MSC100SM70JCU3

Datasheet

Buck Chopper SiC MOSFET Power Module

April 2020

Microsemi

a Microchip company

Contents

1 Revision History

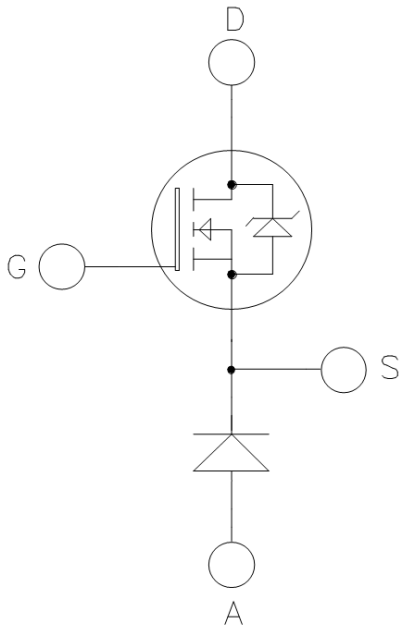
The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

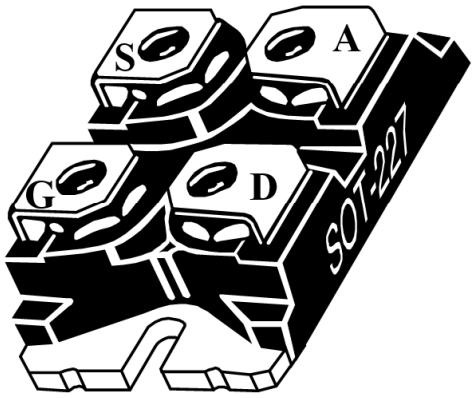
1.1 Revision 1.0

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

2 Product Overview

The MSC100SM70JCU3 device is a buck chopper 700 V, 124 A full Silicon Carbide (SiC) power module.





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 MSC100SM70JCU3 device:

- Silicon carbide (SiC) Schottky diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature-independent switching behavior
  - Positive temperature coefficient on VF
- SiC Power MOSFET
  - High-speed switching
  - Low $R_{DS(on)}$
  - Ultra low loss

2.2 Benefits

The following are benefits of the MSC100SM70JCU3 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 MSC100SM70JCU3 device is designed for the following applications:

- AC and DC motor control
- Switched mode power supplies

3 Electrical Specifications

This section provides the electrical specifications for the MSC100SM70JCU3 device.

3.1 SiC MOSFET Characteristics

The following table shows the absolute maximum ratings per SiC MOSFET of the MSC100SM70JCU3 device.

Table 1 • Absolute Maximum Ratings

Symbol	Parameter		Max Ratings	Unit
V_{DSS}	Drain-source voltage		700	V
I_D	Continuous drain current	Tc = 25 °C	124[1]	A
		Tc = 80 °C	98[1]	
I_{DM}	Pulsed drain current		250	
V_{GS}	Gate-source voltage		–10/25	V
R_{DSon}	Drain-source ON resistance		19	mΩ
P_D	Power dissipation	Tc = 25 °C	365	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 MSC100SM70JCU3 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} = 700 V				100	µA
$R_{DS(on)}$	Drain-source on resistance	V_{GS} = 20 V I_D = 40 A	T_J = 25 °C		15	19	mΩ
			T_J = 175 °C		18.8		
$V_{GS(th)}$	Gate-threshold voltage	V_{GS} = V_{DS}, I_D = 4 mA		1.9	2.4		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 MSC100SM70JCU3 device.

Table 3 • Dynamic Characteristics

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V V_{DS} = 700 V f = 1 MHz			4500		pF
C_{oss}	Output capacitance				510		
C_{rss}	Reverse transfer capacitance				29		
Q_g	Total gate charge	V_{GS}= –5/20 V V_{Bus} = 470 V I_D = 40 A			215		nC
Q_{gs}	Gate-source charge				58		
Q_{gd}	Gate-drain charge				35		
$T_{d(on)}$	Turn-on delay time	V_{GS} = –5/20 V V_{Bus} = 400 V I_D = 80 A T_J = 150 °C R_{GON} = 27 Ω R_{GOFF} = 4.7 Ω			40		ns
T_r	Rise time				35		
$T_{d(off)}$	Turn-off delay time				50		
T_f	Fall time				20		
E_{on}	Turn on energy	V_{GS} = –5/20 V V_{Bus} = 400 V I_D = 80 A R_{GON} = 27 Ω R_{GOFF} = 4.7 Ω	T_J = 150 °C		545		µJ
E_{off}	Turn off energy		T_J = 150 °C		186		µJ
R_{Gint}	Internal gate resistance				0.69		Ω
R_{thJC}	Junction-to-case thermal resistance					0.41	°C/W

The following table shows the body diode ratings and characteristics of MSC100SM70JCU3 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		3.4		V
		V_{GS} = –5 V ; I_{SD} = 40 A		3.8		
t_{rr}	Reverse recovery time	I_{SD} = 40 A V_{GS} = –5 V V_R = 400 V di_F/dt = 1000 A/µs		38		ns
Q_{rr}	Reverse recovery charge			318		nC
I_{rr}	Reverse recovery current			14.8		A

3.2 SiC Chopper Diode Ratings and Characteristics

The following table shows the SiC chopper diode ratings and characteristics of MSC100SM70JCU3 device.

Table 5 • SiC Schottky Diode Ratings and Characteristics

Symbol	Characteristics	Test Conditions		Min	Typ	Max	Unit
V_{RRM}	Peak repetitive reverse voltage					700	V
I_{RRM}	Reverse leakage current	V_R = 700 V	T_J = 25 °C		30	400	µA
			T_J = 175 °C		500		
I_F	DC forward current		T_C = 75 °C		60		A
V_F	Diode forward voltage	I_F = 60 A	T_J = 25 °C		1.5	1.8	V
			T_J = 175 °C		1.9		
Q_C	Total capacitive charge	V_R = 400 V			166		nC
C	Total capacitance	f = 1 MHz, V_R = 200 V			300		pF
		f = 1 MHz, V_R = 400 V			256		
R_{thJC}	Junction-to-case thermal resistance					0.742	°C/W

3.3 Thermal and Package Characteristics

The following table shows the thermal and package characteristics of MSC100SM70JCU3 device.

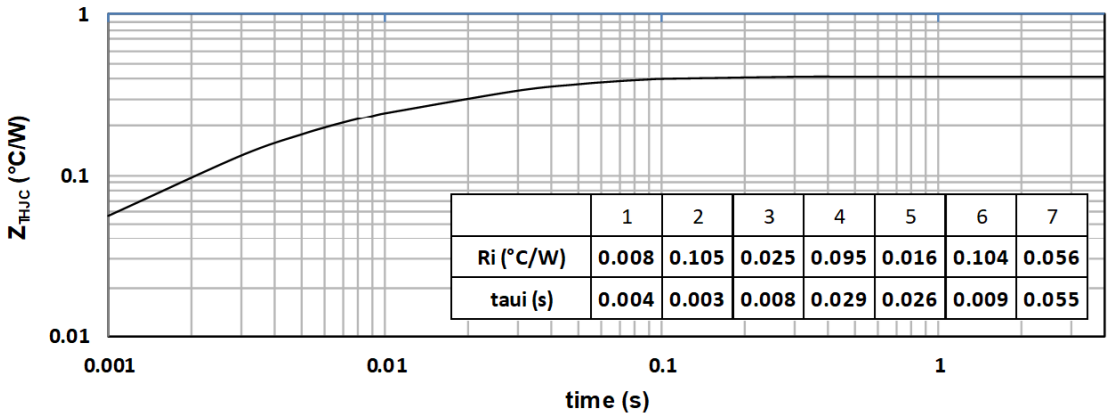
Table 6 • Thermal and Package Characteristics

Symbol	Characteristics	Min	Typ	Max	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t =1 min, 50 Hz/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

This section shows the typical SiC MOSFET performance curves of the MSC100SM70JCU3 device.

Figure 1 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.008	0.105	0.025	0.095	0.016	0.104	0.056
taui (s)	0.004	0.003	0.008	0.029	0.026	0.009	0.055

Figure 2 • Output Characteristics, T_J=25 °C

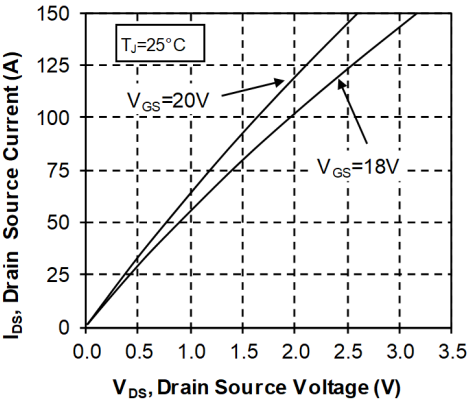


Figure 3 • Output Characteristics, T_J=175 °C

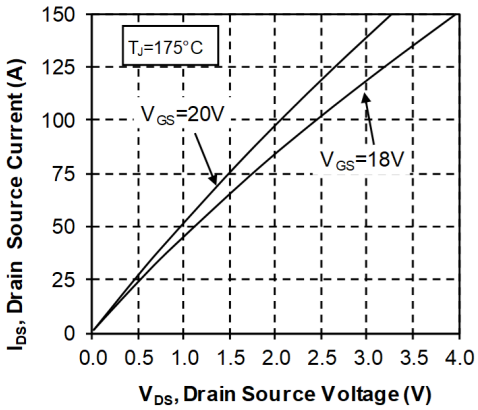


Figure 4 • Normalized $R_{DS(on)}$ vs. Temperature

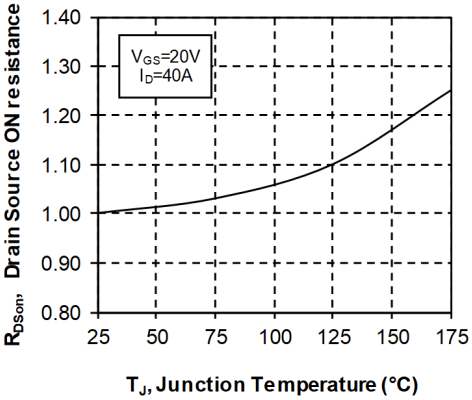


Figure 5 • Transfer Characteristics

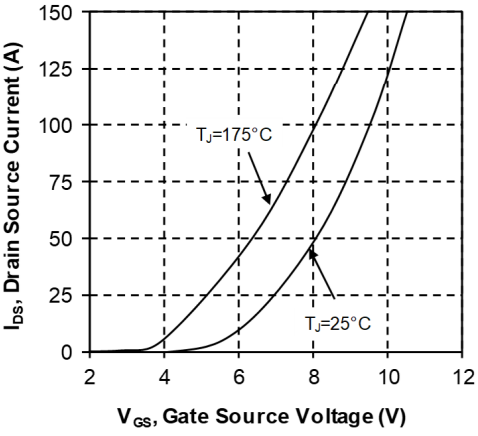


Figure 6 • Capacitance vs. Drain Source Voltage

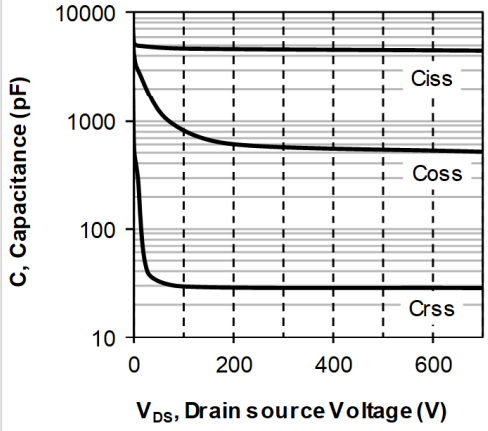


Figure 7 • Gate Charge vs. Gate Source Voltage

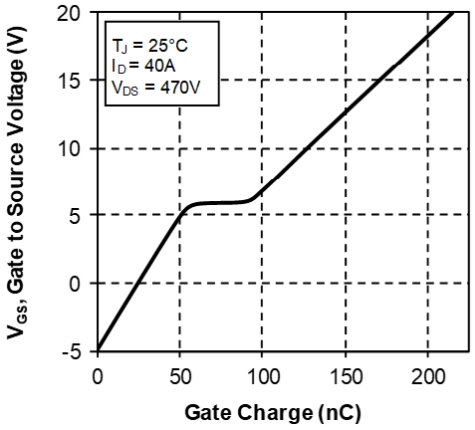


Figure 8 • Body Diode Characteristics, T_J=25 °C

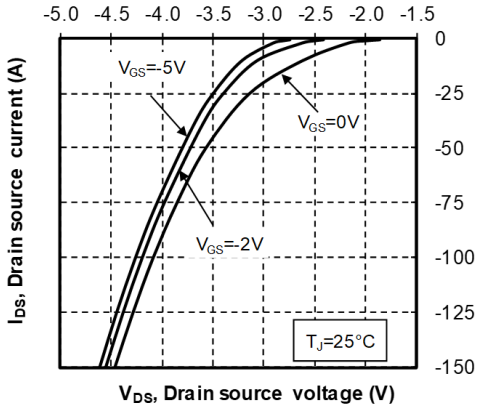


Figure 9 • 3rd Quadrant Characteristics, T_J=25 °C

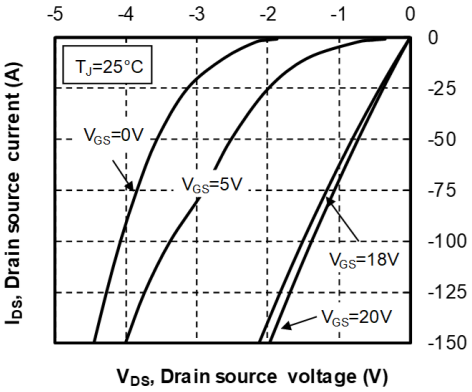


Figure 10 • Body Diode Characteristics, T_J=175 °C

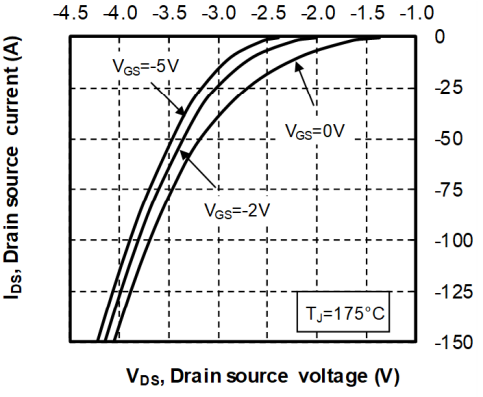


Figure 11 • 3rd Quadrant Characteristics, T_J=175 °C

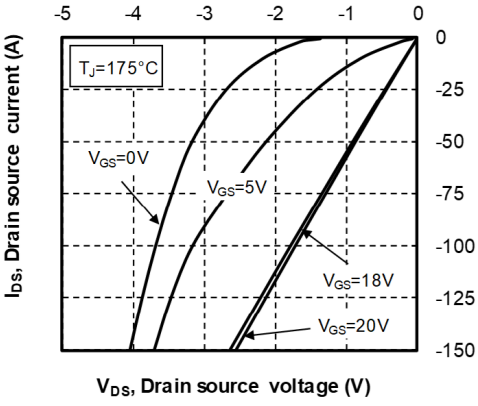


Figure 12 • Switching Energy vs. Current

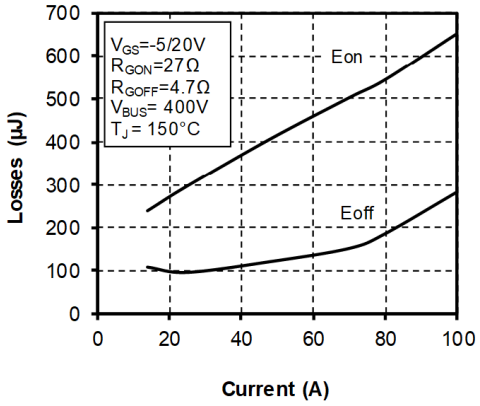


Figure 13 • Turn on Energy vs. Rg

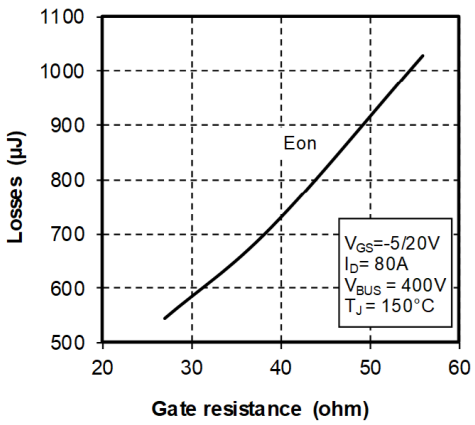


Figure 14 • Turn off Energy vs. Rg

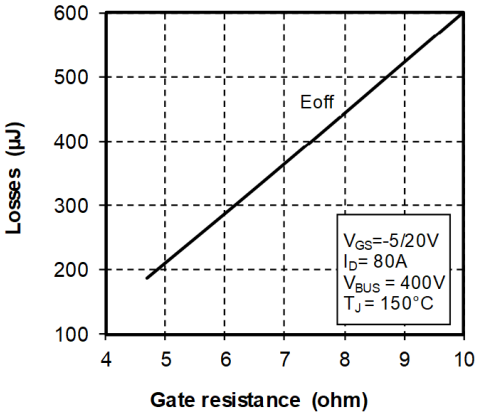
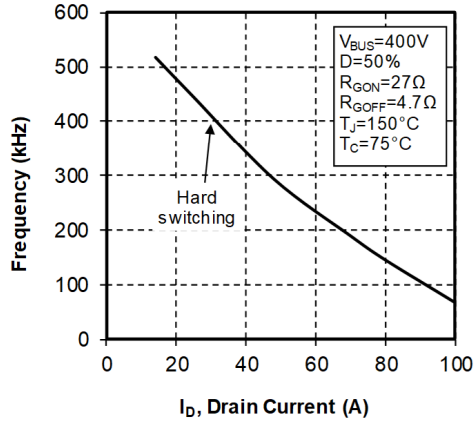


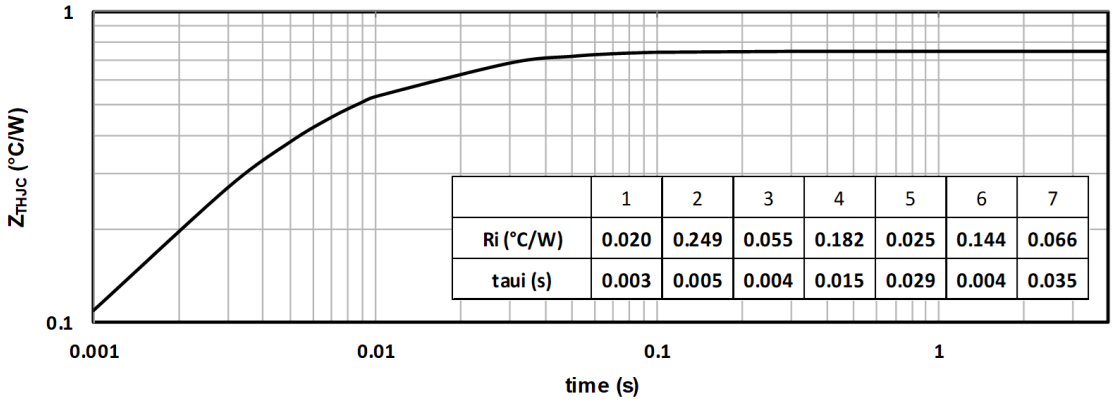
Figure 15 • Operating Frequency vs. Drain Current



3.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of MSC100SM70JCU3 device.

Figure 16 • Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.020	0.249	0.055	0.182	0.025	0.144	0.066
taui (s)	0.003	0.005	0.004	0.015	0.029	0.004	0.035

Figure 17 • Forward Characteristics

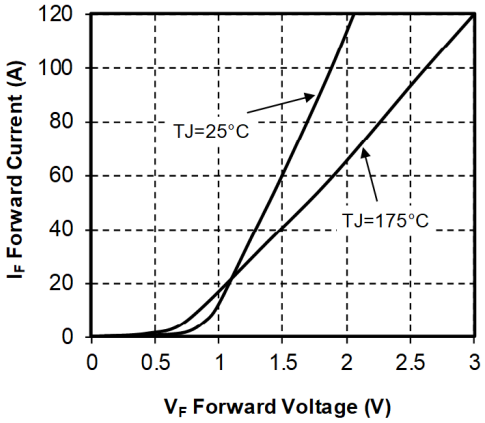
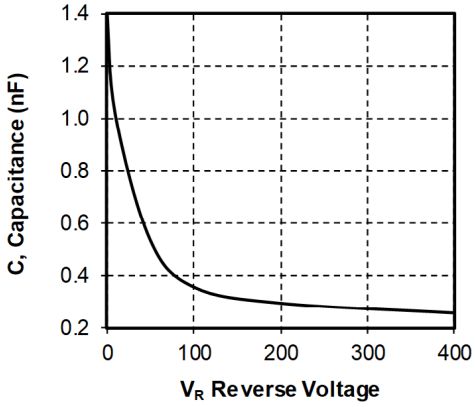


Figure 18 • Capacitance vs. Reverse Voltage



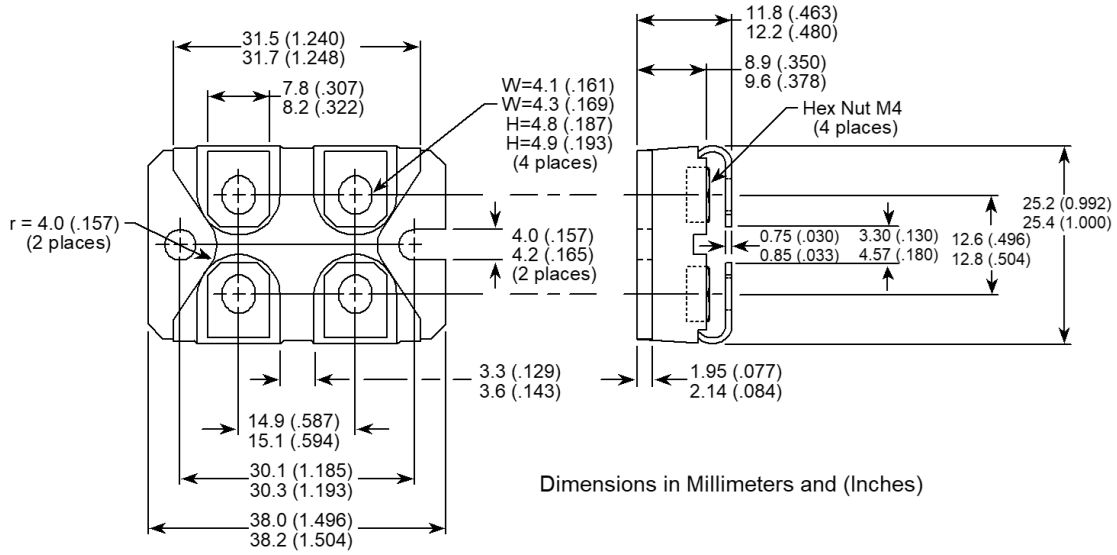
4 Package Specifications

The following section shows the package specification of MSC100SM70JCU3 device.

4.1 Package Outline Drawing

The following image illustrates the package outline drawing of MSC100SM70JCU3 device. The dimensions are in millimeters and (inches).

Figure 19 • Package Outline Drawing



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