# MSCSM70HM19CT3AG
# Datasheet
# Full Bridge SiC MOSFET Power Module

April 2020

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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 is the first publication of this document, published in April 2020.

# 2 Product Overview

The MSCSM70HM19CT3AG is a full bridge 700 V/124 A full Silicon Carbide power module.

**Figure 1 • MSCSM70HM19CT3AG Electrical Schematic**

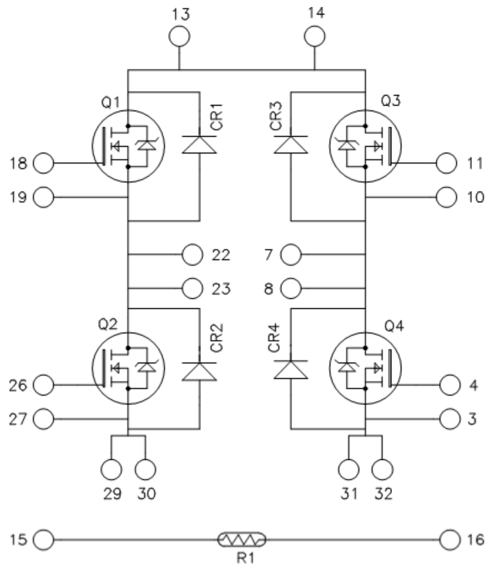
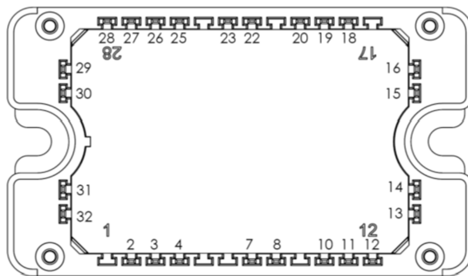



**Figure 2 • MSCSM70HM19CT3AG Pinout Location**




All multiple inputs & outputs must be shorted together
Example: 13/14 ; 29/30 ; 22/23 …

All ratings at $T_J$ = 25 °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 MSCSM70HM19CT3AG device:

- SiC Power MOSFET
  - High-speed switching
  - Low RDS(on)
  - Ultra low loss
- Silicon carbide (SiC) Schottky diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature-independent switching behavior
  - Positive temperature coefficient on VF
- Kelvin source for easy drive
- Very low stray inductance
- Internal thermistor for temperature monitoring
- Aluminum nitride (AlN) substrate for improved thermal performance

## 2.2 Benefits

The following are benefits of the MSCSM70HM19CT3AG device:

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

## 2.3 Applications

The MSCSM70HM19CT3AG device is designed for the following applications:

- Welding converters
- Switched Mode Power Supplies
- Uninterruptible Power Supplies
- EV motor and traction drive

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# 3 Electrical Specifications

This section shows the electrical specifications of the MSCSM70HM19CT3AG device.

## 3.1 SiC MOSFET Characteristics (Per MOSFET)

This section describes the electrical characteristics of the MSCSM70HM19CT3AG device.

**Table 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 | 124[1] | A |
| | | $T_C$ = 80 °C | 98[1] | A |
| $I_{DM}$ | Pulsed drain current | | 250 | A |
| $V_{GS}$ | Gate-source voltage | | –10/25 | V |
| $R_{DSon}$ | Drain-source ON resistance | | 19 | mΩ |
| $P_D$ | Power dissipation | $T_C$ = 25 °C | 365 | W |

**Note:**

1. Specification of SiC MOSFET device but output current must be limited due to the size of power connectors.

**Table 2 • Electrical Characteristics**

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0V; $V_{DS}$ = 700 V | | | | 100 | µA |
| $R_{DSon}$ | Drain–source on resistance | $V_{GS}$ = 20 V<br>$I_D$ = 40 A | $T_J$ = 25 °C | | 15 | 19 | mΩ |
| | | | $T_J$ = 175 °C | | 18.8 | | |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 4 mA | | 1.9 | 2.4 | | V |
| $I_{GSS}$ | Gate–source leakage current | $V_{GS}$ = 20 V, $V_{DS}$ = 0 V | | | | 150 | nA |

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**Table 3 • Dynamic Characteristics**

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{GS}$ = 0 V<br>$V_{DS}$ = 700 V<br>f = 1 MHz | | | 4500 | | pF |
| $C_{oss}$ | Output capacitance | | | | 510 | | pF |
| $C_{rss}$ | Reverse transfer capacitance | | | | 29 | | pF |
| $Q_g$ | Total gate charge | $V_{GS}$= –5/20 V<br>$V_{Bus}$ = 470 V<br>$I_D$ = 40 A | | | 215 | | nC |
| $Q_{gs}$ | Gate–source charge | | | | 58 | | nC |
| $Q_{gd}$ | Gate–drain charge | | | | 35 | | nC |
| $T_{d(on)}$ | Turn-on delay time | $V_{GS}$ = –5/20 V<br>$V_{Bus}$ = 400 V<br>$I_D$ = 80 A<br>TJ = 150 °C<br>$R_{Gon}$ = 27 Ω; $R_{Goff}$ = 4.7 Ω | | | 40 | | ns |
| $T_r$ | Rise time | | | | 35 | | ns |
| $T_{d(off)}$ | Turn-off delay time | | | | 50 | | ns |
| $T_f$ | Fall time | | | | 20 | | ns |
| $E_{on}$ | Turn on energy | Inductive Switching<br>$V_{GS}$ = –5/20 V<br>$V_{Bus}$ = 400 V<br>$I_D$ = 80 A<br>$R_{Gon}$ = 27 Ω<br>$R_{Goff}$ = 4.7 Ω | $T_J$ = 150 °C | | 545 | | µJ |
| $E_{off}$ | Turn off energy | | $T_J$ = 150 °C | | 186 | | µJ |
| $R_{Gint}$ | Internal gate resistance | | | | 0.69 | | Ω |
| $R_{thJC}$ | Junction-to-case thermal resistance | | | | | 0.41 | °C/W |

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

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode forward voltage | $V_{GS}$ = 0 V; $I_{SD}$ = 40 A | | 3.4 | | V |
| | | $V_{GS}$ = –5 V; $I_{SD}$ = 40 A | | 3.8 | | |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 40 A; $V_{GS}$ = –5 V; $V_R$ = 400 V;<br>diF/dt = 1000 A/µs | | 38 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | | 318 | | nC |
| $I_{rr}$ | Reverse recovery current | | | 14.8 | | A |

## 3.2 SiC Schottky Diode Ratings Characteristics

This section shows the SiC Schottky diode ratings and characteristics of the device.

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

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RRM}$ | Peak repetitive reverse voltage | | | | | 700 | V |
| $I_{RRM}$ | Reverse leakage current | $V_R$ = 700 V | $T_J$ = 25 °C | | 15 | 200 | µA |
| | | | $T_J$ = 175 °C | | 250 | | |
| $I_F$ | Forward current | | $T_C$ = 80 °C | | 50 | | A |
| $V_F$ | Diode forward voltage | $I_F$ = 50 A | $T_J$ = 25 °C | | 1.5 | 1.8 | V |
| | | | $T_J$ = 175 °C | | 1.9 | | |
| $Q_C$ | Total capacitive charge | $V_R$ = 400 V | | | 133 | | nC |
| C | Total capacitance | f = 1 MHz, $V_R$ = 200 V | | | 248 | | pF |
| | | f = 1 MHz, $V_R$ = 400 V | | | 216 | | |
| $R_{thJC}$ | Junction-to-case thermal resistance | | | | | 0.86 | °C/W |

## 3.3 Thermal and Package Characteristics

This section shows the thermal and package characteristics of the device.

**Table 6 • Package Characteristics**

| Symbol | Characteristic | | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{ISOL}$ | RMS isolation voltage, any terminal to case t = 1 min, 50/60Hz | | | 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 |

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**Table 7 • Temperature Sensor NTC[1]**

| 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 |
| 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

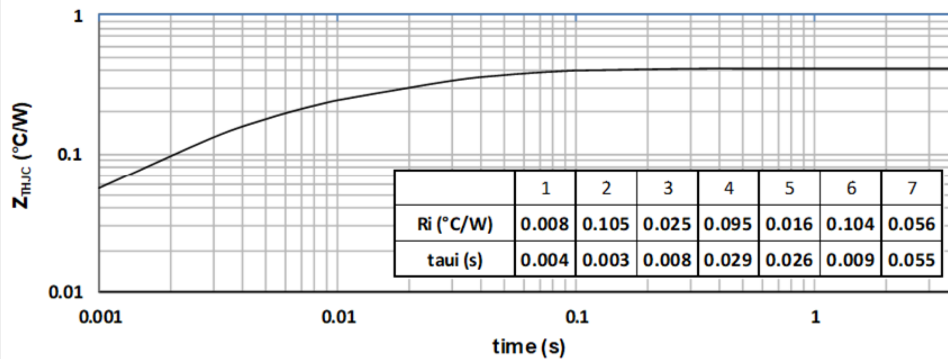
**Note:**

1. See application note APT0406 on *www.microsemi.com*.

## 3.4 Typical SiC MOSFET Performance Curves

This section shows the typical performance curves of the MSCSM70HM19CT3AG SiC MOSFET.

**Figure 3 • Maximum Thermal Impedance**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.008 | 0.105 | 0.025 | 0.095 | 0.016 | 0.104 | 0.056 |
| taui (s) | 0.004 | 0.003 | 0.008 | 0.029 | 0.026 | 0.009 | 0.055 |

**Figure 4 • Output Characteristics, $T_J$ = 25 °C**

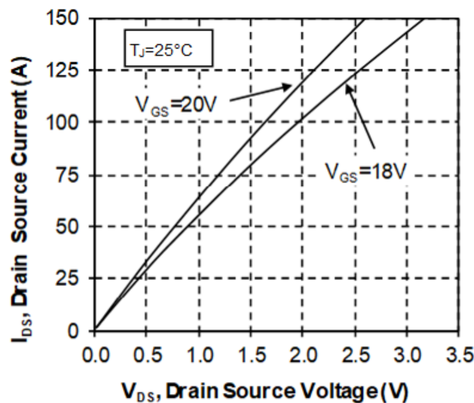



**Figure 5 • Output Characteristics, $T_J$ = 175 °C**

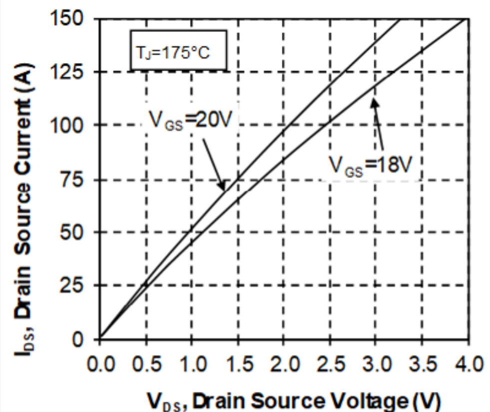


**Figure 6 • Normalized RDS(on) vs. Temperature**

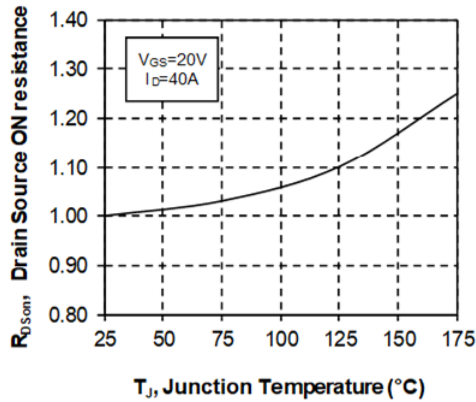



**Figure 7 • Transfer Characteristics**

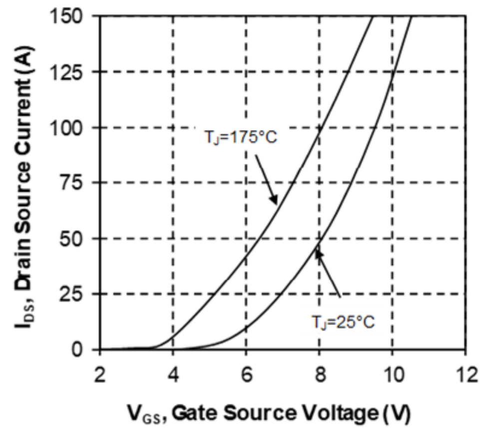



**Figure 8 • Capacitance vs. Drain Source Voltage**

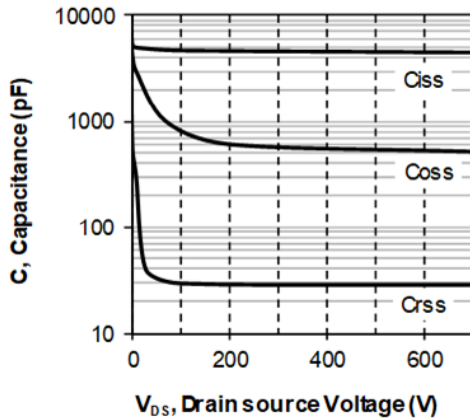



**Figure 9 • Gate Charge vs. Gate Source Voltage**

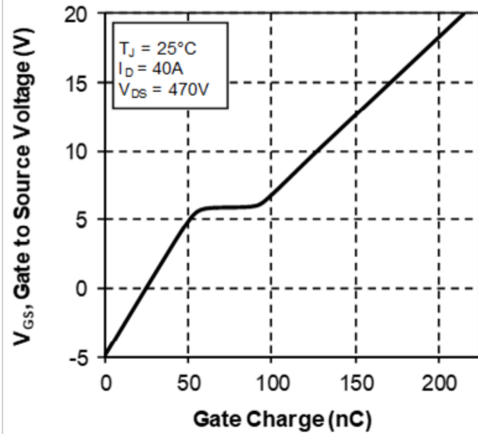



**Figure 10 • Body Diode Characteristics, $T_J$ = 25 °C**

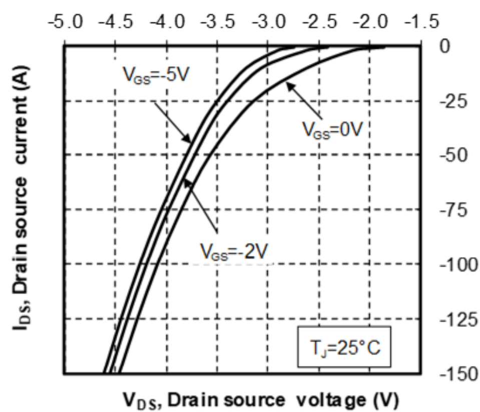



**Figure 11 • 3rd Quadrant Characteristics, $T_J$ = 25 °C**

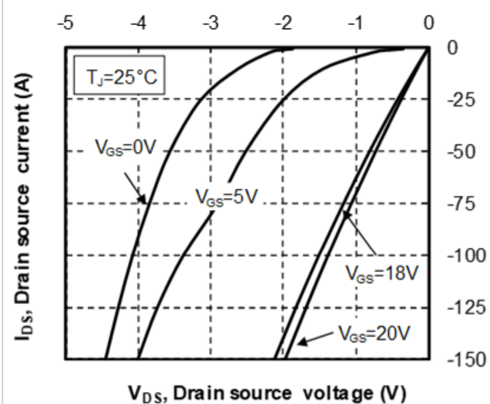


Figure 12 • Body Diode Characteristics, $T_J$ = 175 °C

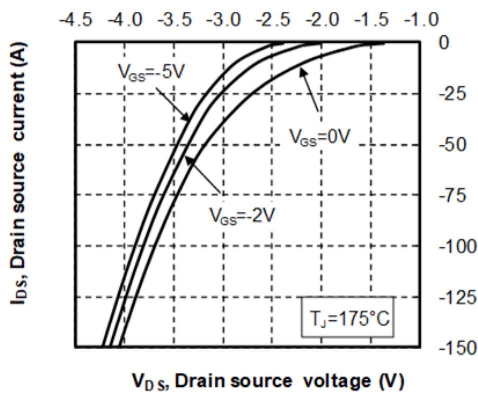



Figure 13 • 3rd Quadrant Characteristics, $T_J$ = 175 °C

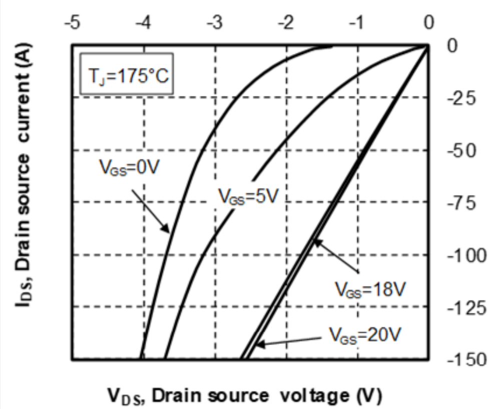



Figure 14 • Switching Energy vs. Current

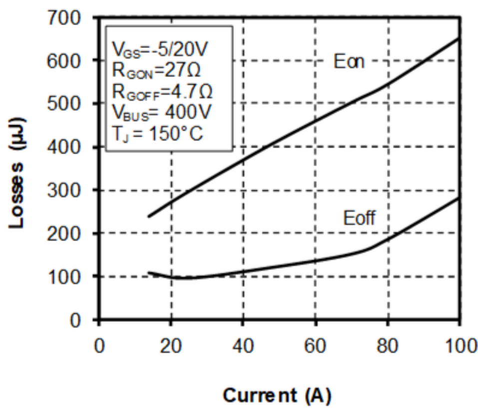



Figure 15 • Turn-on Energy vs. Rg

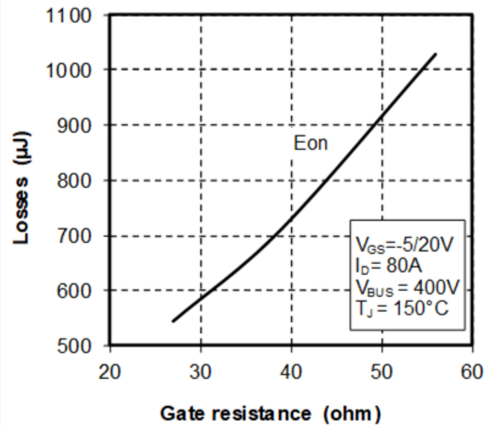



Figure 16 • Turn-off Energy vs. Rg

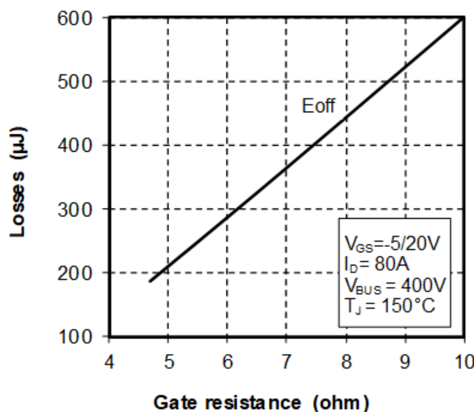
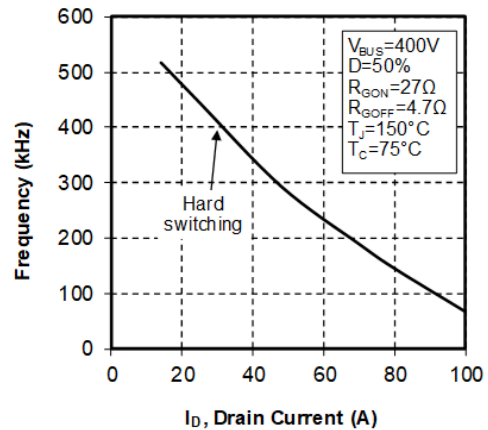


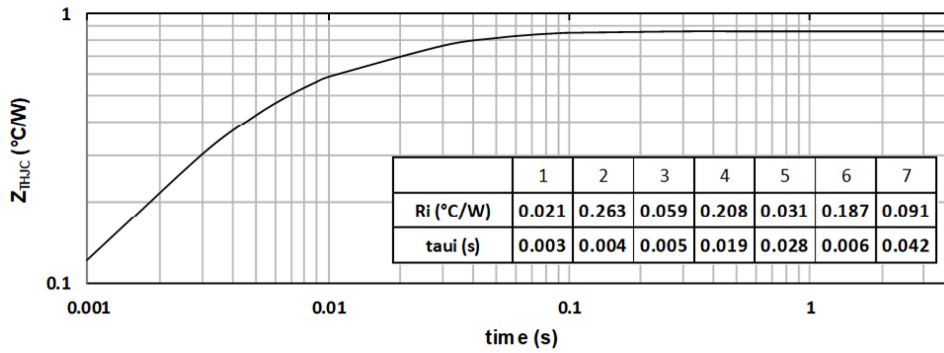

Figure 17 • Operating Frequency vs. Drain Current



## 3.5 Typical SiC Diode Performance

This section shows the typical performance curves of the MSCSM70HM19CT3AG SiC diode.

**Figure 18 • Maximum Thermal Impedance**




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Ri (°C/W) | 0.021 | 0.263 | 0.059 | 0.208 | 0.031 | 0.187 | 0.091 |
| taui (s) | 0.003 | 0.004 | 0.005 | 0.019 | 0.028 | 0.006 | 0.042 |

**Figure 19 • Forward Characteristics**

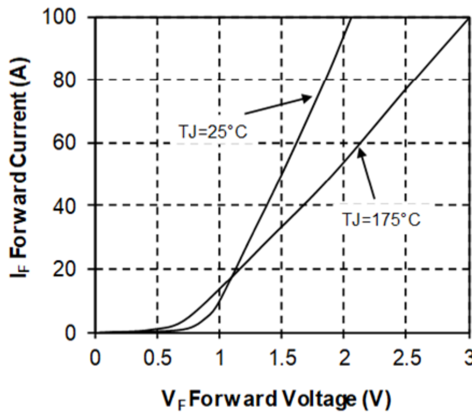
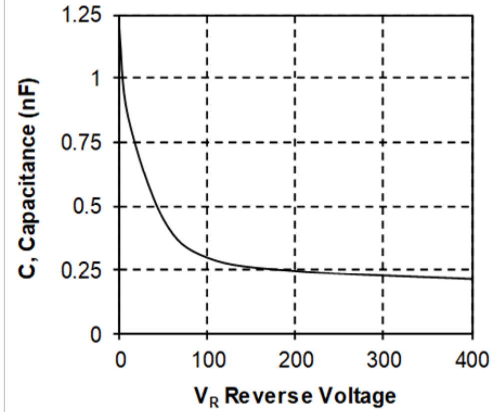


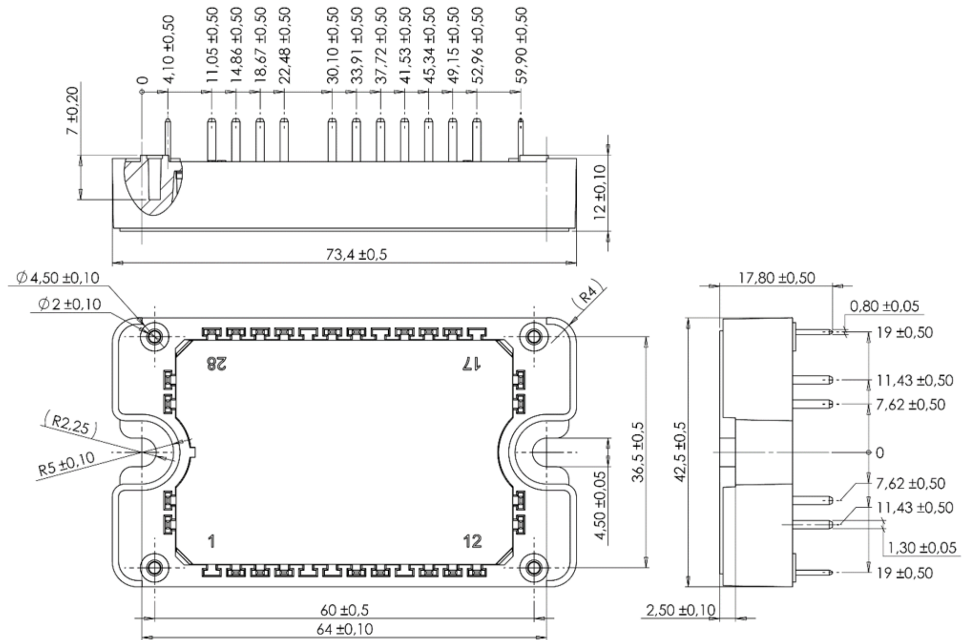

**Figure 20 • Capacitance vs. Reverse Voltage**



# 4 Package Specification

This section shows the package outline of the MSCSM70HM19CT3AG device. All dimensions are in millimeters.

**Figure 21 • Package Outline**




See application note 1906 – Mounting Instructions for SP3F Power Modules on *www.microsemi.com*.

**Microsemi**
2355 W. Chandler Blvd.
Chandler, AZ 85224 USA

Within the USA: +1 (480) 792-7200
Fax: +1 (480) 792-7277

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