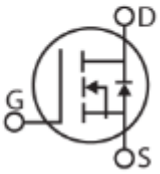
# MSC015SMA070S Silicon Carbide N-Channel Power MOSFET

## 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 MSC015SMA070S device is a 700 V, 15 mΩ SiC MOSFET in a TO-268 (D3PAK) package.




1—Gate
2—Drain
3—Source
Backside—Drain




### 1.1 Features

The following are key features of the MSC015SMA070S 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 °C
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

### 1.2 Benefits

The following are benefits of the MSC015SMA070S 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 MSC015SMA070S 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 MSC015SMA070S device.

## 2.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC015SMA070S device.

**Table 1 • Absolute Maximum Ratings**

| Symbol | Characteristic | Ratings | Unit |
|---|---|---|---|
| $V_{DSS}$ | Drain source voltage | 700 | V |
| $I_D$ | Continuous drain current at $T_C$ = 25 °C | 126 | A |
| | Continuous drain current at $T_C$ = 100 °C | 89 | |
| $I_{DM}$ | Pulsed drain current [1] | 315 | |
| $V_{GS}$ | Gate-source voltage | 23 to –10 | V |
| $P_D$ | Total power dissipation at $T_C$ = 25 °C | 370 | W |
| | Linear derating factor | 2.47 | 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 MSC015SMA070S 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 | °C/W |
| $T_J$ | Operating junction temperature | –55 | | 175 | °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 of the MSC015SMA070S device. $T_J$ = 25 °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 V, $I_D$ = 100 µA | 700 | | | V |
| $R_{DS(on)}$ | Drain-source on resistance [1] | $V_{GS}$ = 20 V, $I_D$ = 40 A | | 15 | 19 | mΩ |
| $V_{GS(th)}$ | Gate-source threshold voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 4 mA | 1.9 | 2.4 | | V |
| $\Delta V_{GS(th)}/\Delta T_J$ | Threshold voltage coefficient | $V_{GS}$ = $V_{DS}$, $I_D$ = 4 mA | | –3.4 | | mV/°C |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{DS}$, = 700 V, $V_{GS}$ = 0 V | | | 100 | µA |
| | | $V_{DS}$ = 700 V, $V_{GS}$ = 0 V<br>$T_J$ = 125 °C | | | 500 | |
| $I_{GSS}$ | Gate-source leakage current | $V_{GS}$ = 20 V/–10 V | | | ±100 | nA |

**Notes:**

1. Pulse test: pulse width < 380 µs, duty cycle < 2%.

The following table shows the dynamic characteristics of the MSC015SMA070S device. $T_J$ = 25 °C unless otherwise specified.

**Table 4 • Dynamic Characteristics**

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{GS}$ = 0 V, $V_{DD}$ = 700 V, $V_{AC}$ = 25 mV, f = 1 MHz | | 4500 | | pF |
| $C_{rss}$ | Reverse transfer capacitance | | | 29 | | |
| $C_{oss}$ | Output capacitance | | | 510 | | |
| $Q_g$ | Total gate charge | $V_{GS}$ = –5 V/20 V, $V_{DD}$ = 470 V<br>$I_D$ = 40 A | | 215 | | nC |
| $Q_{gs}$ | Gate-source charge | | | 58 | | |
| $Q_{gd}$ | Gate-drain charge | | | 35 | | |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 470 V, $V_{GS}$ = -5 V/20 V, $I_D$ = 40 A<br>$R_{G(ext)}$ = 2.5 Ω [1]<br>Freewheeling diode =<br>MSC015SMA070S ($V_{GS}$ = -5 V) | | 38 | | ns |
| $t_r$ | Current rise time | | | 8 | | |
| $t_{d(off)}$ | Turn-off delay time | | | 55 | | |
| $t_f$ | Current fall time | | | 15 | | |
| $E_{on}$ | Turn-on switching energy [2] | | | 420 | | µJ |
| $E_{off}$ | Turn-off switching energy | | | 90 | | |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 470 V, $V_{GS}$ = -5 V/20 V, $I_D$ = 40 A<br>$R_{G(ext)}$ = 2.5 Ω [1]<br>Freewheeling diode =<br>2x MSC010SDA070S | | 30 | | ns |
| $t_r$ | Current rise time | | | 8 | | |
| $t_{d(off)}$ | Turn-off delay time | | | 50 | | |
| $t_f$ | Current fall time | | | 8 | | |
| $E_{on}$ | Turn-on switching energy [2] | | | 217 | | µJ |
| $E_{off}$ | Turn-off switching energy | | | 118 | | |
| ESR | Equivalent series resistance | f = 1 MHz, 25 mV, drain short | | 0.69 | | Ω |
| SCWT | Short circuit withstand time | $V_{DS}$ = 560 V, $V_{GS}$ = 20 V | | 3 | | µs |

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $E_{AS}$ | Avalanche energy, single pulse | $V_{DS}$ = 150 V, $V_{GS}$ = 20 V, $I_D$ = 40 A | | 4400 | | 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 MSC015SMA070S device. $T_J$ = 25 °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 A, $V_{GS}$ = 0 V | | 3.4 | | V |
| | | $I_{SD}$ = 40 A, $V_{GS}$ = –5 V | | 3.8 | | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 40 A, $V_{GS}$ = –5 V<br>$V_{DD}$ = 470 V<br>dI/dt = –1200 A/µs | | 40 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | | 495 | | nC |
| $I_{RRM}$ | Reverse recovery current | | | 19 | | A |

## 2.3 Typical Performance Curves

This section shows the typical performance curves for the MSC015SMA070S device.

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

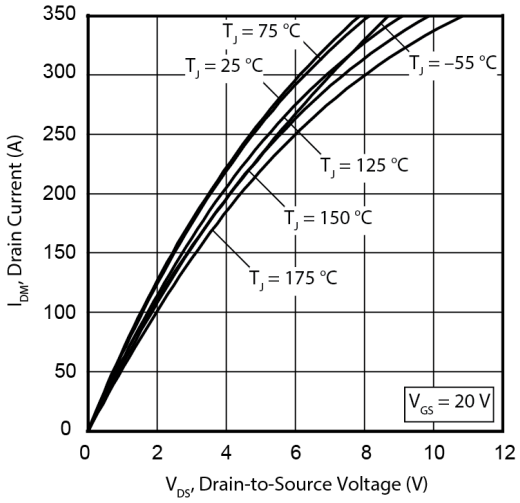



**Figure 2 • Drain Current vs. Drain-to-Source Voltage**

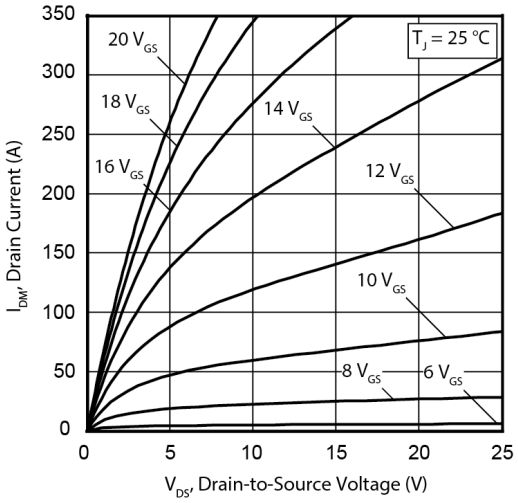


**Figure 3 • Drain Current vs. Drain-to-Source Voltage**

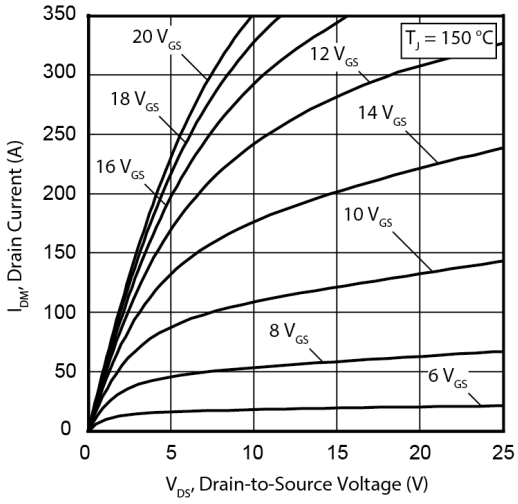



**Figure 4 • Drain Current vs. Drain-to-Source Voltage**

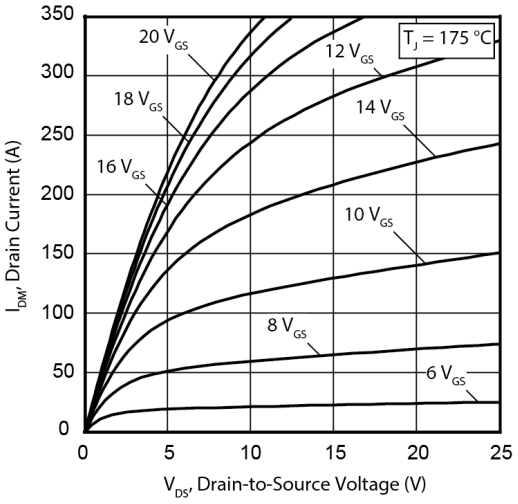



**Figure 5 • RDS(on) vs. Junction Temperature**

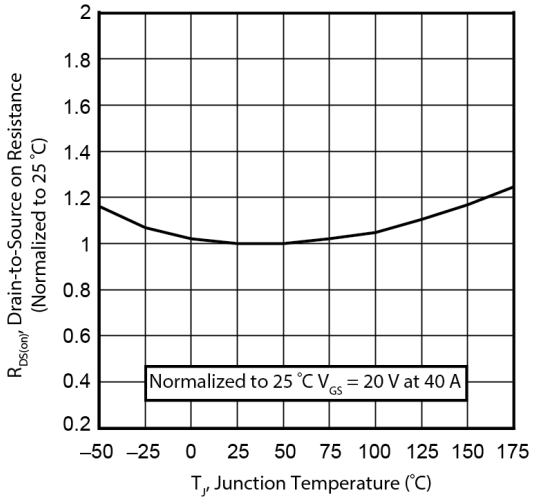



**Figure 6 • Gate Charge Characteristics**

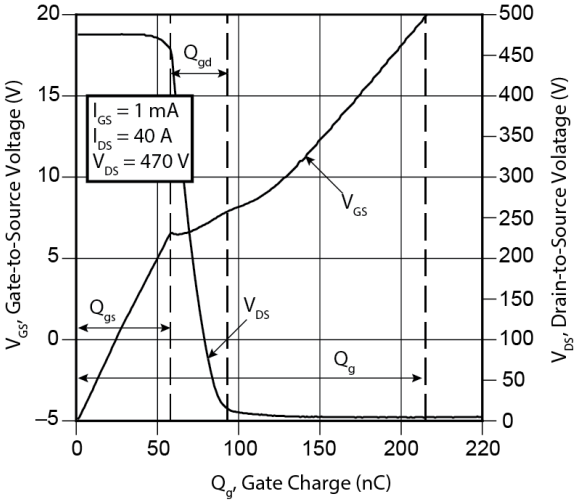



**Figure 7 • Capacitance vs. Drain-to-Source Voltage**

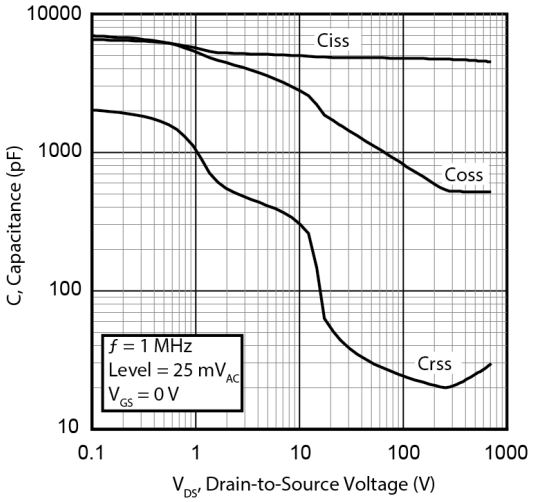



**Figure 8 • IDM vs. Gate-to-Source Voltage**

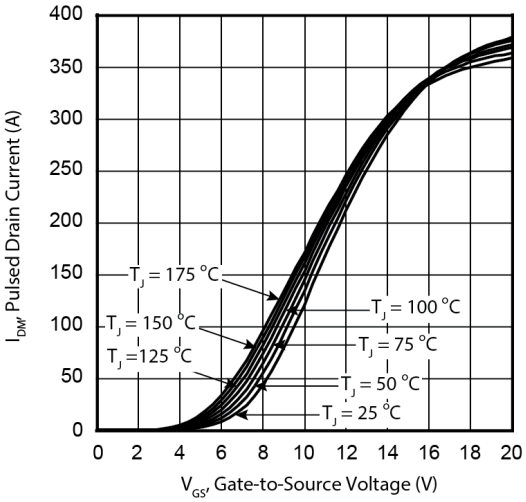


**Figure 9 • IDM vs. VDS Third Quadrant Conduction**

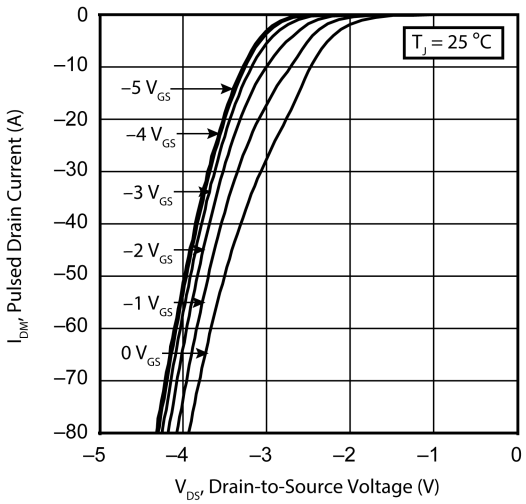



**Figure 10 • IDM vs. VDS Third Quadrant Conduction**

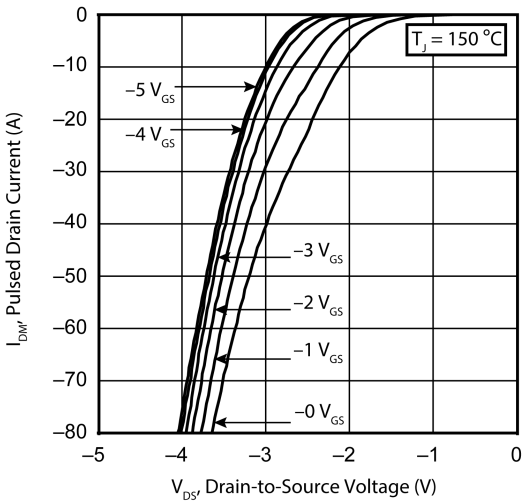



**Figure 11 • VGS(th) vs. Junction Temp.**

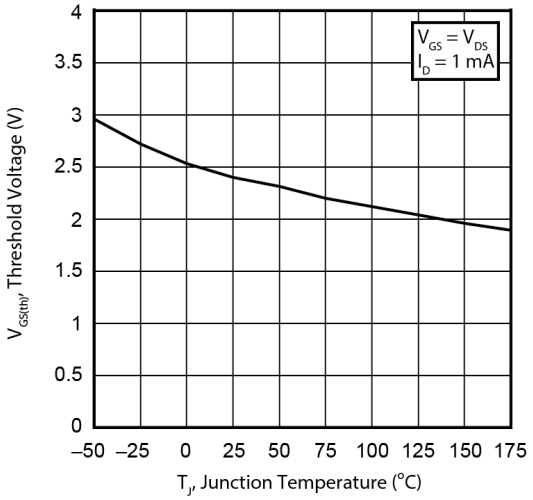



**Figure 12 • Forward Safe Operating Area**

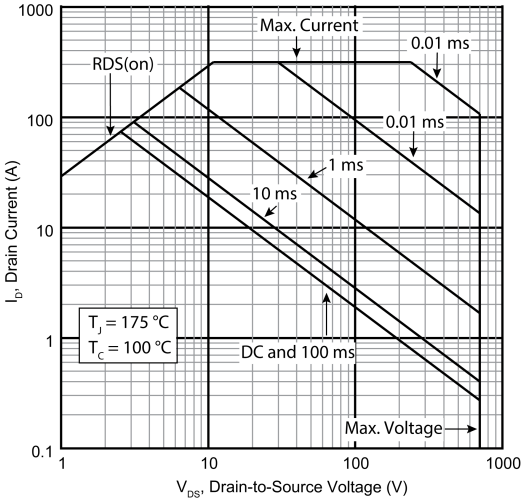
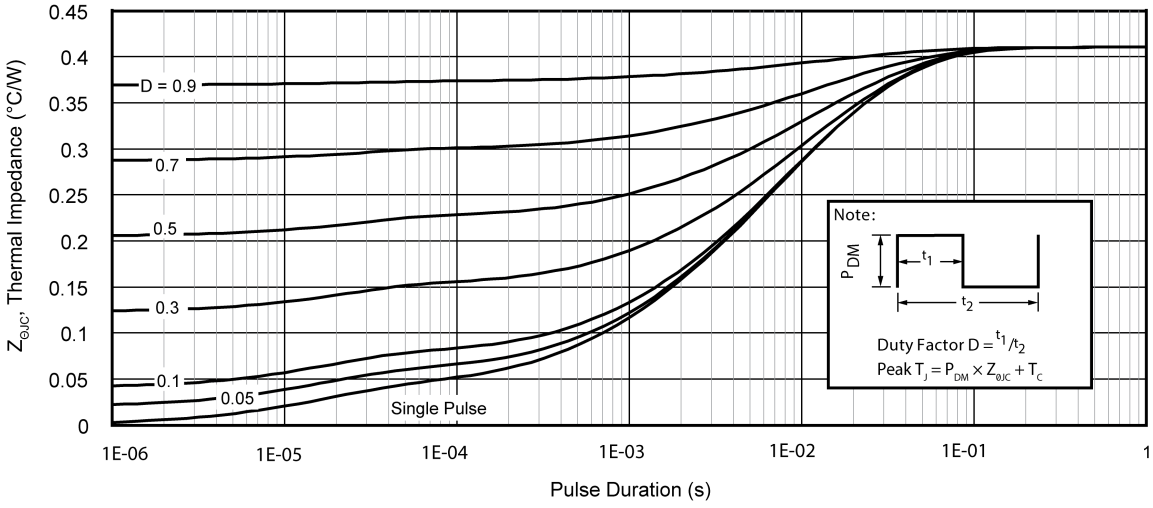



**Figure 13 • Maximum Transient Thermal Impedance**



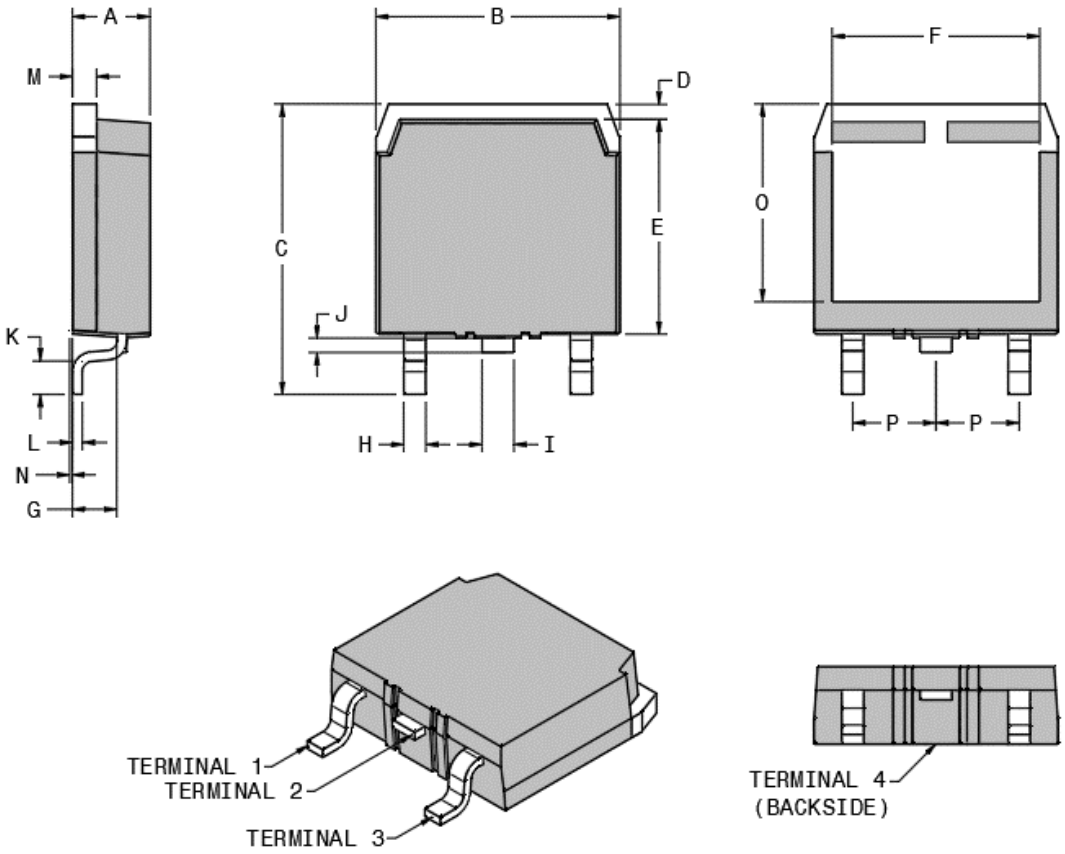
# 3 Package Specification

This section shows the package specification of the MSC015SMA070S device.

## 3.1 Package Outline Drawing

The following figure illustrates the TO-268 package outline of the MSC015SMA070S 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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