MSC40SM120JCU3

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 MSC40SM120JCU3 device is a 1200 V, 55 A full Silicon Carbide power module.

Figure 1 • Electrical Schematic of MSC70SM120JCU3 Device

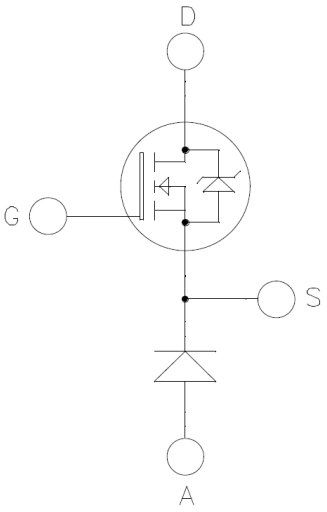
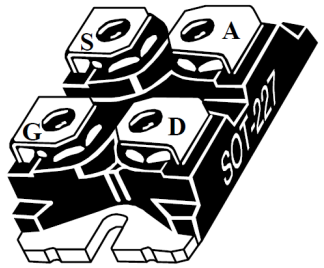


Figure 2 • SOT-227 Pinout Location



All ratings at Tj = 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 the features of MSC40SM120JCU3 device:

- 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 the benefits of MSC40SM120JCU3 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 following are the applications of MSC40SM120JCU3 device:

- AC and DC motor control
- Switched mode power supplies

3 Electrical Specifications

This section provides the electrical specifications for the MSC40SM120JCU3 device.

3.1 SiC MOSFET Characteristics

The following table shows the absolute maximum ratings of MSC40SM120JCU3 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	55	A
		T_C = 80°C	44	
I_{DM}	Pulsed drain current		110	
V_{GS}	Gate–source voltage		–10/25	V
R_{DSon}	Drain–source ON resistance		50	mΩ
P_D	Power dissipation	T_C = 25°C	245	W

The following table shows the electrical characteristics of MSC40SM120JCU3 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			10	100	µA
$R_{DS(on)}$	Drain–source on resistance	V_{GS} = 20 V I_D = 40 A	T_C = 25°C		40	50	mΩ
			T_C = 175°C		64		
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}, I_D = 1 mA		1.8	2.7		V
I_{GSS}	Gate–source leakage current	V_{GS} = 20 V, V_{DS} = 0 V				150	nA

The following table shows the dynamic characteristics of MSC40SM120JCU3 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			1990		pF
C_{oss}	Output capacitance				156		
C_{rss}	Reverse transfer capacitance				17		
Q_g	Total gate charge	V_{GS}= –5/20 V V_{Bus} = 800 V I_D = 40 A			137		nC
Q_{gs}	Gate–source charge				29		
Q_{gd}	Gate–drain charge				31		
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5/20 V V_{Bus} = 600 V I_D = 40 A R_{Gon} = 10 Ω R_{Goff} = 5.8 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 = 40A R_{Gon} = 10 Ω R_{Goff} = 5.8 Ω	T_j = 150°C		0.79		mJ
E_{off}	Turn off energy		T_j = 150°C		0.53		mJ
R_{Gint}	Internal gate resistance				1.2		Ω
R_{thJC}	Junction-to-case thermal resistance					0.61	°C/W

The following table shows the body diode ratings and characteristics of MSC40SM120JCU3 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} = 40 A		5.4		V
t_{rr}	Reverse recovery time	I_{SD} = 40 A ; V_{GS} = –5 V V_R = 800 V ; di_F/dt = 1800 A/µs		31		ns
Q_{rr}	Reverse recovery charge			610		nC
I_{rr}	Reverse recovery current			40		A

3.2 SiC Chopper Diode Ratings and Characteristics

The following table shows the SiC chopper diode ratings and characteristics of MSC40SM120JCU3 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		10	200	µA
			T_j = 175 °C		150		
I_F	DC forward current		T_C = 100 °C		30		A
V_F	Diode forward voltage	I_F = 30 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			130		nC
C	Total capacitance	f = 1 MHz, V_R = 400 V			141		pF
		f = 1 MHz, V_R = 800 V			105		
R_{thJC}	Junction-to-case thermal resistance					0.9	°C/W

3.3 Thermal and Package Characteristics

The following table shows the thermal and package characteristics of MSC40SM120JCU3 device.

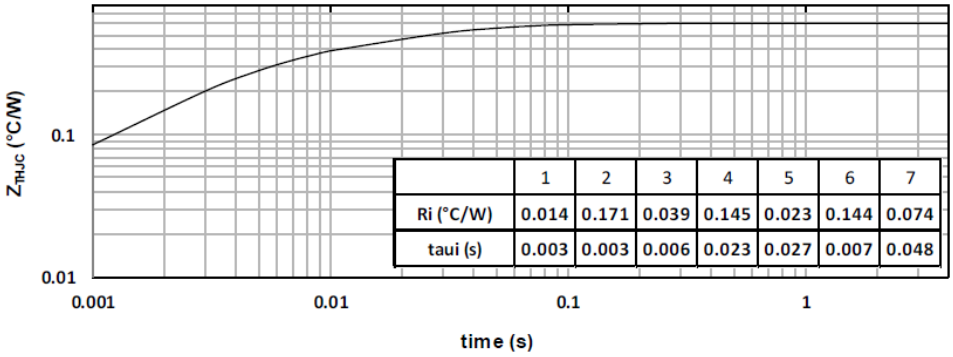
Table 6 • Thermal and Package Characteristics

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 Typical SiC MOSFET Performance Curves

The following images show the SiC MOSFET performance curves of the MSC40SM120JCU3 device.

Figure 3 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.014	0.171	0.039	0.145	0.023	0.144	0.074
taui (s)	0.003	0.003	0.006	0.023	0.027	0.007	0.048

Figure 4 • Output Characteristics, T_J = 25 °C

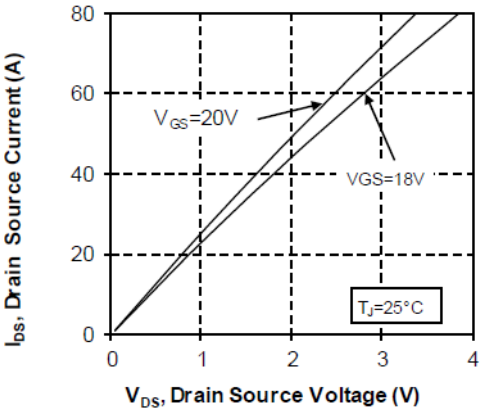


Figure 5 • Output Characteristics, T_J = 175 °C

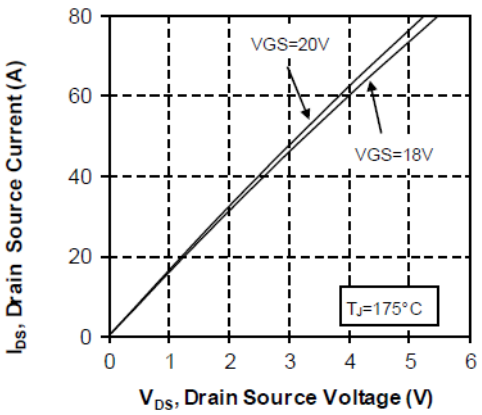


Figure 6 • Normalized $R_{DS(on)}$ vs. Temperature

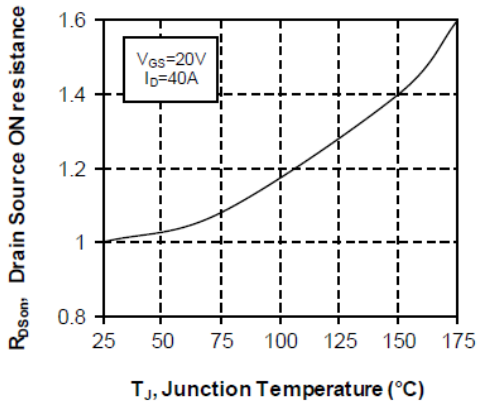


Figure 7 • Transfer Characteristics

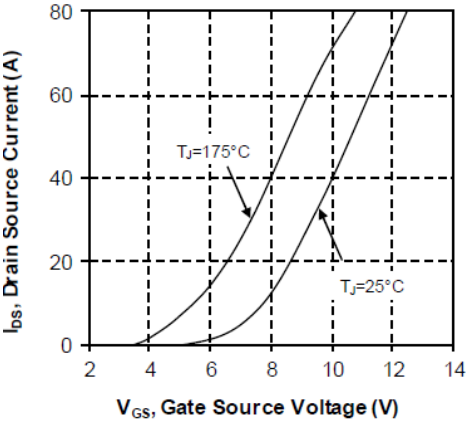


Figure 8 • Switching Energy vs. Rg

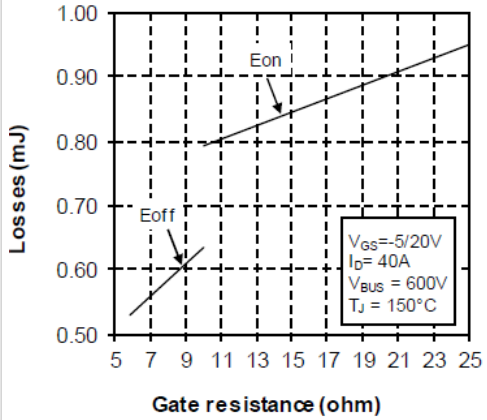


Figure 9 • Switching Energy vs. Current

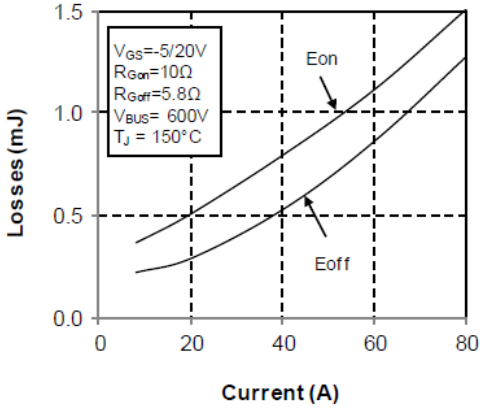


Figure 10 • Capacitance vs. Drain Source Voltage

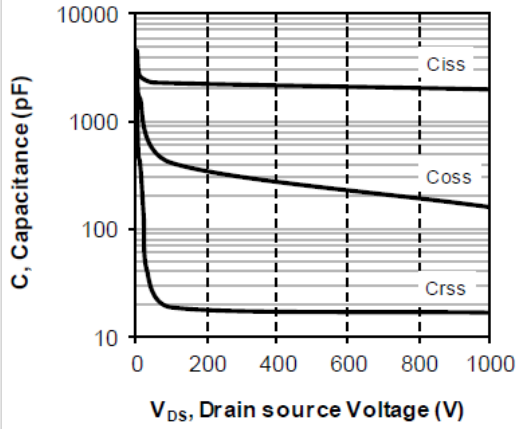


Figure 11 • Gate Charge vs. Gate Source Voltage

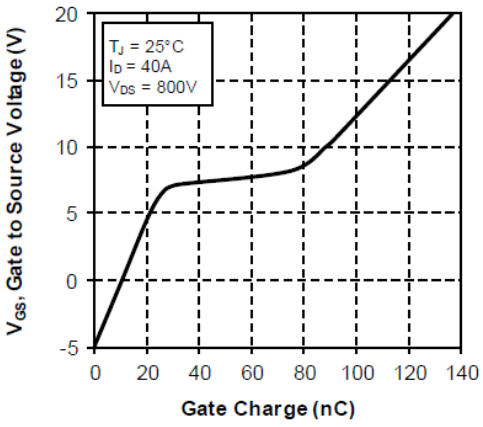


Figure 12 • Body Diode Characteristics, T_J=25 °C

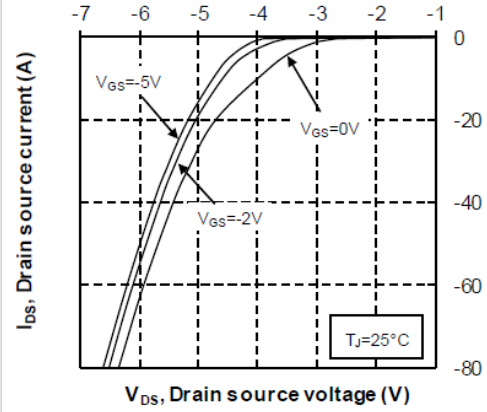


Figure 13 • 3rd Quadrant Characteristics, T_J=25 °C

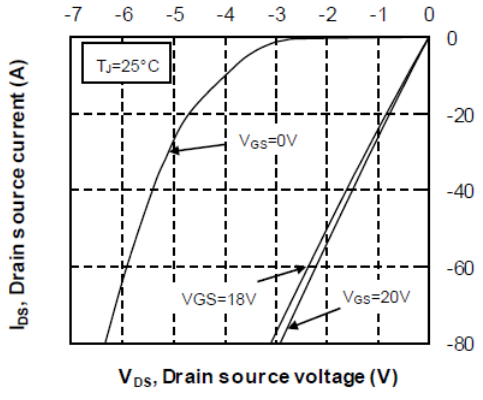


Figure 14 • Body Diode Characteristics, T_J=175 °C

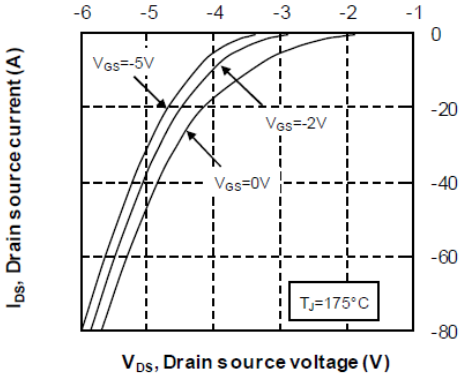


Figure 15 • 3rd Quadrant Characteristics, T_J=175 °C

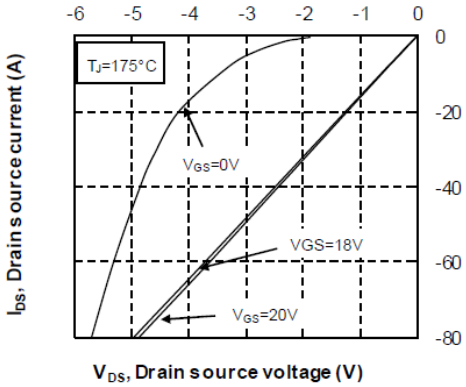
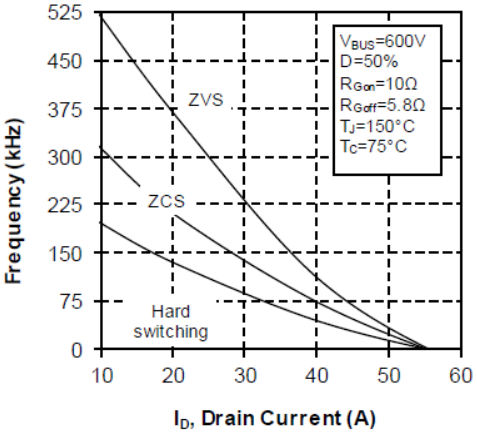


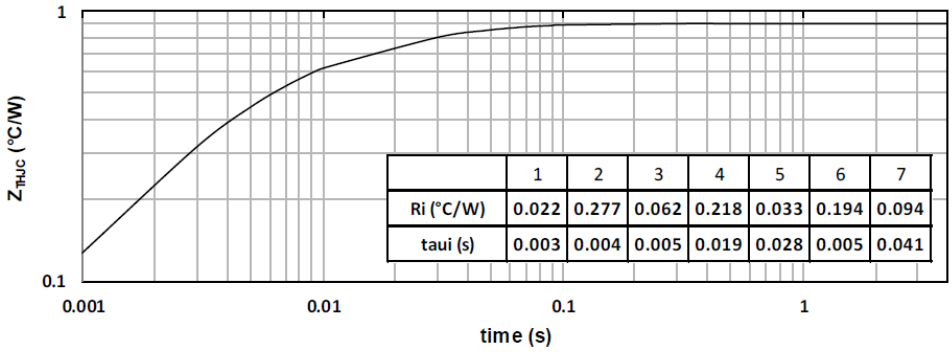
Figure 16 • Operating Frequency vs. Drain Current



3.5 Typical SiC Diode Performance Curves

The following images show the SiC diode performance curves of MSC40SM120JCU3 device.

Figure 17 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.022	0.277	0.062	0.218	0.033	0.194	0.094
taui (s)	0.003	0.004	0.005	0.019	0.028	0.005	0.041

Figure 18 • Forward Characteristics

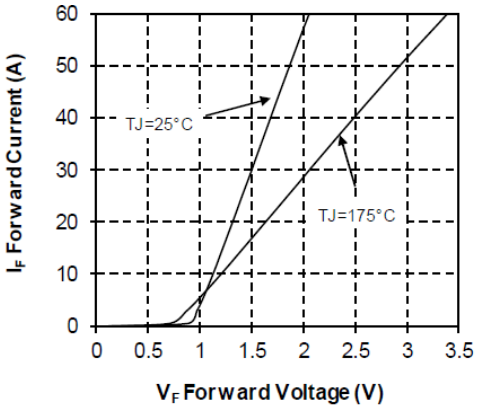
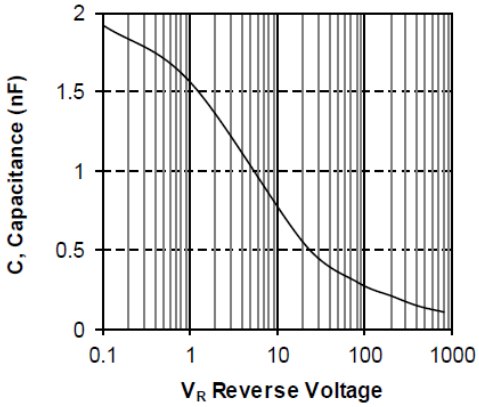


Figure 19 • Capacitance vs. Reverse Voltage



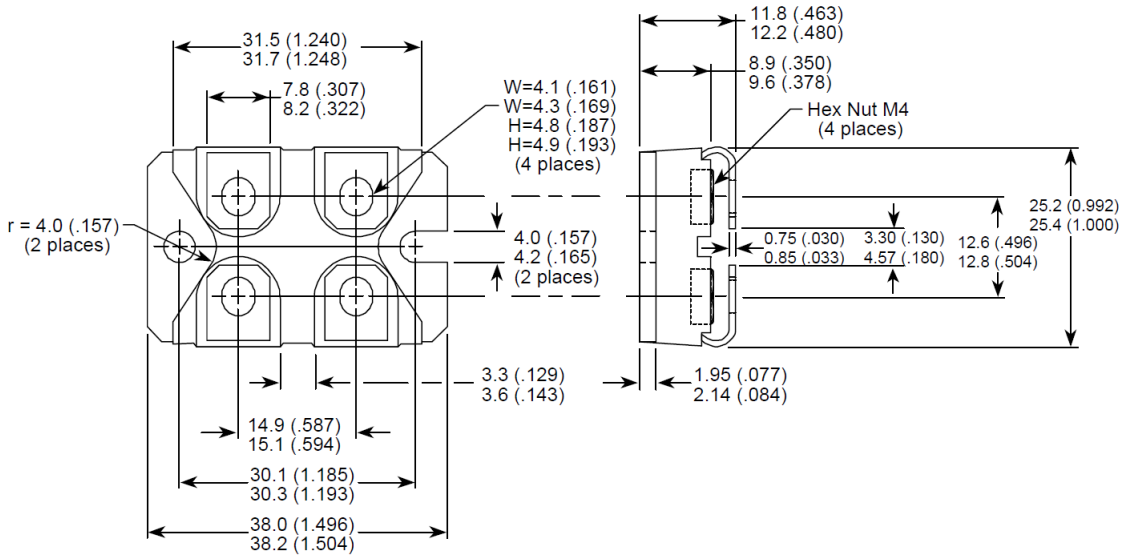
4 Package Specification

The following section shows the package specification of MSC40SM120JCU3 device.

4.1 Package Outline Drawing

The following image illustrates the package outline drawing of MSC40SM120JCU3 device. The dimensions are in millimeters and (inches).

Figure 20 • Package Outline Drawing



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