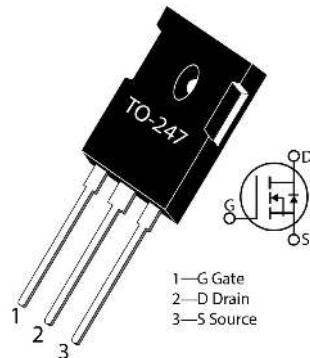


MSC015SMA070B Silicon Carbide N-Channel Power MOSFET

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 MSC015SMA070B device is a 700 V, 15 mΩ SiC MOSFET in a TO-247 package.



Features

The following are key features of the MSC015SMA070B 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 MSC015SMA070B 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 MSC015SMA070B 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 MSC015SMA070B device.

Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC015SMA070B 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 | 140 | A |
| | Continuous drain current at T _C = 100 °C | 99 | |
| I _{DM} | Pulsed drain current ¹ | 350 | |
| V _{GS} | Gate-source voltage | 23 to -10 | V |
| P _D | Total power dissipation at T _C = 25 °C | 455 | W |
| | Linear derating factor | 3.03 | 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 MSC015SMA070B device.

Table 2 • Thermal and Mechanical Characteristics

| Symbol | Characteristic | Min | Typ | Max | Unit |
|------------------|---|-----|------|------|--------|
| R _{θJC} | Junction-to-case thermal resistance | | 0.22 | 0.33 | °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) | | | 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 MSC015SMA070B 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 ¹ | $V_{GS} = 20\text{ V}, I_D = 40\text{ A}$ | | 15 | 19 | m Ω |
| $V_{GS(th)}$ | Gate-source threshold voltage | $V_{GS} = V_{DS}, I_D = 4\text{ mA}$ | 1.9 | 2.4 | | V |
| $\Delta V_{GS(th)}/\Delta T_J$ | Threshold voltage coefficient | $V_{GS} = V_{DS}, I_D = 4\text{ mA}$ | | -3.4 | | mV/ $^\circ\text{C}$ |
| I_{DSS} | Zero gate voltage drain current | $V_{DS} = 700\text{ V}, V_{GS} = 0\text{ V}$ | | | 100 | μA |
| | | $V_{DS} = 700\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | | | 500 | |
| I_{GSS} | Gate-source leakage current | $V_{GS} = 20\text{ V}/-10\text{ V}$ | | | ± 100 | nA |

Note:

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

The following table shows the dynamic characteristics of the MSC015SMA070B 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 | $V_{GS} = 0\text{ V}, V_{DD} = 700\text{ V}, V_{AC} = 25\text{ mV}, f = 1\text{ MHz}$ | | 4500 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 29 | | |
| C_{oss} | Output capacitance | | | 510 | | |
| Q_g | Total gate charge | $V_{GS} = -5\text{ V}/20\text{ V}, V_{DD} = 470\text{ V}, I_D = 40\text{ A}$ | | 215 | | nC |
| Q_{gs} | Gate-source charge | | | 58 | | |
| Q_{gd} | Gate-drain charge | | | 35 | | |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 470\text{ V}, V_{GS} = -5\text{ V}/20\text{ V}, I_D = 40\text{ A}$ | | 20 | | ns |
| t_f | Voltage fall time | | | 35 | | |

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit | |
|--------------|--------------------------------|---|---------------------------------|------|------|---------|----------|
| $t_{d(off)}$ | Turn-off delay time | $R_{g(ext)} = 2.5 \Omega$ Freewheeling diode = MSC015SMA070B $(V_{GS} = -5 V)$ | | 35 | | | |
| t_r | Voltage rise time | | | 18 | | | |
| E_{on} | Turn-on switching energy | | | 420 | | μJ | |
| E_{off} | Turn-off switching energy | | | 90 | | | |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 470 V,$ $V_{GS} = -5 V/20 V,$ $I_D = 40 A$ $R_{g(ext)} = 2.5 \Omega$ Freewheeling diode= MSC050SDA070B | | 20 | | ns | |
| t_f | Voltage fall time | | | 32 | | | |
| $t_{d(off)}$ | Turn-off delay time | | | 38 | | | |
| t_r | Voltage rise time | | | 10 | | | |
| E_{on} | Turn-on switching energy | | | 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 |
| E_{AS} | Avalanche energy, single pulse | $V_{DS} = 150 V, I_D = 40 A$ | | 4400 | | mJ | |

The following table shows the body diode characteristics of the MSC015SMA070B device. $T_J = 25^\circ C$ 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 | $I_{SD} = 40 A, V_{GS} = -5 V$ $V_{DD} = 470 V, di/dt = -1200 A/\mu s$ | | 40 | | ns |
| Q_{rr} | Reverse recovery charge | | | 495 | | nC |
| I_{RRM} | Reverse recovery current | | | 19 | | A |

Typical Performance Curves

This section shows the typical performance curves of the MSC015SMA070B device.

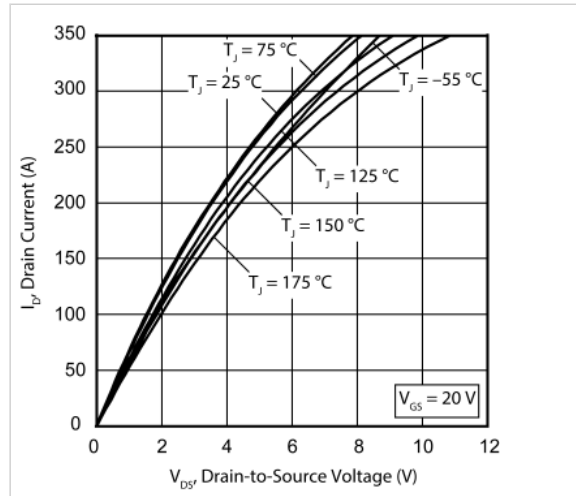


Figure 1 • Drain Current vs. V_{DS}

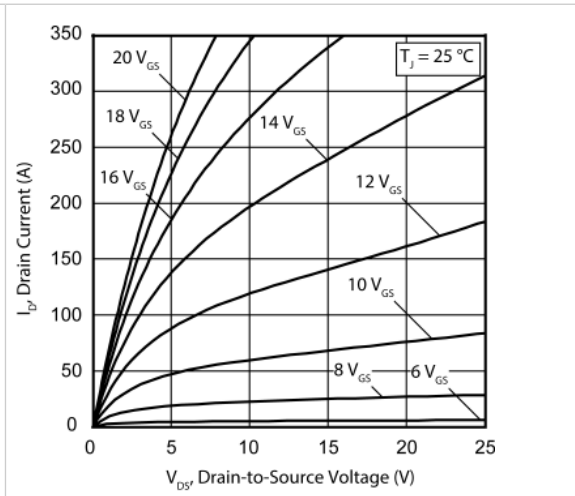


Figure 2 • Drain Current vs. V_{DS}

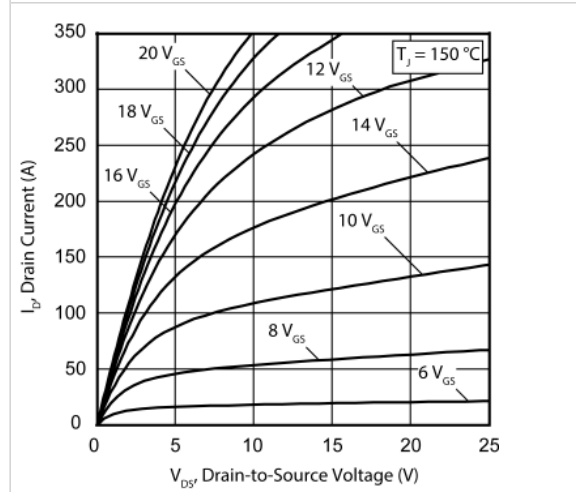


Figure 3 • Drain Current vs. V_{DS}

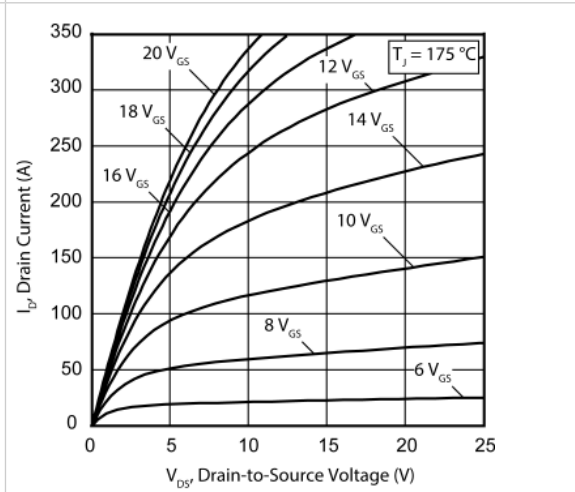


Figure 4 • Drain Current vs. V_{DS}

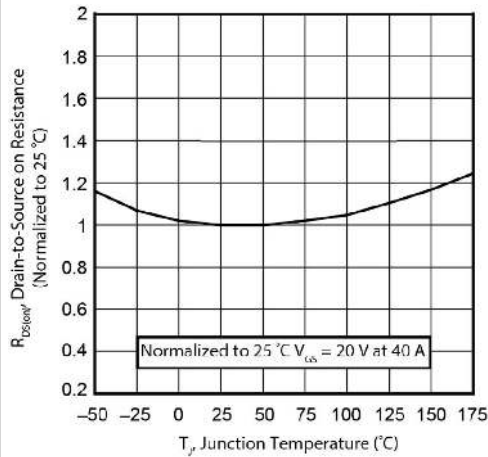


Figure 5 • $R_{DS(on)}$ vs. Junction Temperature

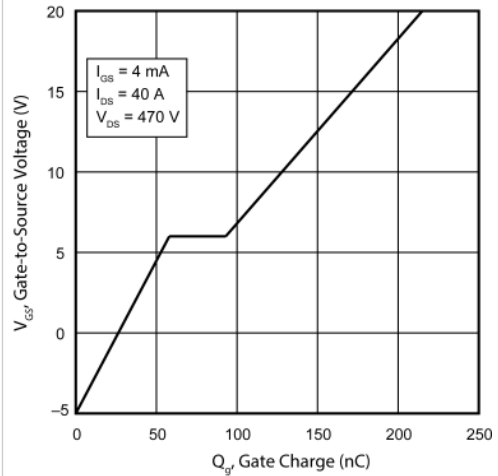


Figure 6 • Gate Charge Characteristics

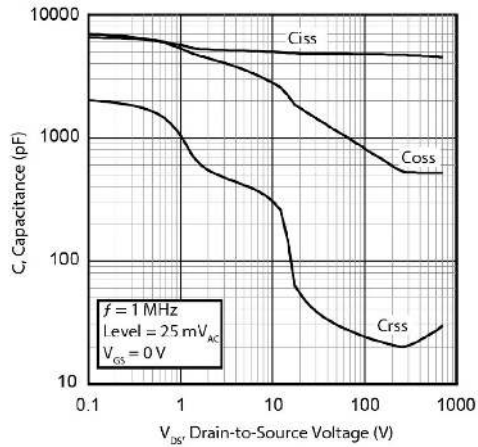


Figure 7 • Capacitance vs. Drain-to-Source Voltage

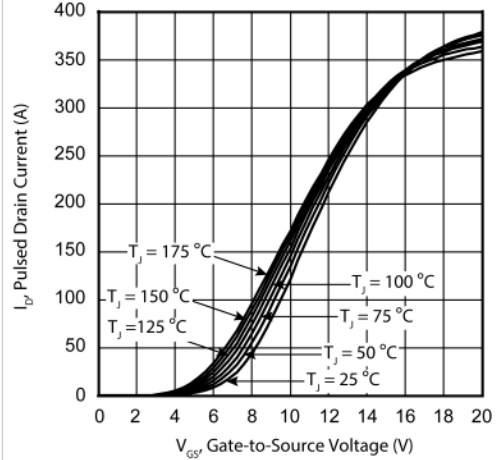


Figure 8 • I_D vs. Gate-to-Source Voltage

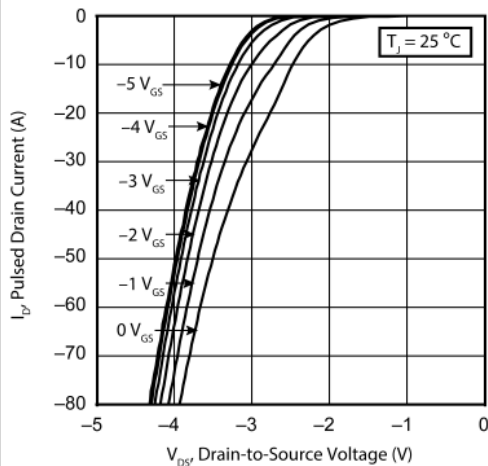


Figure 9 • I_D vs. V_{DS} 3rd Quadrant Conduction

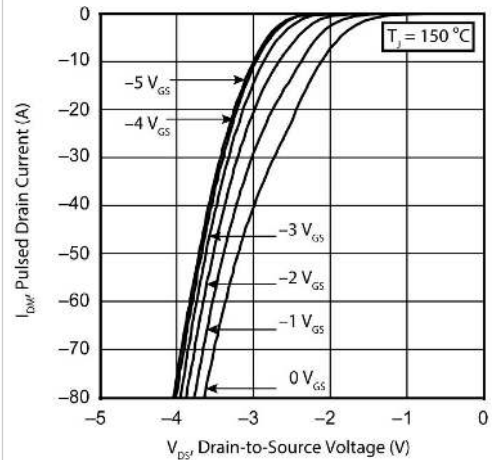


Figure 10 • I_D vs. V_{DS} 3rd Quadrant Conduction

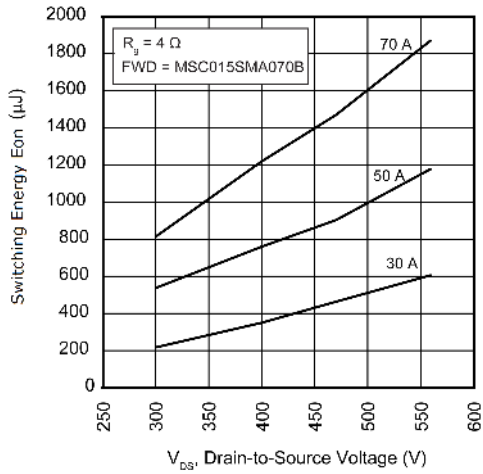


Figure 11 • Switching Energy Eon vs. V_{DS} and I_D

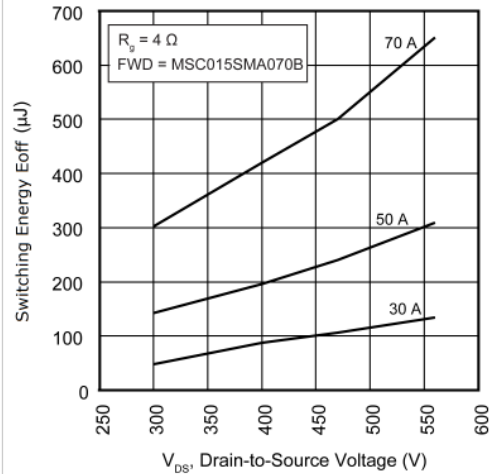


Figure 12 • Switching Energy Eoff vs. V_{DS} and I_D

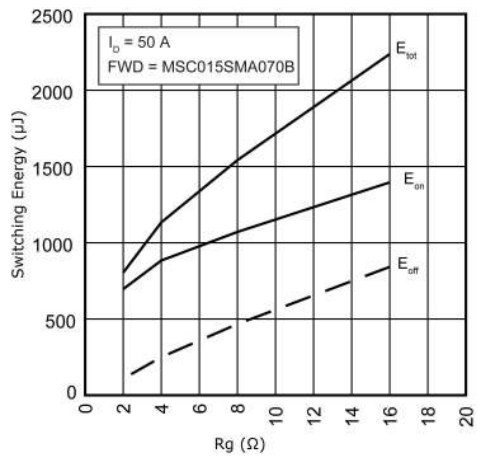


Figure 13 • Switching Energy vs. R_g

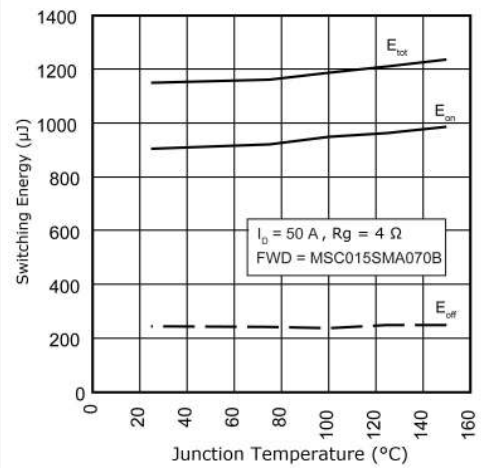


Figure 14 • Switching Energy vs. Temperature

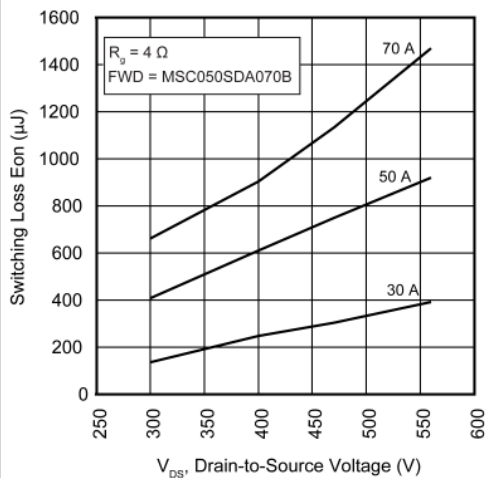


Figure 15 • Switching Energy Eon vs. V_{DS} and I_D

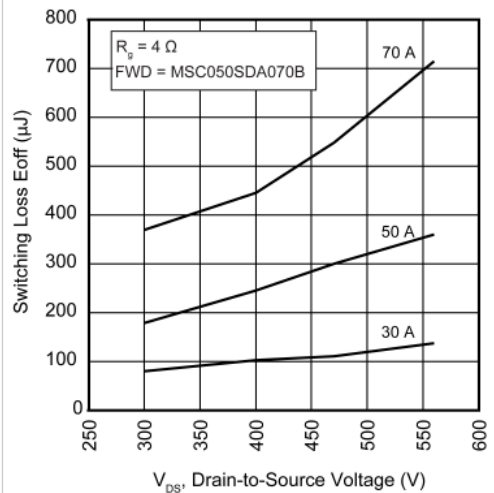


Figure 16 • Switching Energy Eoff vs. V_{DS} and I_D

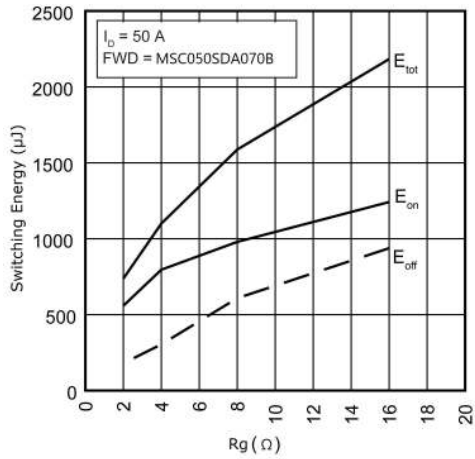


Figure 17 • Switching Energy vs. R_g

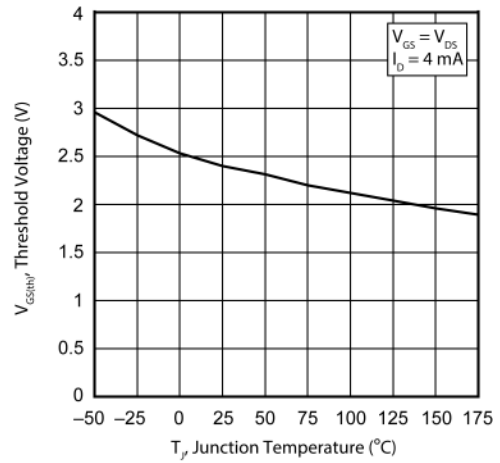


Figure 18 • Threshold Voltage vs. Junction Temp.

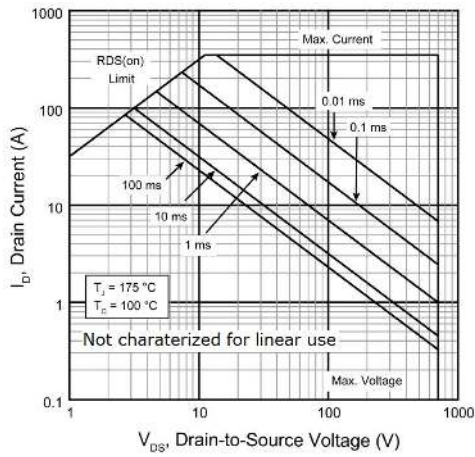


Figure 19 • Forward Safe Operating Area

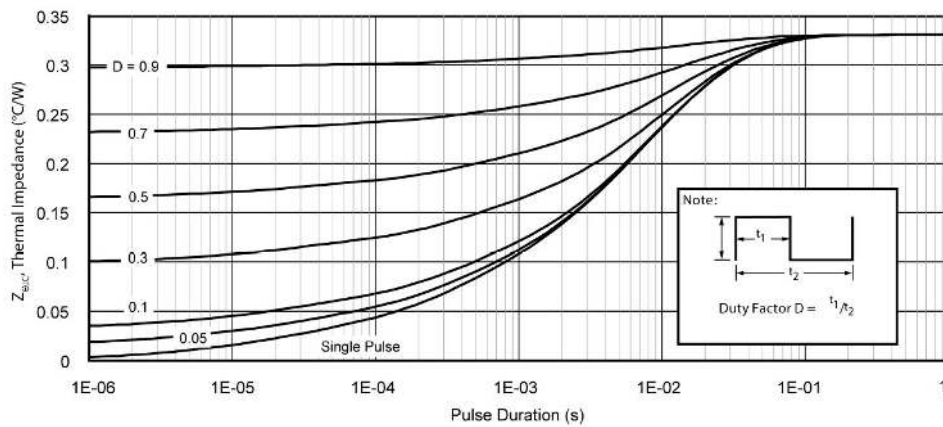


Figure 20 • Maximum Transient Thermal Impedance

Package Specification

This section shows the package specification of the MSC015SMA070B device.

Package Outline Drawing

The following figure illustrates the TO-247 package outline of the MSC015SMA070B device.

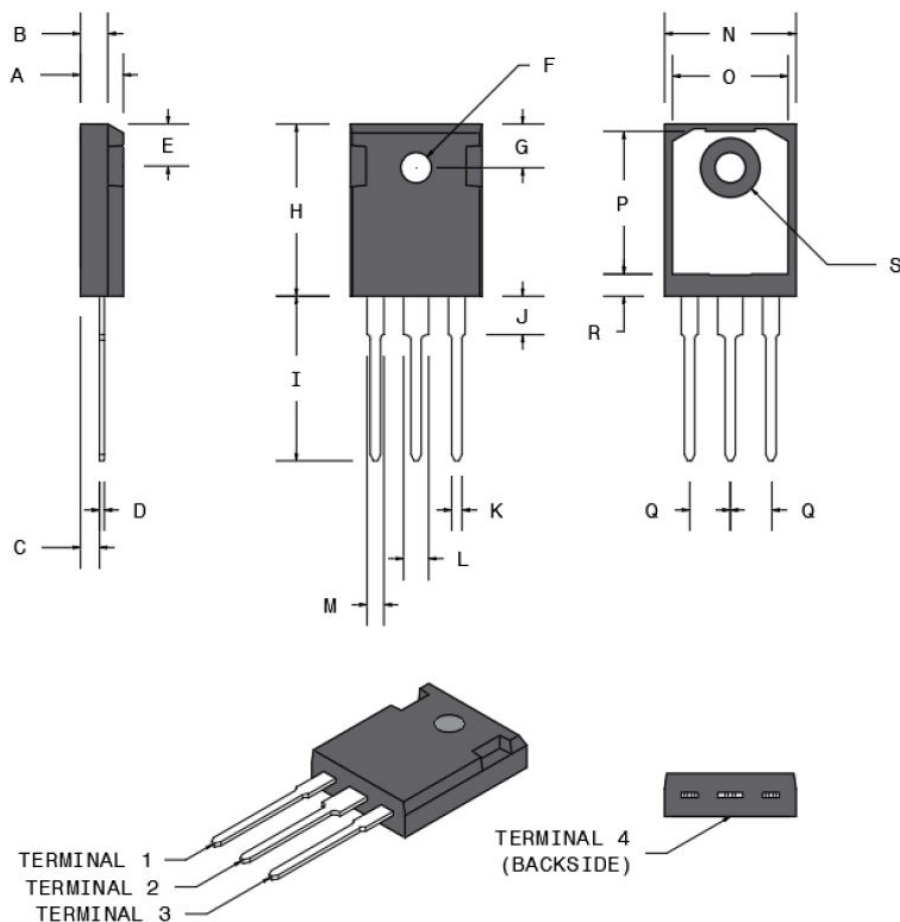


Figure 21 • Package Outline Drawing

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

Table 6 • TO-247 Dimensions

| Symbol | Min (mm) | Max (mm) | Min (in.) | Max (in.) |
|--------|----------|----------|-----------|-----------|
| A | 4.69 | 5.31 | 0.185 | 0.209 |
| B | 1.49 | 2.49 | 0.059 | 0.098 |
| C | 2.21 | 2.59 | 0.087 | 0.102 |
| D | 0.40 | 0.79 | 0.016 | 0.031 |

| Symbol | Min (mm) | Max (mm) | Min (in.) | Max (in.) |
|------------|----------|----------|-----------|-----------|
| E | 5.38 | 6.20 | 0.212 | 0.244 |
| F | 3.50 | 3.81 | 0.138 | 0.150 |
| G | 6.15 BSC | | 0.242 BSC | |
| H | 20.80 | 21.46 | 0.819 | 0.845 |
| I | 19.81 | 20.32 | 0.780 | 0.800 |
| J | 4.00 | 4.50 | 0.157 | 0.177 |
| K | 1.01 | 1.40 | 0.040 | 0.055 |
| L | 2.87 | 3.12 | 0.113 | 0.123 |
| M | 1.65 | 2.13 | 0.065 | 0.084 |
| N | 15.49 | 16.26 | 0.610 | 0.640 |
| O | 13.50 | 14.50 | 0.531 | 0.571 |
| P | 16.50 | 17.50 | 0.650 | 0.689 |
| Q | 5.45 BSC | | 0.215 BSC | |
| R | 2.00 | 2.75 | 0.079 | 0.108 |
| S | 7.10 | 7.50 | 0.280 | 0.295 |
| Terminal 1 | Gate | | | |
| Terminal 2 | Drain | | | |
| Terminal 3 | Source | | | |
| Terminal 4 | Drain | | | |

**Microsemi**

2355 W. Chandler Blvd.
 Chandler, AZ 85224 USA

Within the USA: +1 (480) 792-7200
 Fax: +1 (480) 792-7277

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