

**MSCSM120DAM11CT3AG**  
**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.

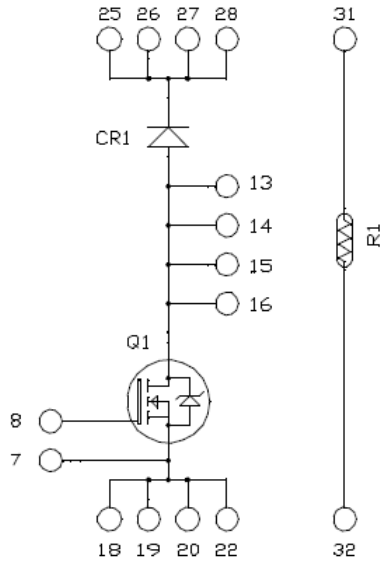
## 1.1 Revision 1.0

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

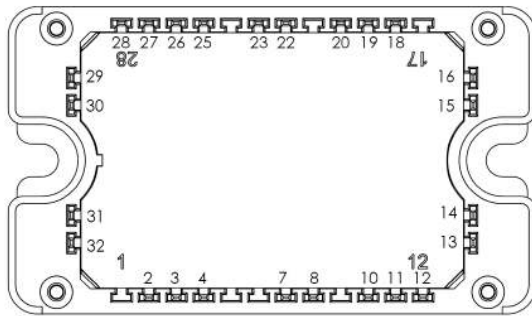
## 2 Product Overview

The MSCSM120DAM11CT3AG device is a boost chopper 1200 V/254 A full Silicon Carbide (SiC) power module.

**Figure 1 • MSCSM120DAM11CT3AG Electrical Schematic**



**Figure 2 • MSCSM120DAM11CT3AG Pinout Location**



Pins 25 to 28 must be shorted together  
 Pins 13 to 16 must be shorted together  
 Pins 18/19/20/22 must be shorted together

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 key features of the MSCSM120DAM11CT3AG device:

- SiC Power MOSFET
  - High speed switching
  - Low  $R_{DS(on)}$
  - Ultra low loss
- SiC Schottky Diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature Independent switching behavior
  - Positive temperature coefficient on VF
- Low stray inductance
- Kelvin source for easy drive
- Internal thermistor for temperature monitoring
- Aluminum nitride (AlN) substrate for improved thermal performance

## 2.2 Benefits

The following are benefits of the MSCSM120DAM11CT3AG device:

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

## 2.3 Applications

The MSCSM120DAM11CT3AG device is designed for the following applications:

- Induction heating and welding
- Solar inverter
- Uninterruptible power supplies

## 3 Electrical Specifications

This section shows the electrical specifications of the MSCSM120DAM11CT3AG device.

### 3.1 SiC MOSFET Characteristics (Per MOSFET)

The following table shows the absolute maximum ratings per MOSFET of the MSCSM120DAM11CT3AG device.

**Table 1 • Absolute Maximum Ratings**

| Symbol       | Parameter                  | Max Ratings                      | Unit             |
|--------------|----------------------------|----------------------------------|------------------|
| $V_{DSS}$    | Drain-source voltage       | 1200                             | V                |
| $I_D$        | Continuous drain current   | $T_C = 25\text{ }^\circ\text{C}$ | 254 <sup>1</sup> |
|              |                            | $T_C = 80\text{ }^\circ\text{C}$ | 202 <sup>1</sup> |
| $I_{DM}$     | Pulsed drain current       | 500                              |                  |
| $V_{GS}$     | Gate-source voltage        | -10/25                           | V                |
| $R_{DS(on)}$ | Drain-source ON resistance | 10.4                             | m $\Omega$       |
| $P_D$        | Power dissipation          | $T_C = 25\text{ }^\circ\text{C}$ | 1067             |

**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 per MOSFET of the MSCSM120DAM11CT3AG device.

**Table 2 • Electrical Characteristics**

| Symbol       | Characteristic                  | Test Conditions                                  | Min                               | Typ  | Max  | Unit          |
|--------------|---------------------------------|--|-----------------------------------|------|------|---------------|
| $I_{DSS}$    | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 1200\text{ V}$ |                                   | 30   | 300  | $\mu\text{A}$ |
| $R_{DS(on)}$ | Drain-source on resistance      | $V_{GS} = 20\text{ V}$<br>$I_D = 120\text{ A}$   | $T_J = 25\text{ }^\circ\text{C}$  | 8.4  | 10.4 | m $\Omega$    |
|              |                                 |  | $T_J = 175\text{ }^\circ\text{C}$ | 13.4 |      |               |
| $V_{GS(th)}$ | Gate threshold voltage          | $V_{GS} = V_{DS}$ , $I_D = 3\text{ mA}$          | 1.8                               | 2.8  |      | V             |
| $I_{GSS}$    | Gate-source leakage current     | $V_{GS} = 20\text{ V}$ , $V_{DS} = 0\text{ V}$   |                                   |      | 300  | nA            |

The following table shows the dynamic characteristics per MOSFET of the MSCSM120DAM11CT3AG device.

**Table 3 • Dynamic Characteristics**

| Symbol       | Characteristic                      | Test Conditions  | Min                               | Typ  | Max   | Unit                      |
|--------------|-------------------------------------|--|-----------------------------------|------|-------|---------------------------|
| $C_{iss}$    | Input capacitance                   | $V_{GS} = 0\text{ V}$<br>$V_{DS} = 1000\text{ V}$<br>$f = 1\text{ MHz}$  |                                   | 9060 |       | pF                        |
| $C_{oss}$    | Output capacitance                  |  |                                   | 810  |       |                           |
| $C_{rss}$    | Reverse transfer capacitance        |  |                                   | 75   |       |                           |
| $Q_g$        | Total gate charge                   | $V_{GS} = -5\text{ V}/20\text{ V}$<br>$V_{BUS} = 800\text{ V}$<br>$I_D = 120\text{ A}$   |                                   | 696  |       | nC                        |
| $Q_{gs}$     | Gate-source charge                  |  |                                   | 123  |       |                           |
| $Q_{gd}$     | Gate-drain charge                   |  |                                   | 150  |       |                           |
| $T_{d(on)}$  | Turn-on delay time                  | $V_{GS} = -5\text{ V}/20\text{ V}$<br>$V_{BUS} = 600\text{ V}$<br>$I_D = 150\text{ A}$<br>$R_{Gon} = 2.7\ \Omega$ ; $R_{Goff} = 1.6\ \Omega$ |                                   | 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<br>$V_{GS} = -5\text{ V}/20\text{ V}$  | $T_j = 150\text{ }^\circ\text{C}$ | 3.0  |       | mJ                        |
| $E_{off}$    | Turn off energy                     | $V_{BUS} = 600\text{ V}$<br>$I_D = 150\text{ A}$<br>$R_{Gon} = 2.7\ \Omega$<br>$R_{Goff} = 1.6\ \Omega$                                      | $T_j = 150\text{ }^\circ\text{C}$ | 2.0  |       | mJ                        |
| $R_{Gint}$   | Internal gate resistance            |  |                                   | 2.0  |       | $\Omega$                  |
| $R_{thJC}$   | Junction-to-case thermal resistance |  |                                   |      | 0.141 | $^\circ\text{C}/\text{W}$ |

The following table shows the body diode ratings and characteristics per MOSFET of the MSCSM120DAM11CT3AG device.

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

| Symbol   | Characteristic           | Test Conditions   | Min | Typ  | Max  | Unit |
|----------|--------------------------|---|-----|------|------|------|
| $V_{SD}$ | Diode forward voltage    | $V_{GS} = 0\text{ V}$ ; $I_{SD} = 120\text{ A}$   |     | 4.0  |      | V    |
|          |                          | $V_{GS} = -5\text{ V}$ ; $I_{SD} = 120\text{ A}$  |     | 4.2  |      |      |
| $t_{rr}$ | Reverse recovery time    | $I_{SD} = 120\text{ A}$ ; $V_{GS} = -5\text{ V}$<br>$V_R = 800\text{ V}$ ; $d_i/dt = 3000\text{ A}/\mu\text{s}$ |     | 90   |      | ns   |
| $Q_{rr}$ | Reverse recovery charge  |   |     | 1650 |      | nC   |
| $I_{rr}$ | Reverse recovery current |   |     |      | 40.5 |      |

### 3.2 SiC Schottky Diode Ratings and Characteristics

The following table shows the SiC Schottky diode ratings and characteristics of the MSCSM120DAM11CT3AG device.

**Table 5 • SiC Schottky Diode Ratings and Characteristics**

| Symbol     | Characteristic                      | Test Conditions                        |                       | Min | Typ  | Max   | Unit                 |
|------------|-------------------------------------|--|-----------------------|-----|------|-------|----------------------|
| $V_{RRM}$  | Peak repetitive reverse voltage     |  |                       |     |      | 1200  | V                    |
| $I_{RM}$   | Reverse leakage current             | $V_R = 1200\text{ V}$                  | $T_J = 25\text{ °C}$  | 60  | 1200 |       | $\mu\text{A}$        |
|            |                                     |  | $T_J = 175\text{ °C}$ | 900 |      |       |                      |
| $I_F$      | DC forward current                  |  |                       |     | 180  |       | A                    |
| $V_F$      | Diode forward voltage               | $I_F = 180\text{ A}$                   | $T_J = 25\text{ °C}$  | 1.5 | 1.8  |       | V                    |
|            |                                     |  | $T_J = 175\text{ °C}$ | 2.1 |      |       |                      |
| QC         | Total capacitive charge             | $V_R = 600\text{ V}$                   |                       |     | 780  |       | nC                   |
| C          | Total capacitance                   | $f = 1\text{ MHz}, V_R = 400\text{ V}$ |                       |     | 846  |       | $\text{pF}$          |
|            |                                     | $f = 1\text{ MHz}, V_R = 800\text{ V}$ |                       |     | 630  |       |                      |
| $R_{thJC}$ | Junction-to-case thermal resistance |  |                       |     |      | 0.175 | $^{\circ}\text{C/W}$ |

### 3.3 Thermal and Package Characteristics

The following table shows the package characteristics of the MSCSM120DAM11CT3AG device.

**Table 6 • Package Characteristics**

| Symbol     | Characteristic   |             |    | Min  | Max             | Unit               |
|------------|--|-------------|----|------|-----------------|--------------------|
| $V_{ISOL}$ | RMS isolation voltage, any terminal to case $t = 1\text{ min}$ , 50 Hz/60 Hz |             |    | 4000 |                 | V                  |
| $T_J$      | Operating junction temperature range   |             |    | -40  | 175             | $^{\circ}\text{C}$ |
| $T_{JOP}$  | Recommended junction temperature under switching conditions                  |             |    | -40  | $T_{Jmax} - 25$ |                    |
| $T_{STG}$  | Storage temperature range  |             |    | -40  | 125             |                    |
| $T_C$      | Operating case temperature   |             |    | -40  | 125             |                    |
| Torque     | Mounting torque  | To heatsink | M4 | 2    | 3               | N.m                |
| Wt         | Package weight   |             |    |      | 110             | g                  |



The following table shows the temperature sensor NTC (see application note [APT0406](#) on [www.microsemi.com](http://www.microsemi.com)) of the MSCSM120DAM11CT3AG device.

**Table 7 • 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> = 298.15 K |     | 3952 |     | K                       |
| ΔB/B                              |                            |     | 4    |     | %                       |
|                                   |                            |     |      |     | T <sub>C</sub> = 100 °C |

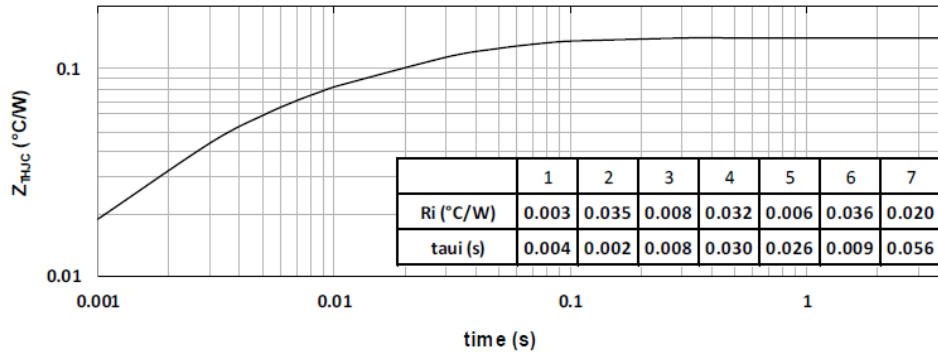
$$R_T = \frac{R_{25}}{\exp\left[B_{25/85}\left(\frac{1}{T_{25}} - \frac{1}{T}\right)\right]}$$

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

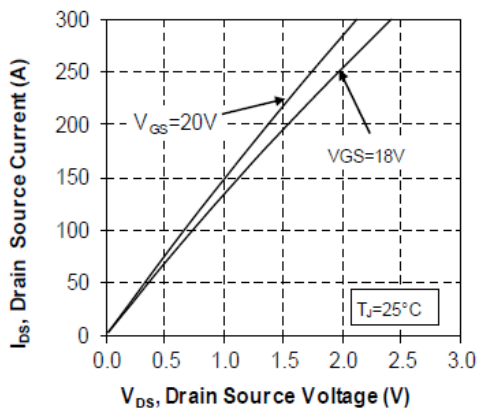
### 3.4 Typical SiC MOSFET Performance Curves

This section shows the typical SiC MOSFET performance curves of the MSCSM120DAM11CT3AG device.

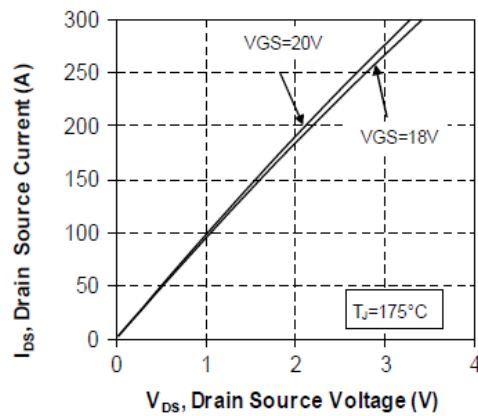
**Figure 3 • Maximum Thermal Impedance**



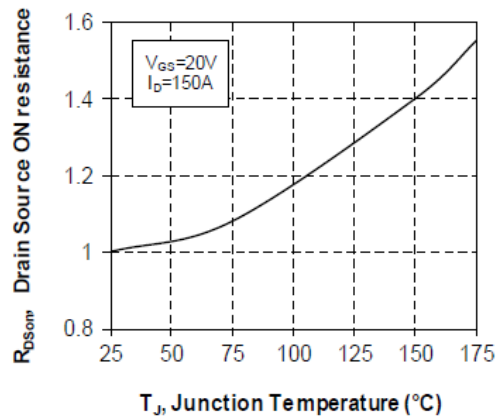
**Figure 4 • Output Characteristics, T<sub>J</sub> = 25 °C**



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



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



**Figure 7 • Transfer Characteristics**

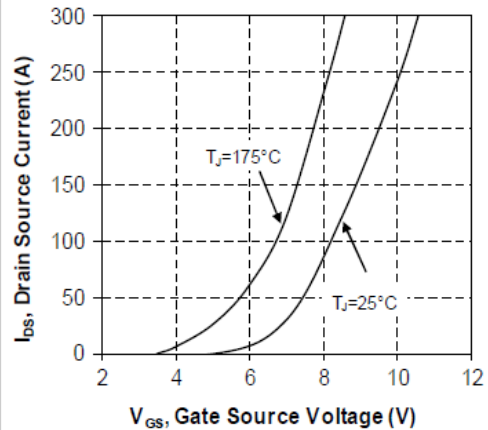


Figure 8 • Switching Energy vs. Rg

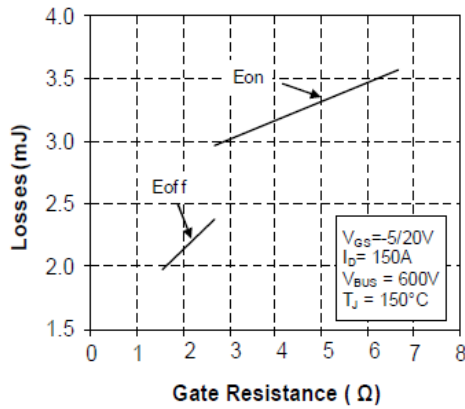


Figure 9 • Switching Energy vs. Current

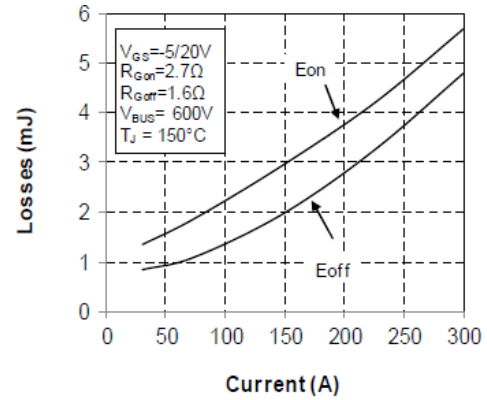


Figure 10 • Capacitance vs. Drain Source Voltage

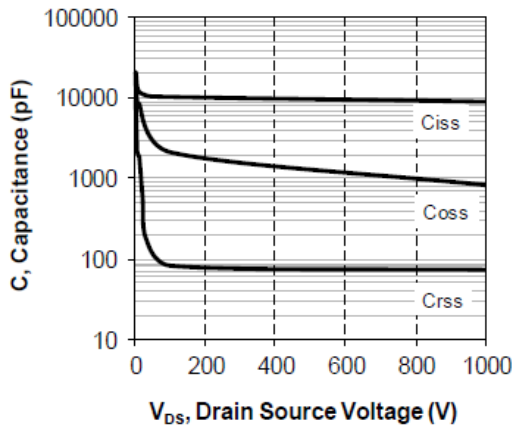


Figure 11 • Gate Charge vs. Gate Source Voltage

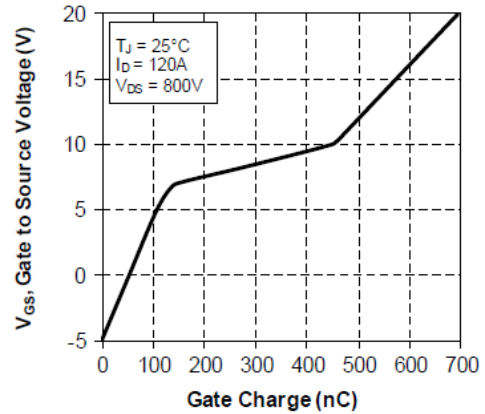


Figure 12 • Body Diode Characteristics, Tj = 25 °C

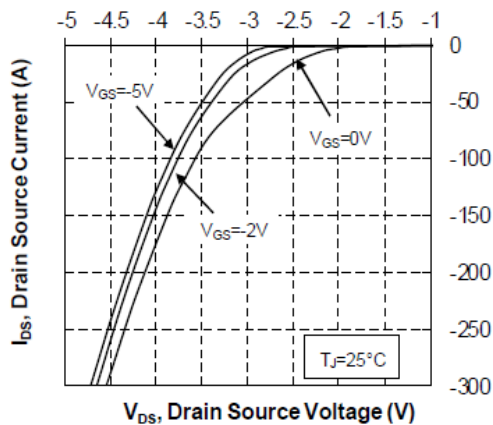
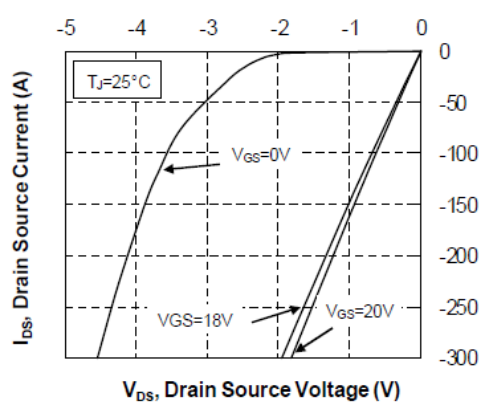
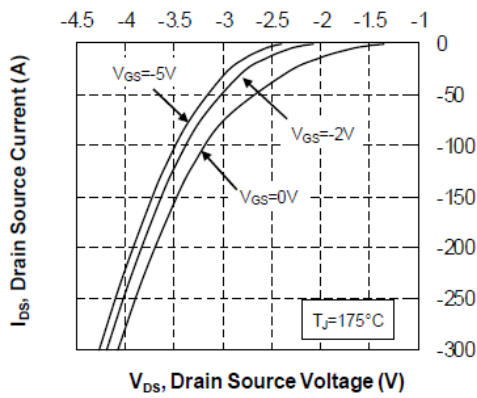


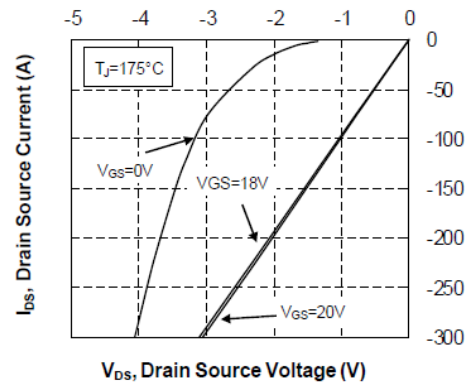
Figure 13 • 3<sup>rd</sup> Quadrant Characteristics, Tj = 25 °C



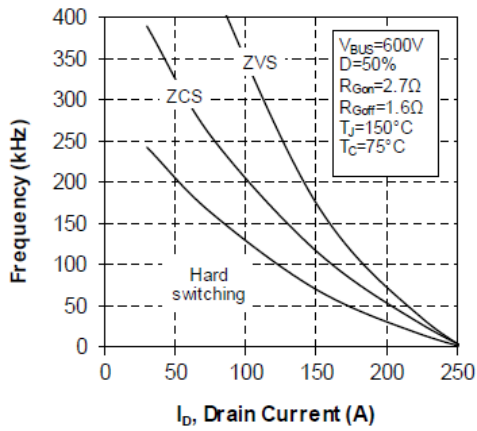
**Figure 14 • Body Diode Characteristics,  $T_J = 175^\circ\text{C}$**



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



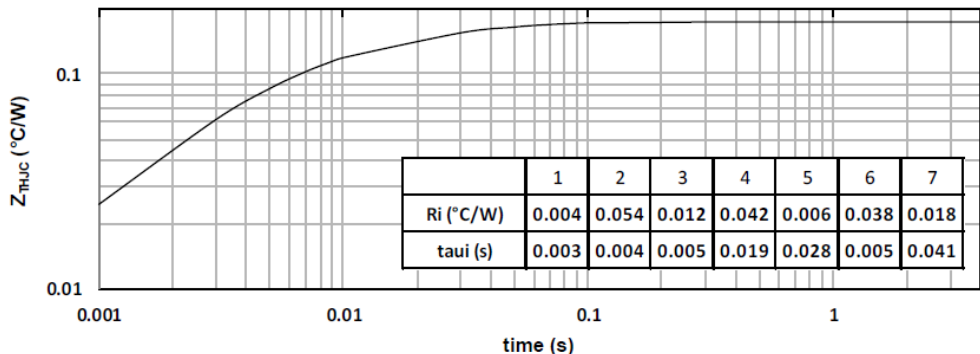
**Figure 16 • Operating Frequency vs. Drain Current**



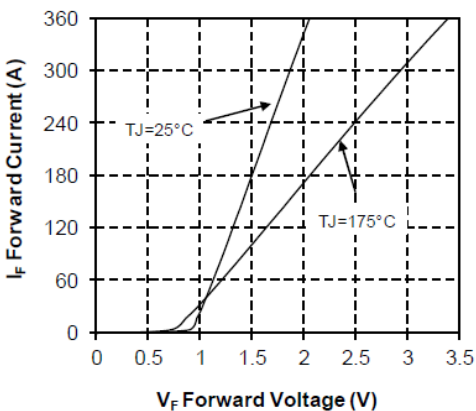
### 3.5 Typical SiC Diode Performance Curves

This sections shows the typical SiC diode performance curves of the MSCSM120DAM11CT3AG device.

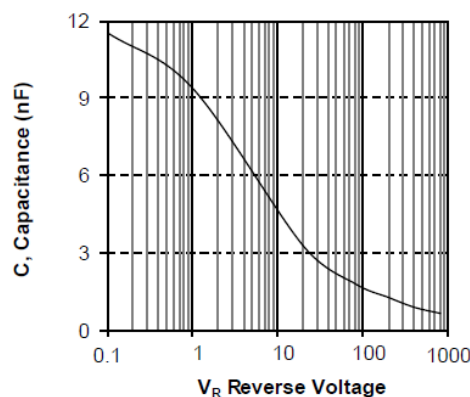
**Figure 17 • Maximum Thermal Impedance**



**Figure 18 • Forward Characteristics**



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



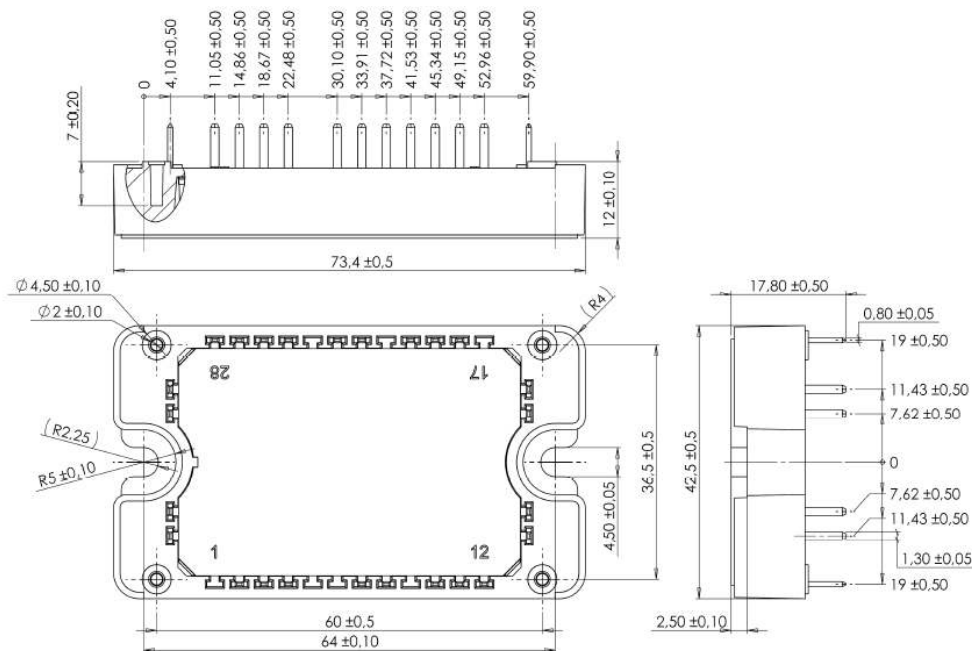
## 4 Package Specification

This section shows the package specification of the MSCSM120DAM11CT3AG device.

### 4.1 Package Outline Drawing

The following figure illustrates the package outline of the MSCSM120DAM11CT3AG device. The dimensions in the following figure are in millimeters.

Figure 20 • Package Outline Drawing



**Note:** See application note [1906—Mounting Instructions for SP3F Power Modules](#) at [www.microsemi.com](http://www.microsemi.com).

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