

**MSC70SM120JCU3**  
**Datasheet**  
**Buck Chopper SiC MOSFET Power Module**

January 2020



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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.

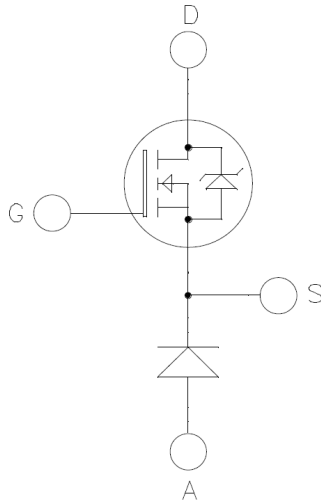
## 1.1 Revision 1.0

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

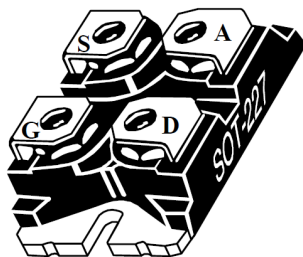
## 2 Product Overview

The MSC70SM120JCU3 device is a 1200 V, 89 A full Silicon Carbide power module.

**Figure 1 • Electrical Schematic of MSC70SM120JCU3 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 MSC70SM120JCU3 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 MSC70SM120JCU3 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 MSC70SM120JCU3 device:

- AC and DC motor control
- Switched mode power supplies

## 3 Electrical Specifications

This section provides the electrical specifications for the MSC70SM120JCU3 device.

### 3.1 SiC MOSFET Characteristics

The following table shows the absolute maximum ratings of MSC70SM120JCU3 device.

**Table 1 • Absolute Maximum Ratings**

Symbol	Parameters		Maximum Ratings	Unit
$V_{DSS}$	Drain–source voltage		1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^{\circ}\text{C}$	89 <sup>1</sup>	A
		$T_C = 80\text{ }^{\circ}\text{C}$	71 <sup>1</sup>	
$I_{DM}$	Pulsed drain current		180	
$V_{GS}$	Gate–source voltage		–10/25	V
$R_{DS(on)}$	Drain–source ON resistance		31	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^{\circ}\text{C}$	395	W

**Note:**

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

The following table shows the electrical characteristics of MSC70SM120JCU3 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	$V_{GS} = 20\text{ V}$ $I_D = 40\text{ A}$	$T_C = 25\text{ }^{\circ}\text{C}$		25	31	m $\Omega$
			$T_C = 175\text{ }^{\circ}\text{C}$		40		
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 1\text{ mA}$		1.8	2.8		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 MSC70SM120JCU3 device.

**Table 3 • Dynamic Characteristics**

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$ $V_{DS} = 1000\text{ V}$ $f = 1\text{ MHz}$			3020		pF
$C_{oss}$	Output capacitance				270		
$C_{rss}$	Reverse transfer capacitance				25		
$Q_g$	Total gate charge	$V_{GS} = -5/20\text{ V}$ $V_{Bus} = 800\text{ V}$ $I_D = 40\text{ A}$			232		nC
$Q_{gs}$	Gate-source charge				41		
$Q_{gd}$	Gate-drain charge				50		
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5/20\text{ V}$ $V_{Bus} = 600\text{ V}$ $I_D = 50\text{ A}$ $R_{Gon} = 8\text{ }\Omega$ $R_{Goff} = 4.7\text{ }\Omega$			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	$T_J = 150^\circ\text{C}$		0.99		mJ
$E_{off}$	Turn off energy	$V_{GS} = -5/20\text{ V}$ $V_{Bus} = 600\text{ V}$ $I_D = 50\text{ A}$ $R_{Gon} = 8\text{ }\Omega$ $R_{Goff} = 4.7\text{ }\Omega$	$T_J = 150^\circ\text{C}$		0.66		mJ
$R_{Gint}$	Internal gate resistance				0.88		$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance					0.38	$^\circ\text{C/W}$

The following table shows the body diode ratings and characteristics of MSC70SM120JCU3 device.

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

Symbol	Characteristics	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$V_{GS} = 0\text{ V}$ $I_{SD} = 40\text{ A}$		4		V
		$V_{GS} = -5\text{ V}$ $I_{SD} = 40\text{ A}$		4.2		
$t_{rr}$	Reverse recovery time	$I_{SD} = 40\text{ A}$ $V_{GS} = -5\text{ V}$ $V_R = 800\text{ V}$ $di_F/dt = 1000\text{ A}/\mu\text{s}$		90		ns
$Q_{rr}$	Reverse recovery charge			550		nC
$I_{rr}$	Reverse recovery current			13.5		A

### 3.2 SiC Chopper Diode Ratings and Characteristics

The following table shows the SiC chopper diode ratings and characteristics of MSC70SM120JCU3 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	$V_R = 1200\text{ V}$	$T_J = 25\text{ }^{\circ}\text{C}$		15	400	$\mu\text{A}$
			$T_J = 175\text{ }^{\circ}\text{C}$		250		
$I_F$	DC forward current		$T_C = 100\text{ }^{\circ}\text{C}$		50		A
$V_F$	Diode forward voltage	$I_F = 50\text{ A}$	$T_J = 25\text{ }^{\circ}\text{C}$		1.5	1.8	V
			$T_J = 175\text{ }^{\circ}\text{C}$		2.1		
$Q_C$	Total capacitive charge	$V_R = 600\text{ V}$			224		nC
C	Total capacitance	$f = 1\text{ MHz}, V_R = 400\text{ V}$			246		pF
		$f = 1\text{ MHz}, V_R = 800\text{ V}$			182		
$R_{thJC}$	Junction-to-case thermal resistance					0.56	$^{\circ}\text{C/W}$

### 3.3 Thermal and Package Characteristics

The following table shows the thermal and package characteristics of MSC70SM120JCU3 device.

**Table 6 • Thermal and Package Characteristics**

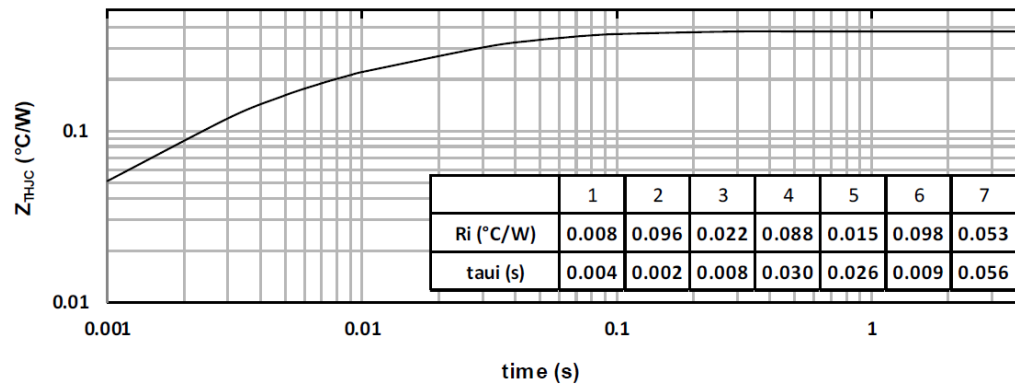
Symbol	Characteristics	Min	Typ	Max	Unit
$V_{ISOL}$	RMS isolation voltage, any terminal to case $t = 1\text{ min}$ , 50/60 Hz	2500			V
$T_{STG}$	Storage temperature range	-55		175	$^{\circ}\text{C}$
$T_J$	Operating junction temperature range	-55		175	
$T_{JOP}$	Recommended junction temperature under switching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



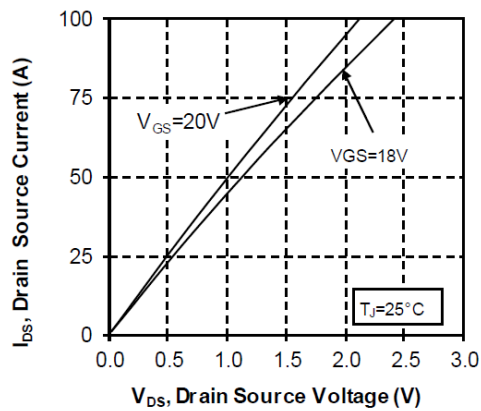
### 3.4 SiC MOSFET Performance Curves

The following images show the SiC MOSFET performance curves of the MSC70SM120JCU3 device.

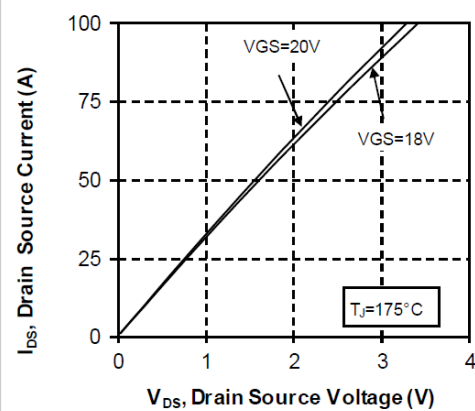
**Figure 3 • Maximum Thermal Impedance**



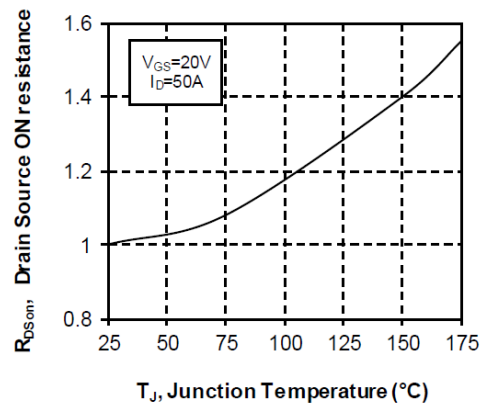
**Figure 4 • Output Characteristics,  $T_J=25^\circ\text{C}$**



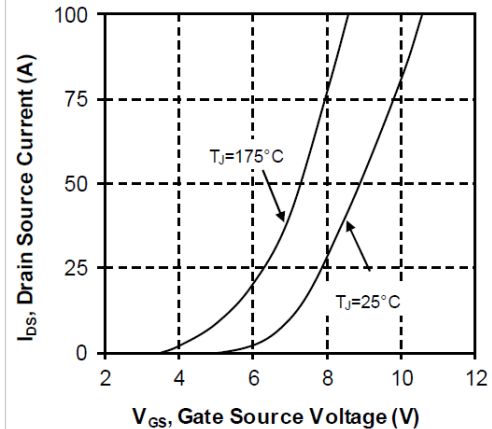
**Figure 5 • Output Characteristics,  $T_J=175^\circ\text{C}$**

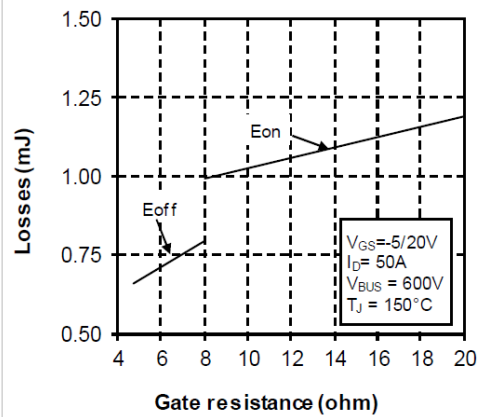
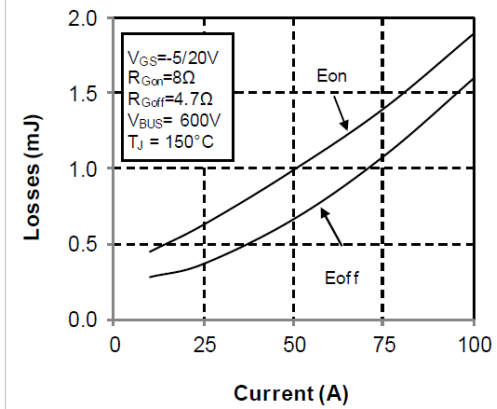
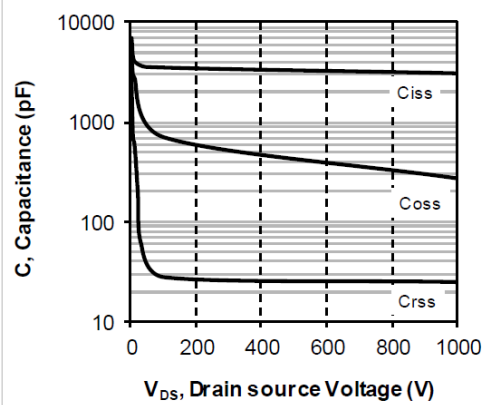
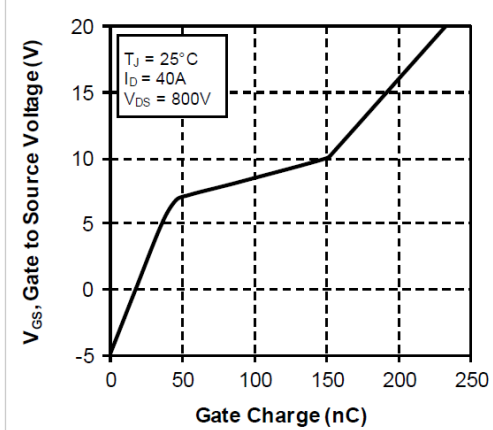
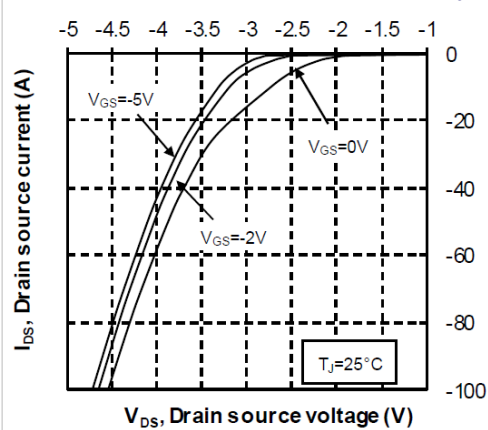
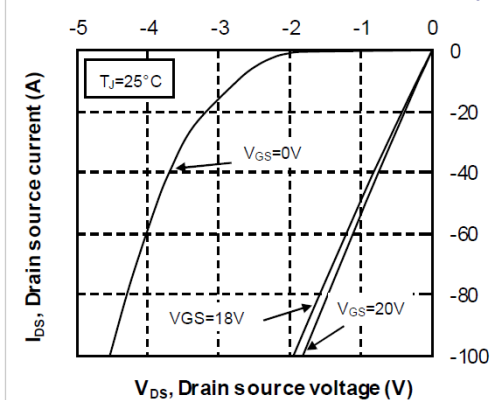


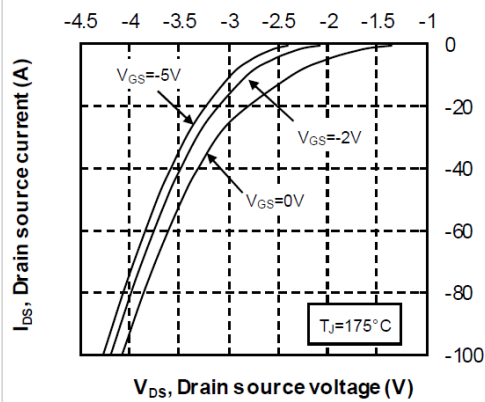
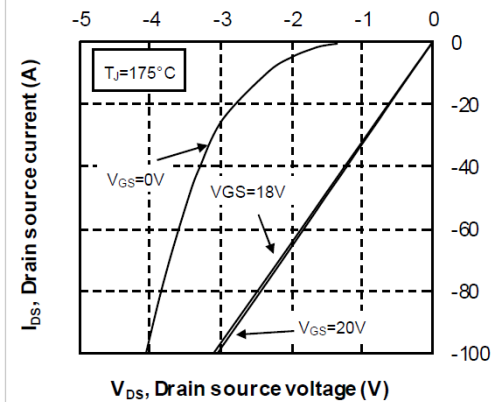
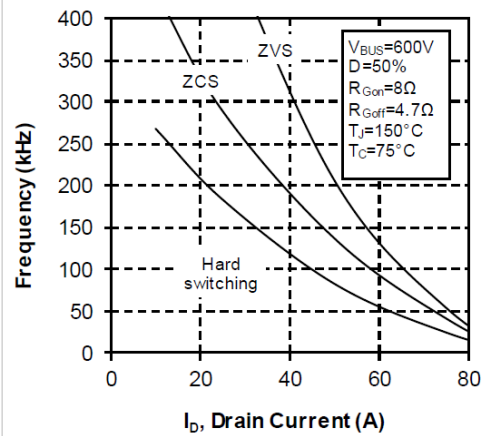
**Figure 6 • Normalized  $R_{DS(on)}$  vs. Temperature**



**Figure 7 • Transfer Characteristics**



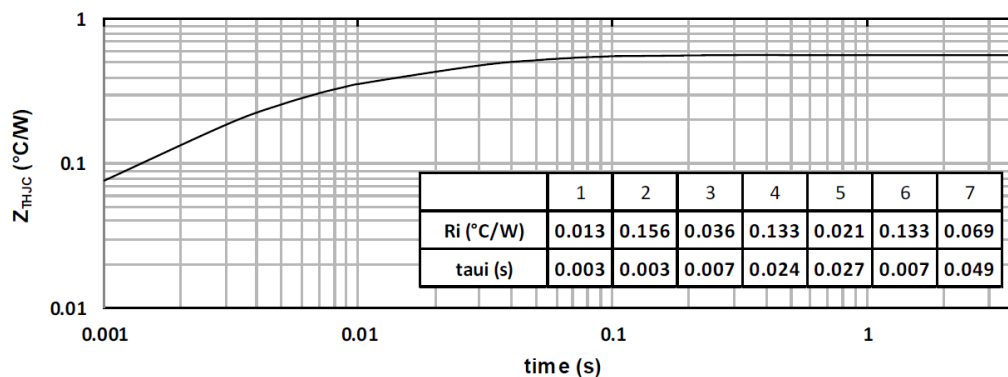
**Figure 8 • Switching Energy vs.  $R_g$** **Figure 9 • Switching Energy vs. Current****Figure 10 • Capacitance vs. Drain Source Voltage****Figure 11 • Gate Charge vs. Gate Source Voltage****Figure 12 • Body Diode Characteristics,  $T_J = 25^\circ C$** **Figure 13 • 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ C$** 

**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**

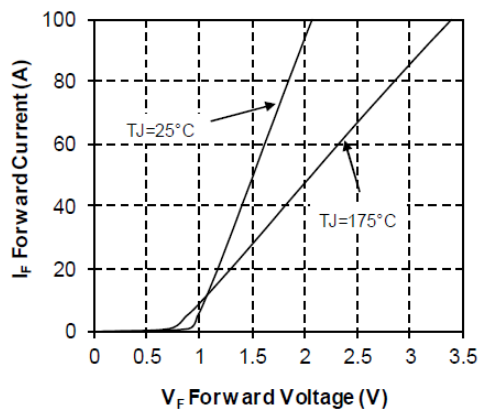
### 3.5 SiC Diode Performance Curves

The following images show the SiC diode performance curves of MSC70SM120JCU3 device.

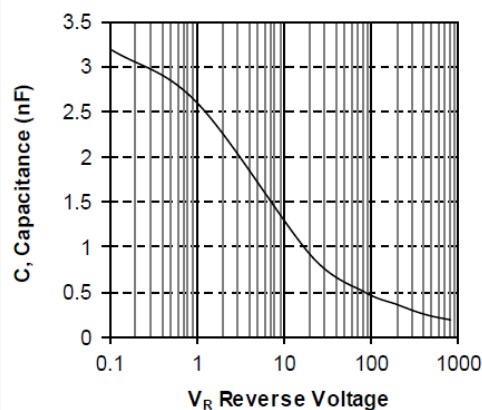
**Figure 17 • Maximum Thermal Impedance**



**Figure 18 • Forward Characteristics**



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



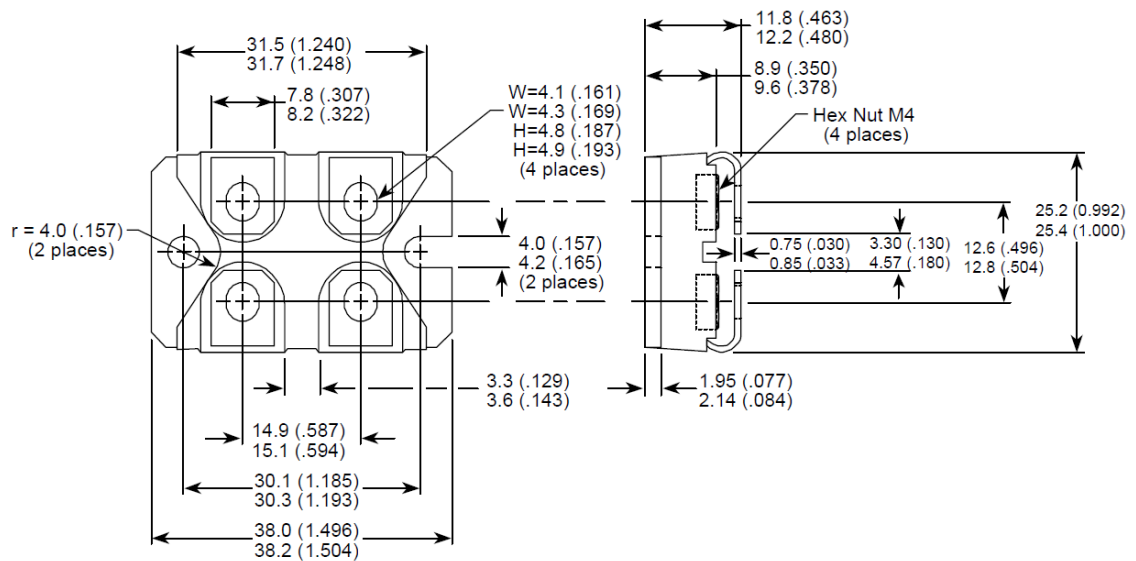
## 4 Package Specification

The following section shows the package specification of MSC70SM120JCU3 device.

### 4.1 Package Outline Drawing

The following image illustrates the package outline drawing of MSC70SM120JCU3 device. The dimensions are in millimeters and (inches).

**Figure 20 • Package Outline Drawing**



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