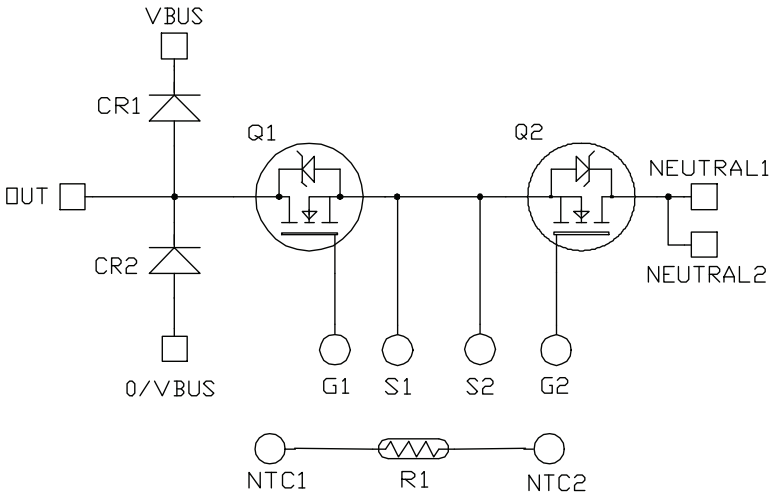
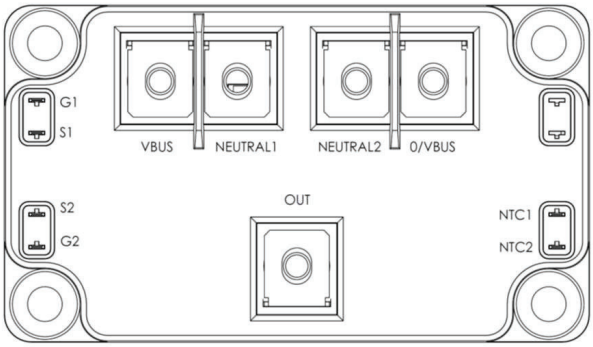
# MSCSM70VR1M03CT6AG

## Vienna Rectifier SiC MOSFET Power Module

## Product Overview

The MSCSM70VR1M03CT6AG device is a Vienna rectifier 700V, 585A silicon carbide (SiC) power module.




**Note:** All ratings at $T_J$ = 25 °C, unless otherwise specified.

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

## Features

The following are key features of the MSCSM70VR1M03CT6AG device:

- 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 $V_F$
- Kelvin source for easy drive
- Low stray inductance
- M5 power connectors
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

The following are the benefits of MSCSM70VR1M03CT6AG device:

- Outstanding performance at high frequency operation
- High-power and high-efficiency rectifiers and converters
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Low profile
- RoHS compliant

## Application

The MSCSM70VR1M03CT6AG device is designed for the following applications:

- Power factor correction
- Switched mode power supplies
- Uninterruptible power supplies

# 1. Electrical Specifications

This section provides the electrical specifications of the MSCSM70VR1M03CT6AG device.

## 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM70VR1M03CT6AG device.

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

| Symbol | Parameter | | Maximum Ratings | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source voltage | | 700 | V |
| $I_D$ | Continuous drain current | $T_C$ = 25 °C | 585 | A |
| | | $T_C$ = 80 °C | 465 | |
| $I_{DM}$ | Pulsed drain current | | 1200 | |
| $V_{GS}$ | Gate-Source voltage | | –10/23 | V |
| $R_{DS(on)}$ | Drain-Source ON resistance | | 3.8 | mΩ |
| $P_D$ | Power dissipation | $T_C$ = 25 °C | 1625 | W |

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM70VR1M03CT6AG device.

**Table 1-2. Electrical Characteristics**

| Symbol | Characteristics | Test Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0V<br>$V_{DS}$ = 700V | | — | — | 500 | µA |
| $R_{DS(on)}$ | Drain–Source on resistance | $V_{GS}$ = 20V<br>$I_D$ = 200A | $T_J$ = 25 °C | — | 3 | 3.8 | mΩ |
| | | | $T_J$ = 175 °C | — | 3.75 | — | |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{GS}$ = $V_{DS}$<br>$I_D$ = 20 mA | | 1.9 | 2.4 | — | V |
| $I_{GSS}$ | Gate–Source leakage current | $V_{GS}$ = 20V; $V_{DS}$ = 0V | | — | — | 500 | nA |

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM70VR1M03CT6AG device.

**Table 1-3. Dynamic Characteristics**

| Symbol | Characteristics | Test Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{GS}$ = 0V | | — | 22.5 | — | nF |
| $C_{oss}$ | Output capacitance | $V_{DS}$ = 700V | | — | 2.6 | — | |
| $C_{rss}$ | Reverse transfer capacitance | f = 1 MHz | | — | 0.14 | — | |
| $Q_g$ | Total gate charge | $V_{GS}$ = –5V/20V | | — | 1075 | — | nC |
| $Q_{gs}$ | Gate-Source charge | $V_{Bus}$ = 470V | | — | 290 | — | |
| $Q_{gd}$ | Gate-Drain charge | $I_D$ = 200A | | — | 175 | — | |
| $T_{d(on)}$ | Turn-on delay time | $V_{GS}$ = –5V/20V | $T_J$ = 150°C | — | 78 | — | ns |
| $T_r$ | Rise time | $V_{Bus}$ = 400V | | — | 125 | — | |
| $T_{d(off)}$ | Turn-off delay time | $I_D$ = 400A | | — | 214 | — | |
| $T_f$ | Fall time | $R_{G(on)}$ = 5.6Ω | | | 92 | — | |
| | | $R_{G(off)}$ = 3.2Ω | | | | | |
| $E_{on}$ | Turn-on energy | $V_{GS}$ = –5V/20V | $T_J$ = 150 °C | — | 5 | — | mJ |
| $E_{off}$ | Turn-off energy | $V_{Bus}$ = 400V | $T_J$ = 150 °C | — | 8.8 | — | |
| | | $I_D$ = 400A | | | | | |
| | | $R_{G(on)}$ = 5.6Ω | | | | | |
| | | $R_{G(off)}$ = 3.2Ω | | | | | |
| $R_{Gint}$ | Internal gate resistance | | | — | 1.1 | — | Ω |
| $R_{thJC}$ | Junction-to-case thermal resistance | | | — | — | 0.092 | °C/W |

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM70VR1M03CT6AG device.

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

| Symbol | Characteristics | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode forward voltage | $V_{GS}$ = 0V; $I_{SD}$ = 200A | — | 3.4 | — | V |
| | | $V_{GS}$ = –5V; $I_{SD}$ = 200A | — | 3.8 | — | |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 200A; $V_{GS}$ = –5V | — | 40 | — | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_R$ = 470V; $di_F/dt$ = 6000 A/µs | — | 2.5 | — | µC |
| $I_{rr}$ | Reverse recovery current | | — | 95 | — | A |

## 1.2 SiC Diode Ratings and Characteristics (Per SiC Diode)

The following table lists the SiC diode ratings and characteristics of MSCSM70VR1M03CT6AG device.

**Table 1-5. SiC Diode Ratings and Characteristics**

| Symbol | Characteristics | Test Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RRM}$ | Peak repetitive reverse voltage | | | — | — | 1200 | V |
| $I_{RM}$ | Reverse leakage current | $V_R$ = 1200V | $T_J$ = 25 °C | — | 90 | 1200 | µA |
| | | | $T_J$ = 175 °C | — | 1500 | — | |
| $I_F$ | DC forward current | | $T_C$ = 100 °C | — | 300 | — | A |
| $V_F$ | Diode forward voltage | $I_F$ = 300A | $T_J$ = 25 °C | — | 1.5 | 1.8 | V |
| | | | $T_J$ = 175 °C | — | 2.1 | — | |
| $Q_C$ | Total capacitive charge | $V_R$ = 600V | | — | 1344 | — | nC |
| C | Total capacitance | f = 1 MHz<br>$V_R$ = 400V | | — | 1476 | — | pF |
| | | f = 1 MHz<br>$V_R$ = 600V | | — | 1092 | — | |
| $R_{thJH}$ | Junction-to-case thermal resistance | | | — | — | 0.109 | °C/W |

## 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM70VR1M03CT6AG device.

**Table 1-6. Thermal and Package Characteristics**

| Symbol | Characteristics | | | Min. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{ISOL}$ | RMS isolation voltage, any terminal to case t =1 min, 50 Hz/60 Hz | | | 4000 | — | V |
| $T_J$ | Operating junction temperature range | | | –40 | 175 | °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 | M6 | 3 | 5 | N.m |
| | | For terminals | M5 | 2 | 3.5 | |
| Wt | Package weight | | | — | 300 | g |

The following table lists the temperature sensor NTC of the MSCSM70VR1M03CT6AG device.

**Table 1-7. Temperature Sensor NTC**

| Symbol | Characteristics | | 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 |
| ΔB/B | — | $T_C$ = 100 °C | — | 4 | — | % |

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

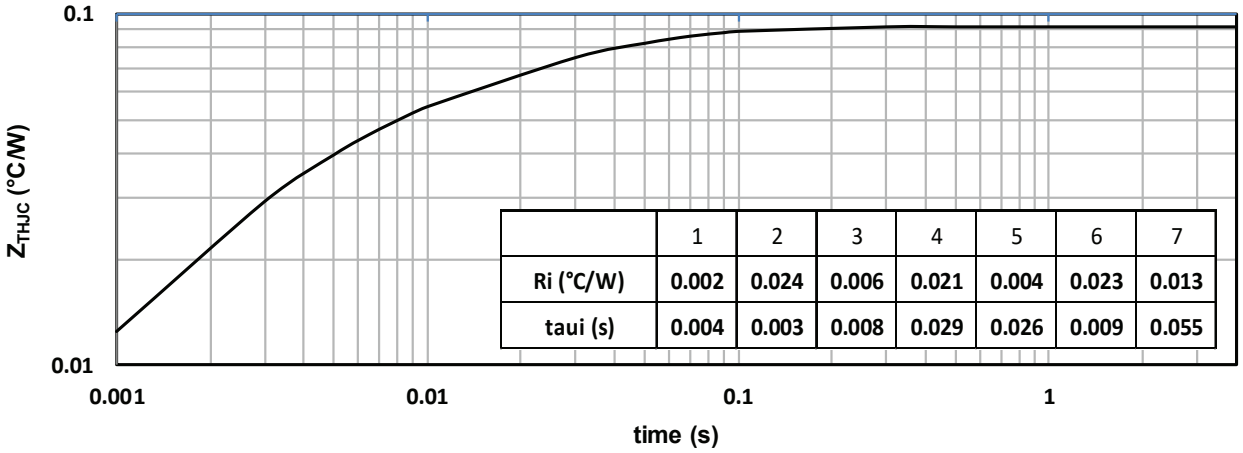
T: Thermistor temperature
$R_T$: Thermistor value at T

**Note:** See APT0406—Using NTC Temperature Sensor Integrated into Power Module for more information.

## 1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of the MSCSM70VR1M03CT6AG device.

**Figure 1-1. Maximum Thermal Impedance**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.002 | 0.024 | 0.006 | 0.021 | 0.004 | 0.023 | 0.013 |
| taui (s) | 0.004 | 0.003 | 0.008 | 0.029 | 0.026 | 0.009 | 0.055 |

**Figure 1-2. Output Characteristics, $T_J$ = 25 °C**

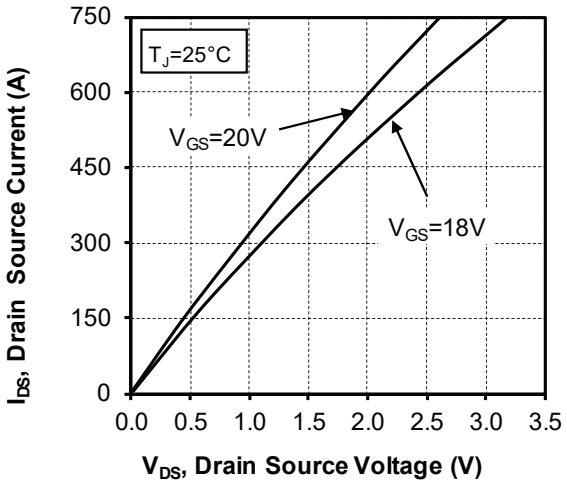



**Figure 1-3. Output Characteristics, $T_J$ = 175 °C**

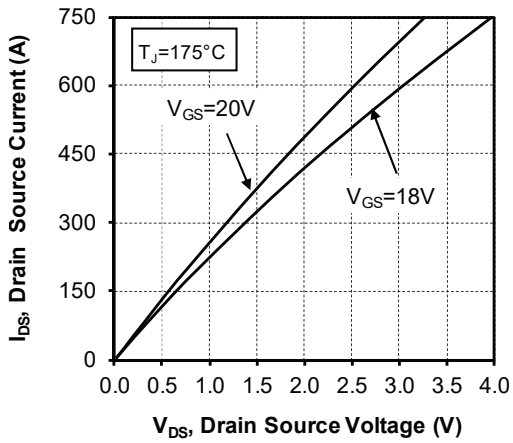


**Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature**

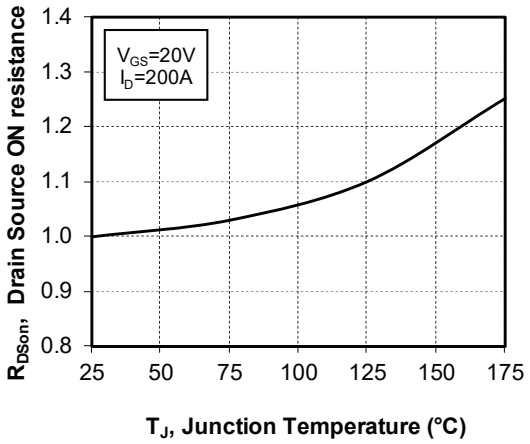



**Figure 1-5. Transfer Characteristics**

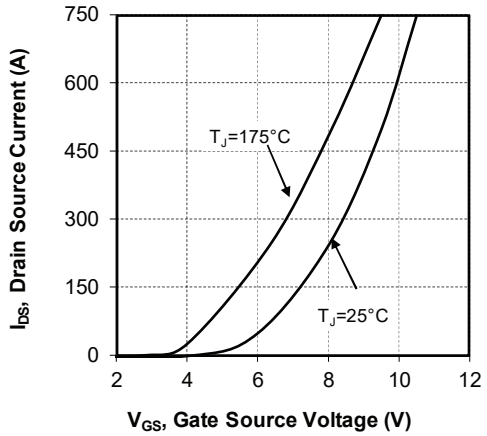



**Figure 1-6. Switching Energy vs. Current**

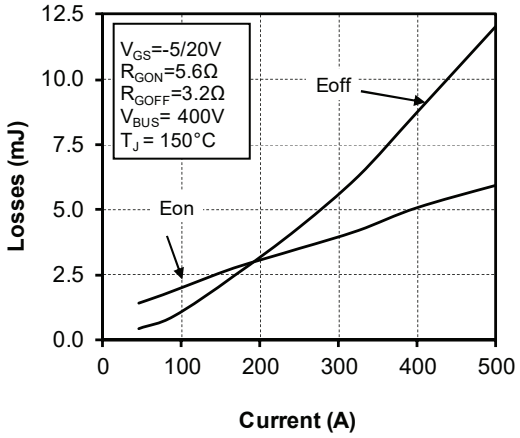



**Figure 1-7. Turn On Energy vs. Rg**

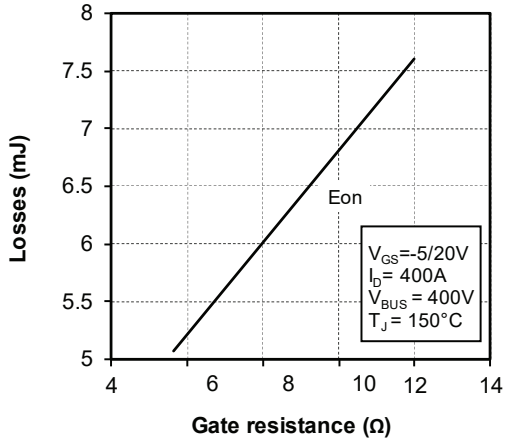



**Figure 1-8. Capacitance vs. Drain Source Voltage**

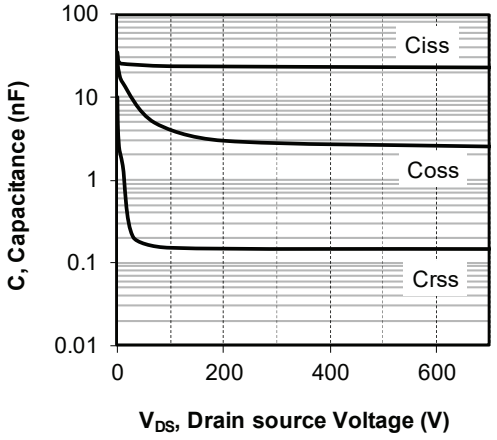



**Figure 1-9. Gate Charge vs. Gate Source Voltage**

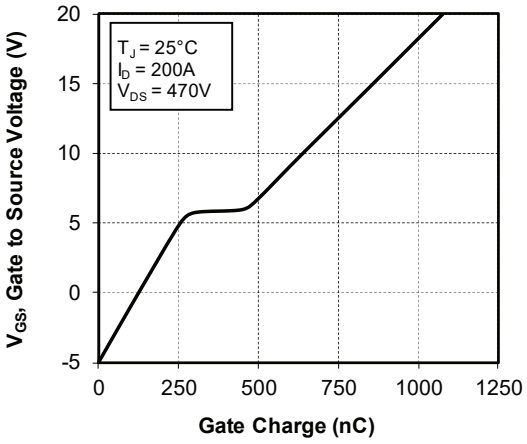


**Figure 1-10. Body Diode Characteristics, $T_J$ = 25 °C**

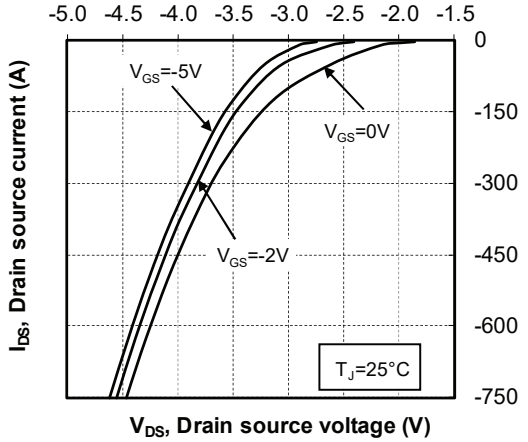



**Figure 1-11. 3rd Quadrant Characteristics, $T_J$ = 25 °C**

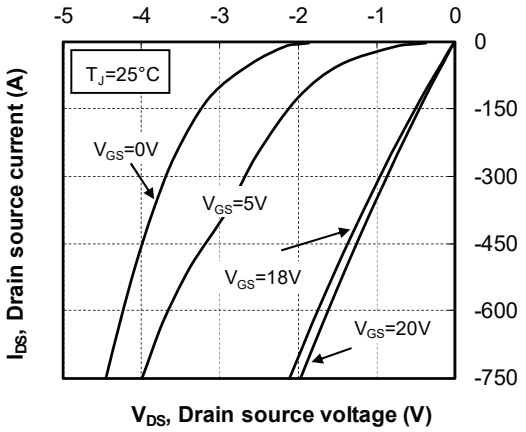



**Figure 1-12. Body Diode Characteristics, $T_J$ = 175 °C**

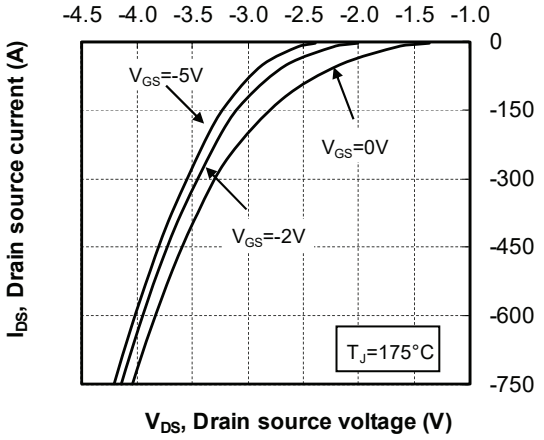



**Figure 1-13. 3rd Quadrant Characteristics, $T_J$ = 175 °C**

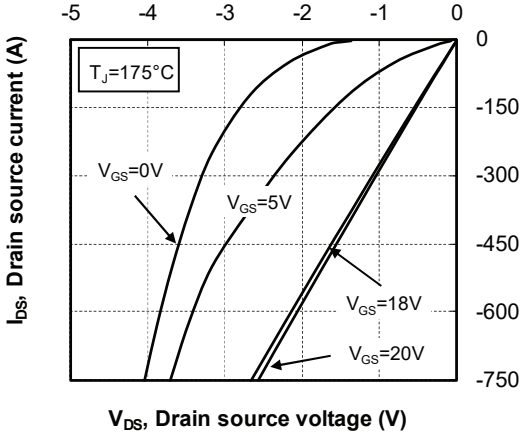



**Figure 1-14. Operating Frequency vs Drain Current**

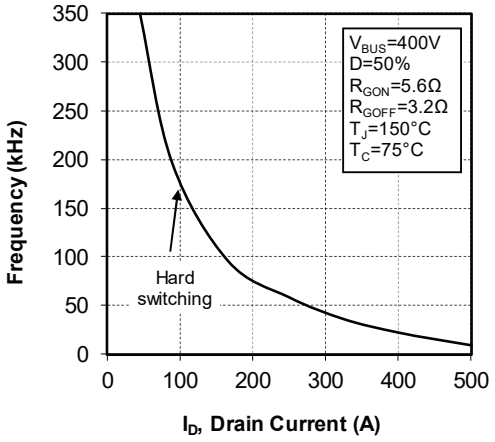
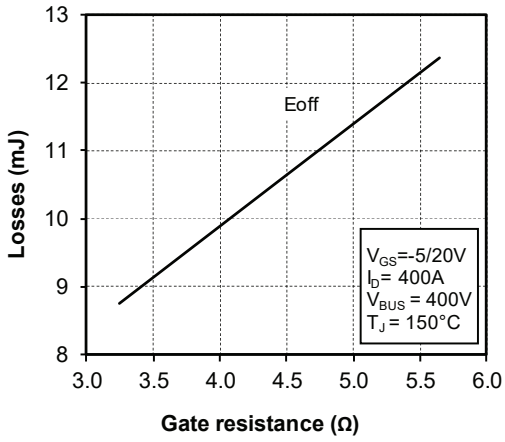


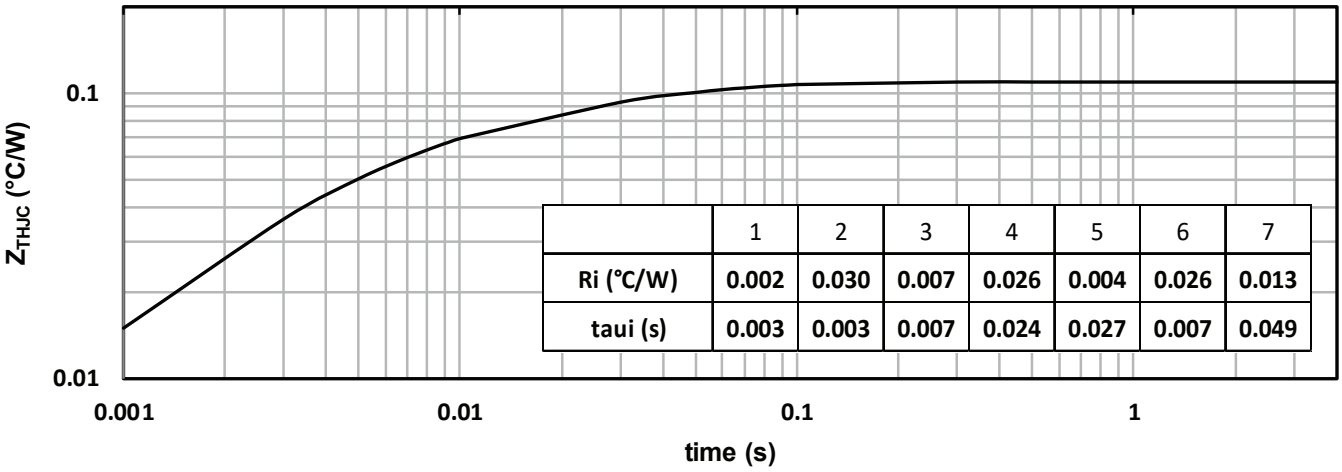

**Figure 1-15. Turn Off Energy vs. Rg**



## 1.5 Typical SiC Diode Performance Curves (Per SiC Diode)

This section shows the typical SiC diode performance curves of the MSCSM70VR1M03CT6AG device.

**Figure 1-16. Junction-to-Heatsink Thermal Impedance**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.002 | 0.030 | 0.007 | 0.026 | 0.004 | 0.026 | 0.013 |
| taui (s) | 0.003 | 0.003 | 0.007 | 0.024 | 0.027 | 0.007 | 0.049 |

**Figure 1-17. Forward Characteristics**

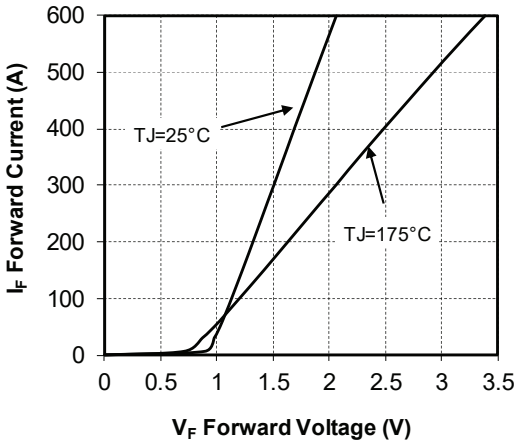
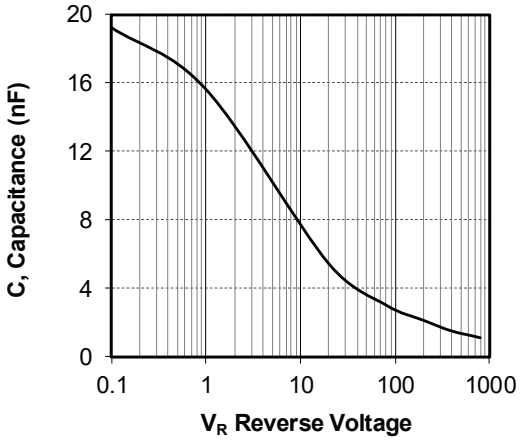



**Figure 1-18. Capacitance vs. Reverse Voltage**



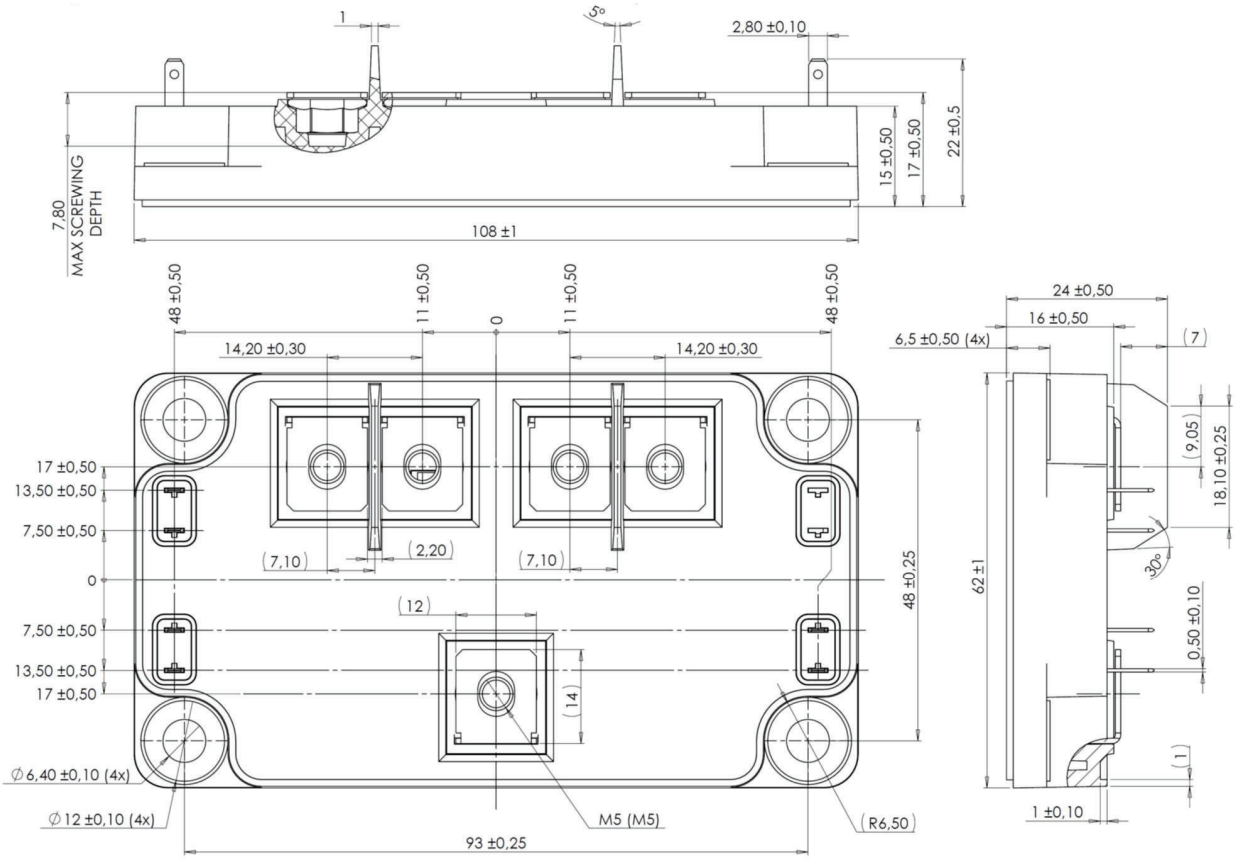
# 2. Package Specifications

The following section shows the package specification of the MSCSM70VR1M03CT6AG device.

## 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM70VR1M03CT6AG device. The dimensions in the following figure are in millimeters.

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



# 3. Revision History

| Revision | Date | Description |
|---|---|---|
| A | 08/2022 | Initial Revision |

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