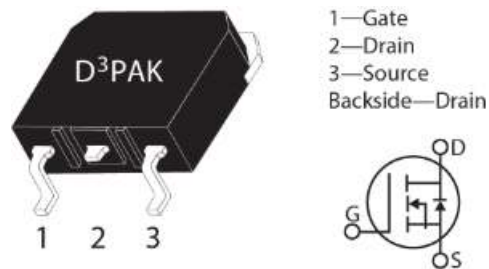


MSC035SMA170S Silicon Carbide N-Channel Power MOSFET

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 MSC035SMA170S device is a 1700 V, 35 mΩ SiC MOSFET in a TO-268 (D³PAK) package.



Features

The following are key features of the MSC035SMA170S 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 MSC035SMA170S 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 MSC035SMA170S 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 MSC035SMA170S device.

Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC035SMA170S device.

Table 1 • Absolute Maximum Ratings

Symbol	Characteristic	Ratings	Unit
V _{DSS}	Drain source voltage	1700	V
I _D	Continuous drain current at T _C = 25 °C	59	A
	Continuous drain current at T _C = 100 °C	42	
I _{DM}	Pulsed drain current ¹	200	
V _{GS}	Gate-source voltage	23 to -10	V
P _D	Total power dissipation at T _C = 25 °C	278	W
	Linear derating factor	1.85	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 MSC035SMA170S device.

Table 2 • Thermal and Mechanical Characteristics

Sym- bol	Characteristic	Min	Typ	Max	Unit
R _{θJC}	Junction-to-case thermal resistance		0.36	0.54	°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
			3.9		g

Electrical Performance

The following table shows the static characteristics of the MSC035SMA170S 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	$V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$	1700			V
$R_{DS(on)}$	Drain-source on resistance ¹	$V_{GS} = 20\text{ V}, I_D = 30\text{ A}$		35	45	m Ω
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}, I_D = 2.5\text{ mA}$	1.8	3.25		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}, I_D = 2.5\text{ mA}$		-5.1		mV/ $^\circ\text{C}$
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 1700\text{ V}, V_{GS} = 0\text{ V}$			100	μA
		$V_{DS} = 1700\text{ V}, V_{GS} = 0\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$			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 MSC035SMA170S 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	$V_{GS} = 0\text{ V}, V_{DD} = 1000\text{ V}$ $V_{AC} = 25\text{ mV}, f = 1\text{ MHz}$		3300		μF
C_{rss}	Reverse transfer capacitance			10		
C_{oss}	Output capacitance			150		
Q_g	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}, V_{DD} = 850\text{ V}$ $I_D = 30\text{ A}$		178		nC
Q_{gs}	Gate-source charge			49		
Q_{gd}	Gate-drain charge			27		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 1200\text{ V}, V_{GS} = -5\text{ V}/20\text{ V}$ $I_D = 50\text{ A}, R_{G(ext)} = 4\text{ }\Omega^1$, Freewheeling diode = MSC035SMA170S ($V_g = -5\text{ V}$)		38		ns
t_f	Voltage fall time			20		

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit	
$t_{d(off)}$	Turn-off delay time			26			
t_r	Voltage rise time			10			
E_{on}	Turn-on switching energy ²			2743			μ J
E_{off}	Turn-off switching energy			368			
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 1200$ V, $V_{GS} = -5$ V/20 V $I_D = 50$ A, $R_{G(ext)} = 4 \Omega^1$, Freewheeling diode = MSC050SDA170B		38		ns	
t_f	Voltage fall time			20			
$t_{d(off)}$	Turn-off delay time			26			
t_r	Voltage rise time			10			
E_{on}	Turn-on switching energy ²				2820		μ J
E_{off}	Turn-off switching energy				368		
ESR	Equivalent series resistance		$f = 1$ MHz, 25 mV, drain short		0.85		Ω
SCWT	Short circuit withstand time		$V_{DS} = 1200$ V, $V_{GS} = 20$ V		3		μ s
E_{AS}	Avalanche energy, single pulse	$V_{DS} = 150$ V, $V_{GS} = 20$ V, $I_D = 30$ A		4000		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 MSC035SMA170S 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	$I_{SD} = 30\text{ A}, V_{GS} = 0\text{ V}$		3.7		V
		$I_{SD} = 30\text{ A}, V_{GS} = -5\text{ V}$		3.9		V
t_{rr}	Reverse recovery time	$I_{SD} = 50\text{ A}, V_{GS} = -5\text{ V},$ $V_{DD} = 1200\text{ V}, dI/dt = -1900\text{ A}/\mu\text{s}$		42		ns
Q_{rr}	Reverse recovery charge			510		nC
I_{RRM}	Reverse recovery current			18		A

Typical Performance Curves

This section shows the typical performance curves of the MSC035SMA170S device.

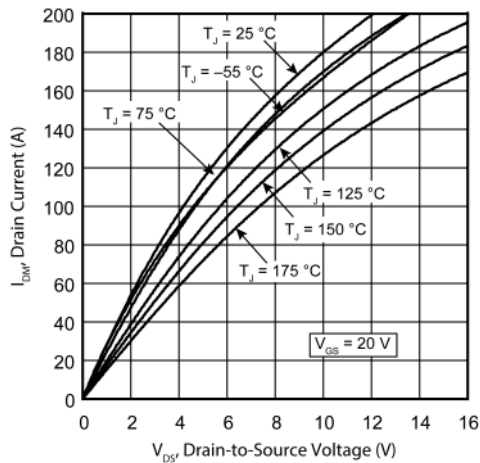


Figure 1 • Drain Current vs. V_{DS}

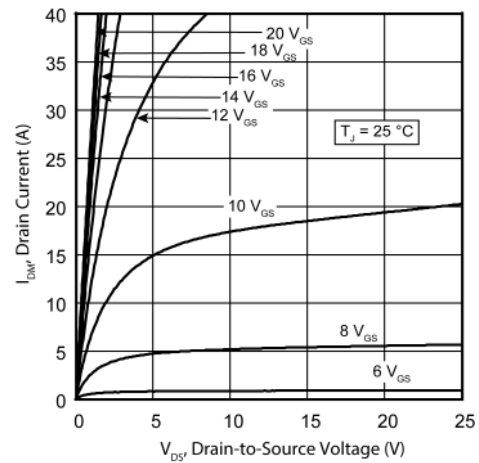


Figure 2 • Drain Current vs. V_{DS}

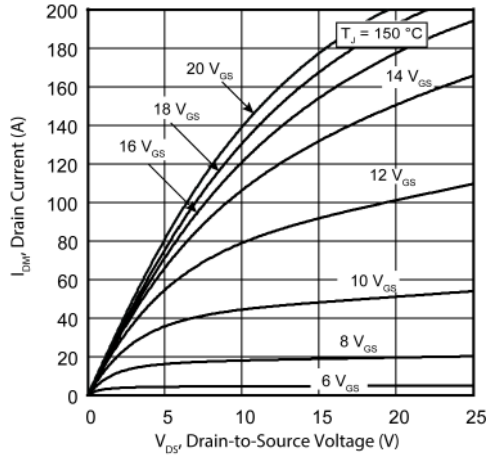


Figure 3 • Drain Current vs. V_{DS}

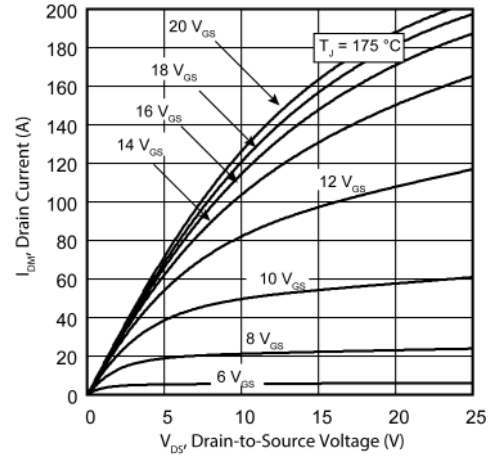


Figure 4 • Drain Current vs. V_{DS}

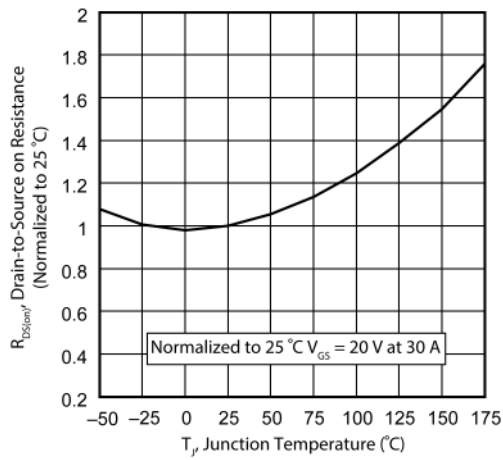


Figure 5 • $R_{DS(on)}$ vs. Junction Temperature

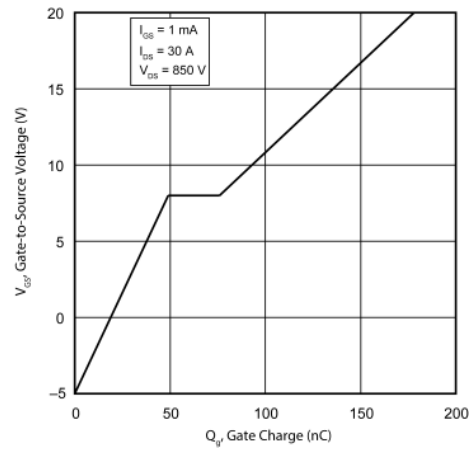


Figure 6 • Gate Charge Characteristics

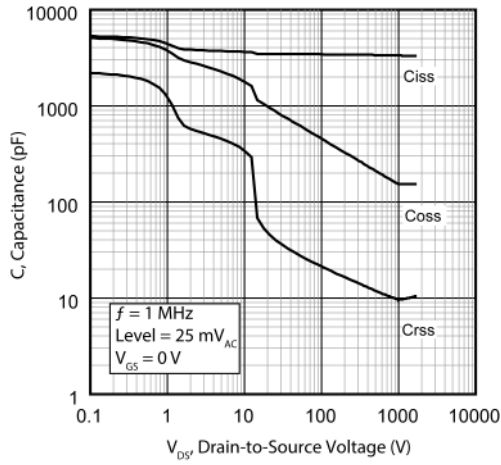


Figure 7 • Capacitance vs. Drain-to-Source Voltage

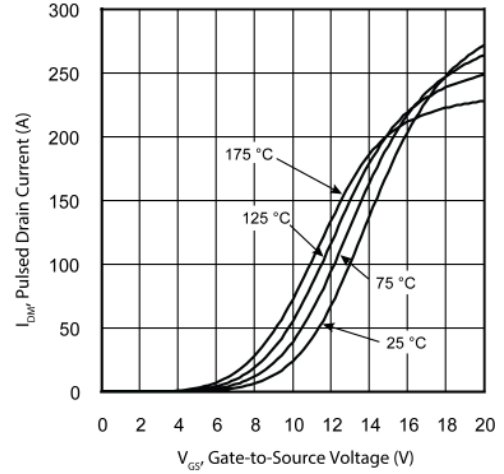


Figure 8 • I_{DM} vs. Gate-to-Source Voltage

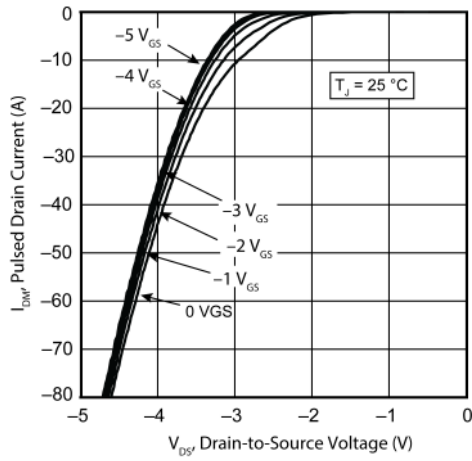


Figure 9 • I_{DM} vs. V_{DS} 3rd Quadrant Conduction

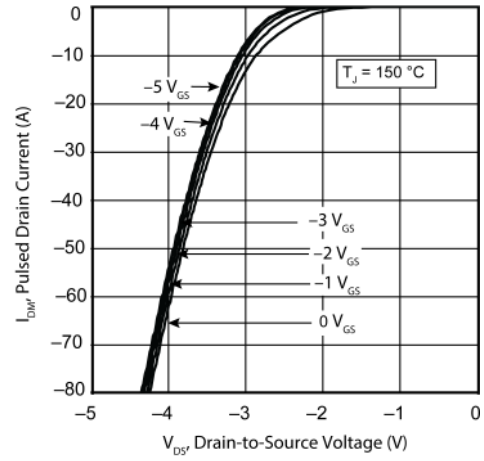


Figure 10 • I_{DM} vs. V_{DS} 3rd Quadrant Conduction

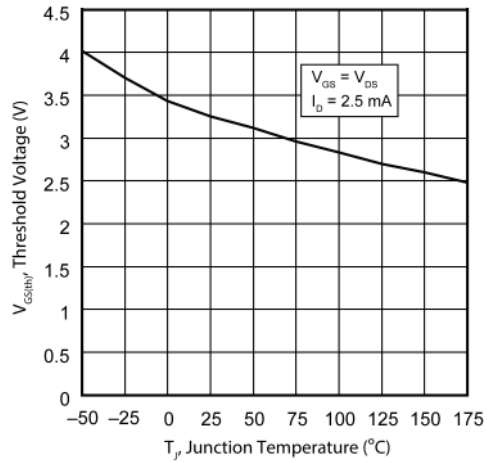


Figure 11 • Threshold Voltage vs. Junction Temp.

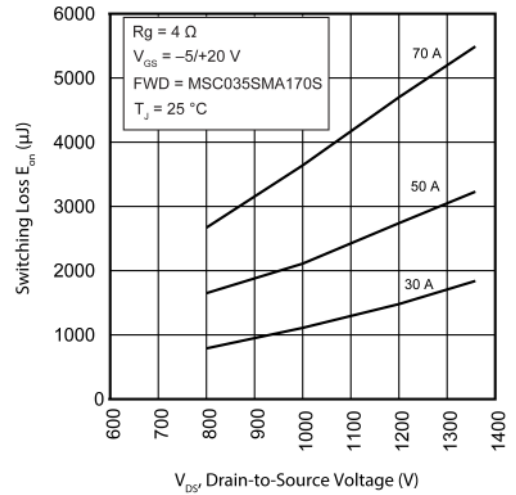


Figure 12 • Switching Energy E_{on} vs. V_{DS} and I_D

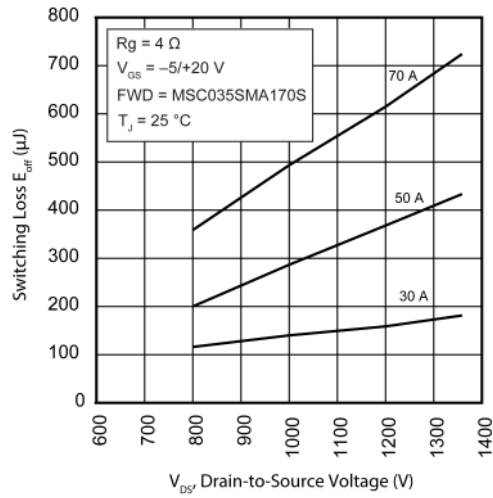


Figure 13 • Switching Energy E_{off} vs. V_{DS} & I_D

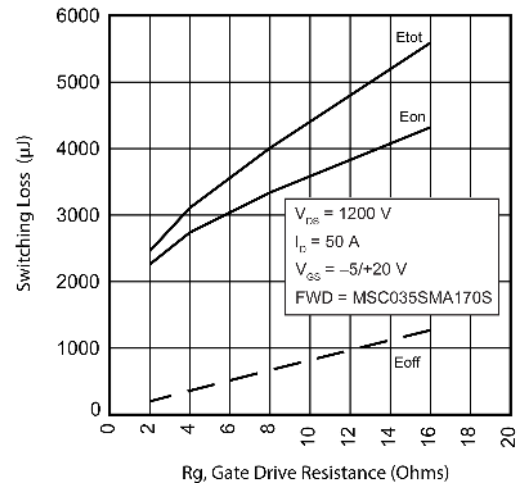


Figure 14 • Switching Energy vs. R_g

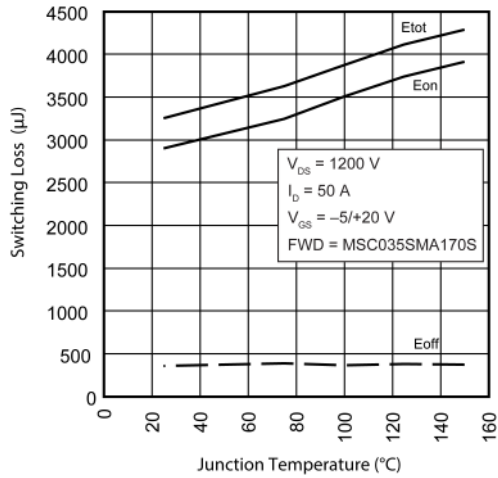


Figure 15 • Switching Energy vs. T_j

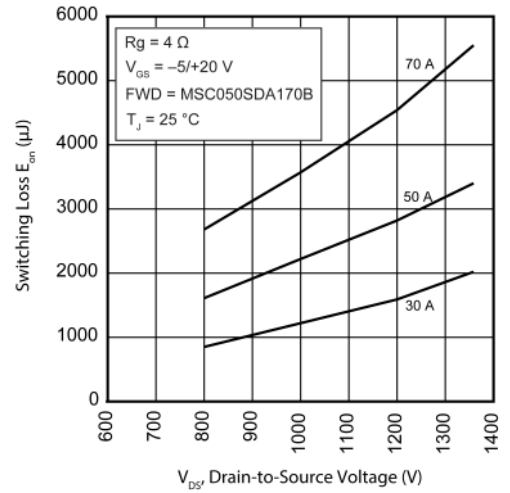


Figure 16 • Switching Energy E_{on} vs. V_{DS} and I_D

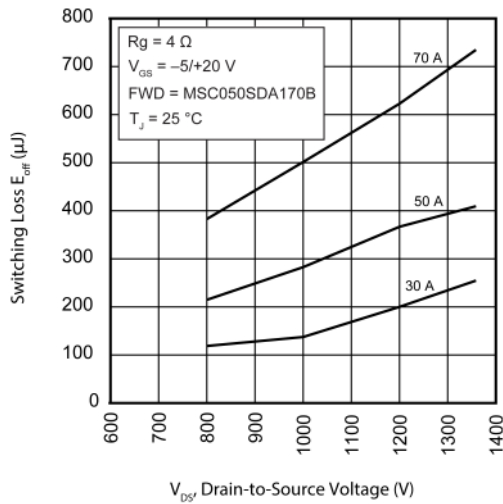


Figure 17 • Switching Energy E_{off} vs. V_{DS} and I_D

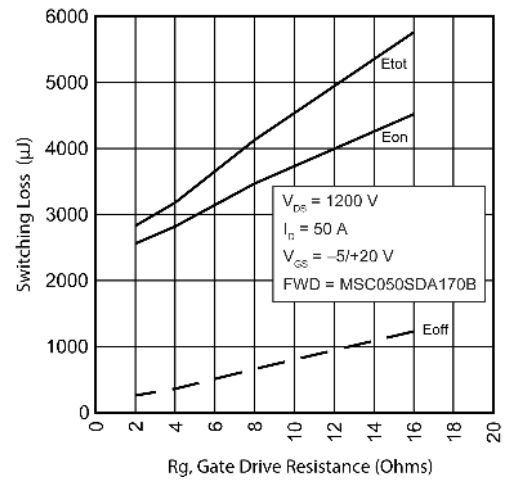


Figure 18 • Switching Energy vs. R_g

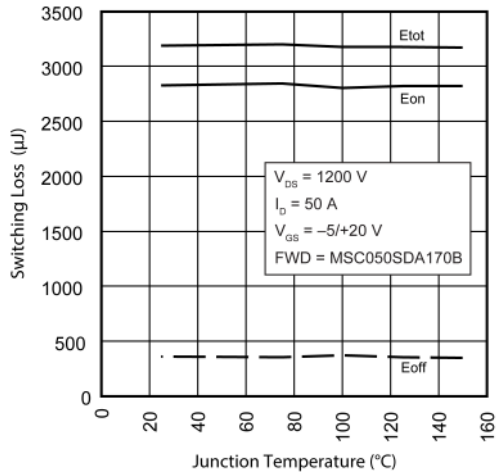


Figure 19 • Switching Energy vs. T_j

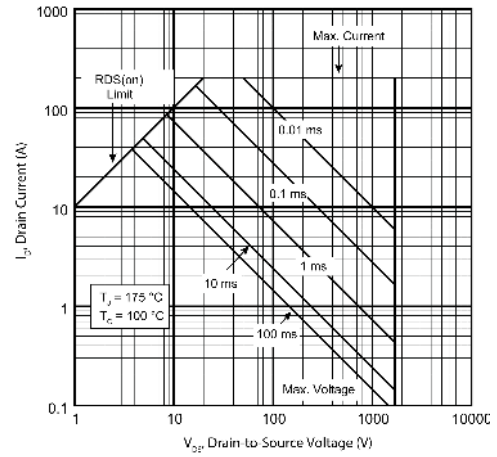


Figure 20 • Forward Safe Operating Area

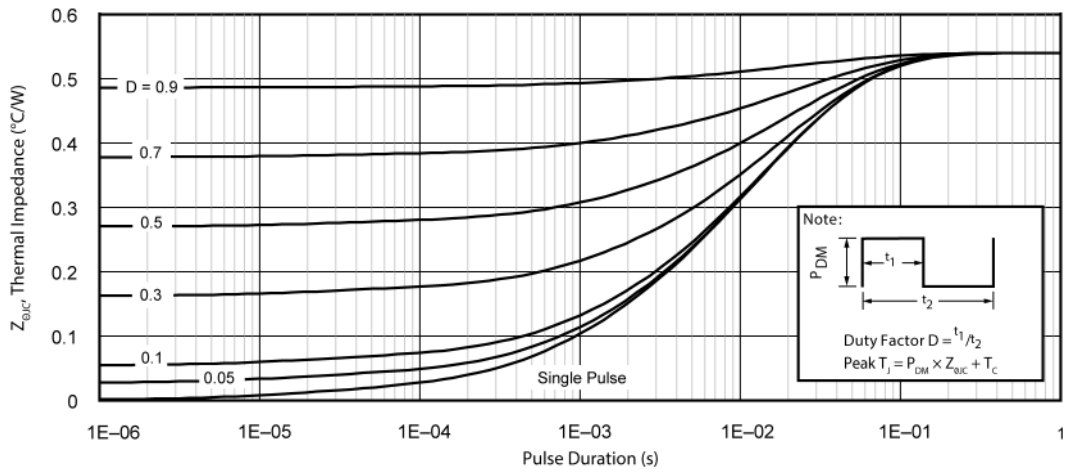


Figure 21 • Maximum Transient Thermal Impedance

Package Specification

This section shows the package specification of the MSC035SMA170S device.

Package Outline Drawing

The following figure illustrates the TO-268 package drawing for the MSC035SMA170S device. The dimensions in the figure below are in millimeters and (inches).

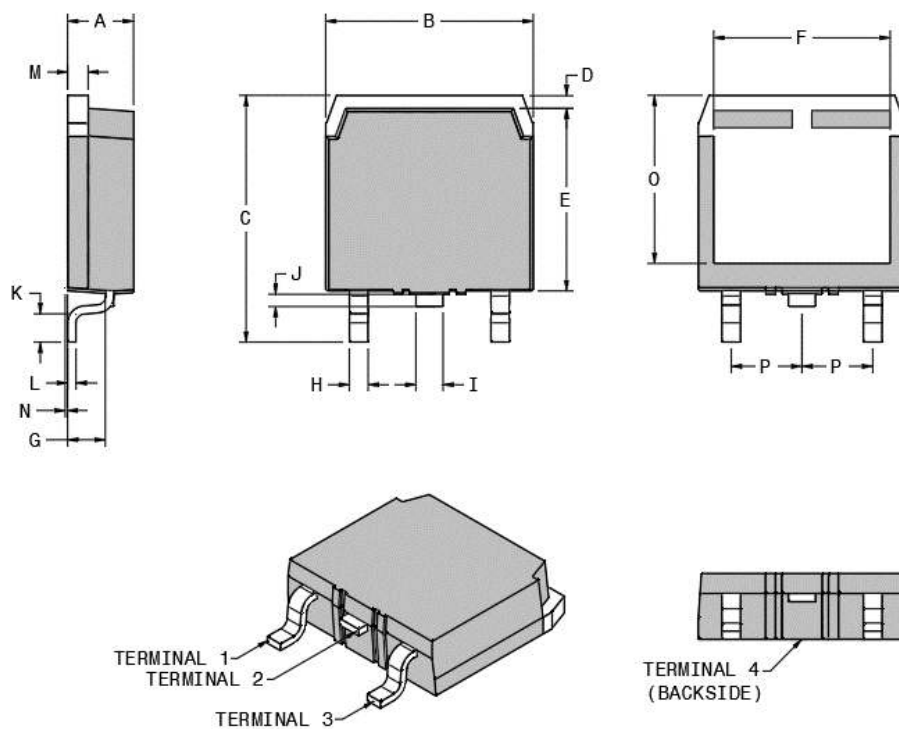


Figure 22 • Package Outline Drawing

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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