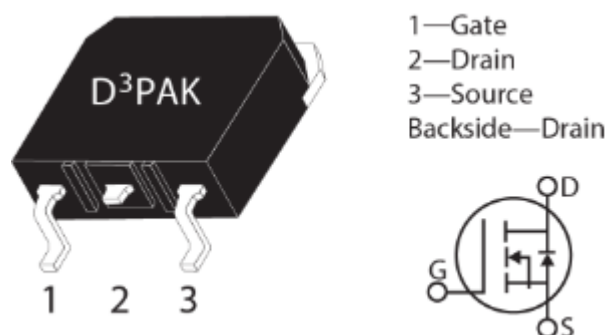


# MSC025SMA120S Silicon Carbide N-Channel Power MOSFET

## 1 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 MSC025SMA120S device is a 1200 V, 25 mΩ SiC MOSFET in a TO-268 (D3PAK) package.



### 1.1 Features

The following are key features of the MSC025SMA120S 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

### 1.2 Benefits

The following are benefits of the MSC025SMA120S 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

### 1.3 Applications

The MSC025SMA120S 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

## 2 Device Specifications

This section shows the specifications of the MSC025SMA120S device.

### 2.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC025SMA120S device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Characteristic	Ratings	Unit
$V_{DS}$	Drain source voltage	1200	V
$I_D$	Continuous drain current at $T_C = 25\text{ }^{\circ}\text{C}$	89	A
	Continuous drain current at $T_C = 100\text{ }^{\circ}\text{C}$	63	
$I_{DM}$	Pulsed drain current <sup>1</sup>	222	
$V_{GS}$	Gate-source voltage	23 to -10	V
$P_D$	Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	370	W
	Linear derating factor	2.47	W/ $^{\circ}\text{C}$

**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 MSC025SMA120S device.

**Table 2 • Thermal and Mechanical Characteristics**

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance		0.27	0.41	$^{\circ}\text{C}/\text{W}$
$T_J$	Operating junction temperature	-55		175	$^{\circ}\text{C}$
$T_{STG}$	Storage temperature	-55		150	
$T_L$	Soldering temperature for 10 seconds (1.6 mm from case)			260	
$Wt$	Package weight		0.14		oz
			4.0		g

## 2.2 Electrical Performance

The following table shows the static characteristics for the MSC025SMA120S device.  $T_J = 25^\circ\text{C}$  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>	$V_{GS} = 20\text{ V}$ , $I_D = 40\text{ A}$		25	31	m $\Omega$
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 3\text{ mA}$	1.8	2.8		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}$ , $I_D = 3\text{ mA}$		-3.5		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$			100	$\mu\text{A}$
		$V_{DS} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ $T_J = 125^\circ\text{C}$			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 MSC025SMA120S device.  $T_J = 25^\circ\text{C}$  unless otherwise specified.

**Table 4 • Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$ , $V_{DD} = 1000\text{ V}$ , $V_{AC} = 25\text{ mV}$ , $f = 1\text{ MHz}$		3020		pF
$C_{rss}$	Reverse transfer capacitance			25		
$C_{oss}$	Output capacitance			270		
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$ , $V_{DD} = 800\text{ V}$ $I_D = 40\text{ A}$		232		nC
$Q_{gs}$	Gate-source charge			41		
$Q_{gd}$	Gate-drain charge			50		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{ V}$ , $V_{GS} = -5\text{ V}/20\text{ V}$ , $I_D = 40\text{ A}$		21		ns
$t_r$	Current rise time	$R_{G(ext)} = 2.5\text{ }\Omega$ <sup>1</sup>		14		
$t_{d(off)}$	Turn-off delay time	Freewheeling diode = MSC025SMA120S		45		
$t_f$	Current fall time			18		
$E_{on}$	Turn-on switching energy <sup>2</sup>			850		$\mu\text{J}$
$E_{off}$	Turn-off switching energy			100		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{ V}$ , $V_{GS} = -5\text{ V}/20\text{ V}$ , $I_D = 40\text{ A}$		18		ns
$t_r$	Current rise time	$R_{G(ext)} = 2.5\text{ }\Omega$ <sup>1</sup>		12		
$t_{d(off)}$	Turn-off delay time	Freewheeling diode = MSC030SDA120S		45		
$t_f$	Current fall time			14		
$E_{on}$	Turn-on switching energy <sup>2</sup>			730		$\mu\text{J}$
$E_{off}$	Turn-off switching energy			100		
ESR	Equivalent series resistance	$f = 1\text{ MHz}$ , 25 mV, drain short		0.88		$\Omega$

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
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	$V_{DS} = 150\text{ V}$ , $V_{GS} = 20\text{ V}$ , $I_D = 40\text{ A}$		3500		mJ

#### Notes:

1.  $R_G$  is total gate resistance excluding internal gate driver impedance.
2.  $E_{on}$  includes energy of the freewheeling diode.

The following table shows the body diode characteristics of the MSC025SMA120S device.

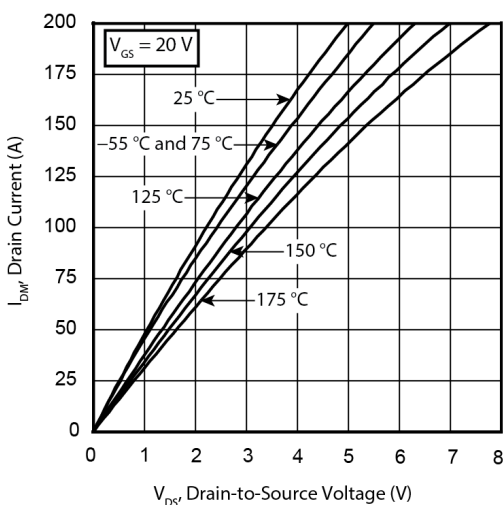
**Table 5 • Body Diode Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 40\text{ A}$ , $V_{GS} = 0\text{ V}$		4.0		V
		$I_{SD} = 40\text{ A}$ , $V_{GS} = -5\text{ V}$		4.2		V
$t_{rr}$	Reverse recovery time	$I_{SD} = 40\text{ A}$ , $V_{GS} = -5\text{ V}$		90		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 800\text{ V}$		550		nC
$I_{RRM}$	Reverse recovery current	$dI/dt = -1000\text{ A}/\mu\text{s}$		13.5		A

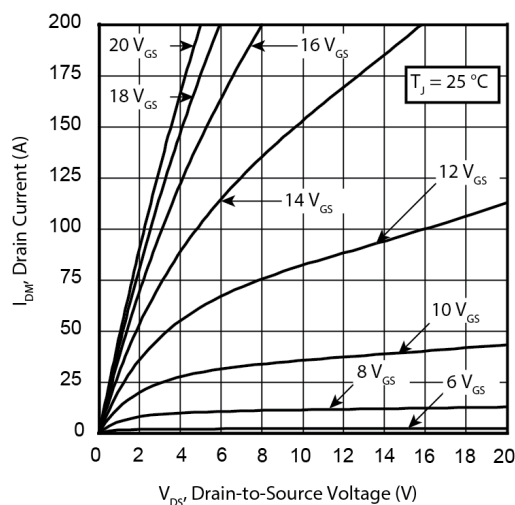
## 2.3 Typical Performance Curves

This section shows the typical performance curves of the MSC025SMA120S device.

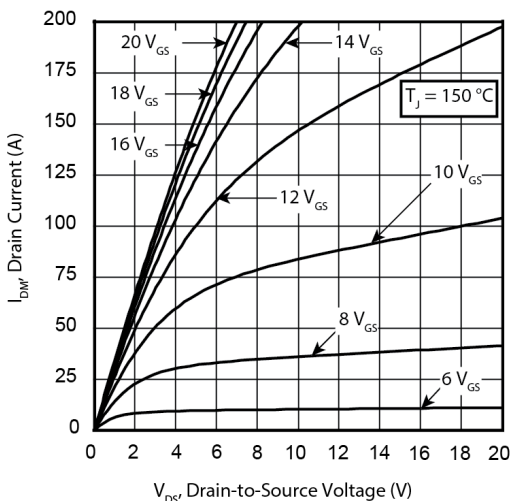
**Figure 1 • Drain Current vs. Drain-to-Source Voltage**



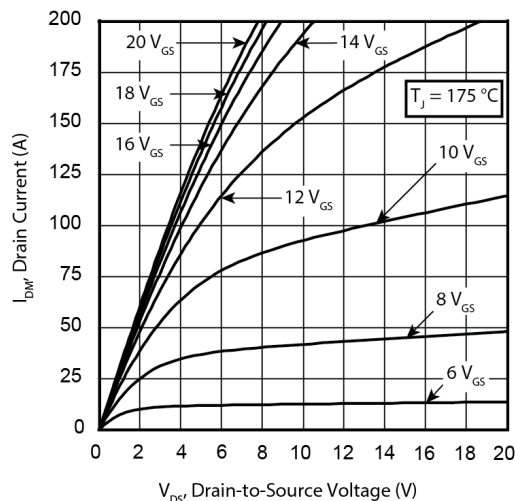
**Figure 2 • Drain Current vs. Drain-to-Source Voltage**



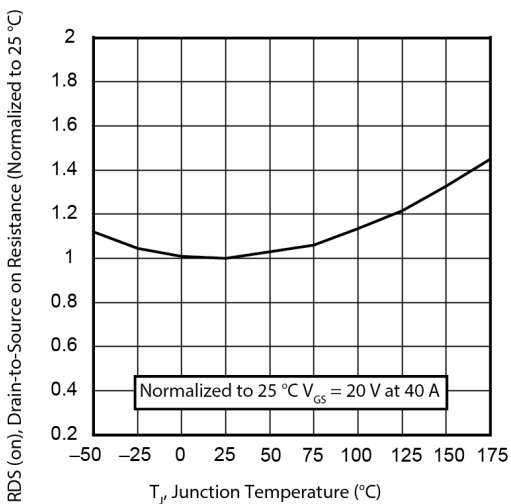
**Figure 3 • Drain Current vs. Drain-to-Source Voltage**



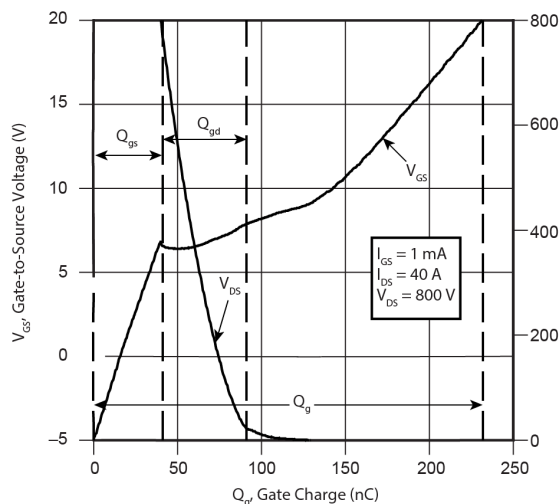
**Figure 4 • Drain Current vs. Drain-to-Source Voltage**



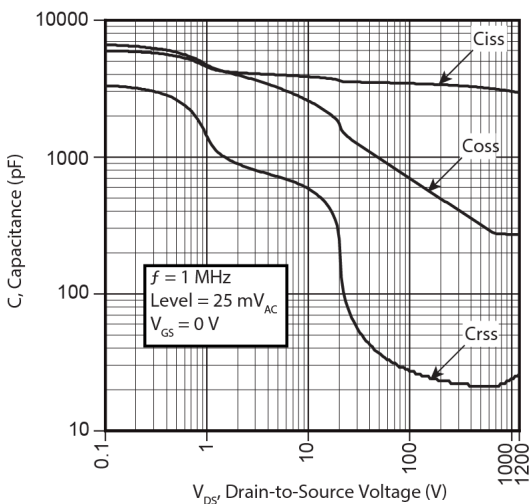
**Figure 5 • RDS(on) vs. Junction Temperature**



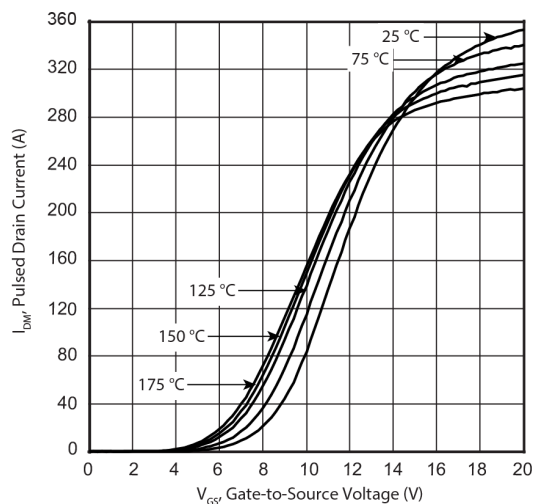
**Figure 6 • Gate Charge Characteristics**



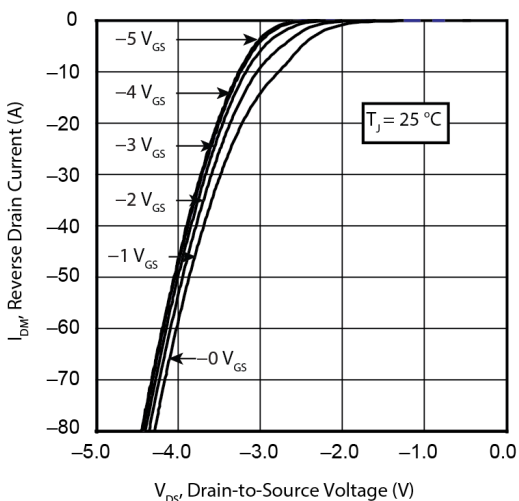
**Figure 7 • Capacitance vs. Drain-to-Source Voltage**



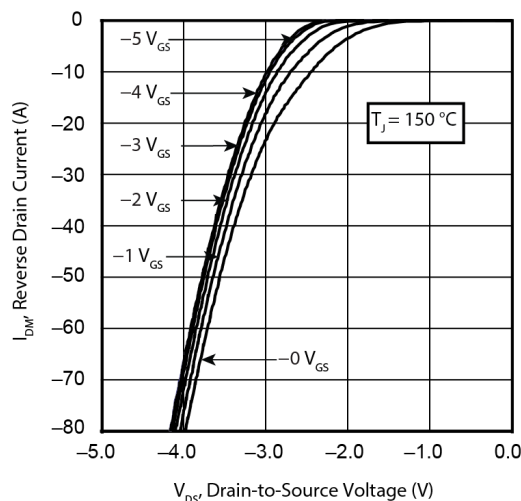
**Figure 8 • IDM vs. Gate-to-Source Voltage**



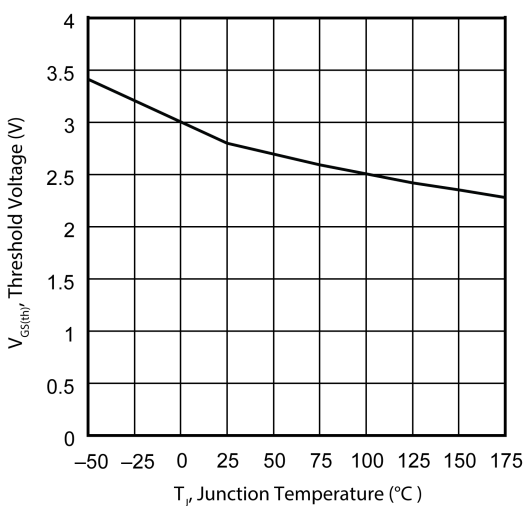
**Figure 9 • IDM vs. VDS Third Quadrant Conduction**



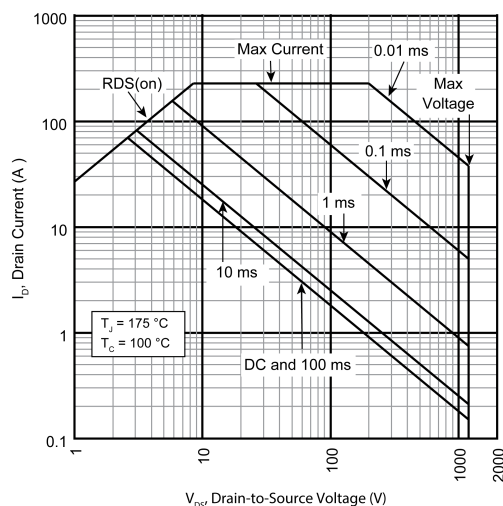
**Figure 10 • IDM vs. VDS Third Quadrant Conduction**



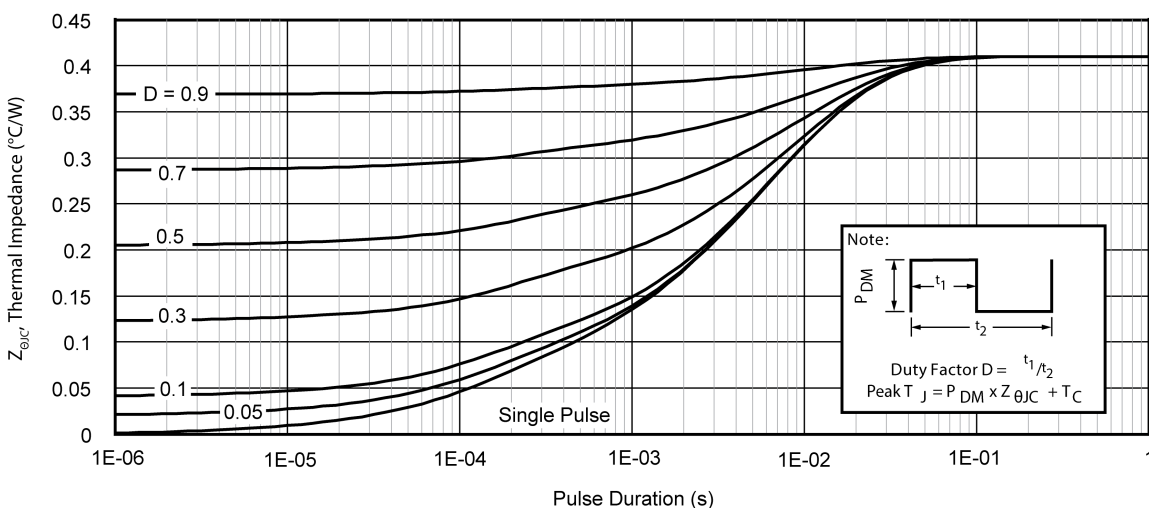
**Figure 11 • VGS(th) vs. Junction Temperature**



**Figure 12 • Forward Safe Operating Area**



**Figure 13 • Maximum Transient Thermal Impedance**



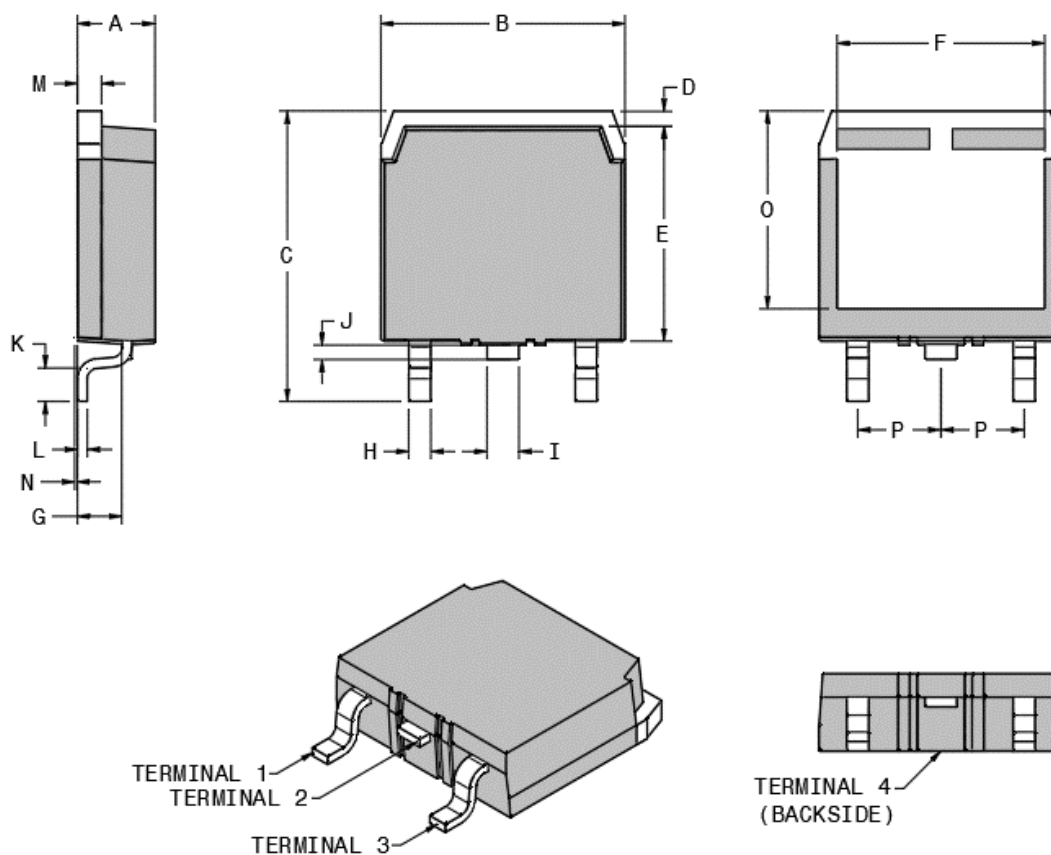
## 3 Package Specification

This section shows the package specification of the MSC025SMA120S device.

### 3.1 Package Outline Drawing

The following figure illustrates the TO-268 package outline of the MSC025SMA120S device.

**Figure 14 • 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
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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