MSC130SM120JCU3

Datasheet

Buck Chopper SiC MOSFET Power Module

January 2020

a MICROCHIP company

Contents

1 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.

1.1 Revision 1.0

Revision 1.0 was published in January 2020. It is the first publication of this document.

2 Product Overview

The MSC130SM120JCU3 device is a 1200 V, 173 A full Silicon Carbide power module.

Figure 1 • Electrical Schematic of MSC130SM120JCU3 Device

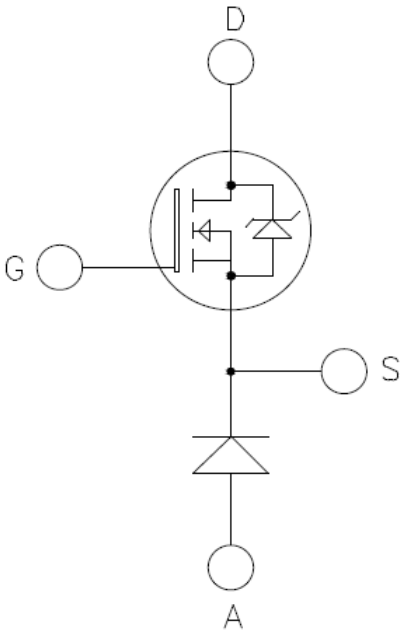
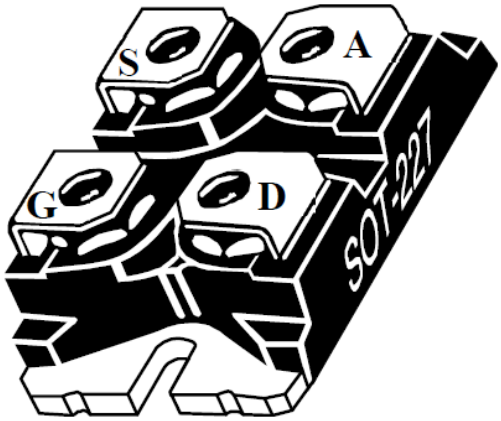


Figure 2 • SOT-227 Pinout Location



All ratings at T_j = 25 °C, unless otherwise specified.

Caution: These devices are sensitive to electrostatic discharge. Proper handling procedures should be followed.

2.1 Features

The following are key features of the MSC130SM120JCU3 device:

- Silicon Carbide (SiC) Power MOSFET
  - Low $R_{DS(on)}$
  - High temperature performance
- SiC Schottky Diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on VF

2.2 Benefits

The following are benefits of the MSC130SM120JCU3 device:

- High efficiency converter
- Very low stray inductance
- Outstanding performance at high frequency operation
- Stable temperature behavior
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- RoHS compliant

2.3 Applications

The MSC130SM120JCU3 device is designed for the following applications:

- AC and DC motor control
- Switched mode power supplies

3 Electrical Specifications

This section shows the specifications of the MSC130SM120JCU3 device.

3.1 SiC MOSFET Characteristics

The following table shows the absolute maximum ratings of MSC130SM120JCU3 device.

Table 1 • Absolute Maximum Ratings

Symbol	Parameters		Maximum Ratings	Unit
V_{DSS}	Drain–source voltage		1200	V
I_D	Continuous drain current	T_C = 25°C	173[1]	A
		T_C = 80°C	138[1]	
I_{DM}	Pulsed drain current		350	
V_{GS}	Gate–source voltage		–10/25	V
R_{DSon}	Drain–source ON resistance		16	mΩ
P_D	Power dissipation	T_C = 25°C	745	W

Note:

1. Specification of SiC MOSFET device but output current must be limited due to the size of power connectors.

The following table shows the electrical characteristics of MSC130SM120JCU3 device.

Table 2 • Electrical Characteristics

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V ; V_{DS} = 1200 V			20	200	µA
$R_{DS(on)}$	Drain–source on resistance	V_{GS} = 20 V I_D = 80 A	T_C = 25°C		12.5	16	mΩ
			T_C = 175°C		20		
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}, I_D = 2 mA		1.8	2.8		V
I_{GSS}	Gate–source leakage current	V_{GS} = 20 V, V_{DS} = 0 V				200	nA

The following table shows the dynamic characteristics of MSC130SM120JCU3 device.

Table 3 • Dynamic Characteristics

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V V_{DS} = 1000 V f = 1 MHz			6040		pF
C_{oss}	Output capacitance				540		
C_{rss}	Reverse transfer capacitance				50		
Q_g	Total gate charge	V_{GS}= –5/20 V V_{Bus} = 800 V I_D = 80 A			464		nC
Q_{gs}	Gate–source charge				82		
Q_{gd}	Gate–drain charge				100		
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5/20 V V_{Bus} = 600 V I_D = 100 A R_{Gon} = 4 Ω R_{Goff} = 2.4 Ω			30		ns
T_r	Rise time				30		
$T_{d(off)}$	Turn-off delay time				50		
T_f	Fall time				25		
E_{on}	Turn on energy	Inductive Switching V_{GS} = –5/20 V V_{Bus} = 600 V I_D = 100 A R_{Gon} = 4 Ω R_{Goff} = 2.4 Ω	T_J = 150°C		1.98		mJ
E_{off}	Turn off energy		T_J = 150°C		1.3		mJ
R_{Gint}	Internal gate resistance				2.94		Ω
R_{thJC}	Junction-to-case thermal resistance					0.2	°C/W

The following table shows the body diode ratings and characteristics of MSC130SM120JCU3 device.

Table 4 • Body Diode Ratings and Characteristics

Symbol	Characteristics	Test Conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	V_{GS} = 0 V ; I_{SD} = 80 A		4		V
		V_{GS} = –5 V ; I_{SD} = 80 A		4.2		
t_{rr}	Reverse recovery time	I_{SD} = 80 A ; V_{GS} = –5 V V_R = 800 V ; di_F/dt = 2000 A/µs		90		ns
Q_{rr}	Reverse recovery charge			1100		nC
I_{rr}	Reverse recovery current			27		A

3.2 SiC Chopper Diode Ratings and Characteristics

The following table shows the SiC chopper diode ratings and characteristics of MSC130SM120JCU3 device.

Table 5 • SiC Chopper Diode Ratings and Characteristics

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak repetitive reverse voltage					1200	V
I_{RM}	Reverse leakage current	V_R=1200 V	T_J = 25 °C		15	400	µA
			T_J = 175 °C		250		
I_F	DC forward current		T_C = 100 °C		50		A
V_F	Diode forward voltage	I_F = 50 A	T_J = 25 °C		1.5	1.8	V
			T_J = 175 °C		2.1		
Q_C	Total capacitive charge	V_R = 600 V			224		nC
C	Total capacitance	f = 1 MHz, V_R = 400 V			246		pF
		f = 1 MHz, V_R = 800 V			182		
R_{thJC}	Junction-to-case thermal resistance					0.56	°C/W

3.3 Thermal and Package Characteristics

The following table shows the thermal and package characteristics of MSC130SM120JCU3 device.

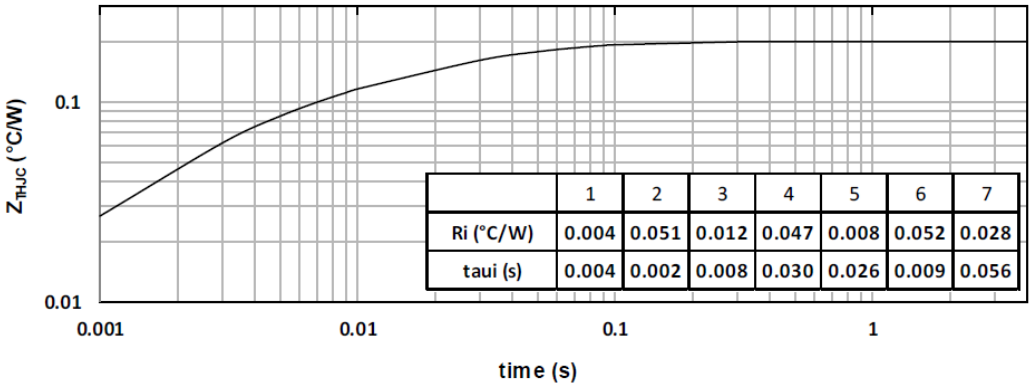
Table 6 • Thermal and Package Characteristics

Symbol	Characteristics	Min	Typ	Max	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t =1 min, 50/60 Hz	2500			V
T_{STG}	Storage temperature range	–55		175	°C
T_J	Operating junction temperature range	–55		175	
T_{JOP}	Recommended junction temperature under switching conditions	–55		T_{Jmax}–25	
Torque	Terminals and mounting screws			1.1	N.m
Wt	Package weight		29.2		g

3.4 SiC MOSFET Performance Curves

This sections shows the typical SiC MOSFET performance curves of the MSC130SM120JCU3 device.

Figure 3 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.004	0.051	0.012	0.047	0.008	0.052	0.028
taui (s)	0.004	0.002	0.008	0.030	0.026	0.009	0.056

Figure 4 • Output Characteristics, T_J=25 °C

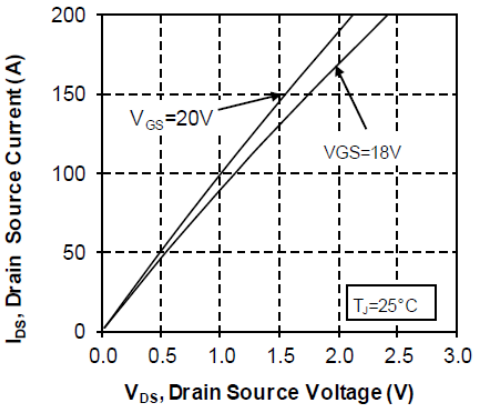


Figure 5 • Output Characteristics, T_J=175 °C

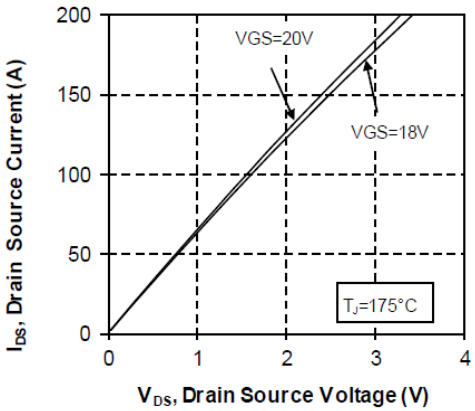


Figure 6 • Normalized $R_{DS(on)}$ vs. Temperature

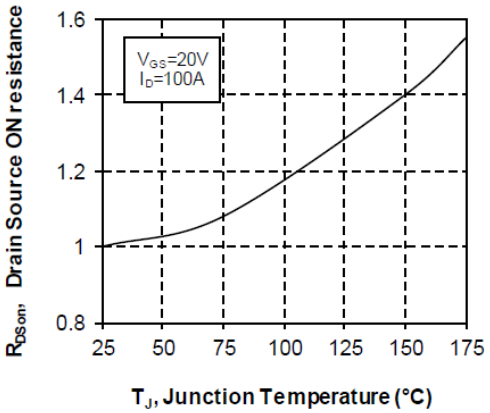


Figure 7 • Transfer Characteristics

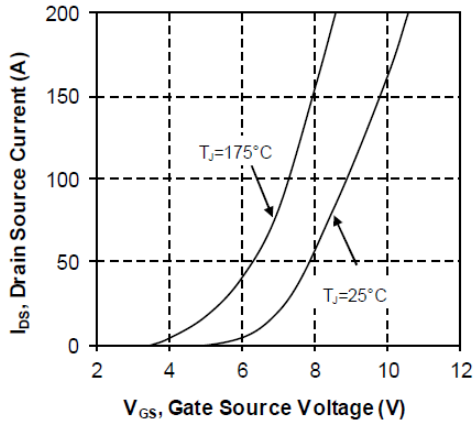


Figure 8 • Switching Energy vs. Rg

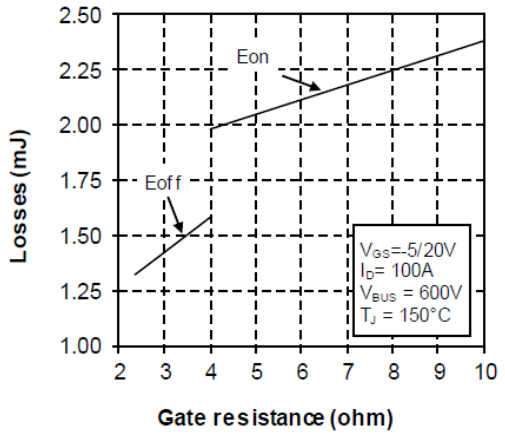


Figure 9 • Switching Energy vs. Current

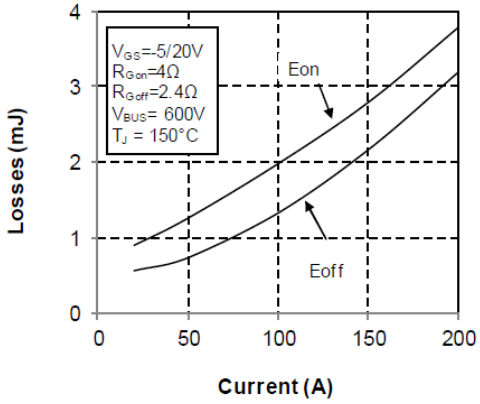


Figure 10 • Capacitance vs. Drain Source Voltage

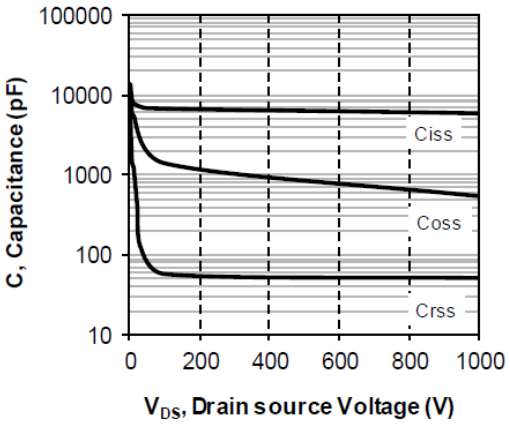


Figure 11 • Gate Charge vs. Gate Source Voltage

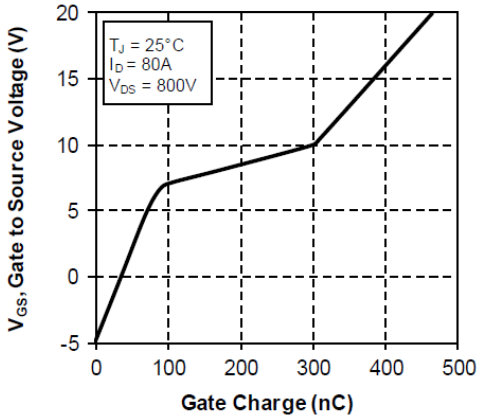


Figure 12 • Body Diode Characteristics, T_J=25 °C

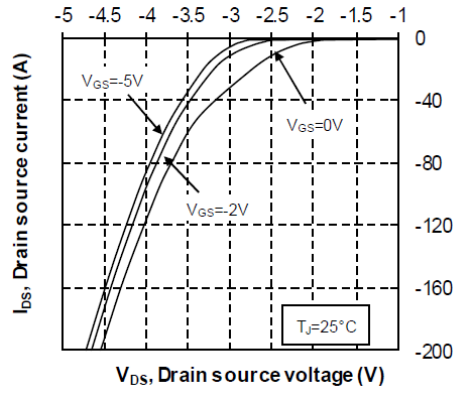


Figure 13 • 3rd Quadrant Characteristics, T_J=25 °C

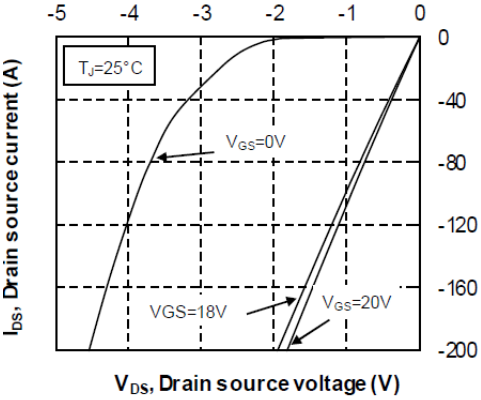


Figure 14 • Body Diode Characteristics, T_J=175 °C

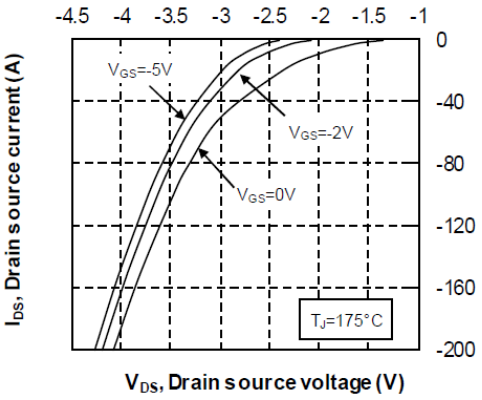


Figure 15 • 3rd Quadrant Characteristics, T_J=175 °C

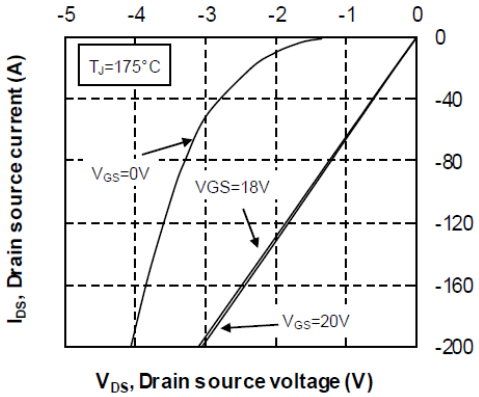
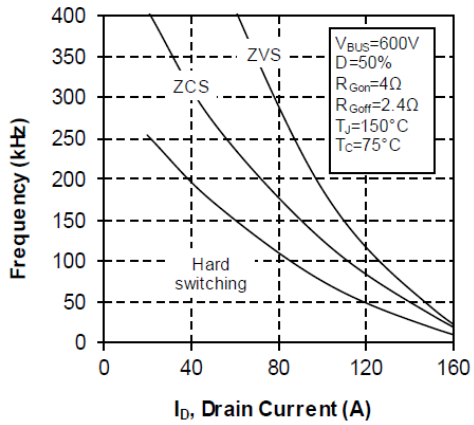


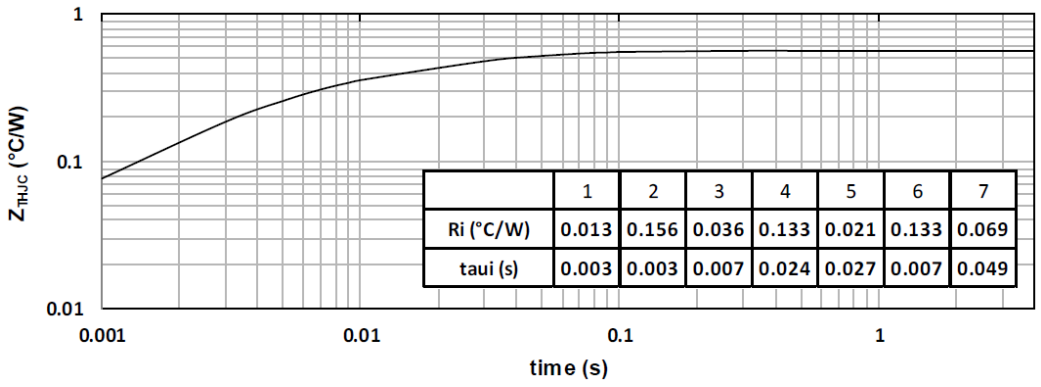
Figure 16 • Operating Frequency vs. Drain Current



3.5 Typical SiC Diode Performance Curves

This sections shows the typical SiC diode performance curves of the MSC130SM120JCU3 device.

Figure 17 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.013	0.156	0.036	0.133	0.021	0.133	0.069
taui (s)	0.003	0.003	0.007	0.024	0.027	0.007	0.049

Figure 18 • Forward Characteristics

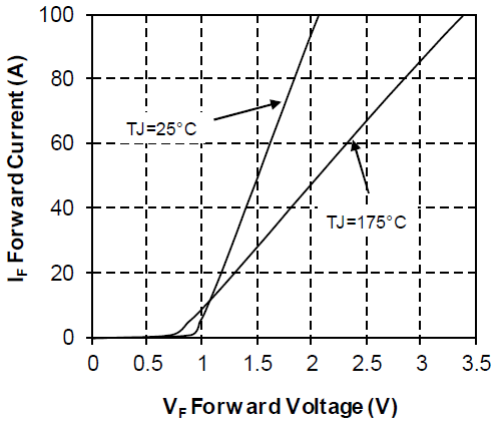
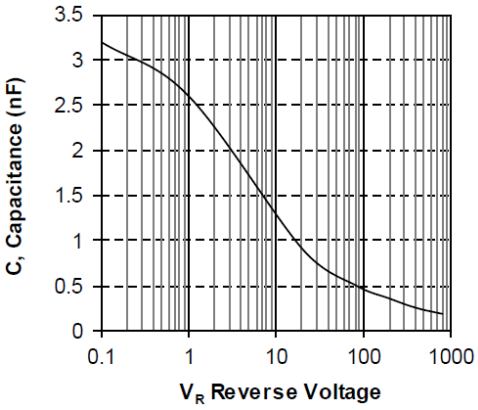


Figure 19 • Capacitance vs. Reverse Voltage



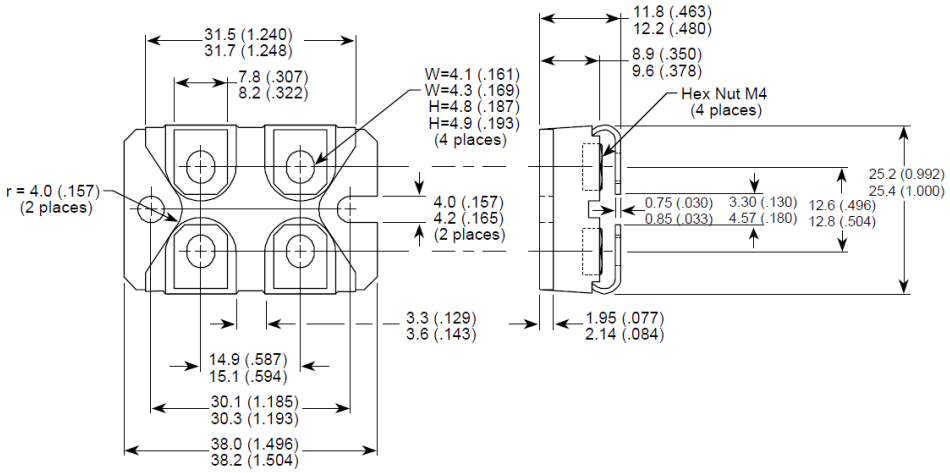
4 Package Specifications

This section shows the package specification of the MSC130SM120JCU3 device.

4.1 Package Outline Drawing

The following figure illustrates the package outline of the MSC130SM120JCU3 device. The dimensions are in millimeters and (inches).

Figure 20 • Package Outline Drawing



Microsemi
2355 W. Chandler Blvd.
Chandler, AZ 85224 USA

Within the USA: +1 (480) 792-7200
Fax: +1 (480) 792-7277

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