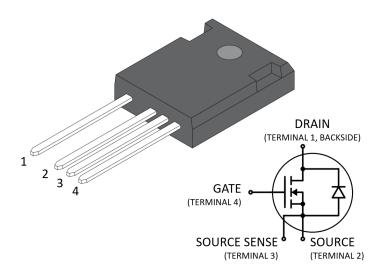


MSC025SMA120B4 Silicon Carbide N-Channel Power MOSFET

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 MSC025SMA120B4 device is a 1200 V, 25 m Ω SiC MOSFET in a TO-247 4-lead package with a source sense.



1.1 Features

The following are key features of the MSC025SMA120B4 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 MSC025SMA120B4 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 MSC025SMA120B4 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 MSC025SMA120B4 device.

2.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings for the MSC025SMA120B4 device.

Table 1 • Absolute Maximum Ratings

Symbol	Characteristic	Ratings	Unit
VDSS	Drain source voltage	1200	V
lo	Continuous drain current at Tc = 25 °C	103	А
	Continuous drain current at Tc = 100 °C	73	_
ldm	Pulsed drain current ¹	275	_
Vgs	Gate-source voltage	23 to -10	V
PD	Total power dissipation at Tc = 25 °C	500	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 for the MSC025SMA120B4 device.

Table 2 • Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Тур	Max	Unit
Reic	Junction-to-case thermal resistance		0.20	0.30	°C/W
۲ı	Operating junction temperature	-55		175	°C
Тѕтб	Storage temperature	-55		150	-
Τι	Soldering temperature for 10 seconds (1.6 mm from case)			260	-
	Mounting torque, 6-32 or M3 screw			10	lbf-in
				1.1	N-m
Wt	Package weight		0.22		OZ
			6.2		g



2.2 Electrical Performance

The following table shows the static characteristics for the MSC025SMA120B4 device. T_J = 25 $^{\circ}$ C unless otherwise specified.

Symbol	Characteristic	Test Conditions	Min	Тур	Max	Unit
V(BR) DSS	Drain-source breakdown voltage	V_{GS} = 0 V, I_{D} = 100 μA	1200			V
RDS(on)	Drain-source on resistance 1	$V_{GS} = 20 \text{ V}, \text{ I}_{D} = 40 \text{ A}$		25	31	mΩ
VGS(th)	Gate-source threshold voltage	V _{GS} = V _{DS} , I _D = 3 mA	1.8	2.8		V
$\Delta V_{GS(th)} / \Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}, I_D = 3 \text{ mA}$		-3.5		mV/°C
Idss	Zero gate voltage drain current	$V_{DS} = 1200 \text{ V}, \text{ V}_{GS} = 0 \text{ V}$			100	μΑ
		V _{DS} = 1200 V, V _{GS} = 0 V T _J = 125 °C			500	-
lgss	Gate-source leakage current	V _{GS} = 20 V/-10 V			±100	nA

Table 3 • Static Characteristics

Note:

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

The following table shows the dynamic characteristics for the MSC025SMA120B4 device. T_J = 25 $^{\circ}$ C unless otherwise specified.

Table 4 • Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Тур	Max	Unit
C iss	Input capacitance	VGS = 0 V, VDD = 1000 V, VAC = 25 mV, 3020 f = 1 MHz 25			pF	
Crss	Reverse transfer capacitance				-	
Coss	Output capacitance			270		-
Qg	Total gate charge	V _{GS} = -5 V/20 V, V _{DD} = 800 V I _D = 40 A	V/20 V, V _{DD} = 800 V 232			nC
Qgs	Gate-source charge		I _D = 40 A 41			-
Q _{gd}	Gate-drain charge		50			_
td(on)	Turn-on delay time	V _{DD} = 800 V, V _{GS} = -5 V/20 V, I _D = 70 A R _{G(ext)} = 2.5 Ω ¹ , Freewheeling diode = MSC025SMA120B4 (Vgs = -5 V)	A 18 35			ns
tr	Current rise time					
td(off)	Turn-off delay time			35		-
tr	Current fall time			10		-
Eon	Turn-on switching energy ²			1065		μ
Eoff	Turn-off switching energy	_		82		-
td(on)	Turn-on delay time	V _{DD} = 800 V, V _{GS} = -5 V/20 V, I _D = 50 A 18			ns	
tr	Current rise time	R _{G(ext)} = 2.5 $Ω^1$, Freewheeling diode =		30		-
td(off)	Turn-off delay time	MSC050SDA120B		35		-
tr	Current fall time	- · ·		10		-
Eon	Turn-on switching energy ²			873		μ
Eoff	Turn-off switching energy			77		-
ESR	Equivalent series resistance	f = 1 MHz, 25 mV, drain short		0.88		Ω
SCWT	Short circuit withstand time	V _{DS} = 960 V, V _{GS} = 20 V		3		μs



Characteristic	Test Conditions	Min	Тур	Max	Unit
	V _{DS} = 150 V, I _D = 40 A		3500		mJ
•		walanche energy, single $V_{DS} = 150 \text{ V}, I_D = 40 \text{ A}$	walanche energy, single V _{DS} = 150 V, I _D = 40 A	walanche energy, single $V_{DS} = 150 \text{ V}$, $I_D = 40 \text{ A}$ 3500	walanche energy, single $V_{DS} = 150 \text{ V}$, $I_D = 40 \text{ A}$ 3500

Notes:

- 1. R_G is total gate resistance excluding internal gate driver impedance.
- 2. Eon includes energy of the freewheeling diode.

The following table shows the body diode characteristics for the MSC025SMA120B4 device. T_J = 25 $^{\circ}$ C unless otherwise specified.

Table 5 • Body Diode Characteristics

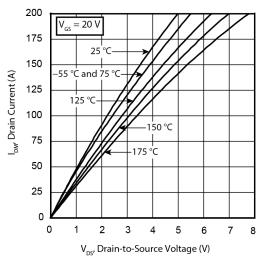
Symbol	Characteristic	Test Conditions	Min	Тур	Max	Unit
Vsd	Diode forward voltage	I _{SD} = 40 A, V _{GS} = 0 V		4.0		V
		I _{SD} = 40 A, V _{GS} = -5 V		4.2		V
trr	Reverse recovery time	I _{SD} = 40 A, V _{GS} = -5 V		90		ns
Qrr	Reverse recovery charge	V _{DD} = 800 V dl/dt = -1000 A/μs		550		nC
RRM	Reverse recovery current	αι/αι = 1000 Α/μ3		13.5		А

2.3 Typical Performance Curves

This section shows the typical performance curves for the MSC025SMA120B4 device.



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



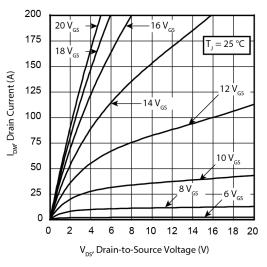




Figure 3 • Drain Current vs. Drain-to-Source Voltage

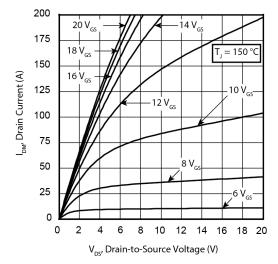
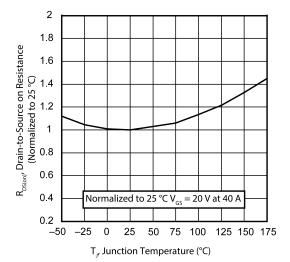


Figure 5 • RDS(on) vs. Junction Temperature





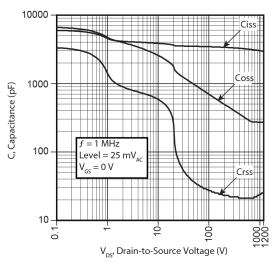


Figure 4 • Drain Current vs. Drain-to-Source Voltage

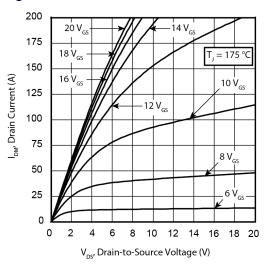
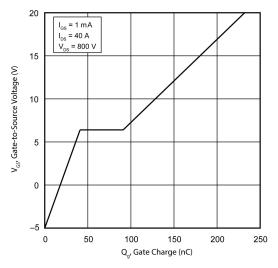
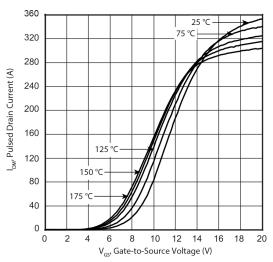


Figure 6 • Gate Charge Characteristics









0 $-5 V_{gs}$ -10 $-4 V_{GS}$ Reverse Drain Current (A) T₁= 25 °C -20 $-3 V_{GS}$ -30 $-2 V_{GS}$ -40 -1 V_{gs} -50 DM' -60 $0 V_{GS}$ -70 -80 -5.0 -4.0 -3.0 -2.0 -1.0 0.0 V_{DS'} Drain-to-Source Voltage (V)

Figure 9 • IDM vs. VDS Third Quadrant Conduction



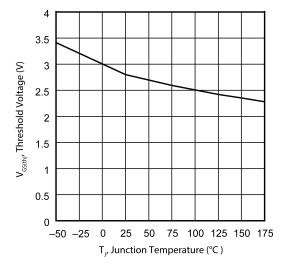
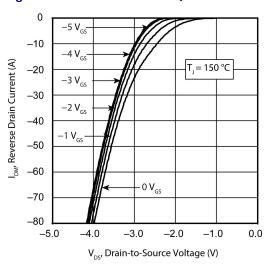
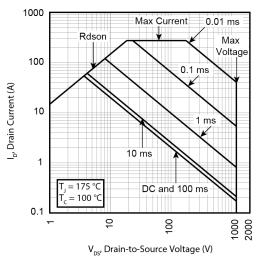


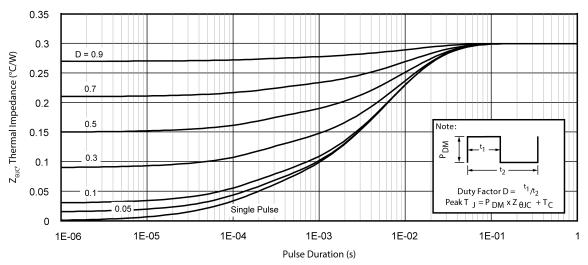


Figure 10 • IDM vs. VDS Third Quadrant Conduction











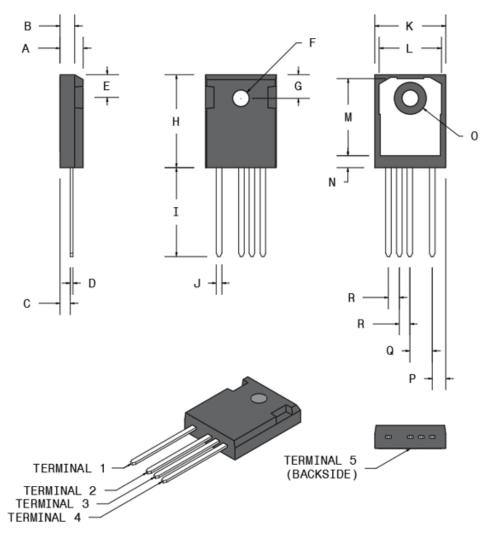
3 Package Specification

This section shows the package specification for the MSC025SMA120B4 device.

3.1 Package Outline Drawing

The following figure illustrates the TO-247 package drawing for the MSC025SMA120B4 device. The dimensions in the figure below are in millimeters and (inches).

Figure 14 • Package Outline Drawing





The following table shows the TO-247 4-lead dimensions and should be used in conjunction with the package outline drawing.

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
A	4.90	5.17	0.193	0.204
В	1.85	2.11	0.073	0.083
С	2.25	2.51	0.089	0.099
D	0.55	0.68	0.022	0.027
E	5.49	5.74	0.216	0.226
F	3.56	3.66	0.140	0.144
G	6.15 BSC		0.242 BSC	
Н	20.83	21.08	0.820	0.830
I	19.81	20.32	0.780	0.800
J	1.07	1.33	0.042	0.052
К	15.77	16.03	0.621	0.631
L	13.89	14.15	0.547	0.557
М	16.25	16.85	0.640	0.663
Ν	2.00	2.75	0.079	0.108
0	7.10	7.50	0.280	0.295
Р	2.87 BSC		0.113 BSC	
Q	5.08 BSC		0.200 BSC	
R	2.54 BSC		0.100 BSC	
Terminal 1	Drain			
Terminal 2	Source			
Terminal 3	Source sense			
Terminal 4	Gate			
Terminal 5	Drain			

Table 6 • TO-247-4L Dimensions





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050-7763 | December 2019 | Released

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