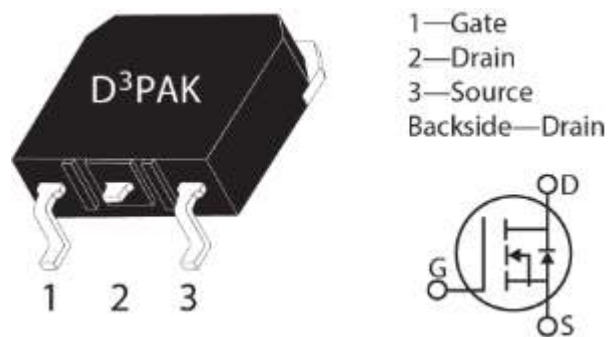


# MSC060SMA070S Silicon Carbide N-Channel Power MOSFET

## 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 MSC060SMA070S device is a 700 V, 60 mΩ SiC MOSFET in a TO-268 (D3PAK) package.



### 1.1 Features

The following are key features of the MSC060SMA070S 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 MSC060SMA070S 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 MSC060SMA070S 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 for the MSC060SMA070S device.

### 2.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings for the MSC060SMA070S device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Characteristic	Ratings	Unit
$V_{DS}$	Drain source voltage	700	V
$I_D$	Continuous drain current at $T_c = 25\text{ }^\circ\text{C}$	37	A
	Continuous drain current at $T_c = 100\text{ }^\circ\text{C}$	26	
$I_{DM}$	Pulsed drain current <sup>1</sup>	93	
$V_{GS}$	Gate-source voltage	23 to -10	V
$P_D$	Total power dissipation at $T_c = 25\text{ }^\circ\text{C}$	130	W
	Linear derating factor	0.86	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 for the MSC060SMA070S device.

**Table 2 • Thermal and Mechanical Characteristics**

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance		0.77	1.16	$^\circ\text{C}/\text{W}$
$T_J$	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 MSC060SMA070S 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	$V_{GS} = 0\text{ V}$ , $I_D = 100\text{ }\mu\text{A}$	700			V
$R_{DS(on)}$	Drain-source on resistance <sup>1</sup>	$V_{GS} = 20\text{ V}$ , $I_D = 20\text{ A}$		60	75	m $\Omega$
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 1\text{ mA}$	1.9	2.4		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}$ , $I_D = 1\text{ mA}$		-3.4		mV/ $^\circ\text{C}$
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 700\text{ V}$ , $V_{GS} = 0\text{ V}$			100	$\mu\text{A}$
		$V_{DS} = 700\text{ V}$ , $V_{GS} = 0\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$			500	
$I_{GSS}$	Gate-source leakage current	$V_{GS} = 20\text{ V}/-10\text{ V}$			$\pm 100$	nA

### Notes:

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

The following table shows the dynamic characteristics for the MSC060SMA070S 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	$V_{GS} = 0\text{ V}$ , $V_{DD} = 700\text{ V}$ , $V_{AC} = 25\text{ mV}$ , $f = 1\text{ MHz}$		1175		pF
$C_{rss}$	Reverse transfer capacitance			8		
$C_{oss}$	Output capacitance			130		
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$ , $V_{DD} = 470\text{ V}$ $I_D = 20\text{ A}$		56		nC
$Q_{gs}$	Gate-source charge			15		
$Q_{gd}$	Gate-drain charge			9		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 470\text{ V}$ , $V_{GS} = -5\text{ V}/20\text{ V}$ , $I_D = 20\text{ A}$		18		ns
$t_r$	Current rise time	$R_{G(ext)} = 4\text{ }\Omega^1$ , Freewheeling diode = MSC060SMA070S ( $V_{GS} = -5\text{ V}$ )		7		
$t_{d(off)}$	Turn-off delay time			26		
$t_f$	Current fall time			7		
$E_{on}$	Turn-on switching energy <sup>2</sup>			140		$\mu\text{J}$
$E_{off}$	Turn-off switching energy			25		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 470\text{ V}$ , $V_{GS} = -5\text{ V}/20\text{ V}$ , $I_D = 20\text{ A}$		20		ns
$t_r$	Current rise time	$R_{G(ext)} = 4\text{ }\Omega^1$ Freewheeling diode = MSC010SDA070B		9		
$t_{d(off)}$	Turn-off delay time			25		
$t_f$	Current fall time			10		
$E_{on}$	Turn-on switching energy <sup>2</sup>			130		$\mu\text{J}$
$E_{off}$	Turn-off switching energy			25		
ESR	Equivalent series resistance	$f = 1\text{ MHz}$ , 25 mV, drain short		2.6		$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 560\text{ V}$ , $V_{GS} = 20\text{ V}$		3		$\mu\text{s}$

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$E_{AS}$	Avalanche energy, single pulse	$V_{DS} = 150\text{ V}$ , $V_{GS} = 20\text{ V}$ , $I_D = 20\text{ A}$		1150		mJ

#### Notes:

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

The following table shows the body diode characteristics for the MSC060SMA070S device.  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

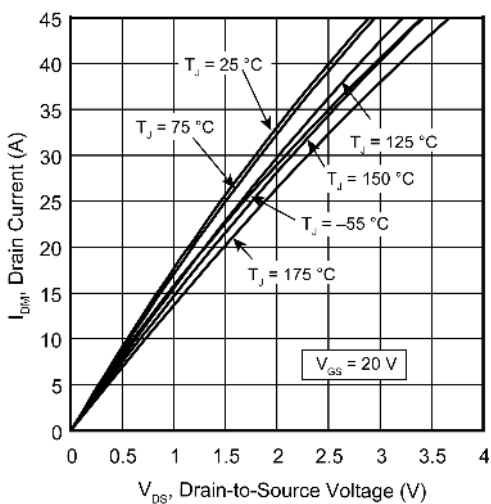
**Table 5 • Body Diode Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 20\text{ A}$ , $V_{GS} = 0\text{ V}$		4.0		V
		$I_{SD} = 20\text{ A}$ , $V_{GS} = -5\text{ V}$		4.2		V
$t_{rr}$	Reverse recovery time	$I_{SD} = 20\text{ A}$ , $V_{GS} = -5\text{ V}$		25		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 470\text{ V}$ $di/dt = -1500\text{ A}/\mu\text{s}$		170		nC
$I_{RRM}$	Reverse recovery current			10		A

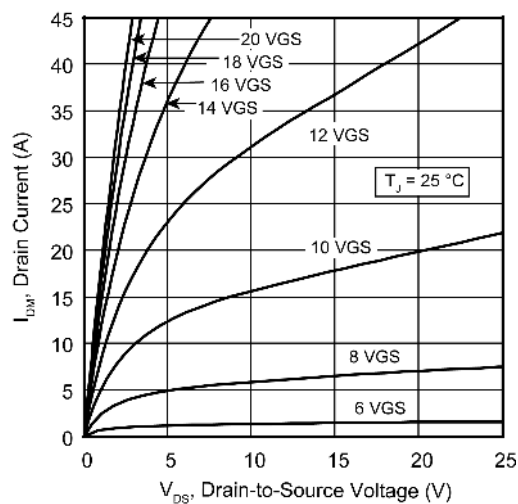
## 2.3 Typical Performance Curves

This section shows the typical performance curves for the MSC060SMA070S device.

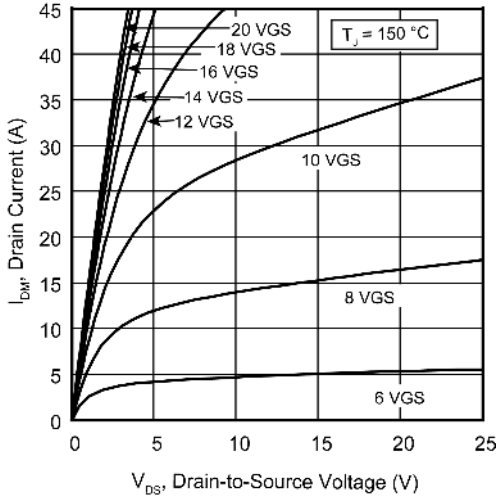
**Figure 1 • Drain Current vs. Drain-to-Source Voltage**



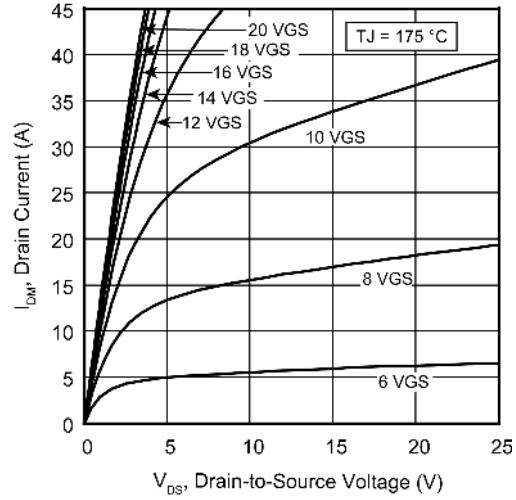
**Figure 2 • Drain Current vs. Drain-to-Source Voltage**



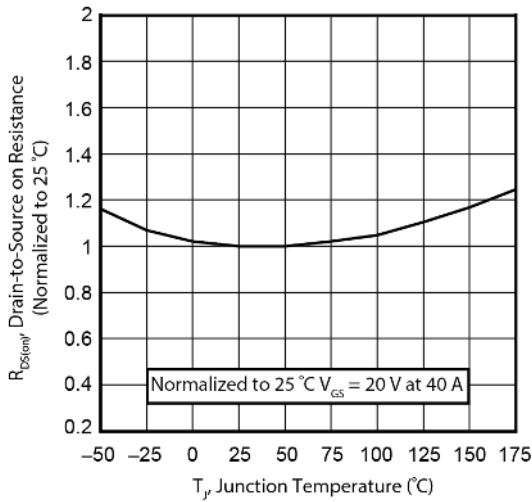
**Figure 3 • Drain Current vs. Drain-to-Source Voltage**



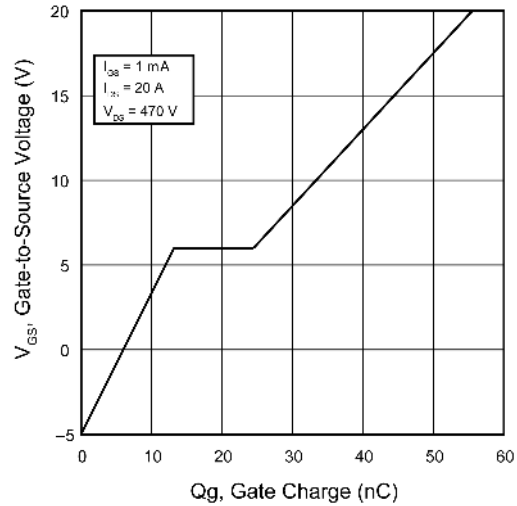
**Figure 4 • Drain Current vs. Drain-to-Source Voltage**



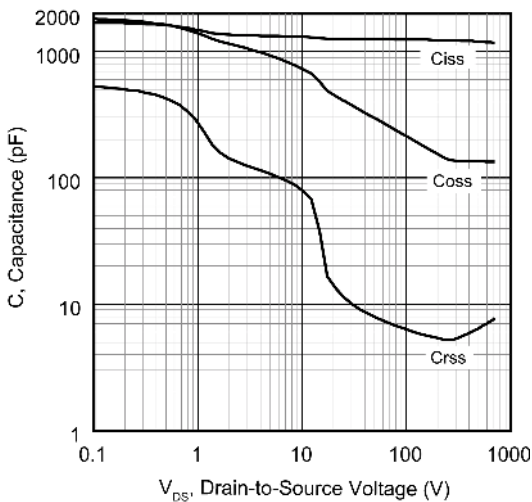
**Figure 5 • RDS(on) vs. Junction Temperature**



**Figure 6 • Gate Charge Characteristics**



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



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

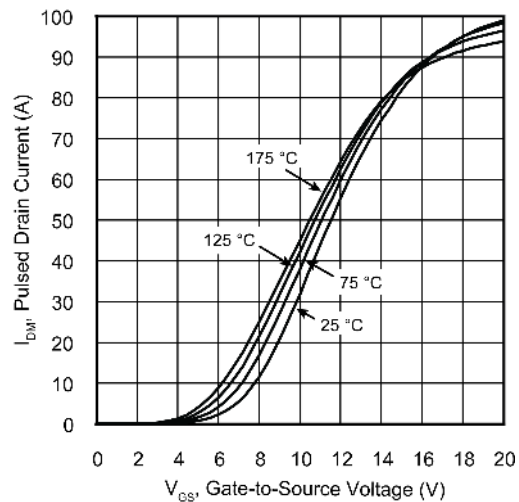


Figure 9 • IDM vs. VDS Third Quadrant Conduction

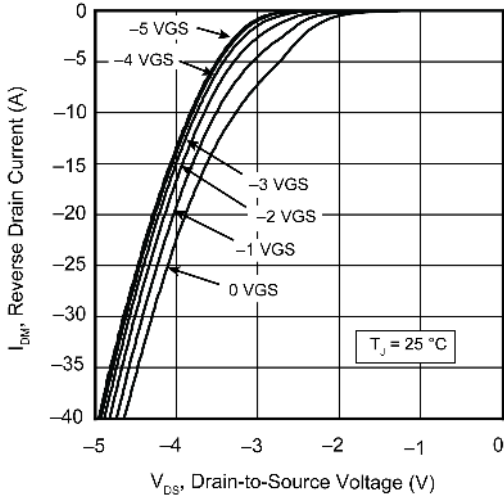


Figure 10 • IDM vs. VDS Third Quadrant Conduction

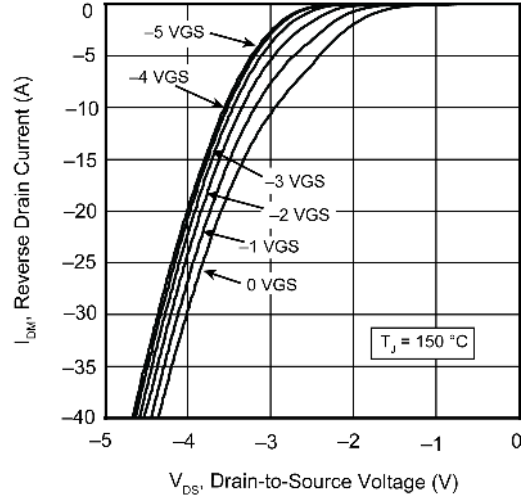


Figure 11 • VGS(th) vs. Junction Temp.

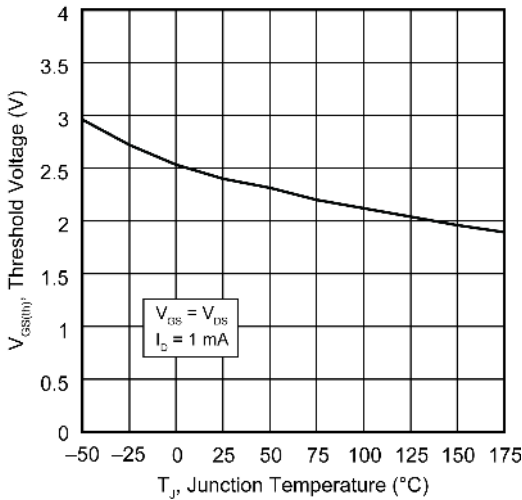


Figure 12 • Forward Safe Operating Area

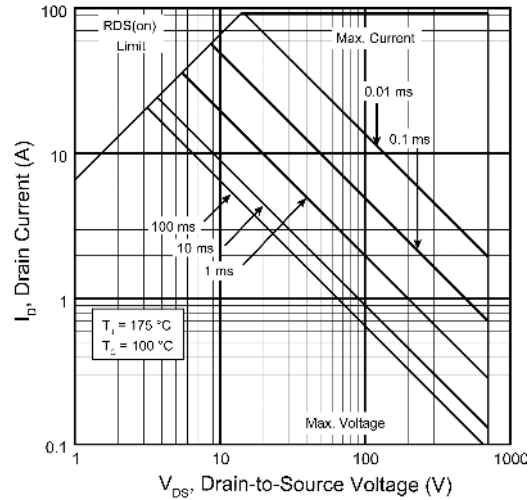
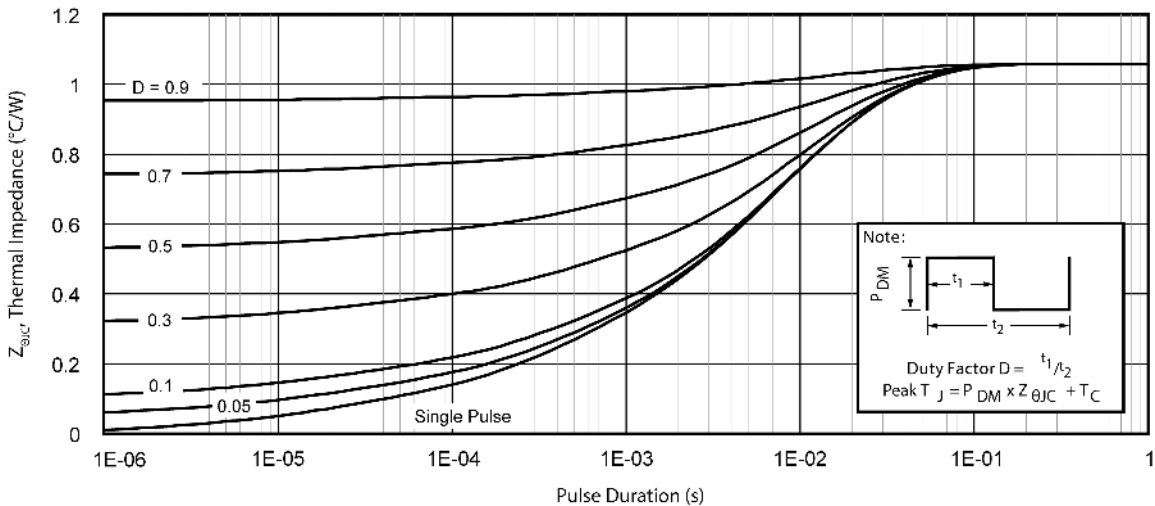


Figure 13 • Maximum Transient Thermal Impedance



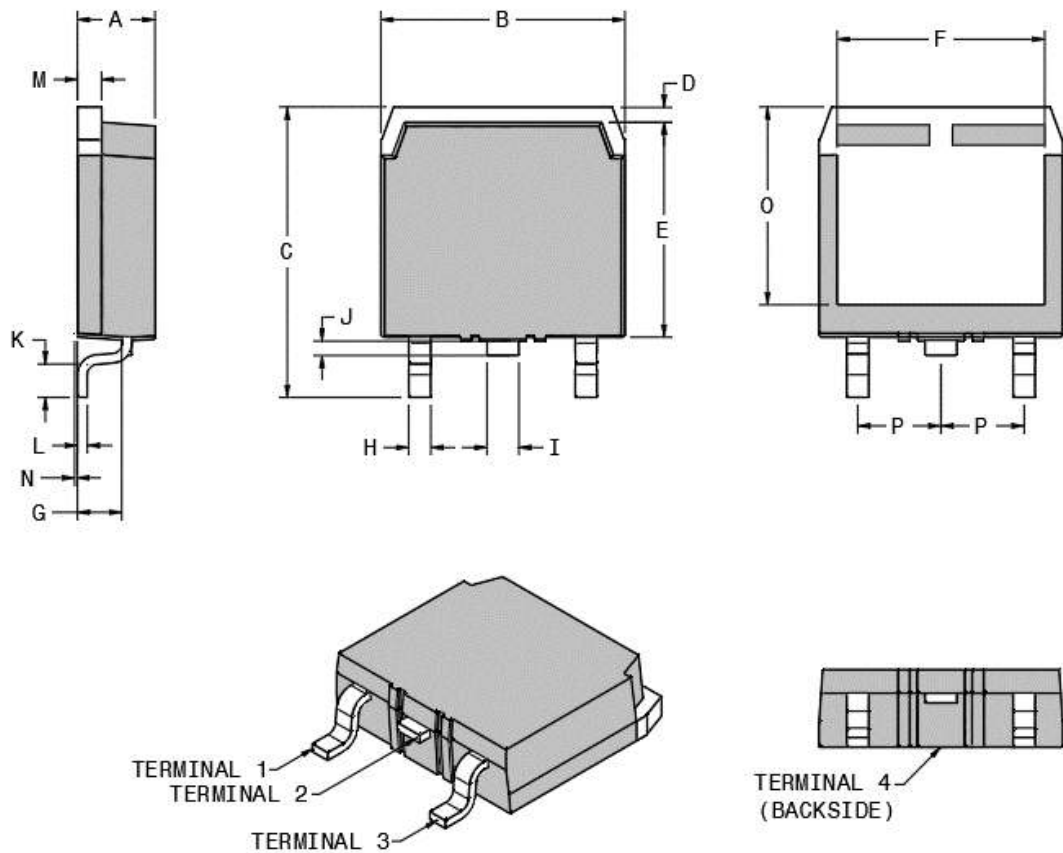
### 3 Package Specification

This section shows the package specification for the MSC060SMA070S device.

#### 3.1 Package Outline Drawing

The following figure illustrates the TO-268 package outline of the MSC060SMA070S 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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