

MSCSM70AM19CT1AG
Datasheet
Phase Leg SiC MOSFET Power Module

April 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 April 2020. It is the first publication of this document.

2 Product Overview

The MSCSM70AM19CT1AG device is a phase leg 700 V,124 A full silicon carbide (SiC) power module.

Figure 1 • MSCSM70AM19CT1AG Electrical Schematic

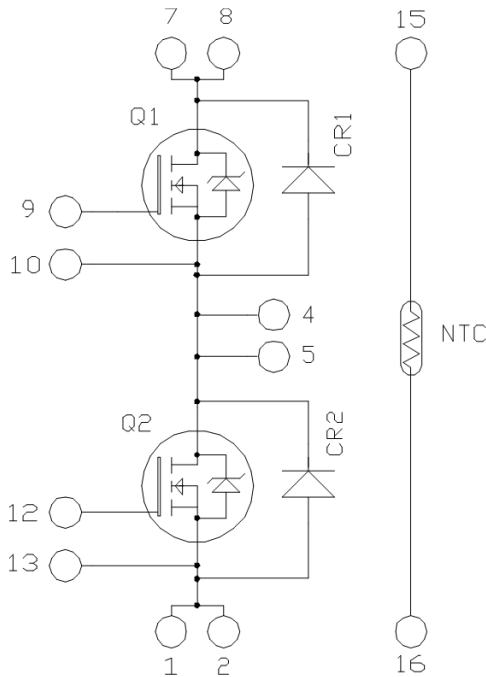
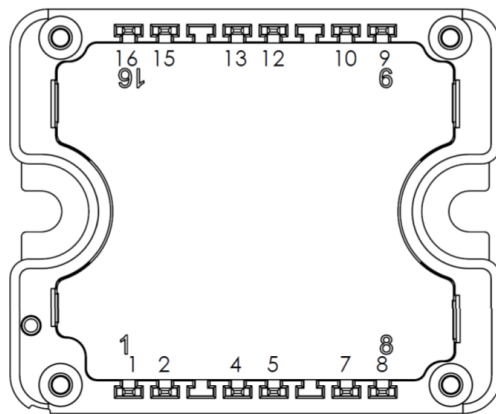


Figure 2 • MSCSM70AM19CT1AG Pinout Location



Pins 1/2 ; 4/5 ; 7/8 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 MSCSM70AM19CT1AG 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
- Very 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 MSCSM70AM19CT1AG 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 MSCSM70AM19CT1AG device is designed for the following applications:

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

3 Electrical Specifications

This section shows the electrical specifications of the MSCSM70AM19CT1AG device.

3.1 SiC MOSFET Characteristics (Per MOSFET)

The following table shows the absolute maximum ratings per MOSFET of the MSCSM70AM19CT1AG device.

Table 1 • Absolute Maximum Ratings

| Symbol | Parameter | Max Ratings | Unit |
|--------------|----------------------------|----------------------------------|------------------|
| V_{DSS} | Drain-source voltage | 700 | V |
| I_D | Continuous drain current | $T_C = 25\text{ }^\circ\text{C}$ | 124 ¹ |
| | | $T_C = 80\text{ }^\circ\text{C}$ | 98 ¹ |
| I_{DM} | Pulsed drain current | 250 | |
| V_{GS} | Gate-source voltage | -10/25 | V |
| $R_{DS(on)}$ | Drain source ON resistance | 19 | m Ω |
| P_D | Power dissipation | $T_C = 25\text{ }^\circ\text{C}$ | 365 |

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 MSCSM70AM19CT1AG device.

Table 2 • Electrical Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|--------------|---------------------------------|---|-----------------------------------|-----|------|---------------|
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}; V_{DS} = 700\text{ V}$ | | | 100 | μA |
| $R_{DS(on)}$ | Drain-source on resistance | $V_{GS} = 20\text{ V}$ $I_D = 40\text{ A}$ | $T_J = 25\text{ }^\circ\text{C}$ | 15 | 19 | m Ω |
| | | | $T_J = 175\text{ }^\circ\text{C}$ | | 18.8 | |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{GS} = V_{DS}, I_D = 4\text{ mA}$ | 1.9 | 2.4 | | 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 per MOSFET of the MSCSM70AM19CT1AG device.

Table 3 • Dynamic Characteristics

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

The following table shows the body diode ratings and characteristics per MOSFET of the MSCSM70AM19CT1AG device.

Table 4 • Body Diode Ratings and Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|----------|--------------------------|--|-----|-----|------|------|
| V_{SD} | Diode Forward Voltage | $V_{GS} = 0\text{ V}; I_{SD} = 40\text{ A}$ | | 3.4 | | V |
| | | $V_{GS} = -5\text{ V}; I_{SD} = 40\text{ A}$ | | 3.8 | | |
| t_{rr} | Reverse recovery time | $I_{SD} = 40\text{ A}; V_{GS} = -5\text{ V}$ $V_R = 400\text{ V}; d_i/dt = 1000\text{ A}/\mu\text{s}$ | | 38 | | ns |
| Q_{rr} | Reverse recovery charge | | | 318 | | nC |
| I_{rr} | Reverse recovery current | | | | 14.8 | |

3.2 SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)

The following table shows the reverse SiC diode ratings and characteristics per SiC diode of the MSCSM70AM19CT1AG device.

Table 5 • SiC Schottky Diode Ratings and Characteristics (Per SiC Diode)

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|------------|-------------------------------------|--|-----------------------|-----|-----|------|----------------------|
| V_{RRM} | Peak repetitive reverse voltage | | | | | 700 | V |
| I_{RM} | Reverse leakage current | $V_R = 700\text{ V}$ | $T_J = 25\text{ °C}$ | 15 | 200 | | 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 |
| | | | $T_J = 175\text{ °C}$ | 1.9 | | | |
| QC | Total capacitive charge | $V_R = 400\text{ V}$ | | | 133 | | nC |
| C | Total capacitance | $f = 1\text{ MHz}, V_R = 200\text{ V}$ | | | 248 | | μF |
| | | $f = 1\text{ MHz}, V_R = 400\text{ V}$ | | | 216 | | |
| R_{thJC} | Junction-to-case thermal resistance | | | | | 0.86 | $^{\circ}\text{C/W}$ |

3.3 Thermal and Package Characteristics

The following table shows the package characteristics of the MSCSM70AM19CT1AG 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 | | | | 80 | g |

The following table shows the temperature sensor NTC (see application note [APT0406](#) on www.microsemi.com) of the MSCSM70AM19CT1AG device.

Table 7 • Temperature Sensor NTC

| Symbol | Characteristic | Min | Typ | Max | Unit |
|-----------------------------------|----------------------------|-------------------------|------|-----|------|
| R ₂₅ | Resistance at 25 °C | | 50 | | kΩ |
| ΔR ₂₅ /R ₂₅ | | | 5 | | % |
| B _{25/85} | T ₂₅ = 298.15 K | | 3952 | | K |
| ΔB/B | | T _C = 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_T: Thermistor value at T

3.4 Typical SiC MOSFET Performance Curves

This sections shows the typical SiC MOSFET performance curves of the MSCSM70AM19CT1AG device.

Figure 3 • Maximum Thermal Impedance

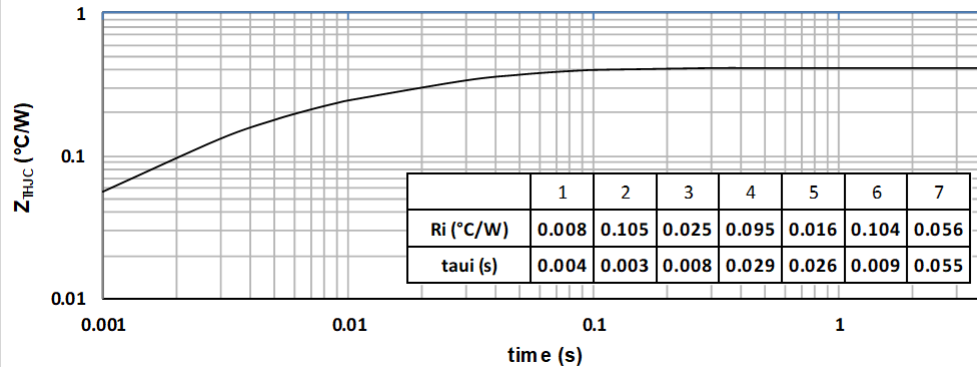


Figure 4 • Output Characteristics, T_J = 25 °C

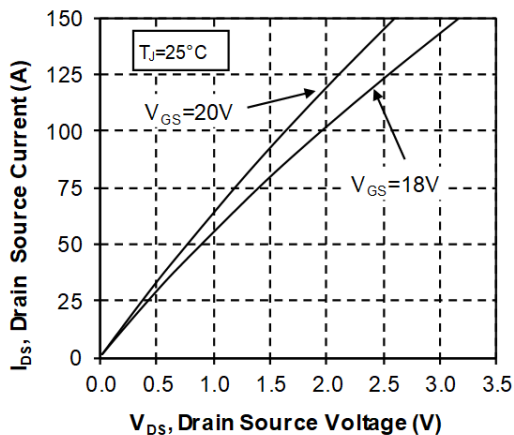


Figure 5 • Output Characteristics, T_J = 175 °C

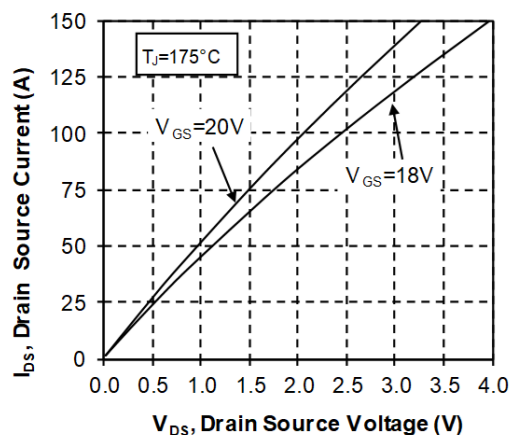


Figure 6 • Normalized $R_{DS(on)}$ vs. Temperature

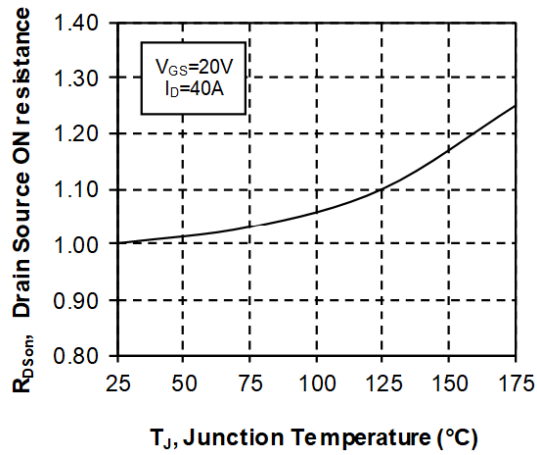


Figure 7 • Transfer Characteristics

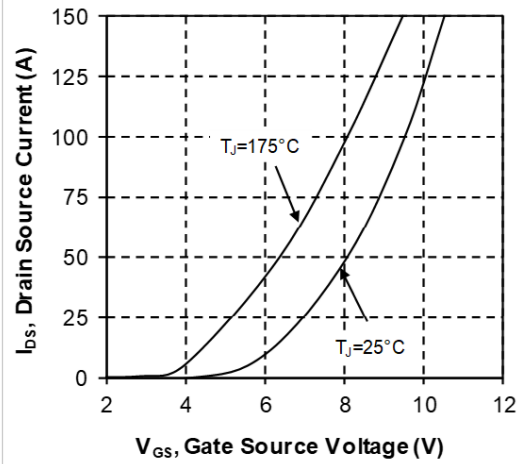


Figure 8 • Capacitance vs. Drain Source Voltage

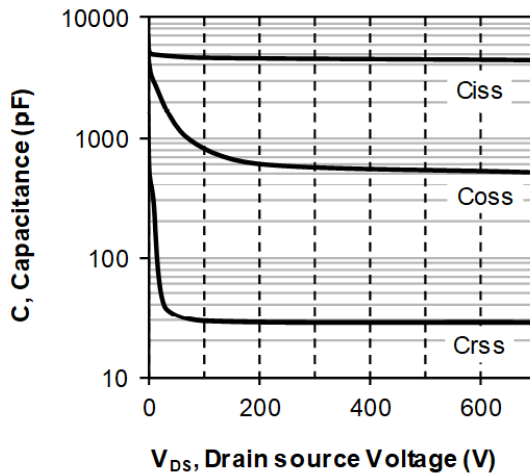


Figure 9 • Gate Charge vs. Gate Source Voltage

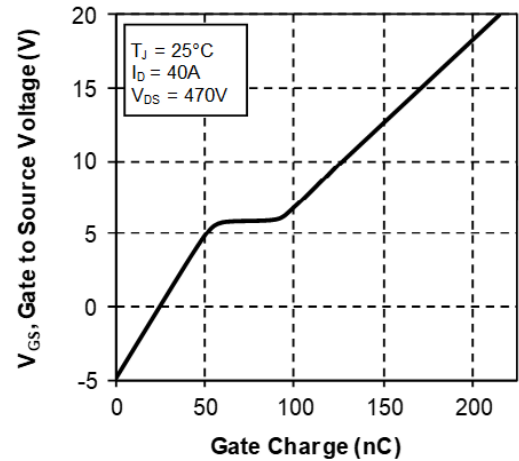


Figure 10 • Body Diode Characteristics, $T_J = 25^\circ\text{C}$

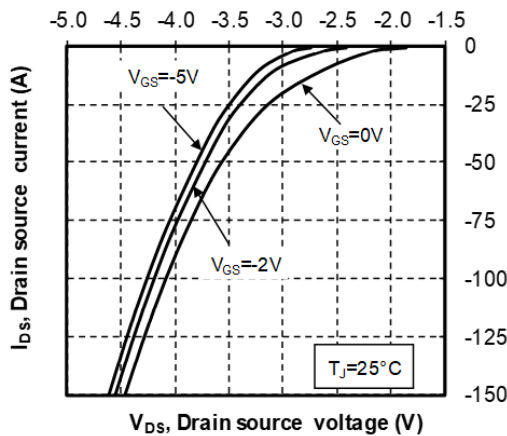


Figure 11 • 3rd Quadrant Characteristics, $T_J = 25^\circ\text{C}$

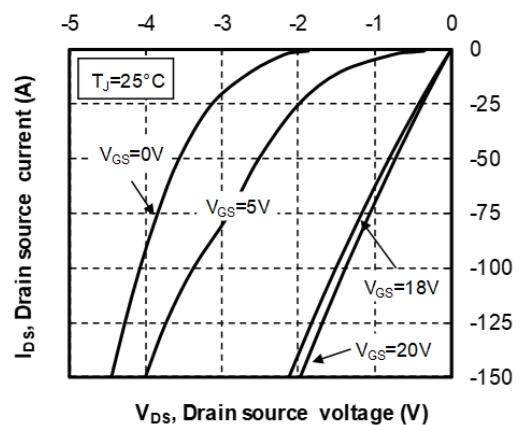


Figure 12 • Body Diode Characteristics, $T_J = 175^\circ\text{C}$

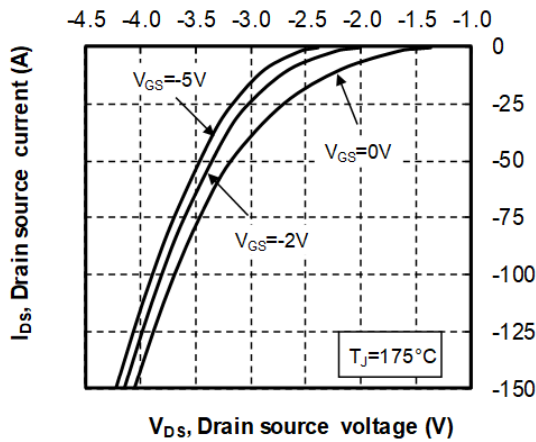


Figure 13 • 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$

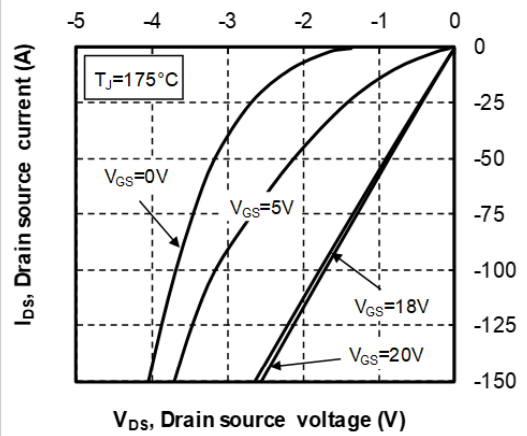


Figure 14 • Switching Energy vs. Current

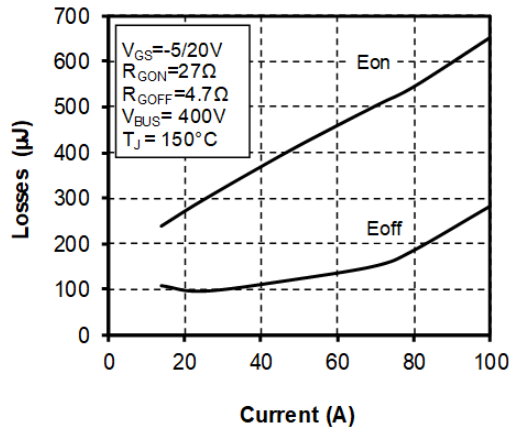


Figure 15 • Turn On Energy vs. Rg

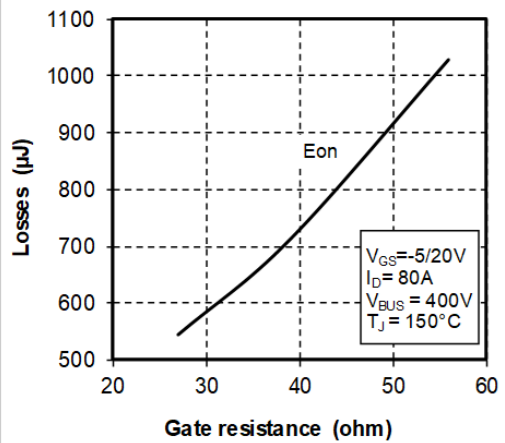


Figure 16 • Turn Off Energy vs. Rg

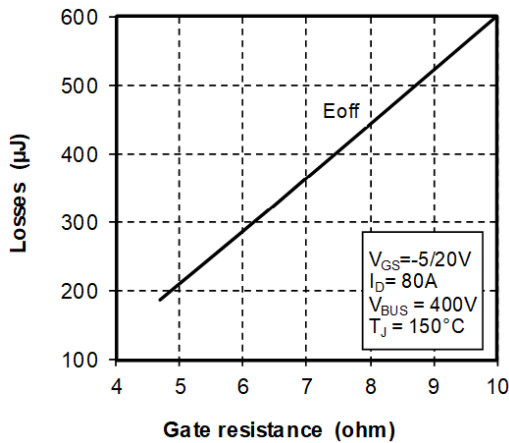
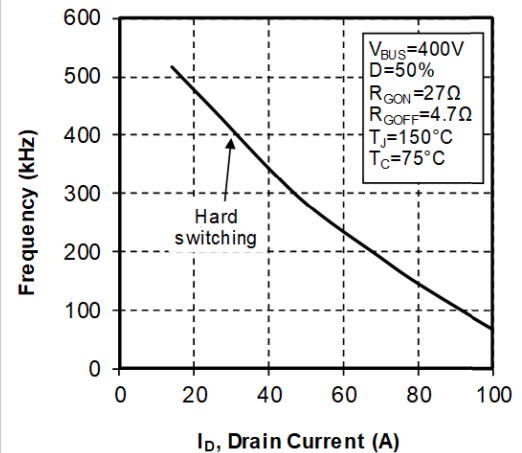


Figure 17 • Operating Frequency vs. Drain Current



3.5 Typical SiC Diode Performance Curves

This sections shows the typical SiC diode performance curves of the MSCSM70AM19CT1AG device.

Figure 18 • Maximum Thermal Impedance

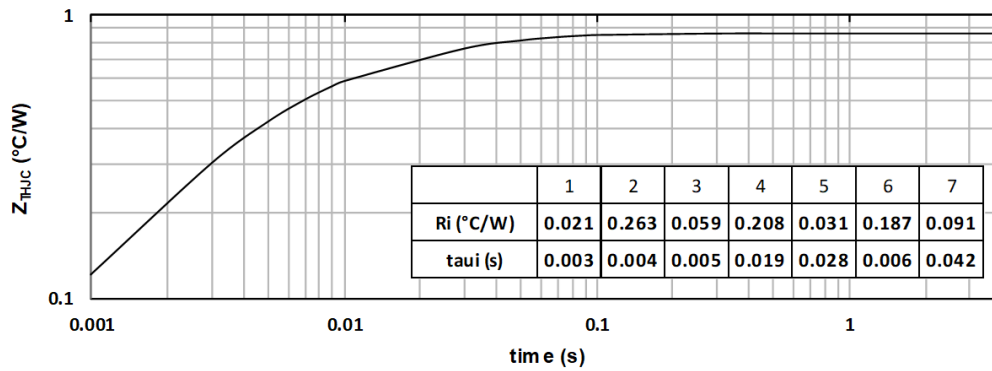


Figure 19 • Forward Characteristics

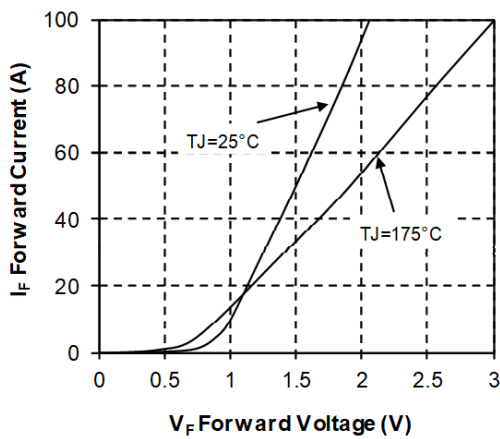
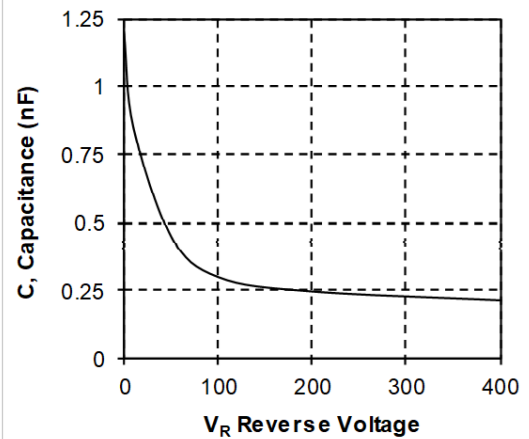


Figure 20 • Capacitance vs. Reverse Voltage



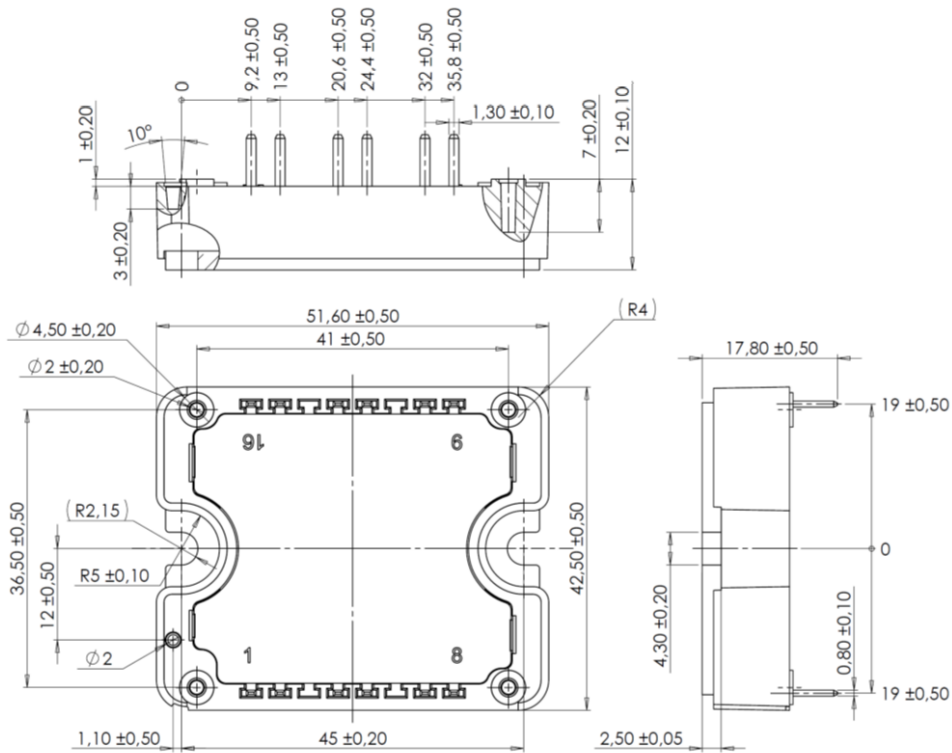
4 Package Specifications

This section shows the package specification of the MSCSM70AM19CT1AG device.

4.1 Package Outline Drawing

The following figure illustrates the package outline of the MSCSM70AM19CT1AG device. The dimensions are in millimeters.

Figure 21 • Package Outline Drawing



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