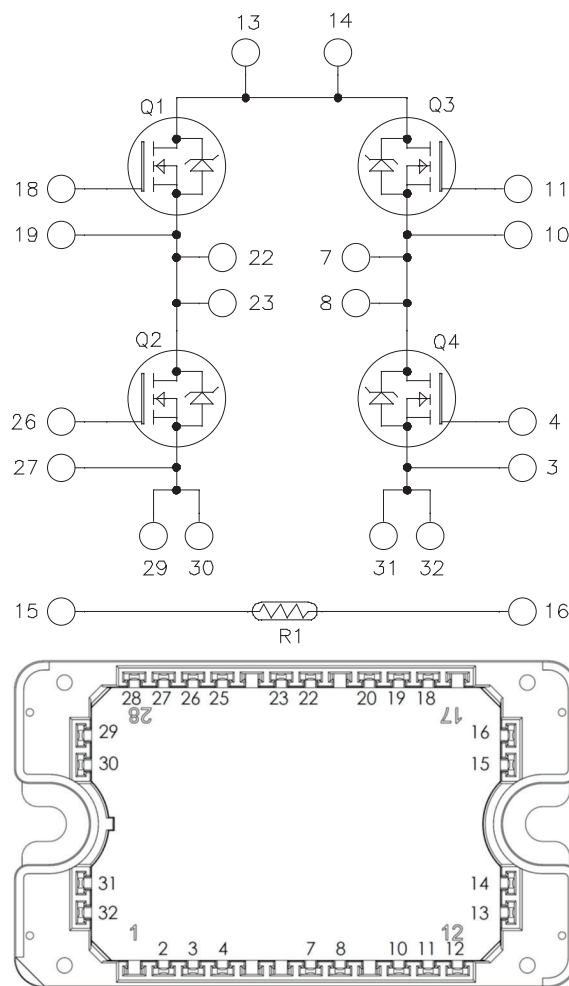


## Full Bridge SiC MOSFET Power Module

### Product Overview

The MSCSM120HM31T3AG device is a phase leg 1200V, 89A silicon carbide (SiC) MOSFET power module.



#### Notes:

- All multiple inputs and outputs must be shorted together. For example, 13/14, 29/30, 22/23, and so on.
- All ratings at  $T_j = 25\text{ }^\circ\text{C}$ , unless otherwise specified.



These devices are sensitive to electrostatic discharge. Proper handling procedures must be followed.

## Features

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The following are key features of the MSCSM120HM31T3AG device:

- SiC Power MOSFET
  - Low  $R_{DS(on)}$
  - High temperature performance
- Kelvin source for easy drive
- Very low stray inductance
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

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The following are the benefits of MSCSM120HM31T3AG device:

- High power and efficiency converters and inverters
- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Solderable terminals both for power and signal for easy PCB mounting
- Low profile
- RoHS compliant

## Application

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The MSCSM120HM31T3AG device is designed for the following applications:

- Welding converters
- Switched mode power supplies
- Uninterruptible power supplies
- EV motor and traction drive

## 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM120HM31T3AG device.

### 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120HM31T3AG device.

**Table 1-1. Absolute Maximum Ratings**

Symbol	Parameter	Maximum Ratings	Unit
$V_{DSS}$	Drain-Source voltage	1200	V
$I_D$	Continuous drain current	$T_C = 25\text{ }^\circ\text{C}$	89
		$T_C = 80\text{ }^\circ\text{C}$	71
$I_{DM}$	Pulsed drain current	180	
$V_{GS}$	Gate-Source voltage	-10/23	V
$R_{DS(on)}$	Drain-Source ON resistance	31	m $\Omega$
$P_D$	Power dissipation	$T_C = 25\text{ }^\circ\text{C}$	395

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120HM31T3AG device.

**Table 1-2. Electrical Characteristics**

Symbol	Characteristic	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	$V_{GS} = 20\text{V}$ $I_D = 40\text{A}$	$T_J = 25\text{ }^\circ\text{C}$	—	25	31	m $\Omega$
			$T_J = 175\text{ }^\circ\text{C}$	—	40	—	
$V_{GS(th)}$	Gate threshold voltage	$V_{GS} = V_{DS}$ $I_D = 3\text{ mA}$	1.8	2.8	—	V	
$I_{GSS}$	Gate-Source leakage current	$V_{GS} = 20\text{V}; V_{DS} = 0\text{V}$	—	—	150	nA	

# MSCSM120HM31T3AG

## Electrical Specifications

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120HM31T3AG device.

**Table 1-3. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0V$	—	3020	—	pF
$C_{oss}$	Output capacitance	$V_{DS} = 1000V$	—	270	—	
$C_{rss}$	Reverse transfer capacitance	$f = 1\text{ MHz}$	—	25	—	
$Q_g$	Total gate charge	$V_{GS} = -5V/20V$	—	232	—	nC
$Q_{gs}$	Gate-Source charge	$V_{Bus} = 800V$	—	41	—	
$Q_{gd}$	Gate-Drain charge	$I_D = 40A$	—	50	—	
$T_{d(on)}$	Turn-on delay time	$V_{GS} = -5V/20V$	—	30	—	ns
$T_r$	Rise time	$V_{Bus} = 800V$	—	30	—	
$T_{d(off)}$	Turn-off delay time	$I_D = 50A$	—	50	—	
$T_f$	Fall time	$R_{G(on)} = 8\Omega$ $R_{G(off)} = 4.7\Omega$	—	25	—	
$E_{on}$	Turn-on energy	$V_{GS} = -5V/20V$	—	1.2	—	mJ
$E_{off}$	Turn-off energy	$V_{Bus} = 600V$ $I_D = 50A$ $R_{G(on)} = 8\Omega$ $R_{G(off)} = 4.7\Omega$				
$R_{Gint}$	Internal gate resistance		—	0.88	—	$\Omega$
$R_{thJC}$	Junction-to-case thermal resistance		—	—	0.38	$^{\circ}C/W$

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120HM31T3AG device.

**Table 1-4. Body Diode Ratings and Characteristics**

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

### 1.2 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120HM31T3AG device.

**Table 1-5. Thermal and Package Characteristics**

Symbol	Characteristics	Min.	Max.	Unit		
V <sub>ISOL</sub>	RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/60 Hz	4000	—	V		
T <sub>J</sub>	Operating junction temperature range	−40	175	°C		
T <sub>JOP</sub>	Recommended junction temperature under switching conditions	−40	T <sub>Jmax</sub> −25			
T <sub>STG</sub>	Storage temperature range	−40	125			
T <sub>C</sub>	Operating case temperature	−40	125			
Torque	Mounting torque	To heatsink	M4	2	3	N.m
Wt	Package weight	—	110			g

The following table lists the temperature sensor NTC of the MSCSM120HM31T3AG device.

**Table 1-6. Temperature Sensor NTC**

Symbol	Characteristic	Min.	Typ.	Max.	Unit
R <sub>25</sub>	Resistance at 25 °C	—	50	—	kΩ
ΔR <sub>25</sub> /R <sub>25</sub>	—	—	5	—	%
B <sub>25/85</sub>	T <sub>25</sub> = 298.15K	—	3952	—	K
ΔB/B	—	T <sub>C</sub> = 100 °C	4	—	%

$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

T: Thermistor temperature  
R<sub>T</sub>: Thermistor value at T

**Note:** See [APT0406—Using NTC Temperature Sensor Integrated into Power Module](#) for more information.

### 1.3 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM120HM31T3AG device.

Figure 1-1. Maximum Thermal Impedance

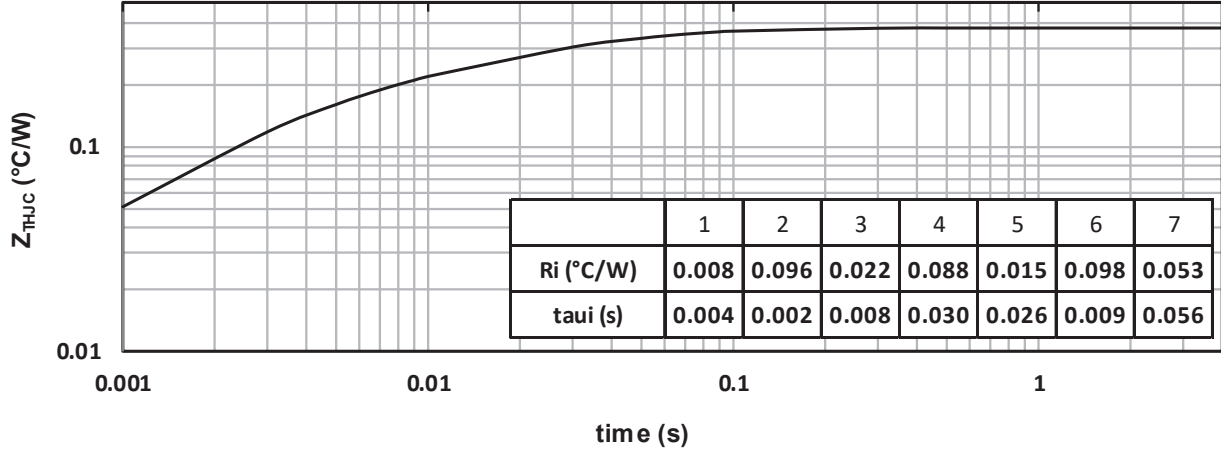


Figure 1-2. Output Characteristics,  $T_J = 25\text{ }^\circ\text{C}$

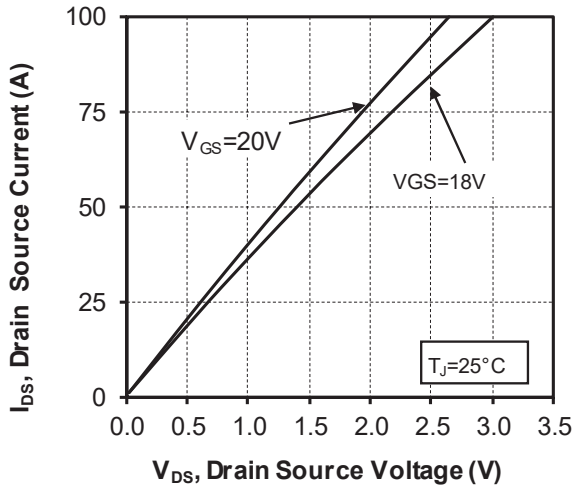
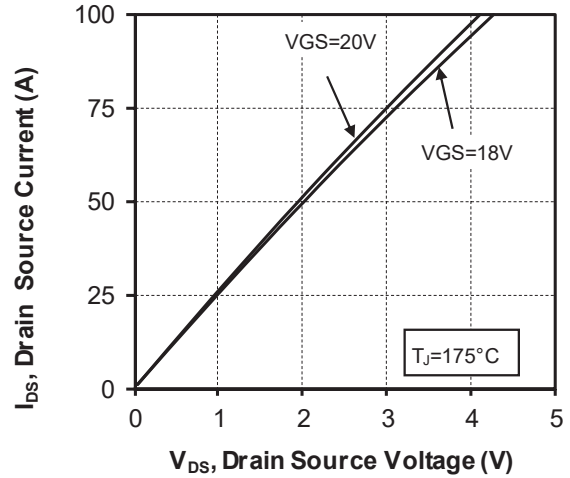
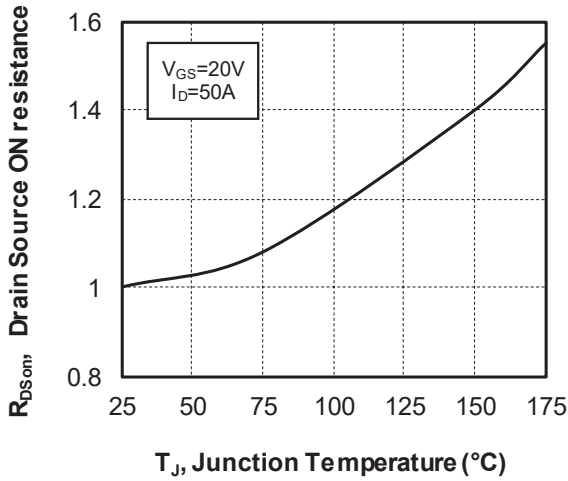


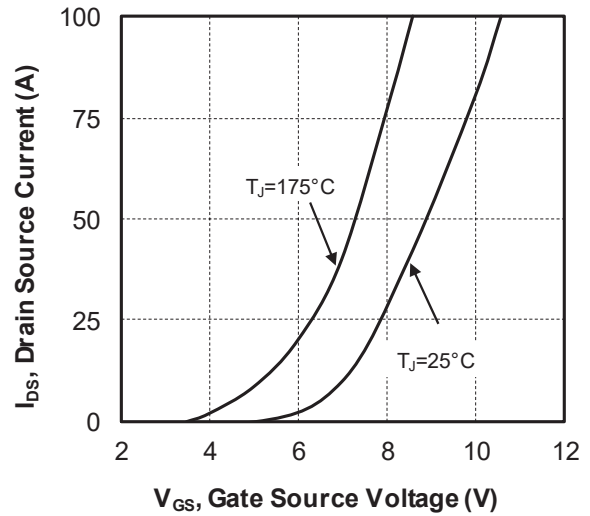
Figure 1-3. Output Characteristics,  $T_J = 175\text{ }^\circ\text{C}$



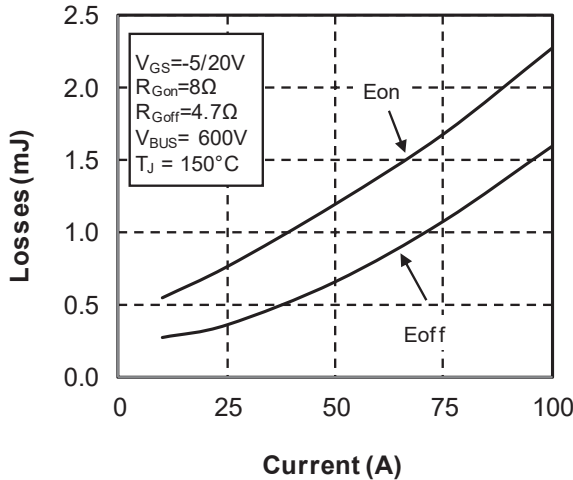
**Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature**



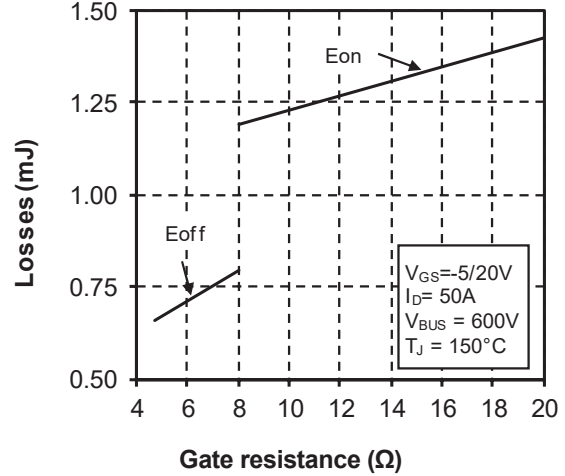
**Figure 1-5. Transfer Characteristics**



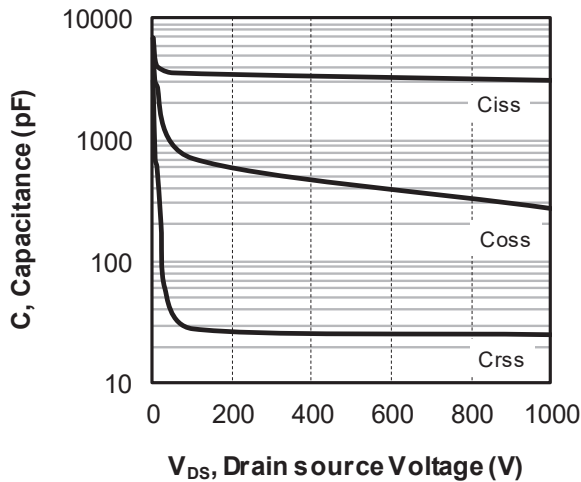
**Figure 1-6. Switching Energy vs. Current**



**Figure 1-7. Switching Energy vs.  $R_g$**



**Figure 1-8. Capacitance vs. Drain Source Voltage**



**Figure 1-9. Gate Charge vs. Gate Source Voltage**

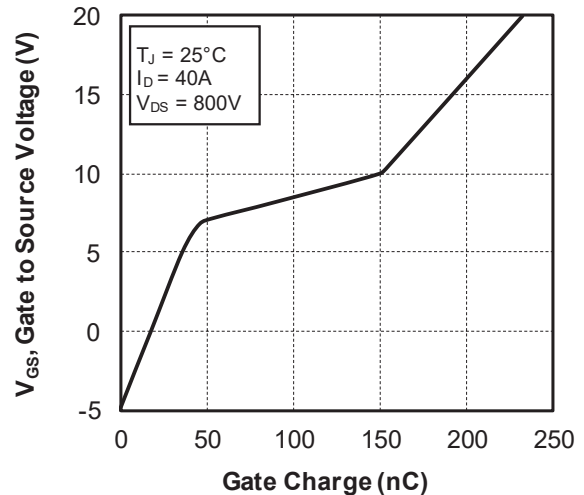


Figure 1-10. Body Diode Characteristics,  $T_J = 25\text{ }^\circ\text{C}$

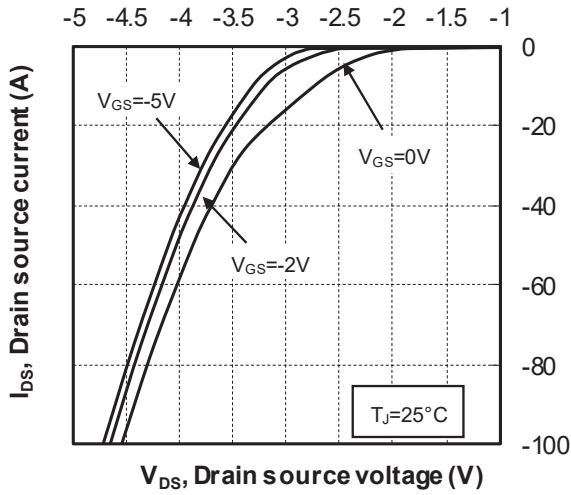


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25\text{ }^\circ\text{C}$

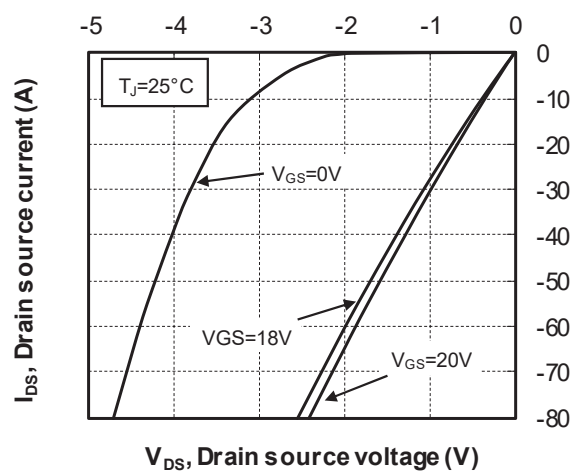


Figure 1-12. Body Diode Characteristics,  $T_J = 175\text{ }^\circ\text{C}$

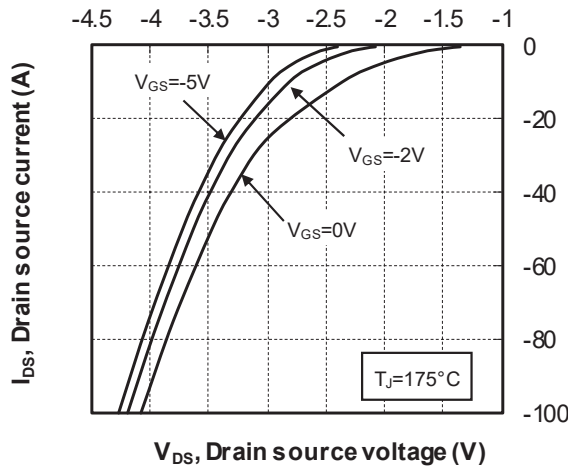


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175\text{ }^\circ\text{C}$

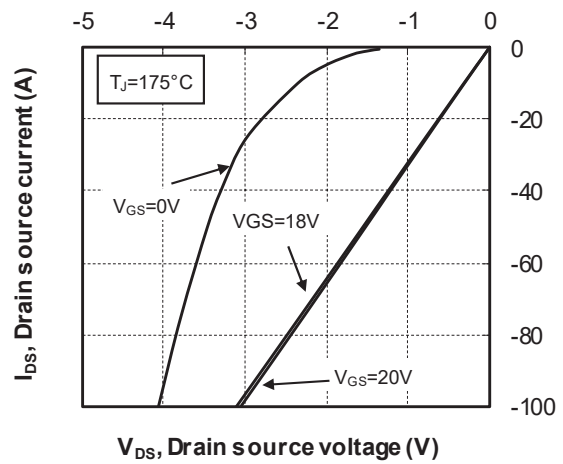
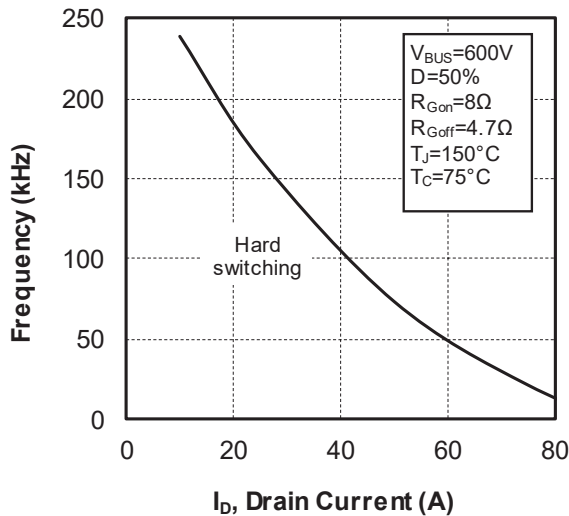


Figure 1-14. Operating Frequency vs. Drain Current





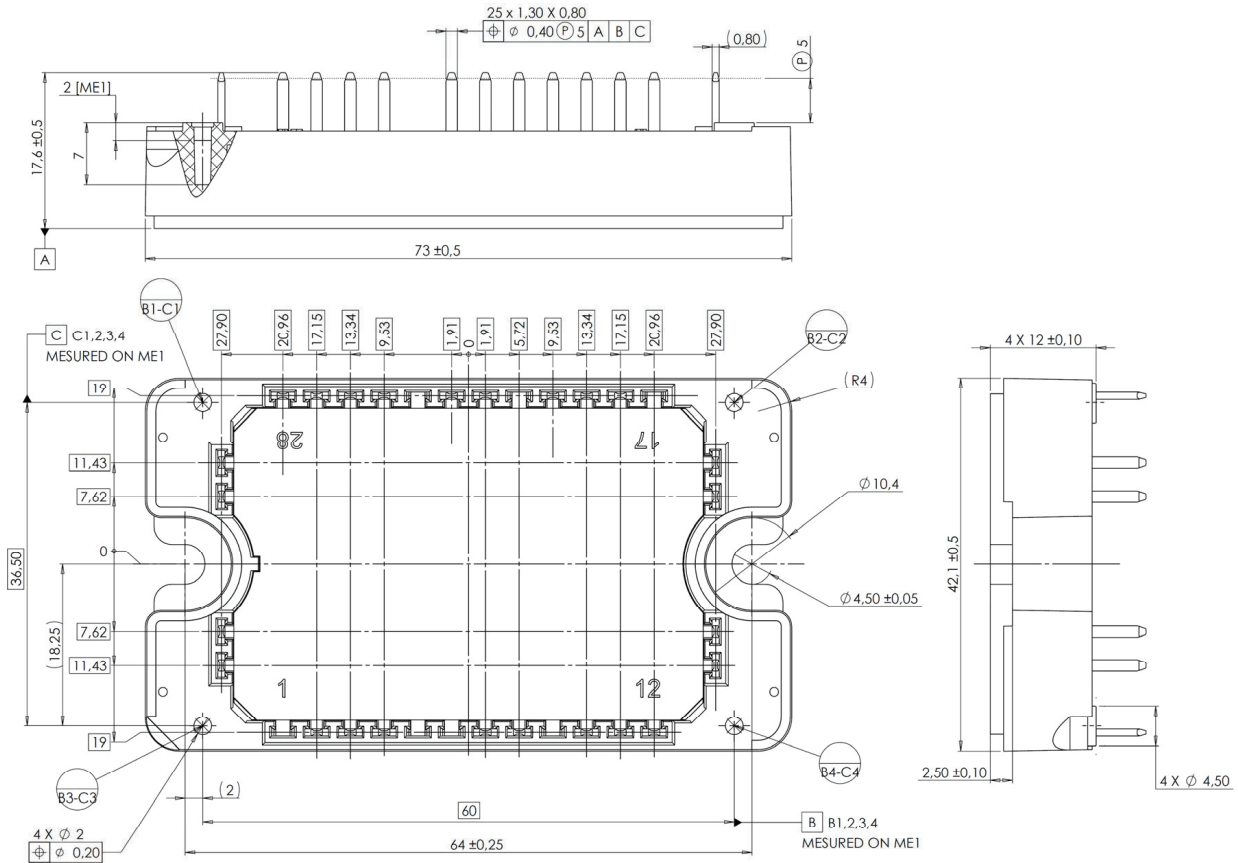
## 2. Package Specifications

The following section shows the package specification of the MSCSM120HM31T3AG device.

### 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120HM31T3AG device. The dimensions in the following figure are in millimeters.

**Figure 2-1. Package Outline Drawing**



**Note:** See [AN3500A—Mounting Instructions for SP1F and SP3F Power Modules](#) for more information.

### 3. Revision History

Revision	Date	Description
A	06/2022	Initial Release

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