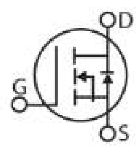
MSC017SMA120S Silicon Carbide N-Channel Power MOSFET

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 MSC017SMA120S device is a 1200 V, 17 mΩ SiC MOSFET in a TO-268 (D3PAK) package.

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



Features

The following are key features of the MSC017SMA120S 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

Benefits

The following are benefits of the MSC017SMA120S 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 MSC017SMA120S 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 MSC017SMA120S device.

Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC017SMA120S device.

Table 1 • Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{DSS}	Drain source voltage	1200	V
I_D	Continuous drain current at T_C = 25 °C	100	A
	Continuous drain current at T_C = 100 °C	71	
I_{DM}	Pulsed drain current[1]	280	
V_{GS}	Gate-source voltage	23 to –10	V
P_D	Total power dissipation at T_C = 25 °C	357	W
	Linear derating factor	3.33	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 MSC017SMA120S device.

Table 2 • Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance		0.28	0.42	°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	
Wt	Package weight		0.14		oz
			4.0		g

Electrical Performance

The following table shows the static characteristics of the MSC017SMA120S 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	1200			V
$R_{DS(on)}$	Drain-source on resistance[1]	V_{GS} = 20 V, I_D = 40 A		17.6	22	mΩ
$V_{GS(th)}$	Gate-source threshold voltage	V_{GS} = $V_{DS,}$ I_D = 4.5 mA	1.9	2.7		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	V_{GS} = V_{DS}, I_D = 4.5 mA		–4.6		mV/°C
I_{DSS}	Zero gate voltage drain current	V_{DS}, = 1200 V, V_{GS} = 0 V			100	µA
		V_{DS} = 1200 V, V_{GS} = 0 V T_J = 125 °C			500	
I_{GSS}	Gate-source leakage current	V_{GS} = 20 V/–10 V			±100	nA

Note:

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

The following table shows the dynamic characteristics of the MSC017SMA120S 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} = 1000 V V_{AC} = 25 mV, ƒ = 1 MHz		5280		pF
C_{rss}	Reverse transfer capacitance			12		
C_{oss}	Output capacitance			265		
Q_g	Total gate charge	V_{GS} = –5 V/20 V, V_{DD} = 800 V I_D = 40 A		249		nC
Q_{gs}	Gate-source charge			63		
Q_{gd}	Gate-drain charge			32		
$t_{d(on)}$	Turn-on delay time	V_{DD} = 800 V, V_{GS} = –5 V/20 V, I_D = 50 A, $R_{g(ext)}$ = 4.0 Ω, Freewheeling diode = MSC017SMA120S (V_{GS} = –5 V)		52		ns
t_f	Voltage fall time			21		
$t_{d(off)}$	Turn-off delay time			49		

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
t_r	Voltage rise time			16		
E_{on}	Turn-on switching energy			1677		µJ
E_{off}	Turn-off switching energy			395		
$t_{d(on)}$	Turn-on delay time	V_{DD} = 800 V, V_{GS} = –5 V/20 V, I_D = 50 A, $R_{g(ext)}$ = 4.0 Ω Freewheeling diode = MSC050SDA120B		49		ns
t_f	Voltage fall time			19		
$t_{d(off)}$	Turn-off delay time			49		
t_r	Voltage rise time			14		
E_{on}	Turn-on switching energy			1329		µJ
E_{off}	Turn-off switching energy			429		
ESR	Equivalent series resistance	f = 1 MHz, 25 mV, drain short		0.71		Ω
SCWT	Short circuit withstand time	V_{DS} = 960 V, V_{GS} = 20 V		3		µs
E_{AS}	Avalanche energy, single pulse	V_{DS} = 150 V, I_D = 30 A		3500		mJ

The following table shows the body diode characteristics of the MSC017SMA120S 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		3.5		V
		I_{SD} = 40 A, V_{GS} = –5 V		3.9		V
t_{rr}	Reverse recovery time	I_{SD} = 50 A, V_{GS} = –5 V, Drive Rg = 4 Ω V_{DD} = 800 V, dI/dt = –2500 A/µs		40		ns
Q_{rr}	Reverse recovery charge			490		nC
I_{RRM}	Reverse recovery current			22		A

Typical Performance Curves

This section shows the typical performance curves of the MSC017SMA120S device.

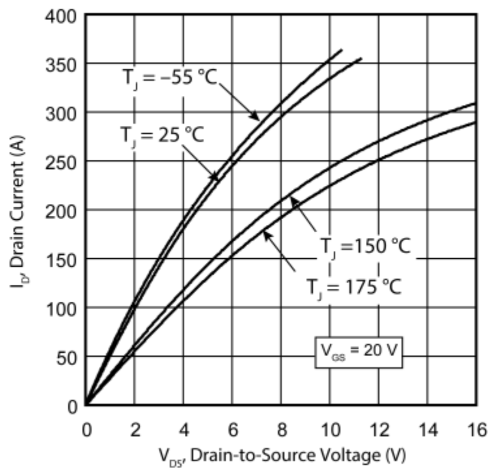


Figure 1 • Drain Current vs. V_{DS}

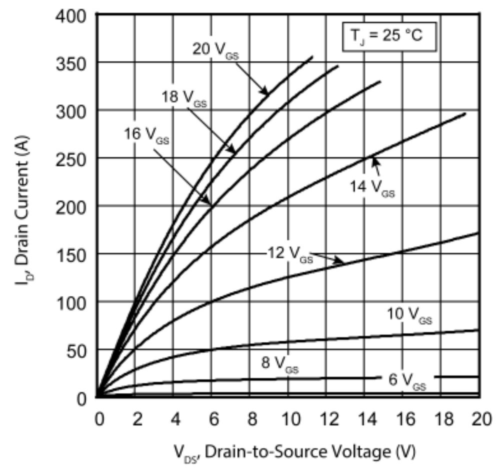


Figure 2 • Drain Current vs. V_{DS}

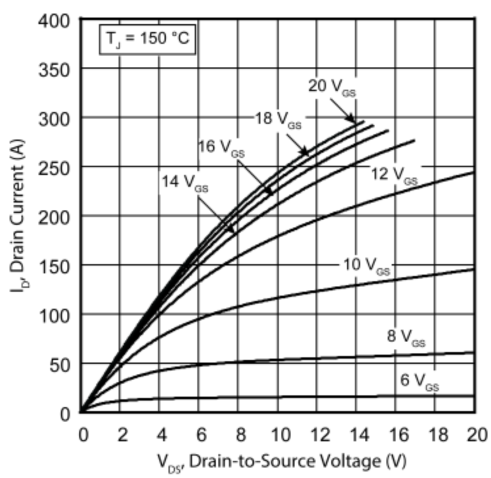


Figure 3 • Drain Current vs. V_{DS}

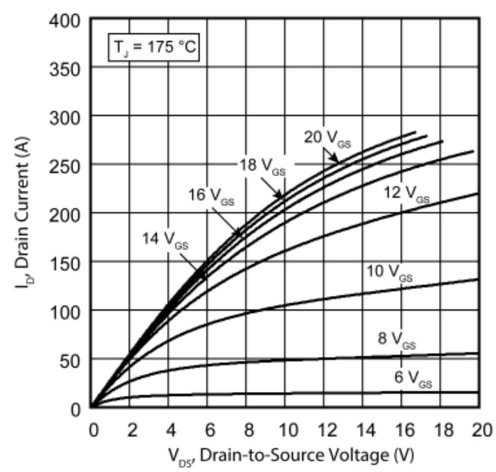


Figure 4 • Drain Current vs. V_{DS}

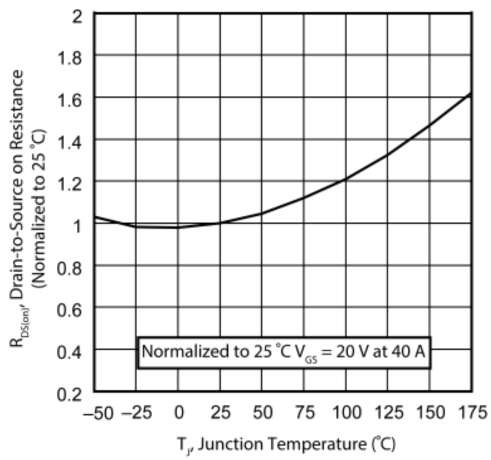


Figure 5 • RDS(on) vs. Junction Temperature

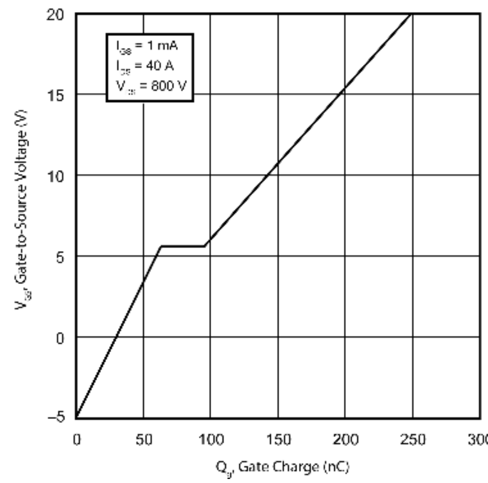


Figure 6 • Gate Charge Characteristics

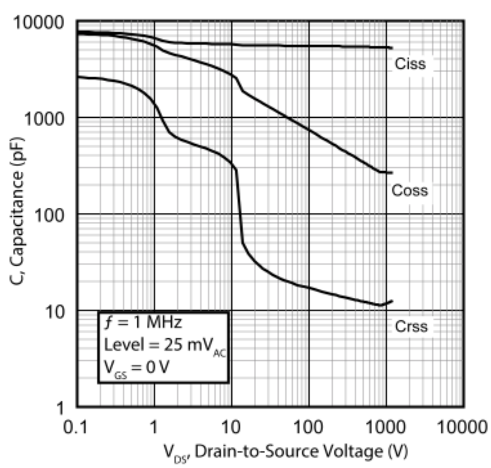


Figure 7 • Capacitance vs. Drain-to-Source Voltage

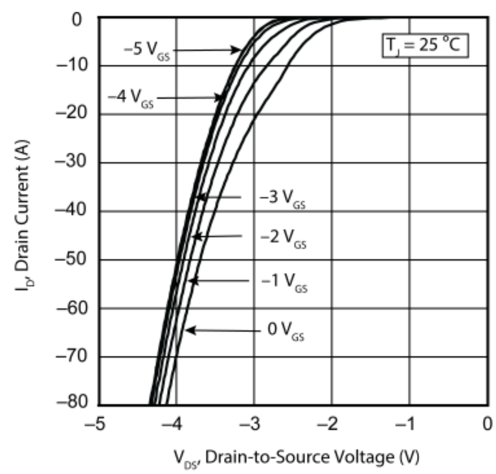


Figure 8 • I_D vs. V_{DS} 3rd Quadrant Conduction

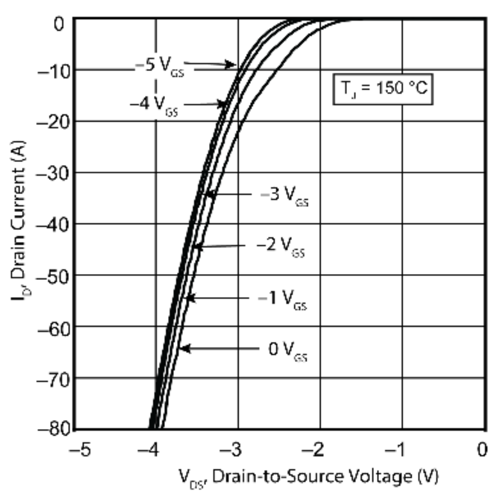


Figure 9 • I_D vs. V_{DS} 3rd Quadrant Conduction

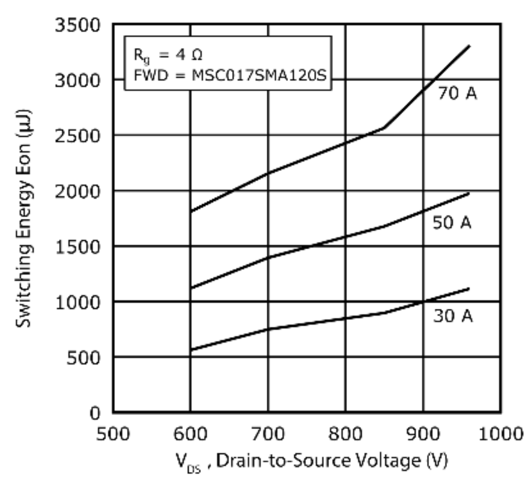


Figure 10 • Switching Energy Eon vs. V_{DS} & I_D

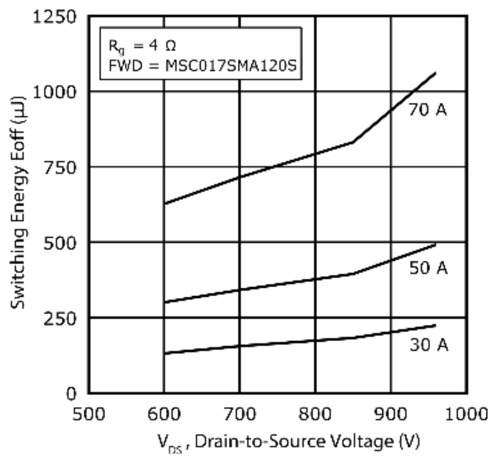


Figure 11 • Switching Energy Eoff vs. V_{DS} & I_D

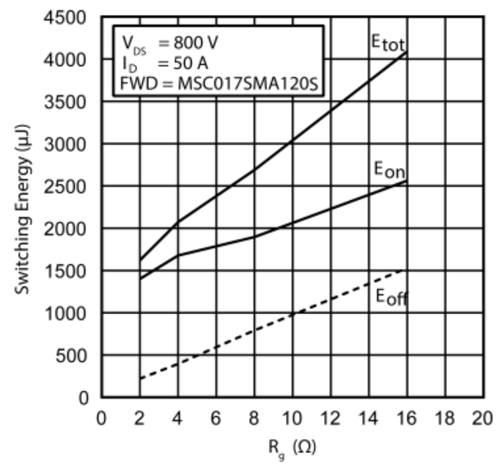


Figure 12 • Switching Energy vs. R_g

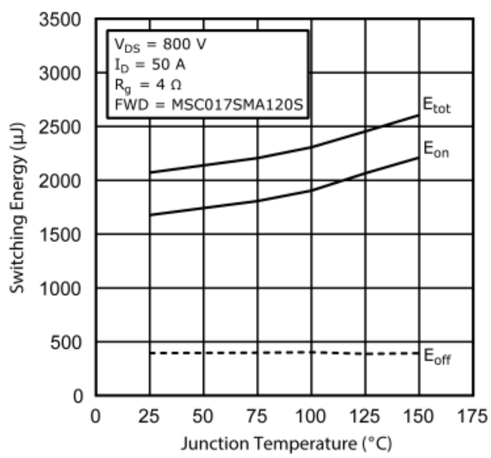


Figure 13 • Switching Energy vs. Temperature

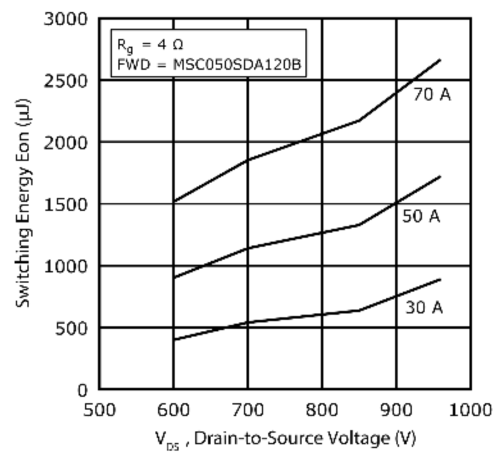


Figure 14 • Switching Energy Eon vs. V_{DS} & I_D

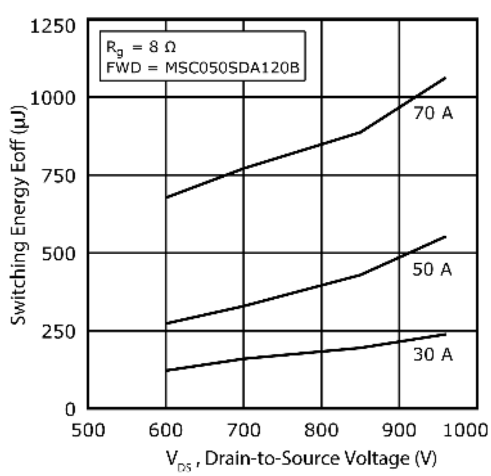


Figure 15 • Switching Energy Eoff vs. V_{DS} & I_D

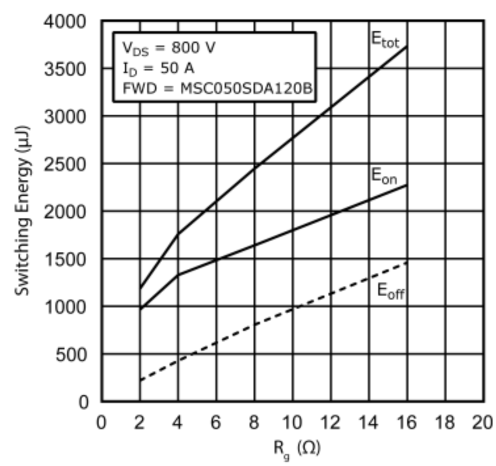


Figure 16 • Switching Energy vs. R_g

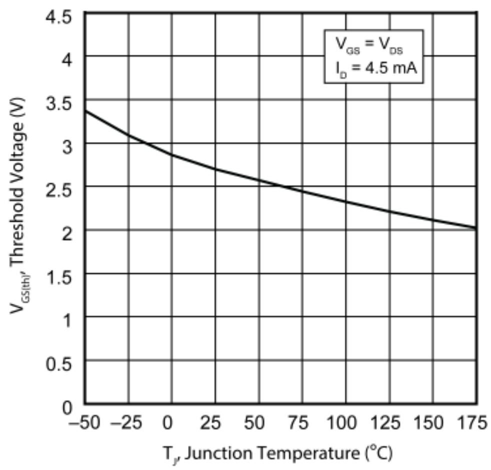


Figure 17 • Threshold Voltage vs. Junction Temp.

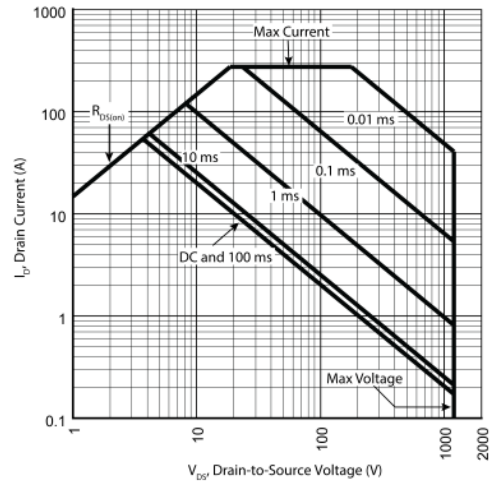


Figure 18 • Forward Safe Operating Area

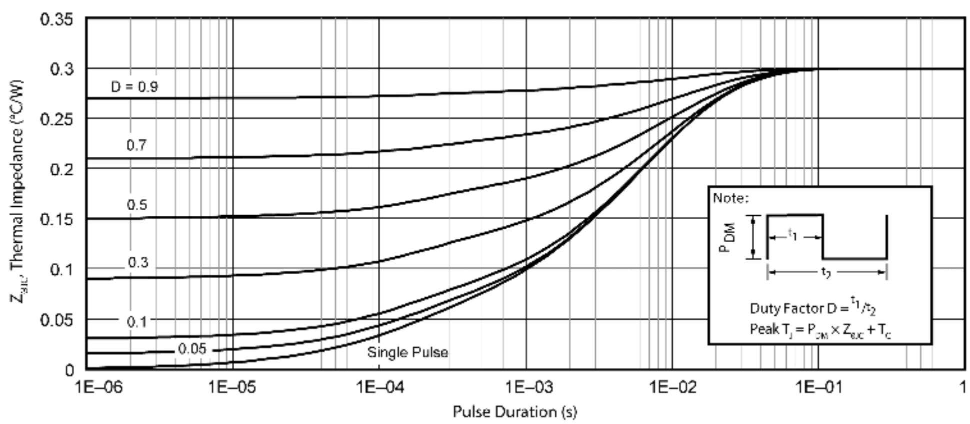


Figure 19 • Maximum Transient Thermal Impedance

Package Specification

This section shows the package specification of the MSC017SMA120S device.

Package Outline Drawing

The following figure illustrates the TO-268 package outline of the MSC017SMA120S device.

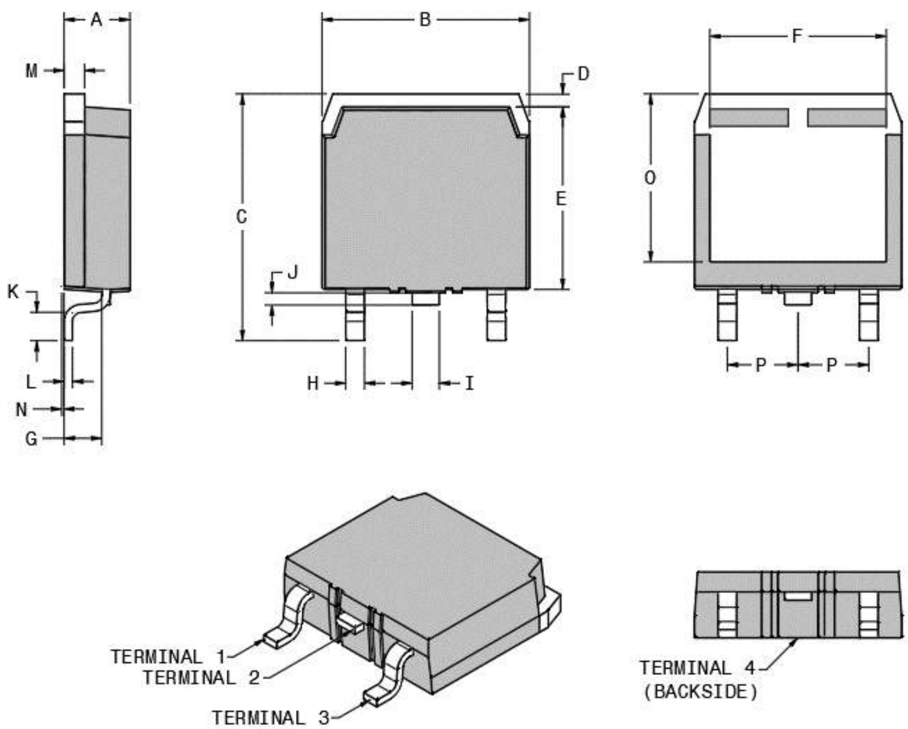


Figure 20 • Package Outline Drawing

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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