# MSCMC120AM03CT6LIAG
# Datasheet
# Very Low Stray Inductance Phase Leg SiC MOSFET Power Module
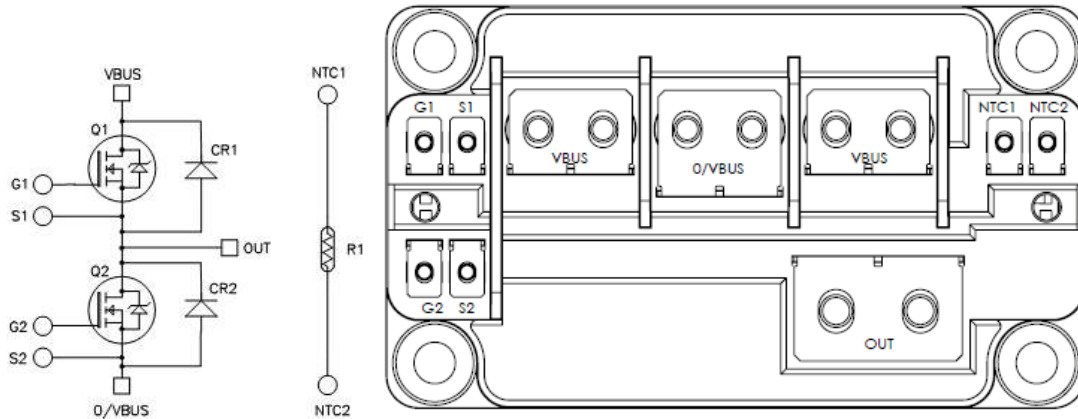
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# Contents

# 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 A

Revision A was published in May 2018. It is the first publication of this document.

# 2 Product Overview

## 2.1 Features

The following are key features of the MSCMC120AM03CT6LIAG device:

- Very low stray inductance
- Internal thermistor for temperature monitoring
- M4 and M5 power connectors
- M2.5 signals connectors
- AlN substrate for improved thermal performance

### 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 benefits of the MSCMC120AM03CT6LIAG device:

- Outstanding performance at high frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction to case thermal resistance
- Low profile
- RoHS compliant

## 2.3 Applications

The MSCMC120AM03CT6LIAG device is designed for the following applications:

- Motor control

*All ratings taken at $T_J$ = 25 °C unless otherwise specified.
*Caution: the devices are sensitive to elctrostatic discharge (ESD). Proper handling procedures should be followed.

# 3 Electrical Specifications

This section details the electrical specifications for the MSCMC120AM03CT6LIAG device.

## 3.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings for the MSCMC120AM03CT6LIAG device (per SiC MOSFET).

**Table 1 • Absolute Maximum Ratings**

| Symbol | Parameter | | Ratings | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain- source voltage | | 1200 | V |
| $I_D$ | Continuous drain current | $T_C$ = 25 °C | 631 | A |
| | | $T_C$ = 80 °C | 475 | |
| $I_{DM}$ | Pulsed drain current | | 1200 | |
| $V_{GS}$ | Gate- source voltage | | −5 to 23 | V |
| $V_{GSOP}$ | Gate- source voltage; recommended operation values | | −5 to 18 | |
| $R_{DS(on)}$ | Drain- source ON resistance | | 3.4 | mΩ |
| $P_D$ | Power dissipation | $T_C$ = 25 °C | 2778 | W |

## 3.2 Electrical Performance

The following tables show the SiC MOSFET characteristics (per SiC MOSFET) of the MSCMC120AM03CT6LIAG device.

### Table 2 • Electrical Characteristics

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|--------|---------------|-----------------|---|-----|-----|-----|------|
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{Ds}$ = 1200 V | | | 200 | 1000 | µA |
| $R_{DS(on)}$ | Drain- source on resistance | $V_{GS}$ = 20 V; $I_D$ = 500 A | $T_j$= 25 °C | | 2.5 | 3.4 | mΩ |
| | | $V_{GS}$ = 18 V; $I_D$ = 500 A | $T_j$ = 175 °C | | 5.2 | | |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{GS}$ = $V_{Ds}$, $I_D$ = 150 mA | | 2 | 2.6 | 4 | V |
| $I_{GSS}$ | Gate- source leakage current | $V_{GS}$ = 20 V, $V_{Ds}$ = 0 V | | | | 6 | µA |

### Table 3 • Dynamic Characteristics

| Symbol | Characteristic | Test conditions | | Min | Typ | Max | Unit |
|--------|---------------|-----------------|---|-----|-----|-----|------|
| $C_{iss}$ | Input capacitance | $V_{GS}$ = 0 V | | | 27.9 | | nF |
| $C_{oss}$ | Output capacitance | $V_{DS}$ = 1000 V | | | 2.2 | | |
| $C_{rss}$ | Reverse transfer capacitance | f = 1 MHz | | | 0.15 | | |
| $Q_g$ | Total gate charge | $V_{GS}$ = −5 to 20 V | | | 1610 | | nC |
| $Q_{gs}$ | Gate – source charge | $V_{Bus}$ = 800 V | | | 460 | | |
| $Q_{gd}$ | Gate – drain charge | $I_D$ = 500 A | | | 500 | | |
| $T_{d(on)}$ | Turn-on delay time | $V_{GS}$ = −5 to 20 V | | | 21 | | ns |
| $T_r$ | Rise time | $V_{Bus}$ = 600 V | | | 19 | | |
| $T_{d(off)}$ | Turn-off delay time | $I_D$ = 500 A | | | 50 | | |
| $T_f$ | Fall time | $R_L$ = 1.2 Ω ; $R_G$ = 0.3 Ω | | | 30 | | |
| $E_{on}$ | Turn on energy | Inductive Switching | $T_j$ = 150 °C | | 7.4 | | mJ |
| $E_{off}$ | Turn off energy | $V_{GS}$ = −5 to 20 V $V_{Bus}$ = 600 V $I_D$ = 500 A $R_G$ = 0.3 Ω | $T_j$ = 150 °C | | 4.8 | | |
| $R_{Gint}$ | Internal gate resistance | | | | 0.71 | | Ω |
| $R_{thJC}$ | Junction-to-case thermal resistance | | | | | 0.054 | °C/W |

### Table 4 • Body Diode Ratings and Characteristics

| Symbol | Characteristic | Test conditions | | Min | Typ | Max | Unit |
|--------|---------------|-----------------|---|-----|-----|-----|------|
| $V_{SD}$ | Diode forward voltage | $V_{GS}$ = −5 V | $T_j$ = 25 °C | | 4 | | V |
| | | $I_{SD}$ = 250 A | $T_j$ = 175 °C | | 3.5 | | |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 500 A ; $V_{GS}$ = −5 V | | | 45 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | | | 4 | | µC |
| $I_{rr}$ | Reverse recovery current | $V_R$ = 800 V ; $di_F$/dt = 10000 A/µs | | | 135 | | A |

The following table shows the SiC diode characteristics (per SiC diode) of the MSCMC120AM03CT6LIAG device.

### Table 5 • SiC Diode Charcteristics

| Symbol | Characteristics | Test conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RRM}$ | Peak repetitive reverse voltage | | | | | 1200 | V |
| $I_{RM}$ | Reverse leakage current | $V_R$ = 1200 V | $T_j$ = 25 °C | | 0.5 | 2.5 | mA |
| | | | $T_j$ = 175 °C | | 1.5 | 5 | |
| $I_F$ | DC forward current | | $T_C$ = 100 °C | | 250 | | A |
| $V_F$ | Diode forward voltage | $I_F$ = 250 A | $T_j$ = 25 °C | | 1.6 | 1.8 | V |
| | | | $T_j$ = 175 °C | | 2.25 | 2.7 | |
| $Q_C$ | Total capacitive charge | $V_R$ = 800 V | | | 1230 | | nC |
| C | Total capacitance | f = 1 MHz, $V_R$ = 400 V | | | 1150 | | pF |
| | | f = 1 MHz, $V_R$ = 800 V | | | 865 | | |
| $R_{thJC}$ | Junction-to-case thermal resistance | | | | | 0.106 | °C/W |

The following tables show the thermal and package characteristics of the MSCMC120AM03CT6LIAG device.

### Table 6 • Package Charcteristics

| Symbol | Characteristic | | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{ISOL}$ | RMS isolation voltage, any terminal to case t = 1 min, 50 to 60 Hz | | | 4000 | | V |
| $T_J$ | Operating junction temperature range | | | −40 | 175 | °C |
| $T_{JOP}$ | Recommended junction temperature under switching conditions | | | −40 | $T_J$max −25 | |
| $T_{STG}$ | Storage temperature range | | | −40 | 125 | |
| $T_C$ | Operating case temperature | | | −40 | 125 | |
| Torque | Mounting torque | For terminals | M2.5 | 0.4 | 0.6 | Nm |
| | | | M4 | 2 | 3 | |
| | | | M5 | 2 | 3.5 | |
| | | To heatsink | M6 | 3 | 5 | |
| $L_{DC}$ | Module stray inductance between VBUS and 0/VBUS | | | | 3 | nH |
| Wt | Package weight | | | | 320 | g |

### Table 7 • Temperature Sensor NTC

| Symbol | Characteristic | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $R_{25}$ | Resistance at 25 °C | | 50 | | kΩ |
| $\Delta R_{25}/R_{25}$ | | | 5 | | % |
| $B_{25/85}$ | $T_{25}$ = 298.15 K | | 3952 | | K |
| $\Delta B/B$ | $T_C$= 100 °C | | 4 | | % |

**Figure 1 • NTC Formula**

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

T: Thermistor temperature $R_T$: Thermistor value at T

Note: See the APT0406 application note at www.microsemi.com.

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## 3.3 Typical Performance Curves

This section shows the typical performance curves for the MSCMC120AM03CT6LIAG device.

The following section details the typical performance curves for SiC MOSFET.

**Figure 2 • Maximum Thermal Impedance**



| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.001 | 0.014 | 0.003 | 0.013 | 0.002 | 0.013 | 0.007 |
| taui (s) | 0.004 | 0.003 | 0.007 | 0.027 | 0.027 | 0.008 | 0.053 |
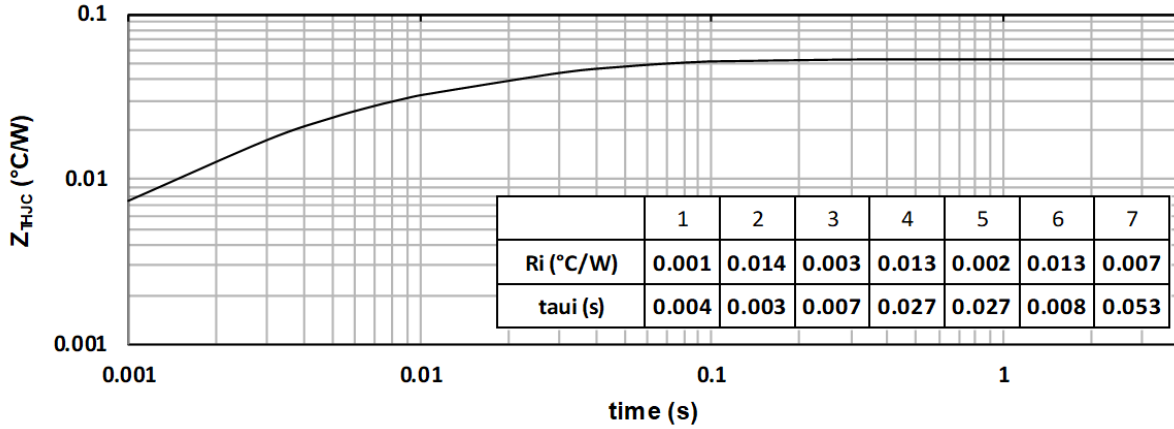
**Figure 3 • Output Characteristics**
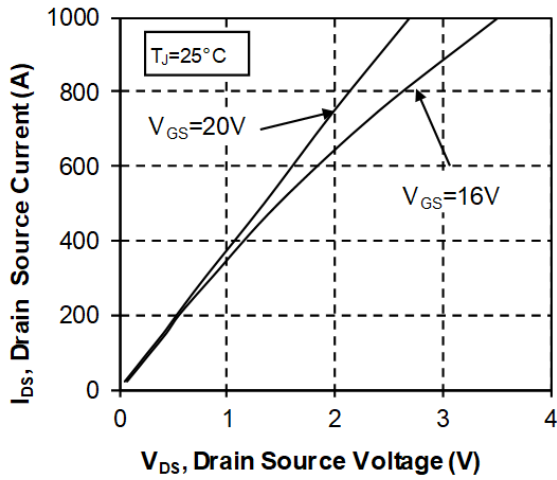


**Figure 4 • Output Characteristics II**
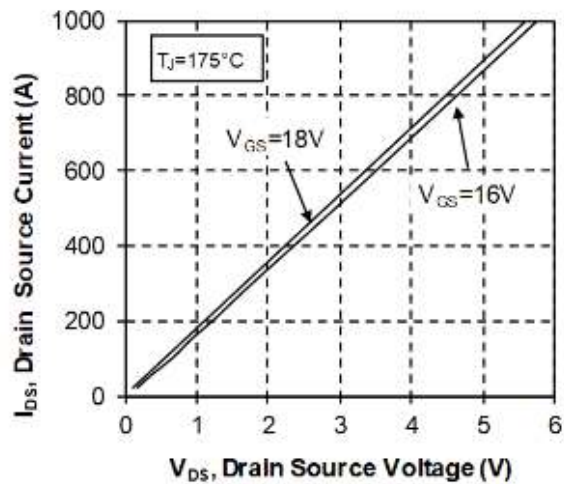
**Figure 5 • Normalized RDS(on) vs. Temperature**
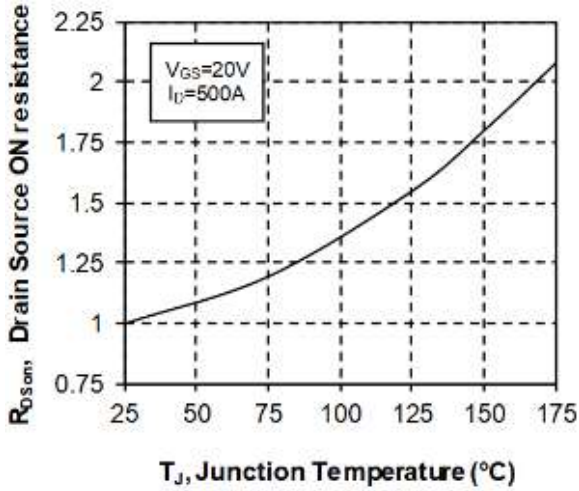


**Figure 6 • Transfer Characteristics**
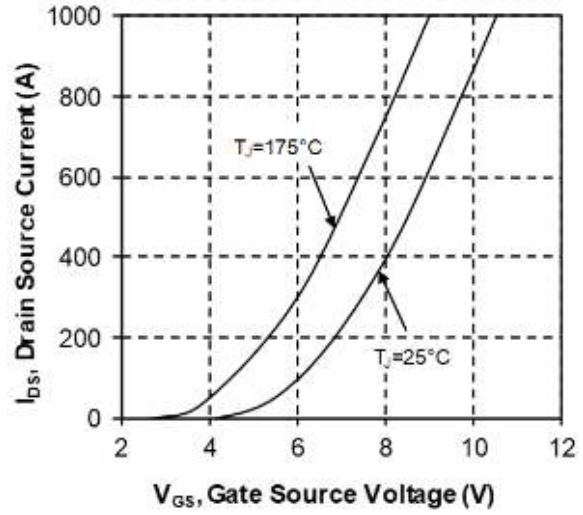


**Figure 7 • Switching Energy vs. Rg**
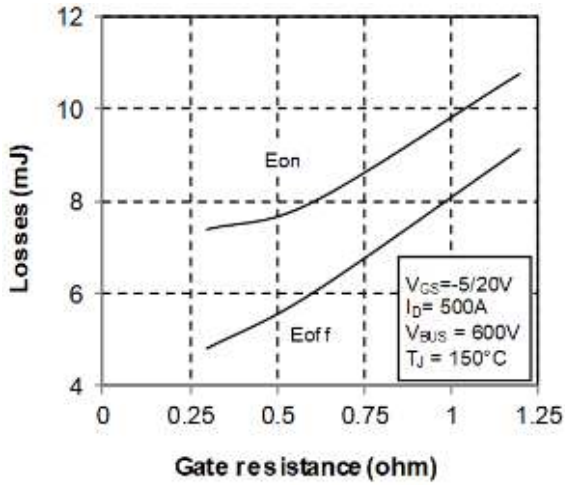


**Figure 8 • Switching Energy vs. Current**
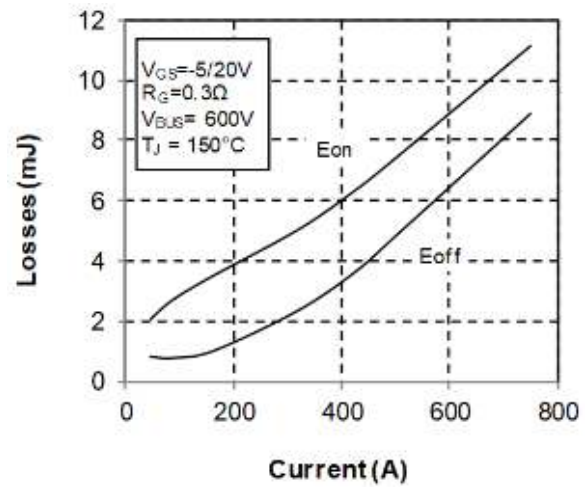


**Figure 9 • Capacitance vs. Drain Source Voltage**
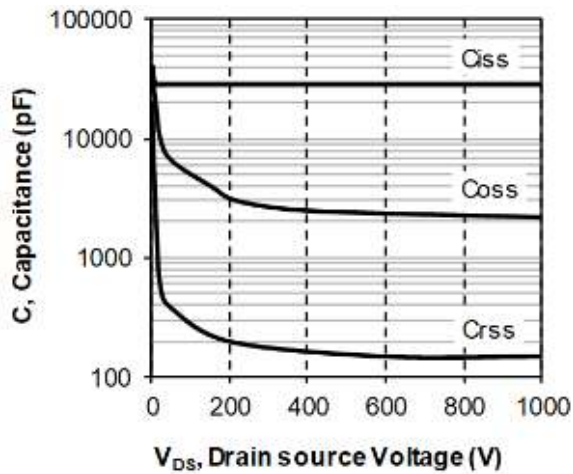


**Figure 10 • Gate Charge vs. Gate Source Voltage**
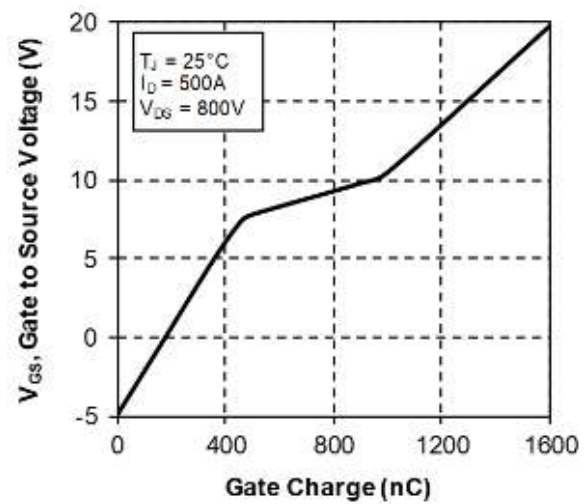
**Figure 11 • Body Diode Characteristics**
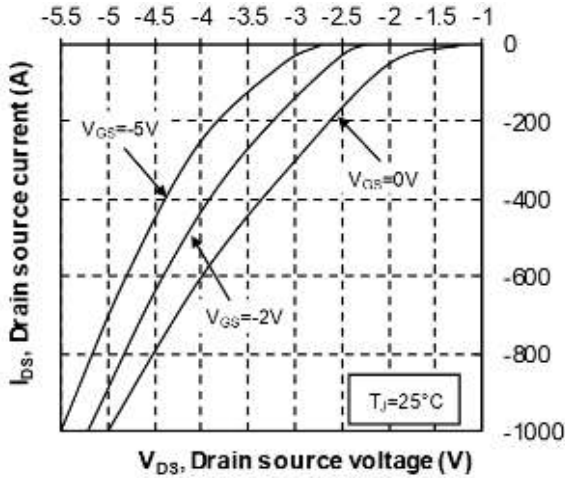


**Figure 12 • 3rd Quadrant Characteristics**
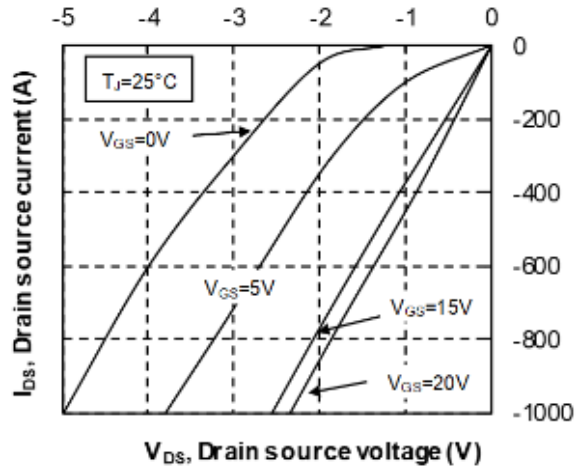


**Figure 13 • Body Diode Characteristics II**
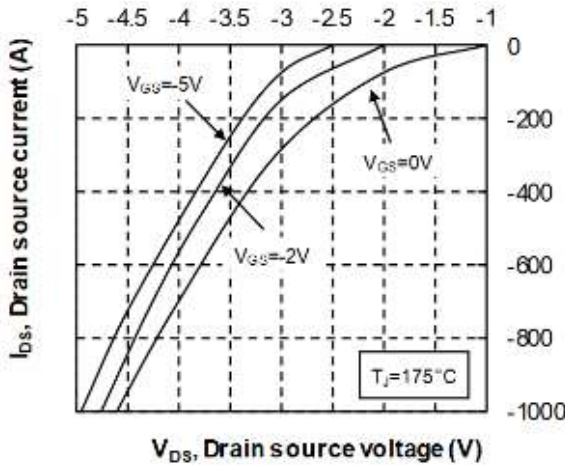


**Figure 14 • 3rd Quadrant Characteristics**
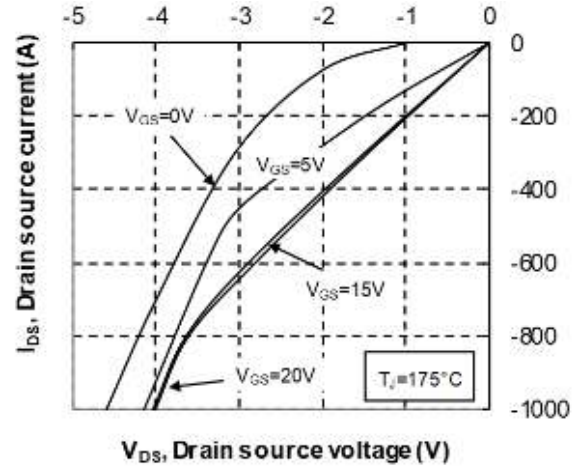


**Figure 15 • Operating Frequency vs. Drain Current**

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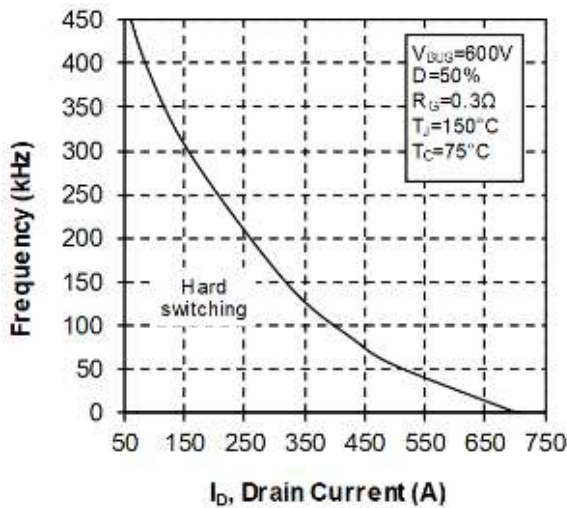
The following section details the typical performance curves for SiC Diode.

### Figure 16 • SiC Diode Maximum Thermal Impedance



| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.002 | 0.028 | 0.007 | 0.025 | 0.004 | 0.026 | 0.014 |
| taui (s) | 0.004 | 0.003 | 0.007 | 0.026 | 0.027 | 0.008 | 0.052 |
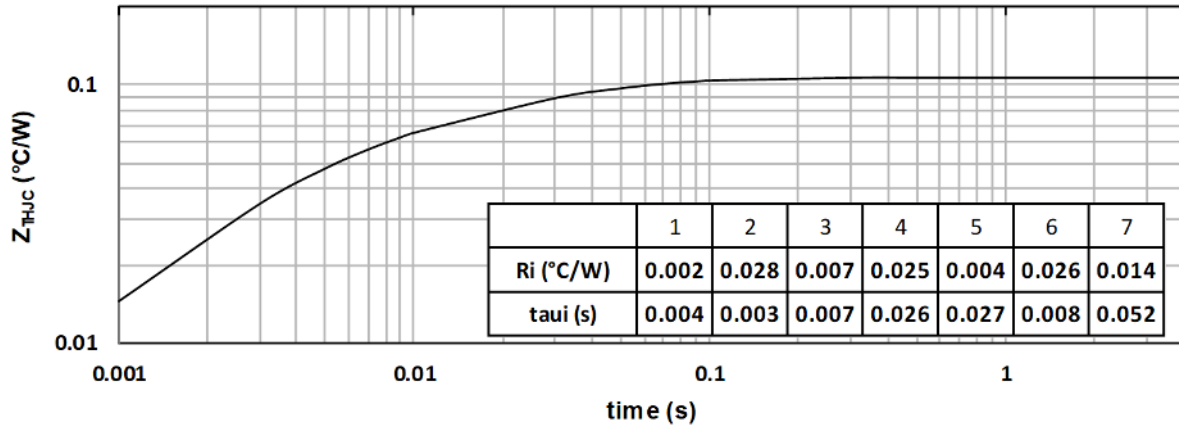
### Figure 17 • Forward Characteristics
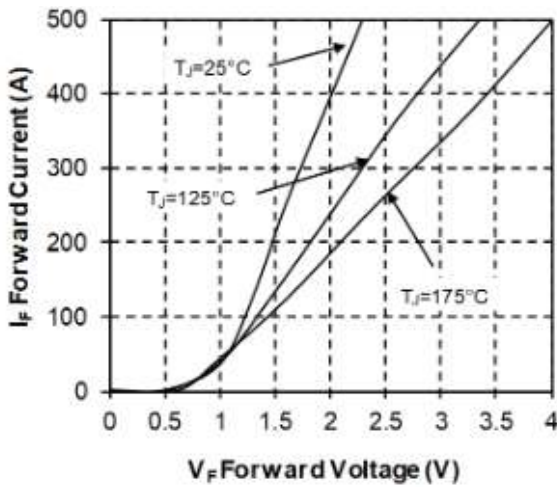


### Figure 18 • Reverse Characteristics
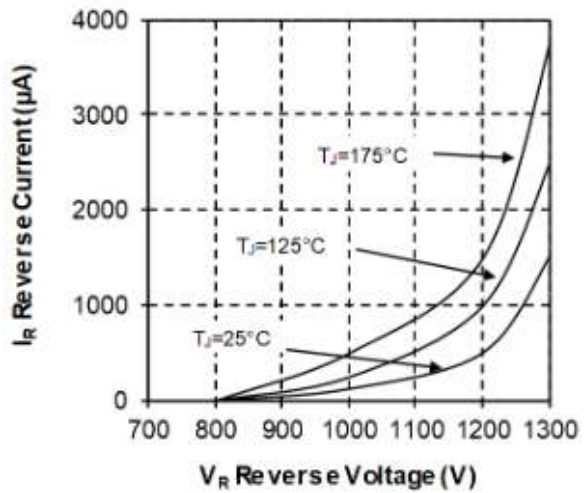


### Figure 19 • Capacitance vs. Reverse Voltage
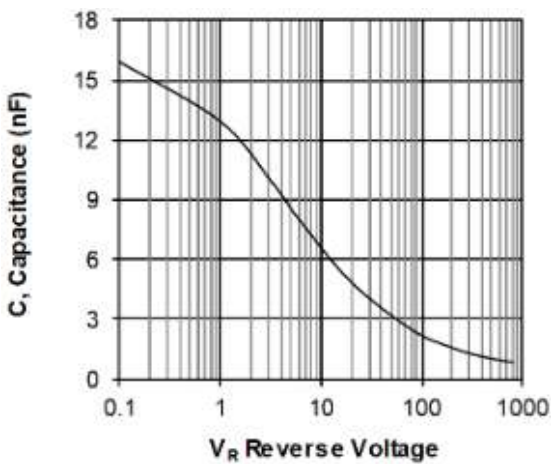
# 4 Package Specification

This section shows the package specification for the MSCMC120AM03CT6LIAG device.

## 4.1 Package Outline Drawing

This section details the package drawing of the MSCMC120AM03CT6LIAG device. Dimensions are in millimeters.

**Figure 20 • Package Outline Drawing**
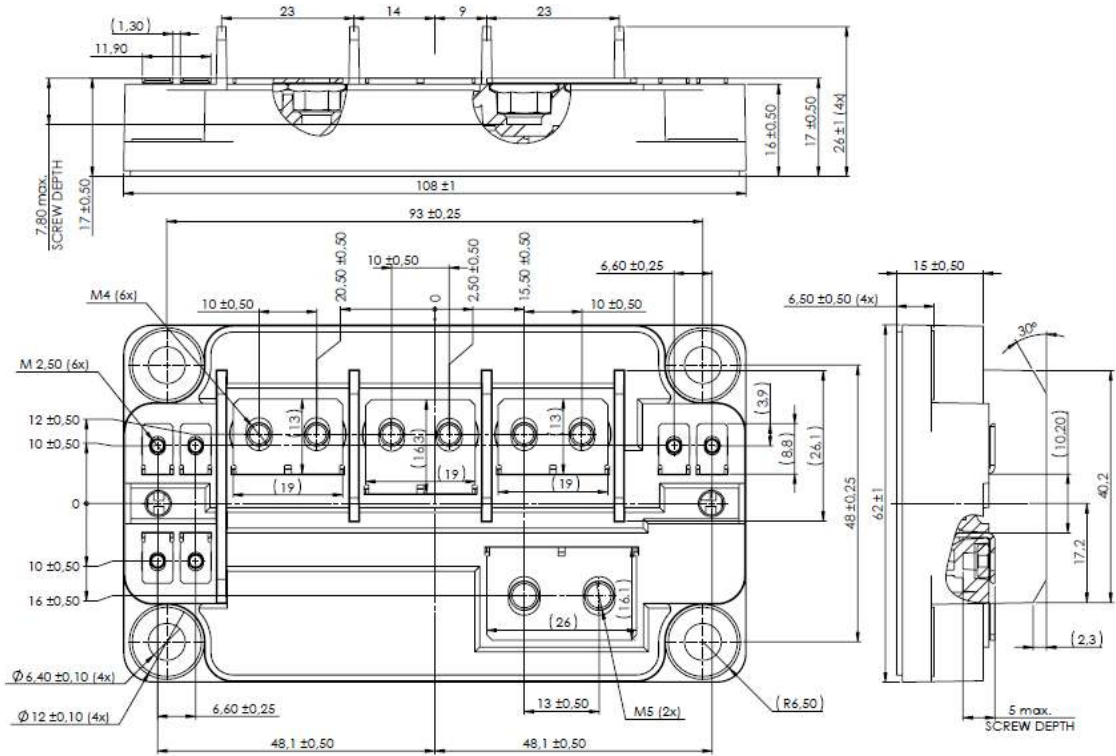


Note: See the AN1911 application note at www.microsemi.com.

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