

MSC70SM120JCU3
Datasheet
Buck Chopper SiC MOSFET Power Module

January 2020



a  **MICROCHIP** company

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

Figure 1 • Electrical Schematic of MSC70SM120JCU3 Device

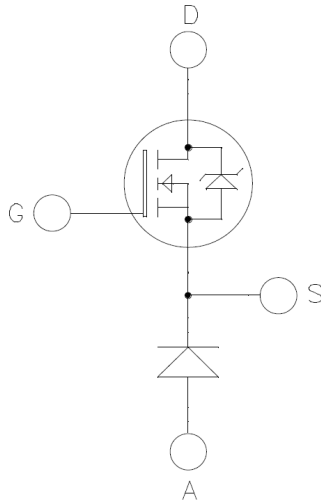
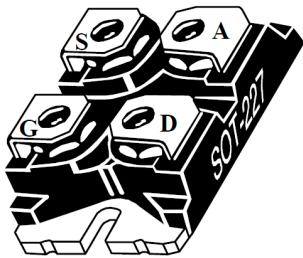


Figure 2 • SOT-227 Pinout Location



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 ¹ |
| | | $T_C = 80\text{ }^\circ\text{C}$ | 71 ¹ |
| I_{DM} | Pulsed drain current | 180 | |
| V_{GS} | Gate–source voltage | –10/25 | V |
| $R_{DS(on)}$ | Drain–source ON resistance | 31 | m Ω |
| P_D | Power dissipation | $T_C = 25\text{ }^\circ\text{C}$ | 395 |

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 | μA |
| $R_{DS(on)}$ | Drain–source on resistance | $V_{GS} = 20\text{ V}$ $I_D = 40\text{ A}$ | $T_C = 25\text{ }^\circ\text{C}$ | 25 | 31 | m Ω |
| | | | $T_C = 175\text{ }^\circ\text{C}$ | 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 | $V_{GS} = -5/20\text{ V}$ $V_{Bus} = 600\text{ V}$ $I_D = 50\text{ A}$ $R_{Gon} = 8\ \Omega$ $R_{Goff} = 4.7\ \Omega$ | | 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 $V_{GS} = -5/20\text{ V}$ $V_{Bus} = 600\text{ V}$ $I_D = 50\text{ A}$ $R_{Gon} = 8\ \Omega$ $R_{Goff} = 4.7\ \Omega$ | $T_J = 150^\circ\text{C}$ | 0.99 | | mJ |
| E_{off} | Turn off energy | | $T_J = 150^\circ\text{C}$ | 0.66 | | mJ |
| R_{Gint} | Internal gate resistance | | | 0.88 | | Ω |
| 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 | |

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 | $V_R = 1200\text{ V}$ | $T_J = 25\text{ °C}$ | 15 | 400 | μA |
| | | | $T_J = 175\text{ °C}$ | | 250 | |
| I_F | DC forward current | | | 50 | | A |
| V_F | Diode forward voltage | $I_F = 50\text{ A}$ | $T_J = 25\text{ °C}$ | 1.5 | 1.8 | V |
| | | | $T_J = 175\text{ °C}$ | | 2.1 | |
| Q_C | Total capacitive charge | $V_R = 600\text{ V}$ | | 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

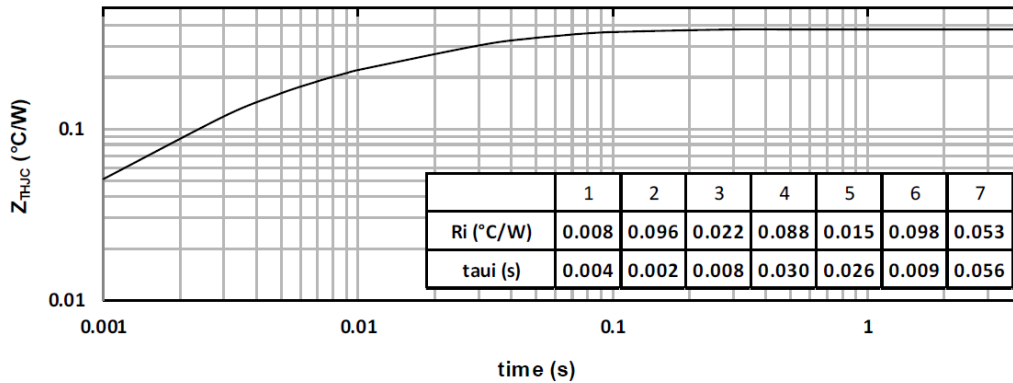


Figure 4 • Output Characteristics, T_J=25 °C

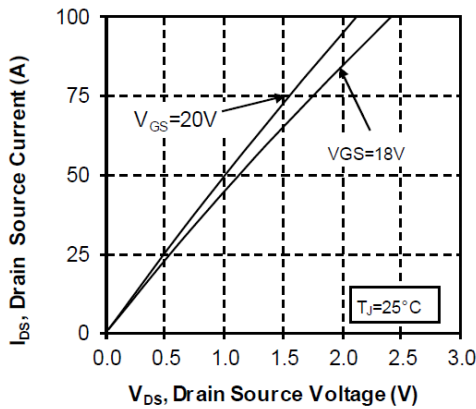


Figure 5 • Output Characteristics, T_J=175 °C

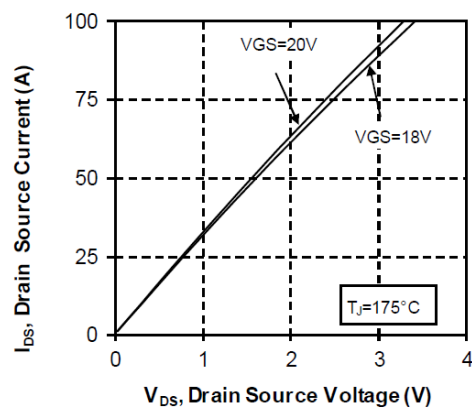


Figure 6 • Normalized R_{DS(on)} vs. Temperature

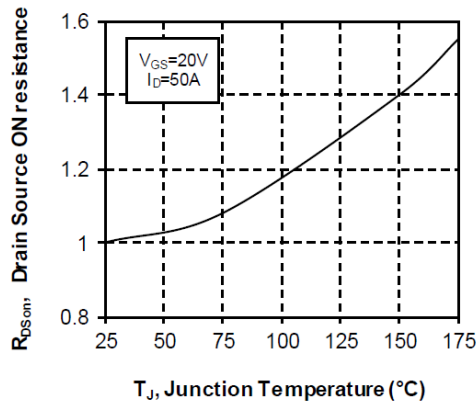


Figure 7 • Transfer Characteristics

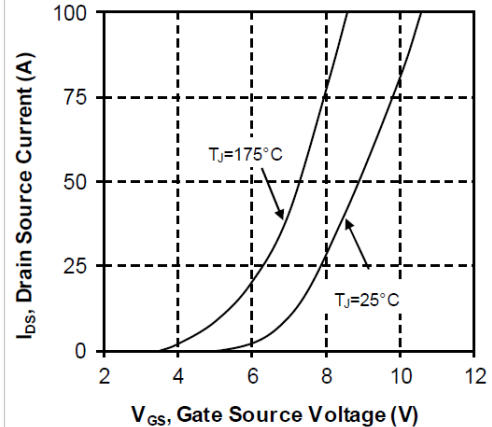


Figure 8 • Switching Energy vs. Rg

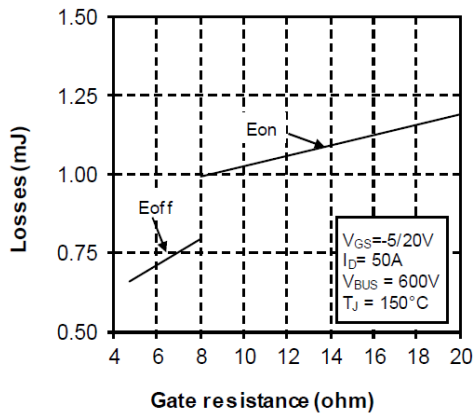


Figure 9 • Switching Energy vs. Current

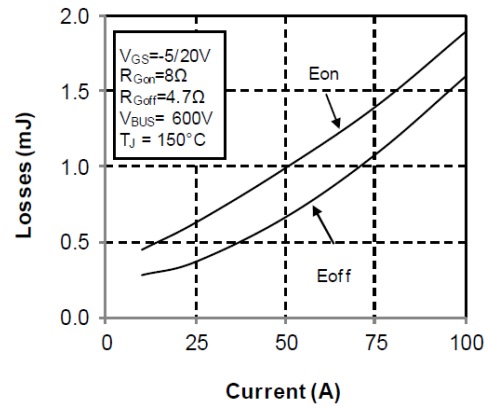


Figure 10 • Capacitance vs. Drain Source Voltage

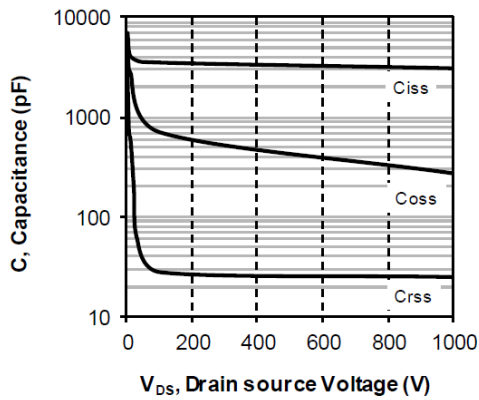


Figure 11 • Gate Charge vs. Gate Source Voltage

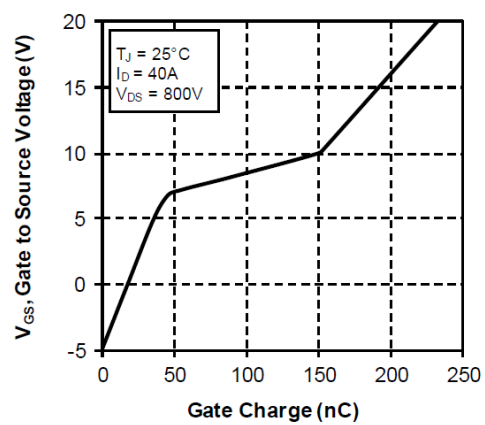


Figure 12 • Body Diode Characteristics, TJ=25 °C

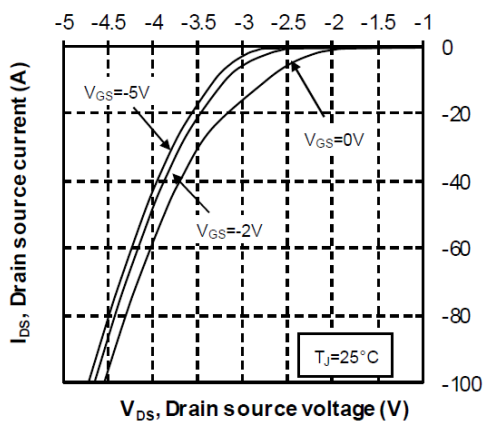


Figure 13 • 3rd Quadrant Characteristics, TJ=25 °C

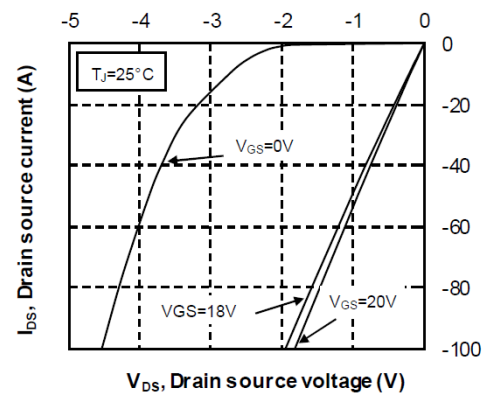


Figure 14 • Body Diode Characteristics, $T_J=175^\circ\text{C}$

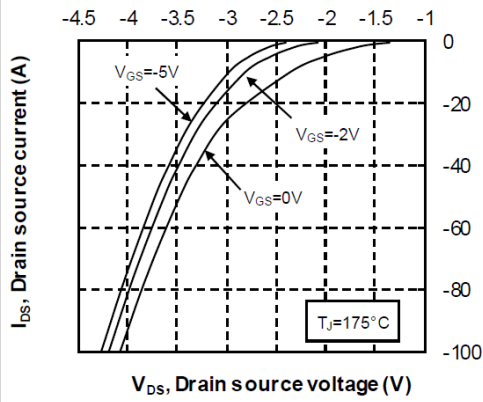


Figure 15 • 3rd Quadrant Characteristics, $T_J=175^\circ\text{C}$

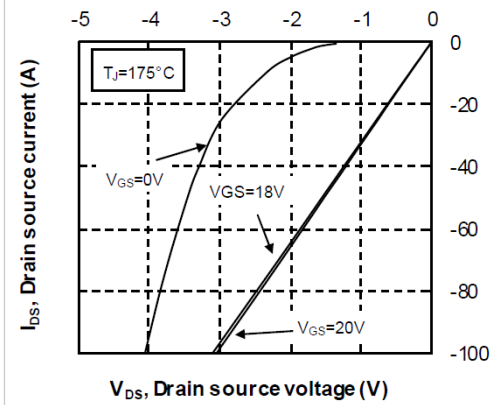
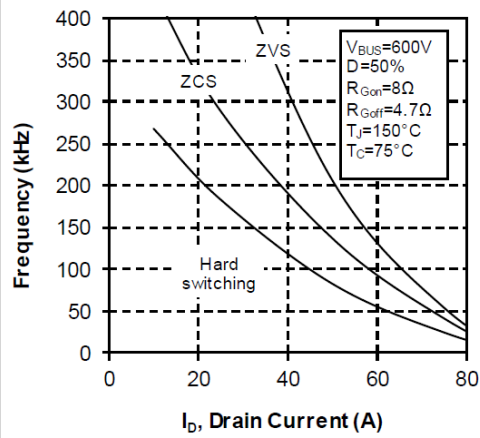


Figure 16 • Operating Frequency vs. Drain Current



3.5 SiC Diode Performance Curves

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

Figure 17 • Maximum Thermal Impedance

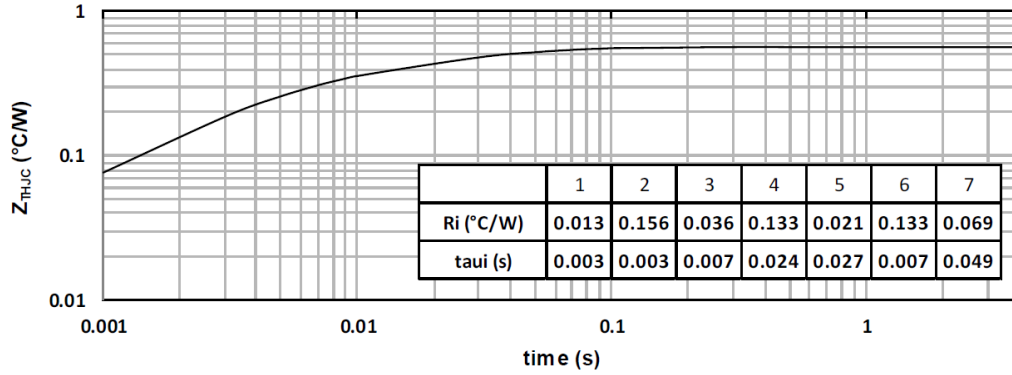


Figure 18 • Forward Characteristics

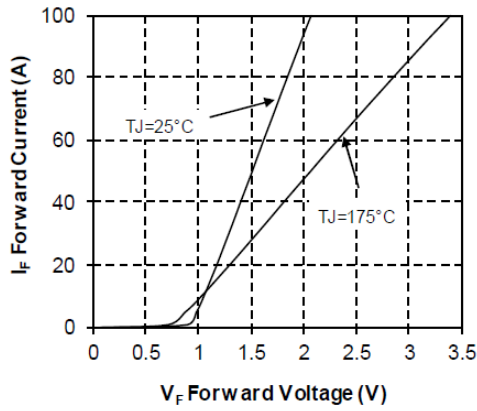
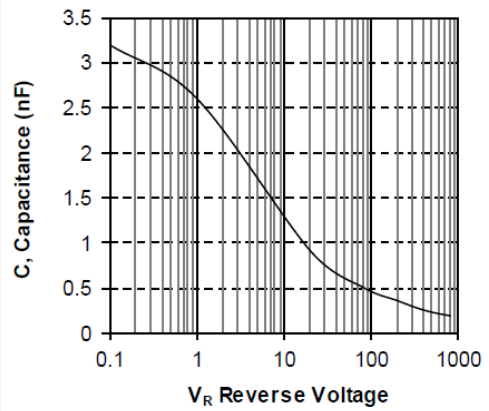


Figure 19 • Capacitance vs. Reverse Voltage



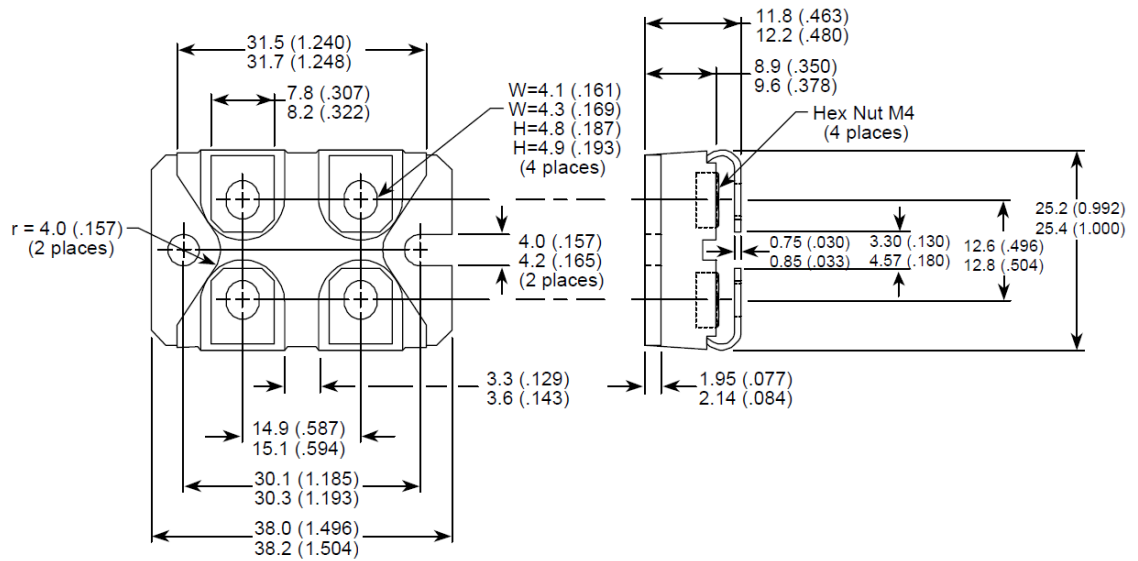
4 Package Specification

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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