

**MSC40SM120JCU2**  
**Datasheet**  
**Boost Chopper SiC MOSFET Power Module**

January 2020



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a  **MICROCHIP** company

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# 1 Revision History

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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

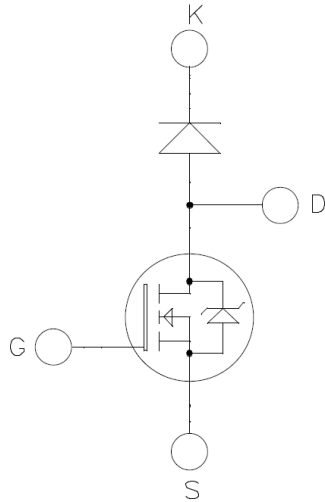
Revision 1.0 was published in January 2020. It is the first publication of this document.

## 2 Product Overview

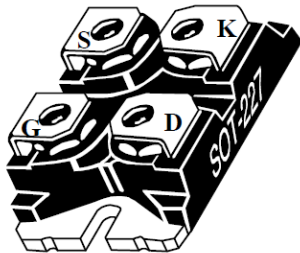
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The MSC40SM120JCU2 is a 1200 V, 55 A full Silicon Carbide power module.

**Figure 1 • Electrical Schematic of MSC40SM120JCU2 Device**



**Figure 2 • SOT-227 Pinout Location**



All ratings at  $T_j = 25\text{ }^\circ\text{C}$ , 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 MSC40SM120JCU2 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 MSC40SM120JCU2 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 MSC40SM120JCU2 device:

- AC and DC motor control
- Switched Mode Power Supplies
- Power Factor Correction
- Brake switch

## 3 Electrical Specifications

This section provides the electrical specifications for the MSC40SM120JCU2 device.

### 3.1 SiC MOSFET Characteristics

The following table shows the absolute maximum ratings of MSC40SM120JCU2 device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Parameters	Maximum Ratings	Unit	
$V_{DSS}$	Drain–source voltage	1200	V	
$I_D$	Continuous drain current	$T_C = 25^\circ\text{C}$	55	A
		$T_C = 80^\circ\text{C}$	44	
$I_{DM}$	Pulsed drain current	110		
$V_{GS}$	Gate–source voltage	–10/25	V	
$R_{DS(on)}$	Drain–source ON resistance	50	m $\Omega$	
$P_D$	Power dissipation	$T_C = 25^\circ\text{C}$	245	W

The following table shows the electrical characteristics of MSC40SM120JCU2 device.

**Table 2 • Electrical Characteristics**

Symbol	Characteristics	Test Conditions	Min	Typ	Max	Unit
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}; V_{DS} = 1200\text{ V}$		10	100	$\mu\text{A}$
$R_{DS(on)}$	Drain–source on resistance	$V_{GS} = 20\text{ V}$ $I_D = 40\text{ A}$	$T_C = 25^\circ\text{C}$	40	50	m $\Omega$
			$T_C = 175^\circ\text{C}$	64		
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}, I_D = 1\text{ mA}$	1.8	2.7		V
$I_{GSS}$	Gate–source leakage current	$V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$			150	nA

The following table shows the dynamic characteristics of MSC40SM120JCU2 device.

**Table 3 • Dynamic Characteristics**

Symbol	Characteristics	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$ $V_{DS} = 1000\text{ V}$ $f = 1\text{ MHz}$		1990		pF
$C_{oss}$	Output capacitance			156		
$C_{riss}$	Reverse transfer capacitance			17		
$Q_g$	Total gate charge	$V_{GS} = -5/20\text{ V}$ $V_{Bus} = 800\text{ V}$ $I_D = 40\text{ A}$		137		nC
$Q_{gs}$	Gate-source charge			29		
$Q_{gd}$	Gate-drain charge			31		
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5/20\text{ V}$ $V_{Bus} = 600\text{ V}$ $I_D = 40\text{ A}$ $R_{Gon} = 10\ \Omega$ $R_{Goff} = 5.8\ \Omega$		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 $V_{GS} = -5/20\text{ V}$ $V_{Bus} = 600\text{ V}$ $I_D = 40\text{ A}$ $R_{Gon} = 10\ \Omega$ $R_{Goff} = 5.8\ \Omega$	$T_J = 150\text{ }^\circ\text{C}$	0.79		mJ
$E_{off}$	Turn off energy		$T_J = 150\text{ }^\circ\text{C}$	0.53		mJ
$R_{Gint}$	Internal gate resistance			1.2		$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance				0.61	$^\circ\text{C/W}$

The following table shows the body diode ratings and characteristics of MSC40SM120JCU2 device.

**Table 4 • Body Diode Ratings and Characteristics**

Sym-bol	Characteristics	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0\text{ V}$ ; $I_{SD} = 40\text{ A}$		5.4		V
$t_{rr}$	Reverse recovery time	$I_{SD} = 40\text{ A}$ ; $V_{GS} = -5\text{ V}$ $V_R = 800\text{ V}$ ; $di_F/dt = 1800\text{ A}/\mu\text{s}$		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 MSC40SM120JCU2 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	$V_R = 1200\text{ V}$	$T_J = 25\text{ °C}$	10	200	$\mu\text{A}$
			$T_J = 175\text{ °C}$	150		
$I_F$	DC forward current			30		A
$V_F$	Diode forward voltage	$I_F = 30\text{ A}$	$T_J = 25\text{ °C}$	1.5	1.8	V
			$T_J = 175\text{ °C}$	2.1		
$Q_C$	Total capacitive charge	$V_R = 600\text{ V}$		130		nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 400\text{ V}$		141		pF
		$f = 1\text{ MHz}, V_R = 800\text{ V}$		105		
$R_{thJC}$	Junction-to-case thermal resistance				0.9	$^{\circ}\text{C/W}$

### 3.3 Thermal and Package Characteristics

The following table shows the thermal and package characteristics of MSC40SM120JCU2 device.

**Table 6 • Thermal and Package Characteristics**

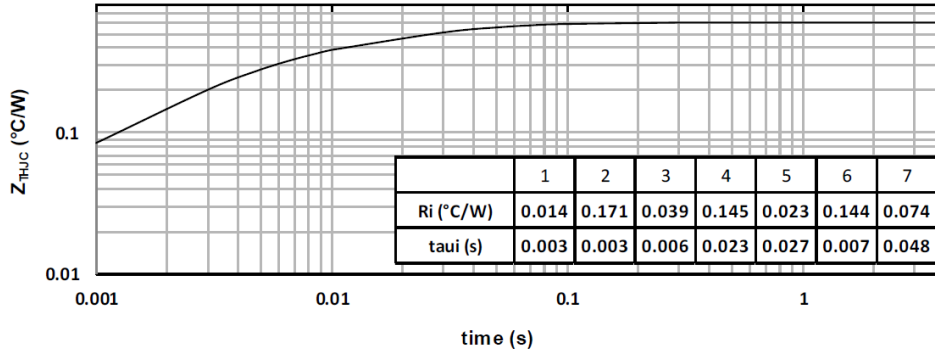
Symbol	Characteristics	Min	Typ	Max	Unit
$V_{ISOL}$	RMS isolation voltage, any terminal to case $t = 1\text{ min}$ , 50/60 Hz	2500			V
$T_{STG}$	Storage temperature range	-55		175	$^{\circ}\text{C}$
$T_J$	Operating junction temperature range	-55		175	
$T_{JOP}$	Recommended junction temperature under switching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



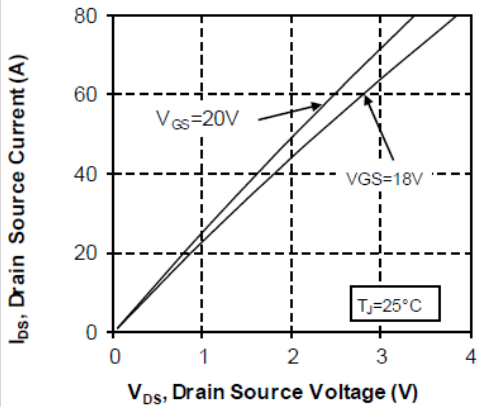
### 3.4 SiC MOSFET Performance Curves

The following images show the SiC MOSFET performance curves of the MSC40SM120JCU2 device.

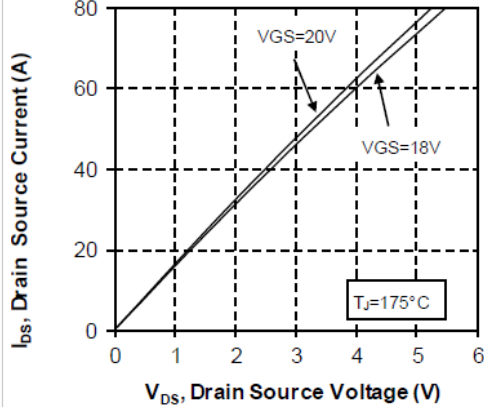
**Figure 3 • Maximum Thermal Impedance**



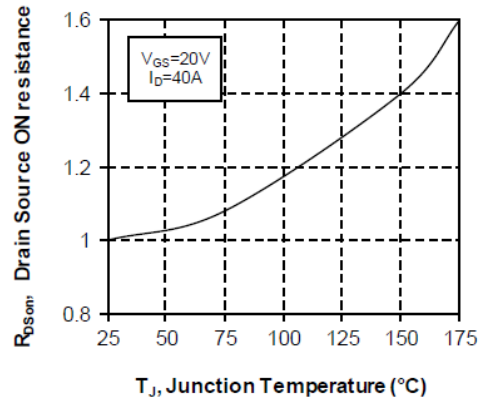
**Figure 4 • Output Characteristics, T<sub>J</sub> = 25 °C**



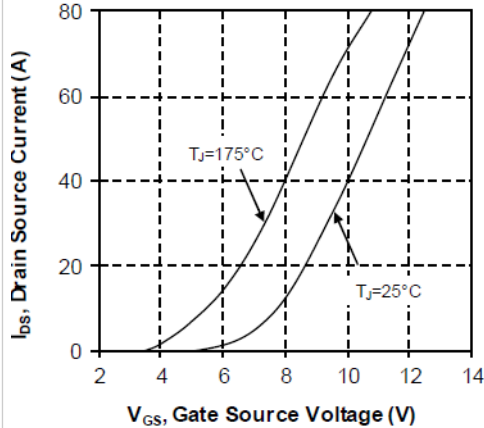
**Figure 5 • Output Characteristics, T<sub>J</sub> = 175 °C**



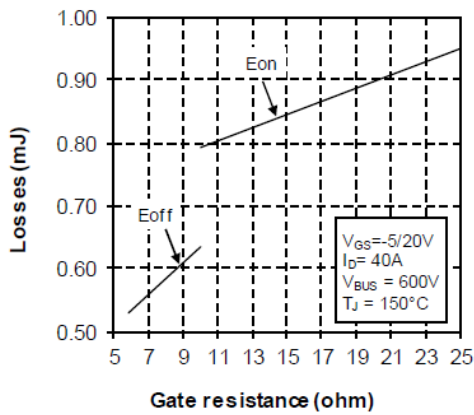
**Figure 6 • Normalized R<sub>DS(on)</sub> vs. Temperature**



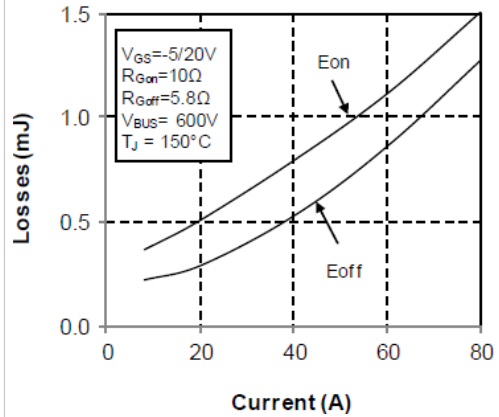
**Figure 7 • Transfer Characteristics**



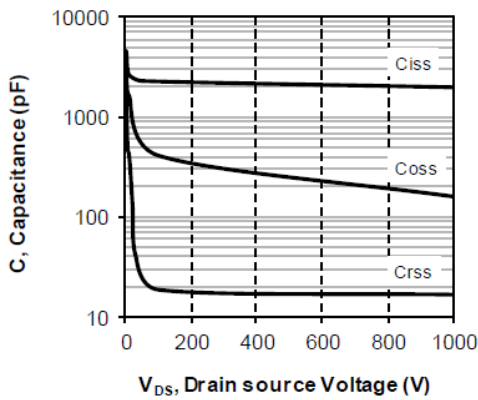
**Figure 8 • Switching Energy vs. Rg**



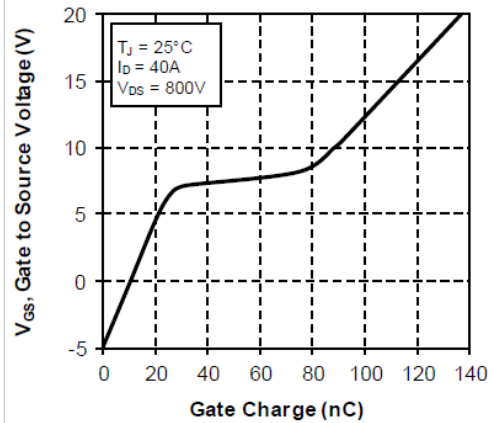
**Figure 9 • Switching Energy vs. Current**



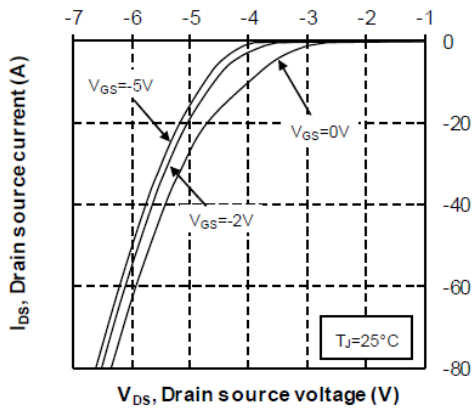
**Figure 10 • Capacitance vs. Drain Source Voltage**



**Figure 11 • Gate Charge vs. Gate Source Voltage**



**Figure 12 • Body Diode Characteristics, TJ = 25 °C**



**Figure 13 • 3<sup>rd</sup> Quadrant Characteristics, TJ = 25 °C**

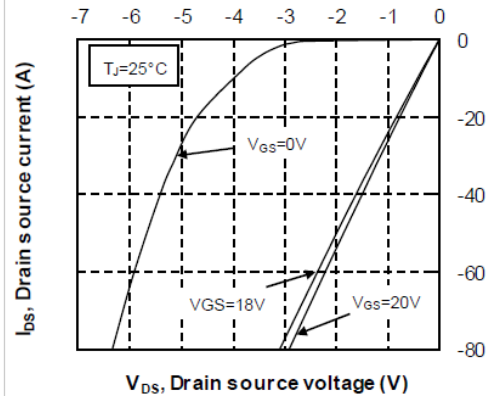


Figure 14 • Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

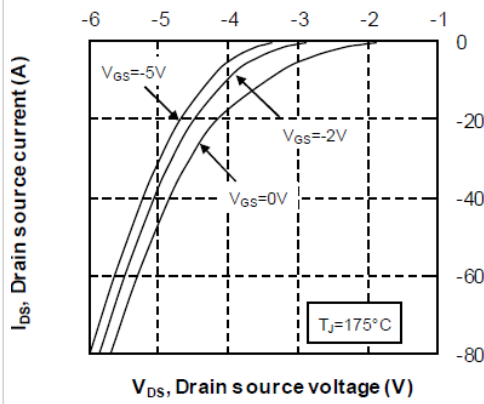


Figure 15 • 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

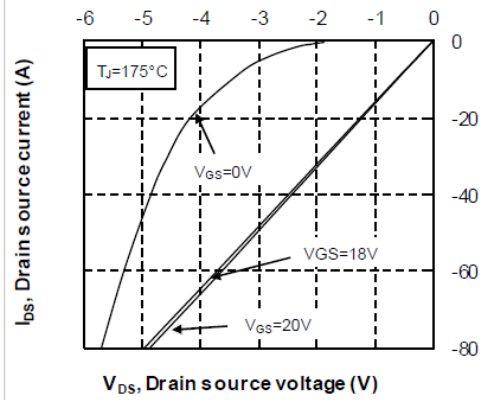
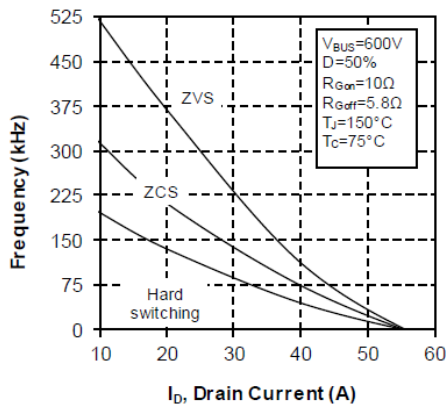


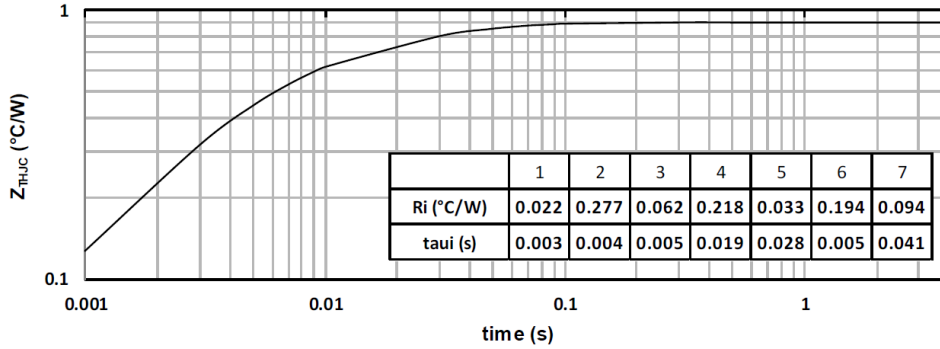
Figure 16 • Operating Frequency vs. Drain Current



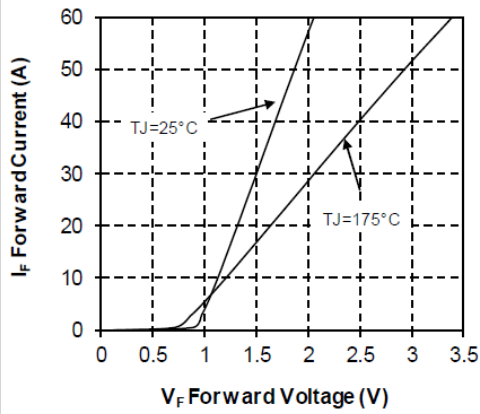
### 3.5 SiC Diode Performance Curves

The following images show the SiC diode performance curves of MSC40SM120JCU2 device.

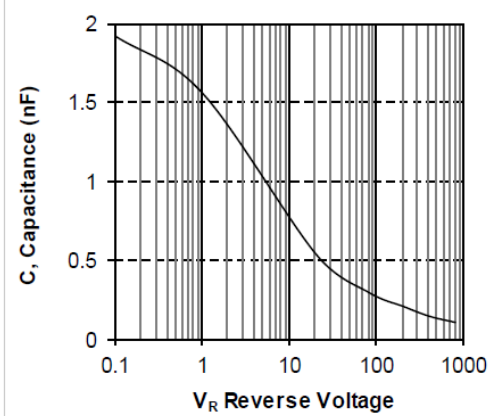
**Figure 17 • Maximum Thermal Impedance**



**Figure 18 • Forward Characteristics**



**Figure 19 • Capacitance vs. Reverse Voltage**



## 4 Package Specifications

The following section illustrates the package outline of MSC40SM120JCU2 device.

### 4.1 Package Outline Drawing

The following image shows the package outline drawing of MSC40SM120JCU2 device. The dimensions are in millimeters and (inches).

**Figure 20 • Package Outline Drawing**

