# MSCSM170TAM45CT3AG
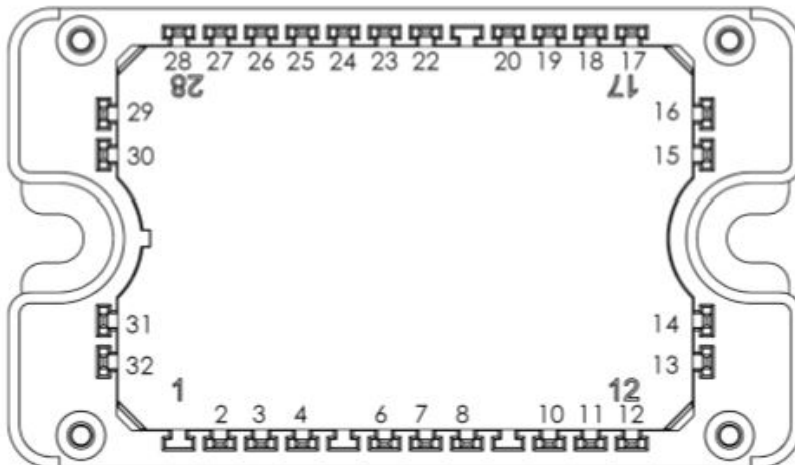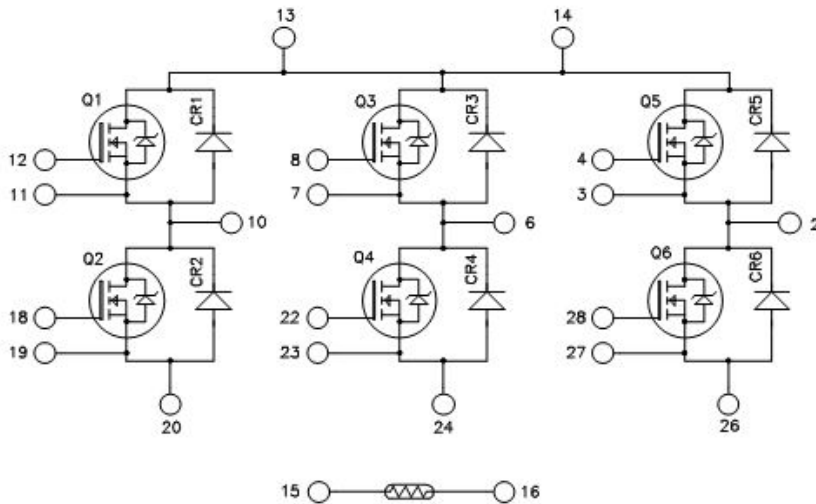
## Triple Phase Bridge SiC MOSFET Power Module

## Product Overview

The MSCSM170TAM45CT3AG device is a triple phase bridge 1700 V, 64 A silicon carbide (SiC) MOSFET power module.





**Note:** Pins 13/14 must be shorted together. Pins 20/24/26 must be shorted together to perform a three phase bridge.

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 MSCSM170TAM45CT3AG 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

## Benefits

The following are the benefits of MSCSM170TAM45CT3AG 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 mounting of PCB
- Low profile
- RoHS Compliant

## Application

The MSCSM170TAM45CT3AG 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 MSCSM170TAM45CT3AG device.

## 1.1    SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM170TAM45CT3AG device.

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

| Symbol | Parameter | | Maximum Ratings | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source voltage | | 1700 | V |
| $I_D$ | Continuous drain current | $T_C$ = 25 °C | 64 | A |
| | | $T_C$ = 80 °C | 51 | |
| $I_{DM}$ | Pulsed drain current | | 130 | |
| $V_{GS}$ | Gate-Source voltage | | −10/23 | V |
| $R_{DS(on)}$ | Drain-Source ON resistance | | 45 | mΩ |
| $P_D$ | Power dissipation | $T_C$ = 25 °C | 319 | W |

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM170TAM45CT3AG device.

**Table 1-2.  Electrical Characteristics**

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V; $V_{DS}$ = 1700 V | | — | 10 | 100 | µA |
| $R_{DS(on)}$ | Drain–Source on resistance | $V_{GS}$ = 20 V | $T_J$ = 25 °C | — | 35 | 45 | mΩ |
| | | $I_D$ = 30 A | $T_J$ = 175 °C | — | 62 | — | |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{GS}$ = $V_{DS}$; $I_D$ = 2.5 mA | | 1.8 | 3.2 | — | V |
| $I_{GSS}$ | Gate–Source leakage current | $V_{GS}$ = 20 V; $V_{DS}$ = 0 V | | — | — | 150 | nA |

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM170TAM45CT3AG device.

**Table 1-3. Dynamic Characteristics**

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{GS}$ = 0 V | | — | 3300 | — | pF |
| $C_{oss}$ | Output capacitance | $V_{DS}$ = 1000 V | | — | 150 | — | |
| $C_{rss}$ | Reverse transfer capacitance | f = 1 MHz | | — | 10 | — | |
| $Q_g$ | Total gate charge | $V_{GS}$ = –5 V/20 V | | — | 178 | — | nC |
| $Q_{gs}$ | Gate-source charge | $V_{Bus}$ = 850 V | | — | 49 | — | |
| $Q_{gd}$ | Gate-drain charge | $I_D$ = 30 A | | — | 27 | — | |
| $T_{d(on)}$ | Turn-on delay time | $T_J$ = 150 °C | | — | 24 | — | ns |
| $T_r$ | Rise time | $V_{GS}$ = –5 V/20 V | | — | 17 | — | |
| $T_{d(off)}$ | Turn-off delay time | $V_{Bus}$ = 900 V | | — | 35 | — | |
| $T_f$ | Fall time | $I_D$ = 50 A $R_{G(on)}$ = 4.7 Ω $R_{G(off)}$ = 2.7 Ω | | | 19 | — | |
| $E_{on}$ | Turn-on energy | $V_{GS}$ = –5 V/20 V $V_{Bus}$ = 900 V $I_D$ = 50 A $R_{G(on)}$ = 4.7 Ω $R_{G(off)}$ = 2.7 Ω | $T_J$ = 150 °C | — | 1.1 | — | mJ |
| $E_{off}$ | Turn-off energy | | $T_J$ = 150 °C | — | 0.16 | — | |
| $R_{Gint}$ | Internal gate resistance | | | — | 0.85 | — | Ω |
| $R_{thJC}$ | Junction-to-case thermal resistance | | | — | — | 0.47 | °C/W |

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM170TAM45CT3AG device.

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

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode forward voltage | $V_{GS}$ = 0 V; $I_{SD}$ = 30 A | — | 3.7 | — | V |
| | | $V_{GS}$ = –5 V; $I_{SD}$ = 30 A | — | 3.9 | — | |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 30 A; $V_{GS}$ = –5 V | — | 27 | — | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_R$ = 900 V; $di_F/dt$ = 1000 A/µs | — | 650 | — | nC |
| $I_{rr}$ | Reverse recovery current | | — | 46 | — | A |

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

The following table lists the SiC diode ratings and characteristics per SiC diode of MSCSM170TAM45CT3AG device.

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

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RRM}$ | Peak repetitive reverse voltage | | | — | — | 1700 | V |
| $I_{RRM}$ | Reverse leakage current | $V_R$ = 1700 V | $T_J$ = 25 °C | — | 10 | 200 | µA |
| | | | $T_J$ = 175 °C | — | 150 | — | |
| $I_F$ | DC forward current | — | $T_C$ = 125 °C | — | 30 | — | A |
| $V_F$ | Diode forward voltage | $I_F$ = 30 A | $T_J$ = 25 °C | — | 1.5 | 1.8 | V |
| | | | $T_J$ = 175 °C | — | 2.3 | — | |
| $Q_C$ | Total capacitive charge | $V_R$ = 900 V | | — | 230 | — | nC |
| C | Total capacitance | f = 1 MHz, $V_R$ = 600 V | | — | 167 | — | pF |
| | | f = 1 MHz, $V_R$ = 900 V | | — | 138 | — | |
| $R_{thJC}$ | Junction-to-case thermal resistance | | | — | — | 0.52 | °C/W |

## 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM170TAM45CT3AG 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 | M4 | 2 | 3 | N.m |
| Wt | Package weight | | | — | 110 | g |

The following table lists the temperature sensor NTC of the MSCSM170TAM45CT3AG device.

**Table 1-7. 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 | — | % |

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

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 MSCSM170TAM45CT3AG device.
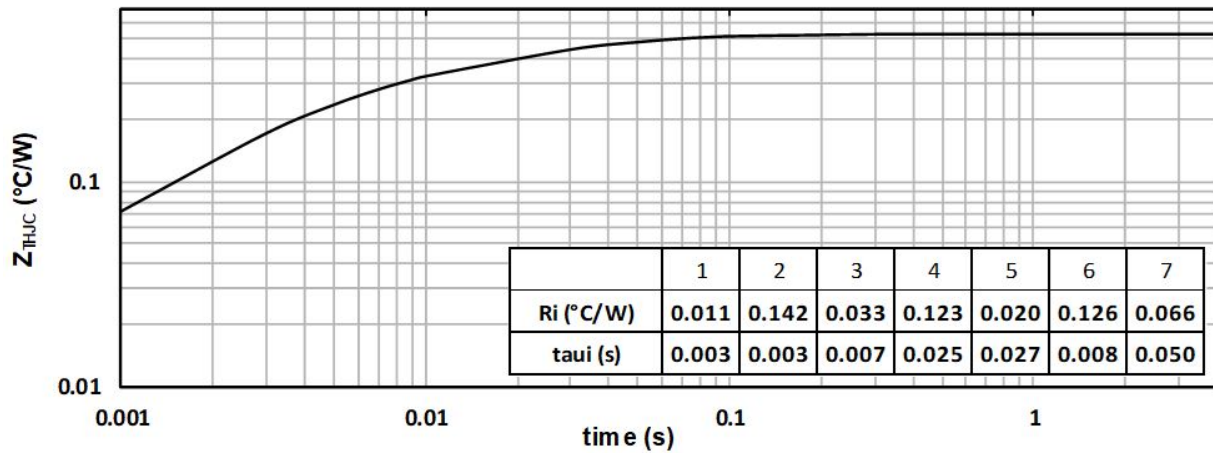
**Figure 1-1. Maximum Thermal Impedance**



| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.010 | 0.124 | 0.029 | 0.110 | 0.018 | 0.116 | 0.062 |
| taui (s) | 0.004 | 0.003 | 0.007 | 0.027 | 0.027 | 0.008 | 0.053 |
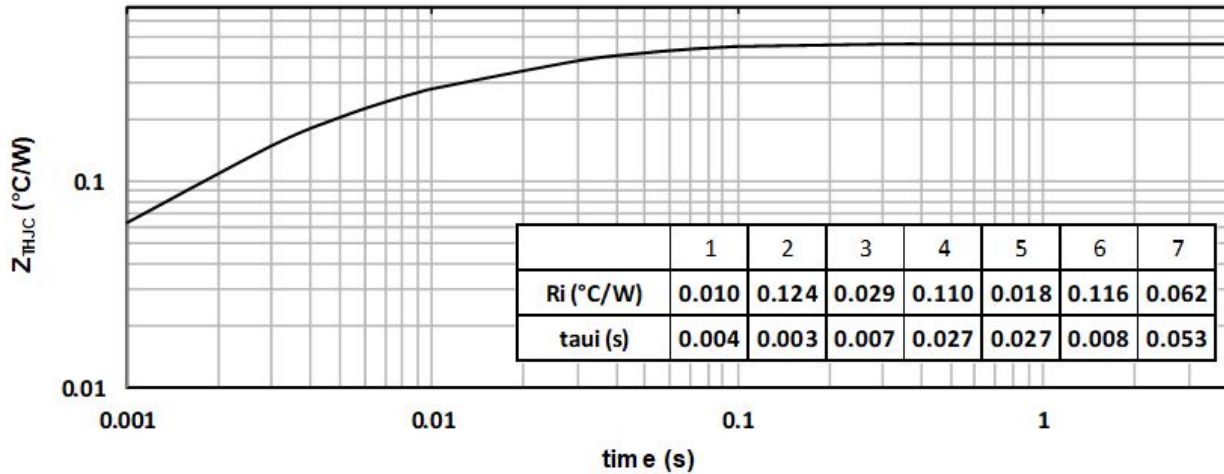
**Figure 1-2. Output Characteristics, T_J = 25 °C**
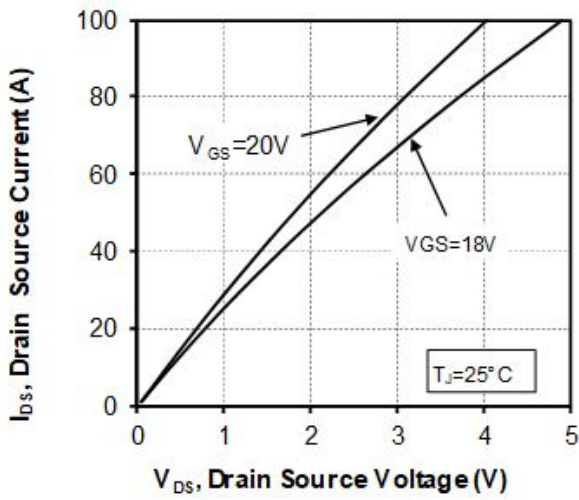


**Figure 1-3. Output Characteristics, T_J = 175 °C**
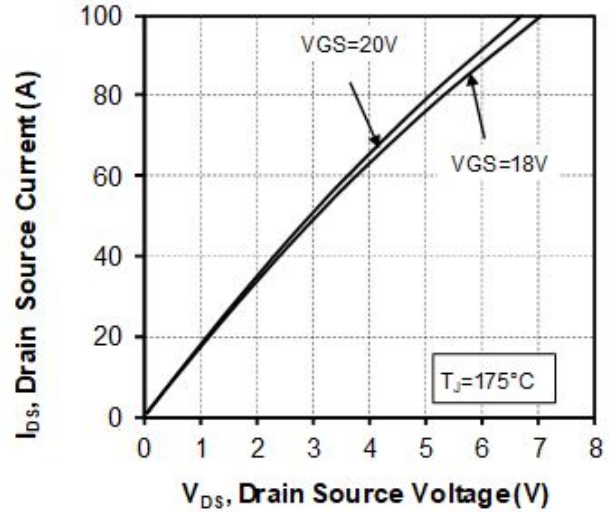


**Figure 1-4. Normalized R_DS(on) vs. Temperature**
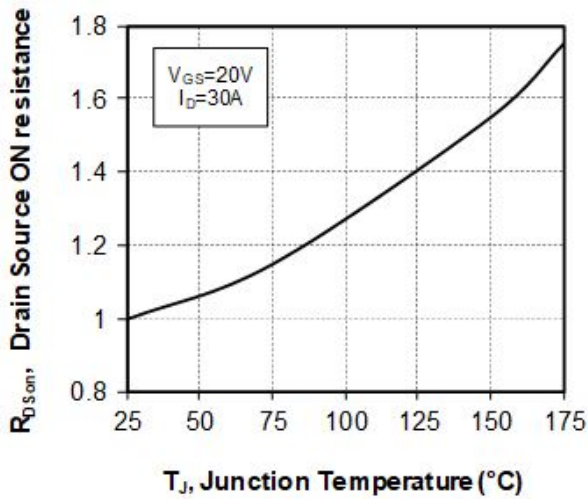


**Figure 1-5. Transfer Characteristics**
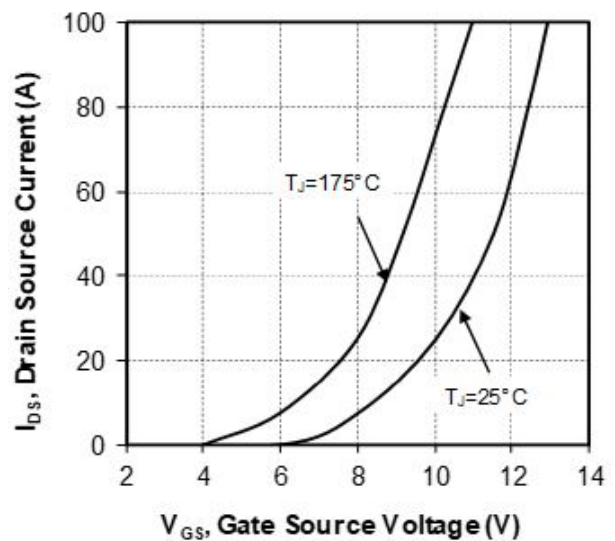
**Figure 1-6. Switching Energy vs. Rg**
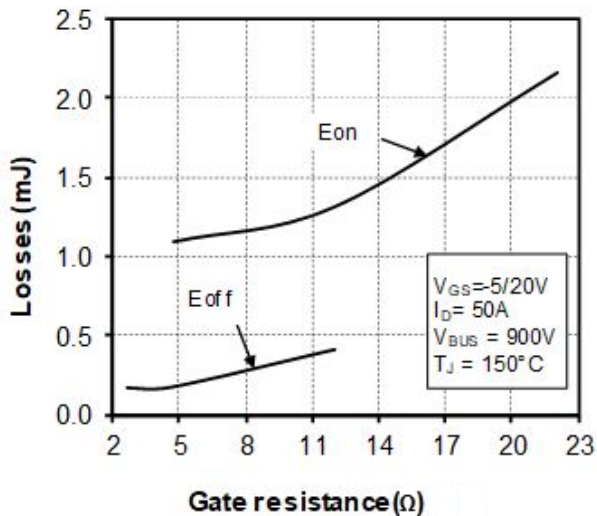


**Figure 1-7. Switching Energy vs. Current**
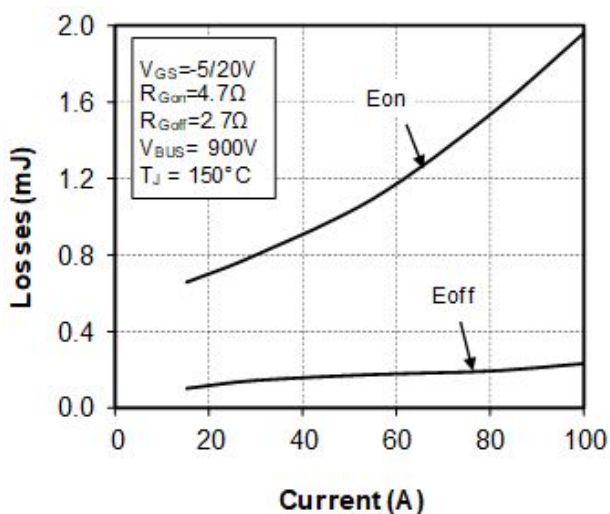


**Figure 1-8. Capacitance vs. Drain Source Voltage**
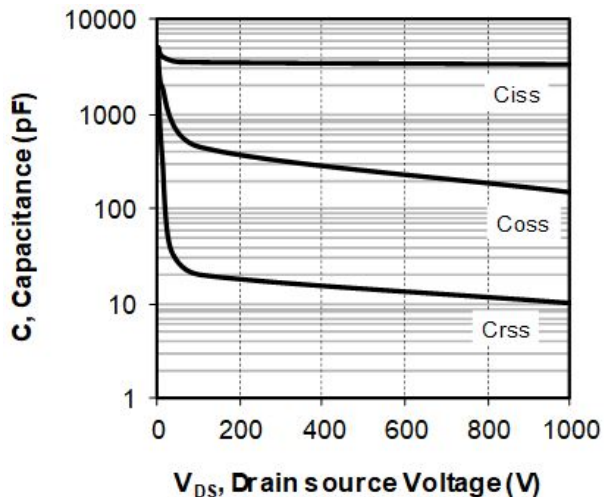


**Figure 1-9. Gate Charge vs. Gate Source Voltage**
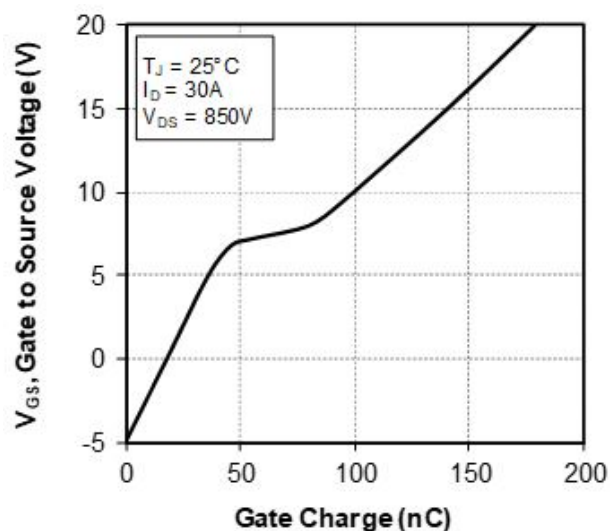
**Figure 1-10. Body Diode Characteristics, $T_J$ = 25 °C**
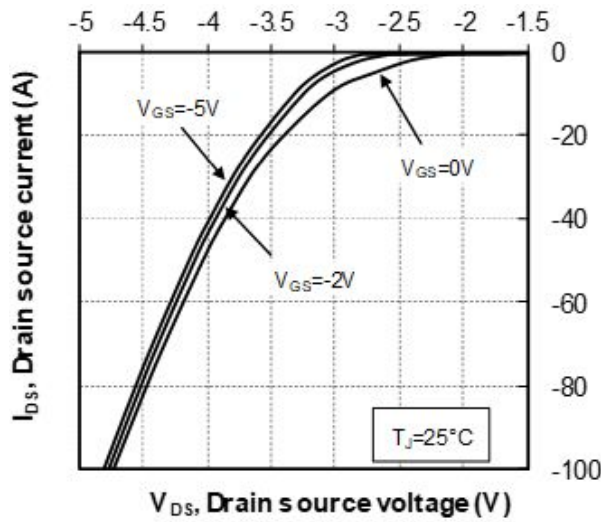


**Figure 1-11. 3rd Quadrant Characteristics, $T_J$ = 25 °C**
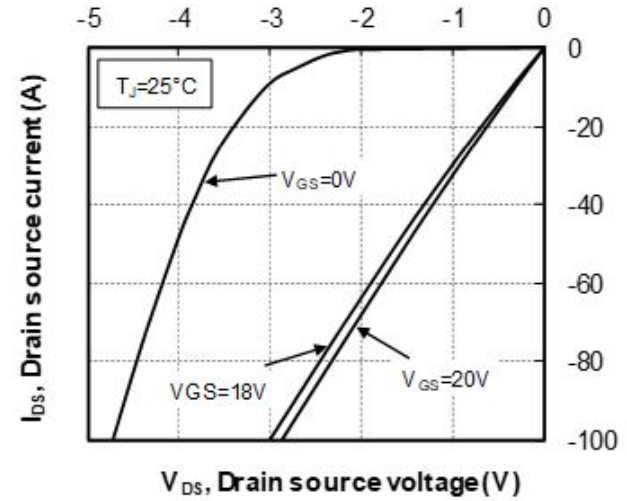


**Figure 1-12. Body Diode Characteristics, $T_J$ = 175 °C**
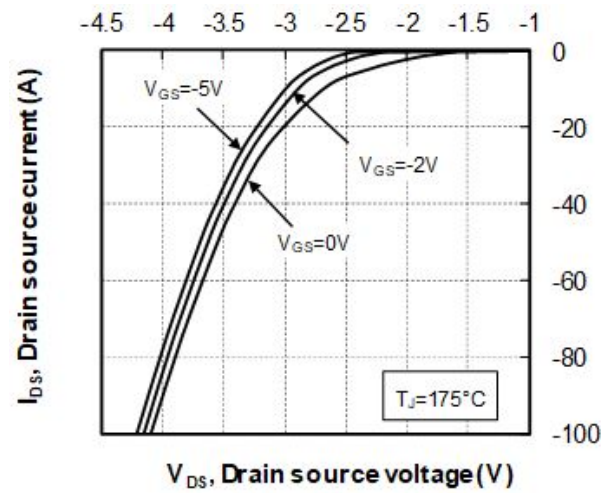


**Figure 1-13. 3rd Quadrant Characteristics, $T_J$ = 175 °C**
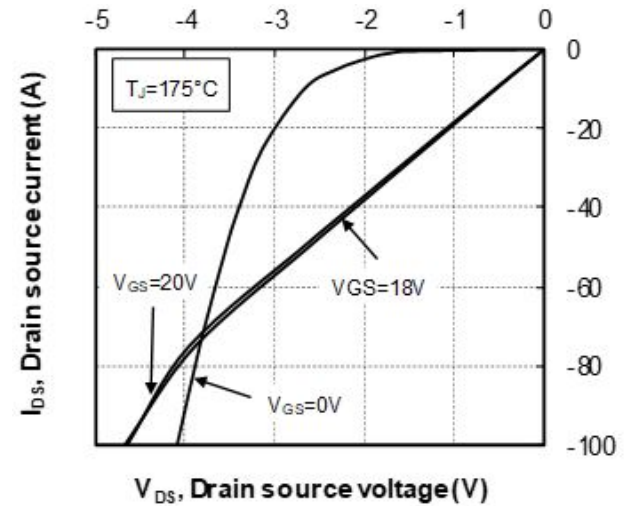
**Figure 1-14. Operating Frequency vs Drain Current**
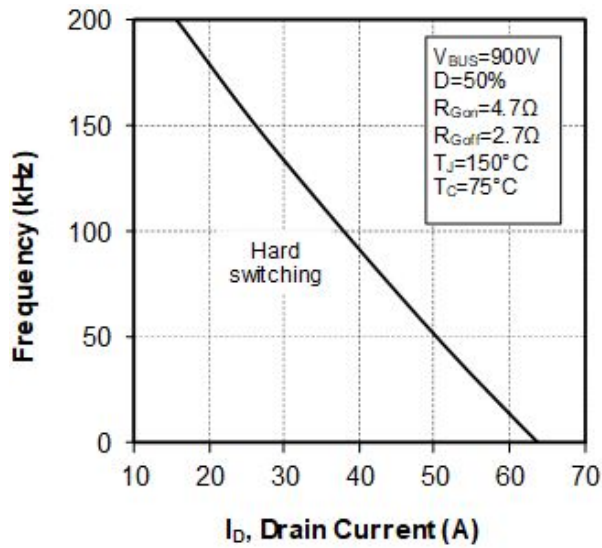


## 1.5    Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM170TAM45CT3AG device.

**Figure 1-15. Maximum Thermal Impedance**



| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.011 | 0.142 | 0.033 | 0.123 | 0.020 | 0.126 | 0.066 |
| taui (s) | 0.003 | 0.003 | 0.007 | 0.025 | 0.027 | 0.008 | 0.050 |

**Figure 1-16. Forward Characteristics**
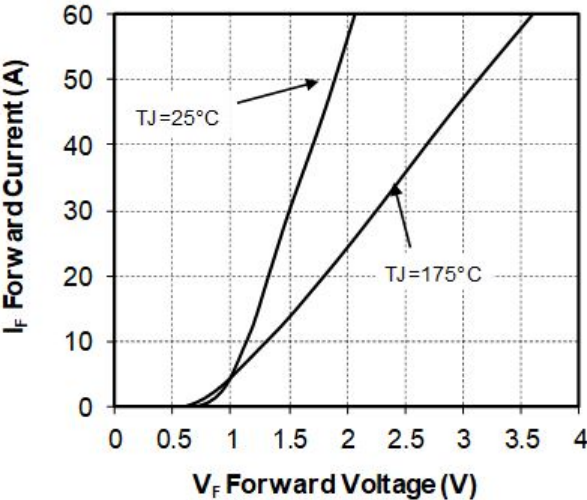


**Figure 1-17. Capacitance vs. Reverse Voltage**
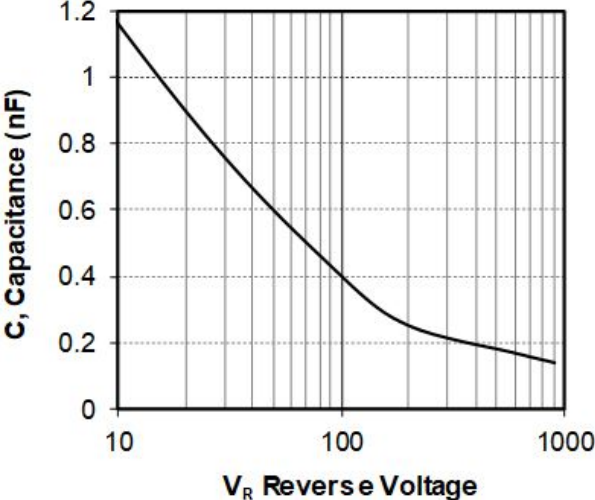
# 2. Package Specifications

The following section shows the package specification of the MSCSM170TAM45CT3AG device.

## 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170TAM45CT3AG device. The dimensions in the following figure are in millimeters.

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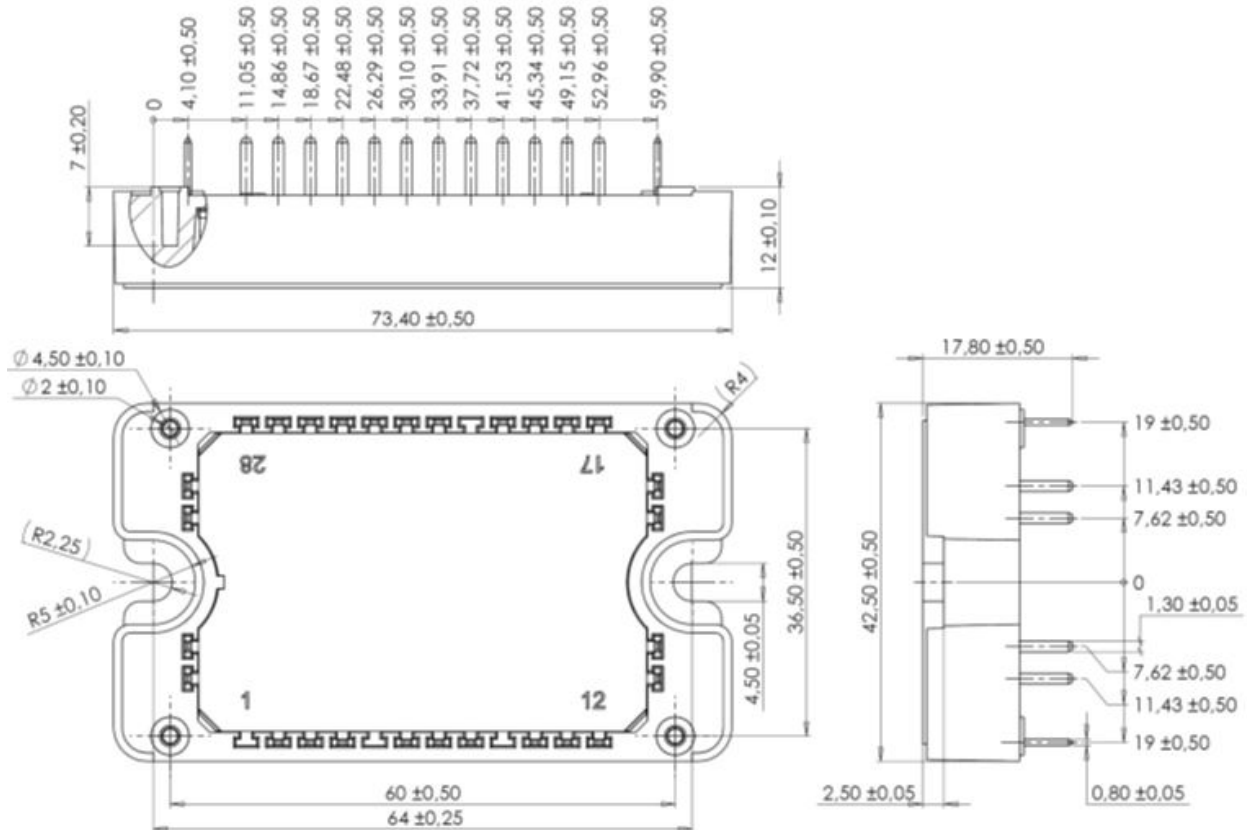


**Note:** See AN3500A—Mounting Instructions for SP1F and SP3F Power Modules for more information..

## 3.    Revision History

| Revision | Date | Description |
|---|---|---|
| A | 04/2021 | This is the first publication of this document. |

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