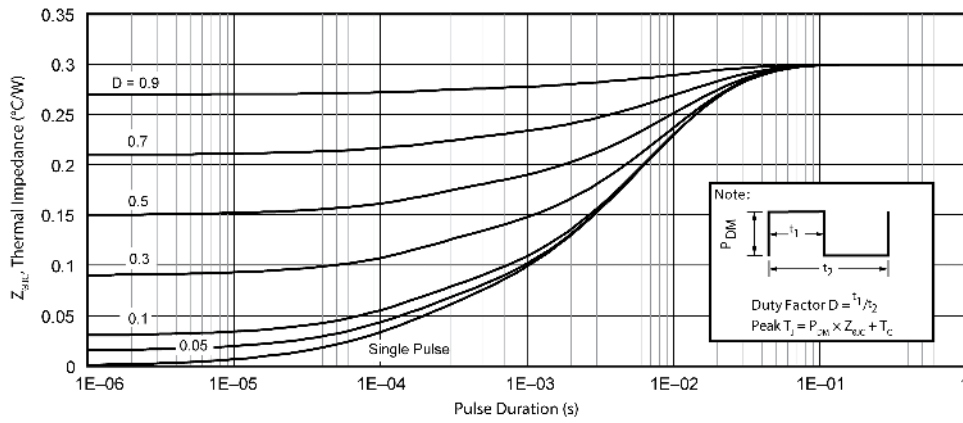


Figure 19 • Maximum Transient Thermal Impedance

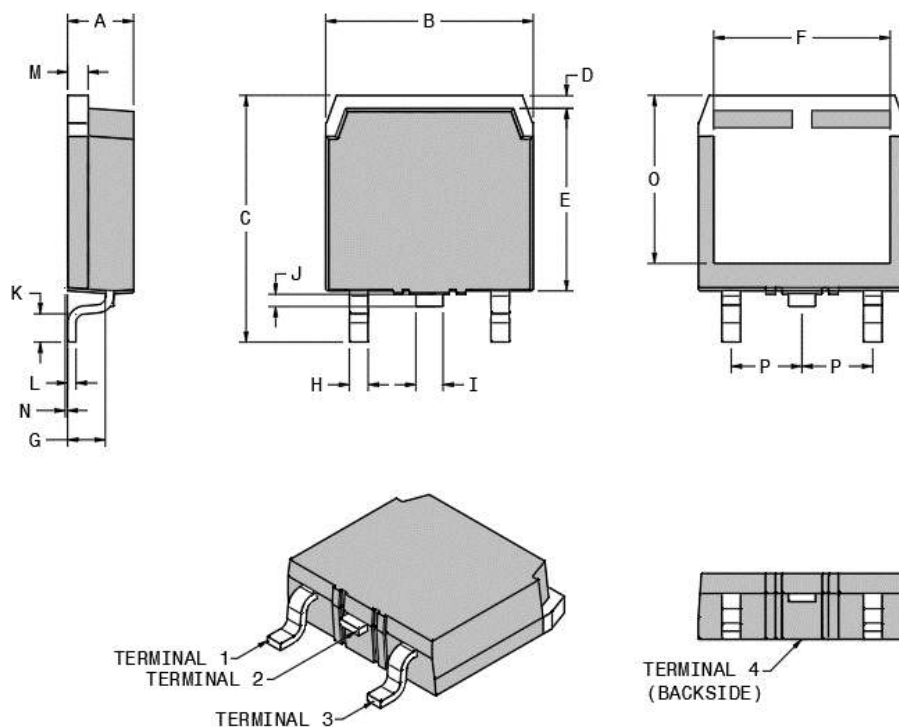


## Package Specification

This section shows the package specification of the MSC017SMA120S device.

### Package Outline Drawing

The following figure illustrates the TO-268 package outline of the MSC017SMA120S device.



**Figure 20 • Package Outline Drawing**

The following table shows the TO-268 dimensions and should be used in conjunction with the package outline drawing.

**Table 6 • TO-268 Dimensions**

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
A	4.90	5.10	0.193	0.201
B	15.85	16.20	0.624	0.638
C	18.70	19.10	0.736	0.752
D	1.00	1.25	0.039	0.049
E	13.80	14.00	0.543	0.551
F	13.30	13.60	0.524	0.535

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
G	2.70	2.90	0.106	0.114
H	1.15	1.45	0.045	0.057
I	1.95	2.21	0.077	0.087
J	0.94	1.40	0.037	0.055
K	2.40	2.70	0.094	0.106
L	0.40	0.60	0.016	0.024
M	1.45	1.60	0.057	0.063
N	0.00	0.18	0.000	0.007
O	12.40	12.70	0.488	0.500
P	5.45 BSC (nom.)		0.215 BSC (nom.)	
Terminal 1	Gate			
Terminal 2	Drain			
Terminal 3	Source			
Terminal 4	Drain			

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050-7781 | October 2020 | Preliminary