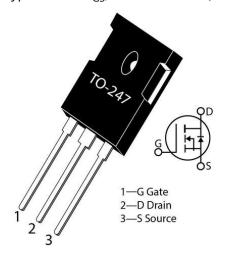
# 1200V, 17 mΩ N-Channel mSiC<sup>™</sup> MOSFET

**MSC017SMA120B** 



#### **Product Overview**

1200V, 17 m $\Omega$  typical at 20 V<sub>GS</sub>, 19 m $\Omega$  typical at 18 V<sub>GS</sub>, Silicon Carbide (SiC) N-Channel MOSFET, TO-247.



#### **Features**

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature, T<sub>I(max)</sub> = 175 °C
- · Fast and reliable body diode
- Superior avalanche ruggedness
- · RoHS compliant

#### **Benefits**

- High efficiency to enable lighter and 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**

- Photovoltaic (PV) inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- · Induction heating and welding
- Hybrid Electric Vehicle (HEV) powertrain and Electric Vehicle (EV) charger
- Power supply and distribution

## 1. Device Specifications

This section shows the specifications of this device.

### 1.1 Absolute Maximum Ratings

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

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
$V_{\rm DSS}$	Drain source voltage	1200	V
$I_D$	Continuous drain current at T <sub>C</sub> = 25 °C	119	Α
	Continuous drain current at T <sub>C</sub> = 100 °C	84	
I <sub>DM</sub>	Pulsed drain current <sup>1</sup>	280	
V <sub>GS</sub>	Gate-source voltage	23 to -10	V
	Transient gate-source voltage	25 to -12	
$P_{D}$	Total power dissipation at T <sub>C</sub> = 25 °C	577	W
	Linear derating factor	3.84	W/°C

#### Note:

1. Repetitive rating: pulse width and case temperature are limited by the maximum junction temperature.

The following table shows the thermal and mechanical characteristics of this device.

**Table 1-2.** Thermal and Mechanical Characteristics

Symbol	Characteristic/Test Conditions	Min.	Тур.	Max.	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance	_	0.20	0.26	°C/W
Tj	Operating junction temperature	-55	_	175	°C
T <sub>STG</sub>	Storage temperature	-55	_	150	
$T_L$	Lead temperature for 10 seconds	_	_	300	°C
_	Mounting torque, 6-32 or M3 screw	_	_	10	lbf.in
		_	_	1.1	N.m
Wt	Package weight	<u> </u>	0.22	_	OZ
		_	6.2	_	g

ESD practices should comply with JESD-625.

### 1.2 Electrical Performance

The following table shows the static characteristics of this device.  $T_J = 25$  °C unless otherwise specified.

Table 1-3. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	$V_{GS} = 0V, I_D = 100 \mu A$	1200	_	_	٧
R <sub>DS(on)</sub> Drain-source on resistance <sup>1</sup>		$V_{GS} = 20V, I_D = 40A$	_	17	22	mΩ
		V <sub>GS</sub> = 18V, I <sub>D</sub> = 40A	_	19	_	
V <sub>GS(th)</sub>	Gate-source threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 4.5 \text{ mA}$	1.9	3	_	٧
I <sub>DSS</sub>	Zero gate voltage drain current	V <sub>DS</sub> = 1200V, V <sub>GS</sub> = 0V	_	0.3	40	μΑ
		$V_{DS}$ = 1200V, $V_{GS}$ = 0V, $T_J$ = 175 °C	_	3.5	_	
$I_{GSS}$	Gate-source leakage current	V <sub>GS</sub> = 20V/–10V	_	_	±100	nA



#### Note:

1. Pulse test: pulse width < 380  $\mu$ s, duty cycle < 2%.

The following table shows the dynamic characteristics of this device.  $T_J$  = 25 °C unless otherwise specified. The dynamic characteristics are characterized, not 100% tested, at the recommended operating  $V_{GS}$  = 20V/–5V.

**Table 1-4.** Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Тур.	Max.	Unit
C <sub>iss</sub>	Input capacitance	$V_{GS} = 0V$	_	4960	_	pF
C <sub>rss</sub>	Reverse transfer capacitance	V <sub>DD</sub> = 1000V	_	18	_	
C <sub>oss</sub>	Output capacitance	$V_{AC} = 25 \text{ mV}$ f = 200 KHz	_	263	_	
Qg	Total gate charge	V <sub>GS</sub> = -5V/20V	_	249	_	nC
Q <sub>gs</sub>	Gate-source charge	V <sub>DD</sub> = 800V	_	63	_	
$Q_{gd}$	Gate-drain charge	I <sub>D</sub> = 40A	_	32	_	
t <sub>d(on)</sub>	Turn-on delay time	V <sub>DD</sub> = 800V	_	52	_	ns
t <sub>f</sub>	Voltage rise time	V <sub>GS</sub> = -5V/20V	_	21	_	
t <sub>d(off)</sub>	Turn-off delay time	$I_D = 50A$	_	49	_	
t <sub>r</sub>	Voltage fall time	$R_{g(ext)} = 4\Omega$	_	18	_	
E <sub>on</sub>	Turn-on switching energy	Freewheeling diode = MSC017SMA120B (V <sub>GS</sub> = -5V);	_	1677	_	μJ
E <sub>off</sub>	Turn-off switching energy	reference Figure 1-18	_	395	_	
ESR	Gate equivalent series resistance	f = 1 MHz, 25 mV, drain short	_	0.71	_	Ω
SCWT	Short circuit withstand time	V <sub>DS</sub> = 960V, V <sub>GS</sub> = 20V	_	3	_	μs
E <sub>AS</sub>	Avalanche energy, single pulse	I <sub>D</sub> = 40A	_	3500	_	mJ

The following table shows the body diode characteristics of this device.  $T_J$  = 25 °C unless otherwise specified.

Table 1-5. Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min.	Тур.	Max.	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 40A, V_{GS} = 0V$	_	3.5	_	V
		$I_{SD} = 40A, V_{GS} = -5V$	_	3.9	_	
t <sub>rr</sub>	Reverse recovery time	$I_{SD}$ = 50A, $V_{GS}$ = -5V, Drive $R_g$ = $4\Omega$ , $V_{DD}$ = 800V,	_	40	_	ns
Q <sub>rr</sub>	Reverse recovery charge	dl/dt = -2500 A/μs	_	490	_	nC
I <sub>RRM</sub>	Reverse recovery current		_	22	_	Α



## 1.3 Typical Performance Curves

Data for performance curves are characterized, not 100% tested.

Figure 1-1. Drain Current vs.  $V_{DS}$  at  $T_J$ 

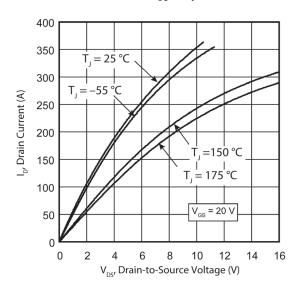


Figure 1-2. Drain Current vs.  $V_{DS}$  at  $V_{GS}$ 

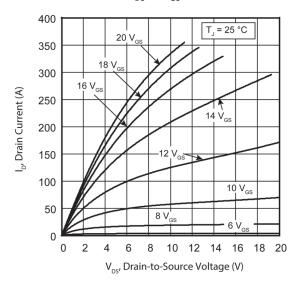


Figure 1-3. Drain Current vs.  $V_{DS}$  at  $V_{GS}$ 

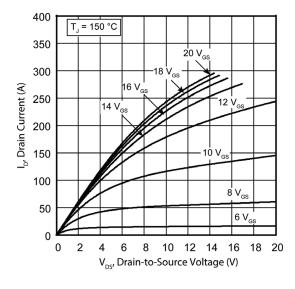


Figure 1-4. Drain Current vs. V<sub>DS</sub> at V<sub>GS</sub>

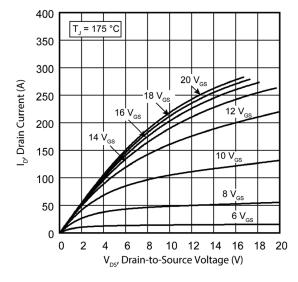




Figure 1-5. R<sub>DS(on)</sub> vs. Junction Temperature

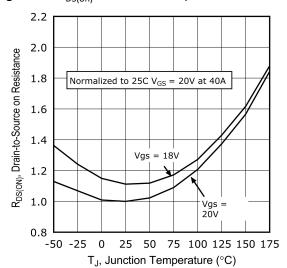


Figure 1-6. Gate Charge Characteristics

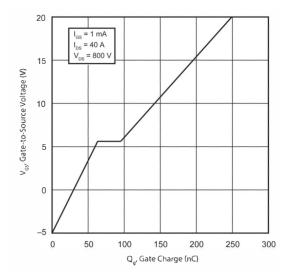


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

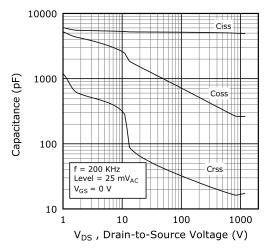


Figure 1-8. Output Charge vs. Drain-to-Source Voltage

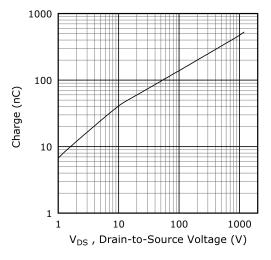
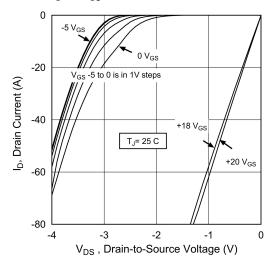




Figure 1-9.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



**Figure 1-10.** I<sub>D</sub> vs. V<sub>DS</sub> 3<sup>rd</sup> Quadrant Conduction

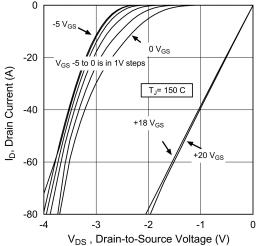


Figure 1-11. Switching Energy Eon vs.  $V_{DS} \& I_{D}$ 

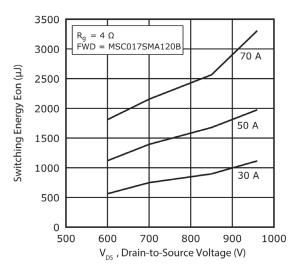


Figure 1-12. Switching Energy Eoff vs.  $V_{DS} \& I_{D}$ 

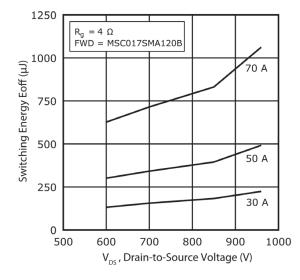




Figure 1-13. Switching Energy vs. R<sub>g</sub>

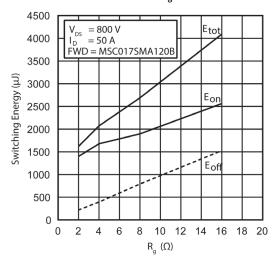


Figure 1-14. Switching Energy vs. Junction Temperature

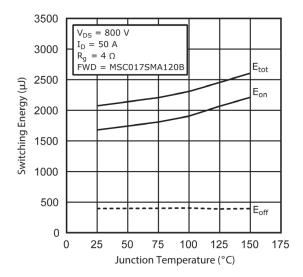
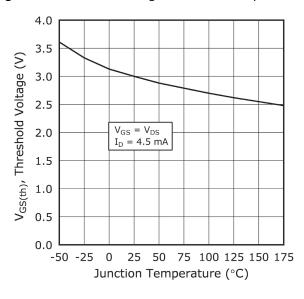


Figure 1-15. Threshold Voltage vs. Junction Temperature Figure 1-16. Forward Safe Operating Area



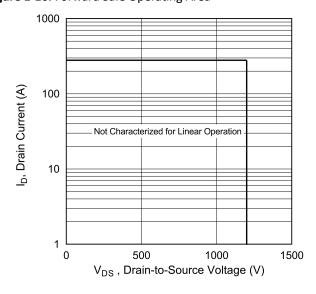
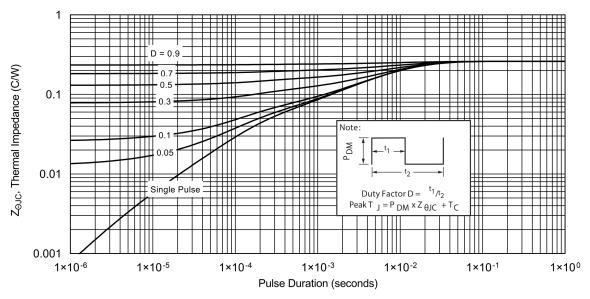


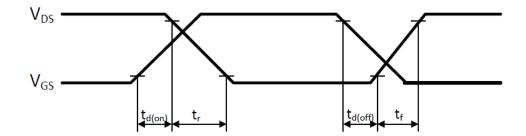


Figure 1-17. Maximum Transient Thermal Impedance



The following figure shows the switching waveform diagram of this device.

Figure 1-18. Switching Waveform





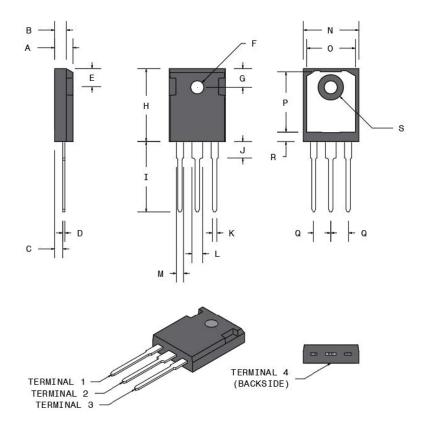
# 2. Package Specification

This section shows the package specification of this device.

### 2.1 Package Outline Drawing

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

Figure 2-1. Package Outline Drawing



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

Table 2-1. TO-247 Dimensions

Symbol	Min. (mm)	Max. (mm)	Min. (in.)	Max. (in.)
Α	4.69	5.31	0.185	0.209
В	1.49	2.49	0.059	0.098
С	2.21	2.59	0.087	0.102
D	0.40	0.79	0.016	0.031
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	
Н	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



continued						
Symbol	Min. (mm)	Max. (mm)	Min. (in.)	Max. (in.)		
M	1.65	2.13	0.065	0.084		
N	15.49	16.26	0.610	0.640		
0	13.50	14.50	0.531	0.571		
Р	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					



# 3. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Table 3-1. Revision History

Revision	Date	Description
Α	09/2023	The following changes are made in this revision of the document:
		Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00005088A, which replaces the previous Microsemi literature number 050-7778.
		Added Figure 1-8.
		• Updated Figure 1-9, Figure 1-10 and Figure 1-15.
Initial releases (Microsemi Revisions A and B)	09/2020-11/2020	Initial releases.



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