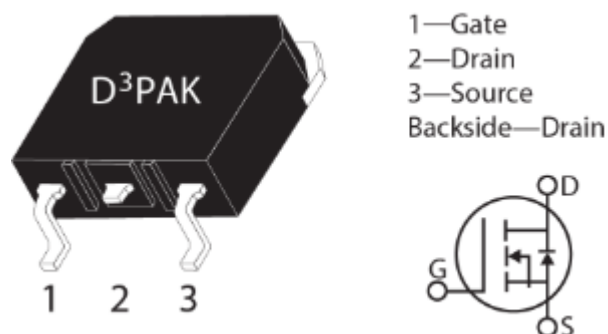


MSC040SMA120S Silicon Carbide N-Channel Power MOSFET

1 Product Overview

This section shows the product overview for the MSC040SMA120S device.



1.1 Features

The following are key features of the MSC040SMA120S device:

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature, $T_{J(max)} = 175\text{ }^{\circ}\text{C}$
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

1.2 Benefits

The following are benefits of the MSC040SMA120S 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 MSC040SMA120S 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 MSC040SMA120S device.

2.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings for the MSC040SMA120S device.

Table 1 • Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{DS}	Drain source voltage	1200	V
I_D	Continuous drain current at $T_C = 25\text{ }^{\circ}\text{C}$	61	A
	Continuous drain current at $T_C = 100\text{ }^{\circ}\text{C}$	43	
I_{DM}	Pulsed drain current ¹	140	
V_{GS}	Gate-source voltage	25 to -10	V
P_D	Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	295	W
	Linear derating factor	1.96	W/ $^{\circ}\text{C}$

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 MSC040SMA120S device.

Table 2 • Thermal and Mechanical Characteristics

Symbol	Characteristic	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance		0.38	0.51	$^{\circ}\text{C}/\text{W}$
T_J	Operating junction temperature	-55		175	$^{\circ}\text{C}$
T_{STG}	Storage temperature	-55		175	
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 for the MSC040SMA120S device. $T_J = 25^\circ\text{C}$ unless otherwise specified.

Table 3 • Static Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$, $I_D = 100\text{ }\mu\text{A}$	1200			V
$R_{DS(on)}$	Drain-source on resistance ¹	$V_{GS} = 20\text{ V}$, $I_D = 40\text{ A}$		40	50	m Ω
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$, $I_D = 1\text{ mA}$	1.8	2.6		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}$, $I_D = 1\text{ mA}$		-4.5		mV/ $^\circ\text{C}$
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$			100	μA
		$V_{DS} = 1200\text{ V}$, $T_J = 125^\circ\text{C}$, $V_{GS} = 0\text{ V}$			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 for the MSC040SMA120S device. $T_J = 25^\circ\text{C}$ unless otherwise specified.

Table 4 • Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	$V_{GS} = 0\text{ V}$, $V_{DD} = 1000\text{ V}$, $V_{AC} = 25\text{ mV}$, $f = 1\text{ MHz}$		1990		pF
C_{rss}	Reverse transfer capacitance			17		
C_{oss}	Output capacitance			156		
Q_g	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$, $V_{DD} = 800\text{ V}$, $I_D = 40\text{ A}$		137		nC
Q_{gs}	Gate-source charge			29		
Q_{gd}	Gate-drain charge			31		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}/20\text{ V}$, $I_D = 40\text{ A}$, $R_{G(ext)} = 5.3\text{ }\Omega$, $T_C = 25^\circ\text{C}$		10		ns
t_r	Current rise time	Freewheeling diode = MSC015SDA120B		10		
$t_{d(off)}$	Turn-off delay time			55		
t_f	Current fall time			25		
E_{on2}	Turn-on switching energy ²			930		μJ
E_{off}	Turn-off switching energy			585		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{ V}$, $V_{GS} = 0\text{ V}/20\text{ V}$, $I_D = 40\text{ A}$, $R_{G(ext)} = 5.3\text{ }\Omega$, $T_C = 150^\circ\text{C}$		10		ns
t_r	Current rise time	Freewheeling diode = MSC015SDA120B		10		
$t_{d(off)}$	Turn-off delay time			74		
t_f	Current fall time			37		
E_{on2}	Turn-on switching energy ²			890		μJ
E_{off}	Turn-off switching energy			855		
ESR	Equivalent series resistance	$f = 1\text{ MHz}$, 25 mV, drain short		1.2		Ω

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
SCWT	Short circuit withstand time	$V_{DS} = 960\text{ V}$, $V_{GS} = 20\text{ V}$, $T_C = 25\text{ }^{\circ}\text{C}$		3		μs
E_{AS}	Avalanche energy, single pulse	$V_{DS} = 150\text{ V}$, $V_{GS} = 20\text{ V}$, $I_D = 40\text{ A}$, $T_C = 25\text{ }^{\circ}\text{C}$, $L_L = 2.5\text{ mH}$		2000		mJ

Notes:

1. R_G is total gate resistance excluding internal gate driver impedance.
2. E_{on2} includes energy of MSC015SDA120B freewheeling diode.

2.3 Body Diode Characteristics

The following table shows the body diode characteristics for the MSC040SMA120S device. $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 5 • Body Diode Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	$I_{SD} = 40\text{ A}$, $V_{GS} = 0\text{ V}$		3.9		V
V_{SD}	Diode forward voltage	$I_{SD} = 40\text{ A}$, $V_{GS} = -5\text{ V}$		4.1		V
t_{rr}	Reverse recovery time	$I_{SD} = 40\text{ A}$, $V_{GS} = -5\text{ V}$		100		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 800\text{ V}$		550		nC
I_{rrm}	Reverse recovery current	$dI/dt = -1000\text{ A}/\mu\text{s}$		12.5		A

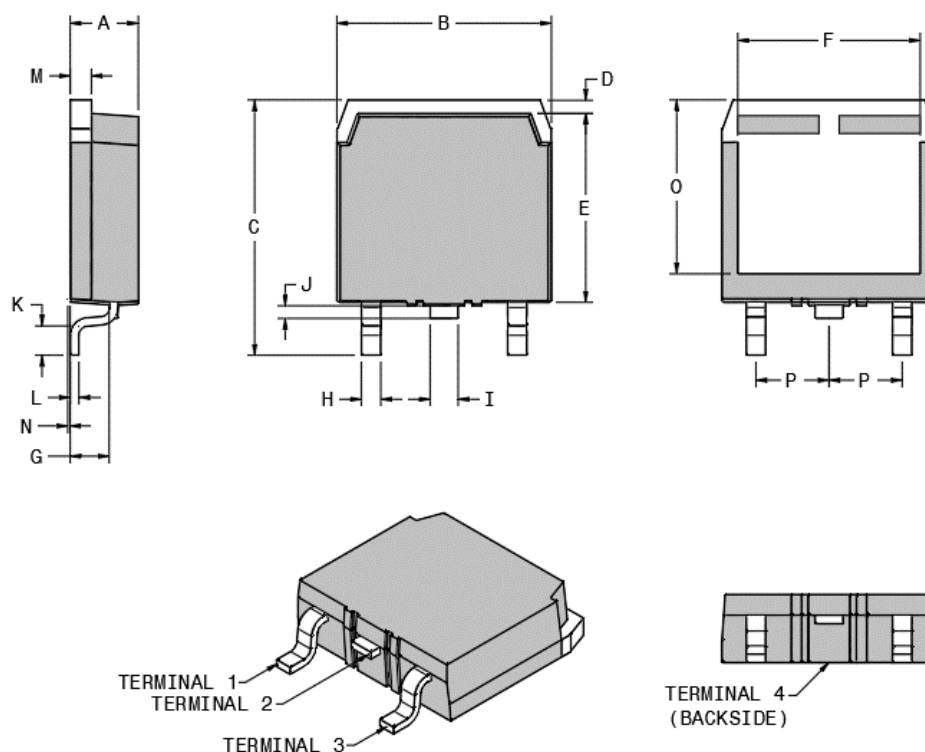
3 Package Specification

This section shows the package specification for the MSC040SMA120S device.

3.1 Package Outline Drawing

This section shows the TO-268 package drawing for the MSC040SMA120S device. The dimensions in the figure below are in millimeters and (inches).

Figure 1 • 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	16.05	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

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
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		0.215 BSC	
Terminal 1	Gate			
Terminal 2	Drain			
Terminal 3	Source			
Terminal 4	Drain			

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