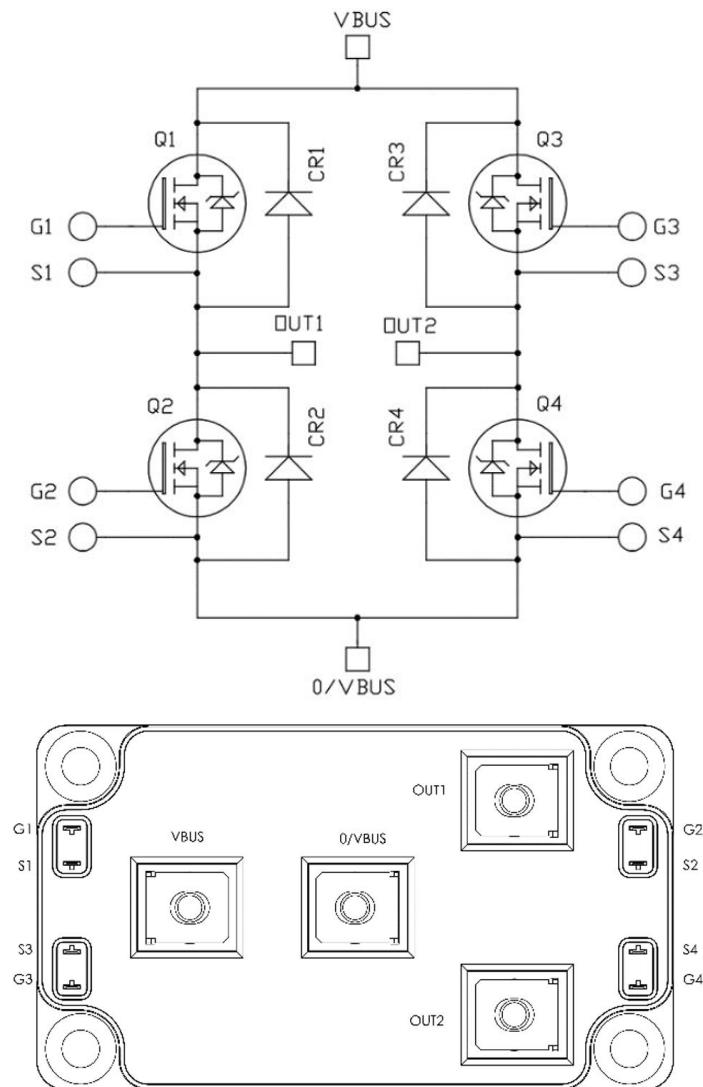


## Full Bridge SiC Power Module

### Product Overview

The MSCSM170HM12CAG device is a 1700 V/179 A full bridge silicon carbide (SiC) power module.



All ratings at  $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified.

**Caution:** These devices are sensitive to electrostatic discharge. Proper handling procedures must be followed.

## Features

The following are the key features of MSCSM170HM12CAG 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 VF
- Kelvin source for easy drive
- Low stray inductance
- M5 power connectors
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

The following are the benefits of MSCSM170HM12CAG device:

- High efficiency converter
- Outstanding performance at high-frequency operation
- Stable temperature behavior
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- RoHS compliant

## Applications

The following are the applications of MSCSM170HM12CAG device:

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

## 1. Electrical Specifications

The following sections show the electrical specifications of the MSCSM170HM12CAG device.

### 1.1 SiC MOSFET Characteristics (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the MSCSM170HM12CAG device.

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

| Symbol       | Parameter                  |                                    | Maximum Ratings | Unit       |
|--------------|----------------------------|------------------------------------|-----------------|------------|
| $V_{DS}$     | Drain-Source voltage       |                                    | 1700            | V          |
| $I_D$        | Continuous drain current   | $T_C = 25\text{ }^{\circ}\text{C}$ | 179             | A          |
|              |                            | $T_C = 80\text{ }^{\circ}\text{C}$ | 142             |            |
| $I_{DM}$     | Pulsed drain current       |                                    | 360             |            |
| $V_{GS}$     | Gate-Source voltage        |                                    | -10/23          | V          |
| $R_{DS(on)}$ | Drain-Source ON resistance |                                    | 15              | m $\Omega$ |
| $P_D$        | Power dissipation          | $T_C = 25\text{ }^{\circ}\text{C}$ | 843             | W          |

The following table lists the electrical characteristics (per SiC MOSFET) of the MSCSM170HM12CAG device.

**Table 1-2. Electrical Characteristics**

| Symbol       | Characteristic                  | Test Conditions                                  |                                     | Min | Typ  | Max | Unit          |
|--------------|---------------------------------|--------------------------------------------------|-------------------------------------|-----|------|-----|---------------|
| $I_{DSS}$    | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$ ; $V_{DS} = 1700\text{ V}$ |                                     | —   | 30   | 300 | $\mu\text{A}$ |
| $R_{DS(on)}$ | Drain-Source on resistance      | $V_{GS} = 20\text{ V}$<br>$I_D = 90\text{ A}$    | $T_J = 25\text{ }^{\circ}\text{C}$  | —   | 11.7 | 15  | m $\Omega$    |
|              |                                 |                                                  | $T_J = 175\text{ }^{\circ}\text{C}$ | —   | 20.8 | —   |               |
| $V_{GS(th)}$ | Gate threshold voltage          | $V_{GS} = V_{DS}$ ; $I_D = 7.5\text{ mA}$        |                                     | 1.8 | 3.2  | —   | V             |
| $I_{GSS}$    | Gate-Source leakage current     | $V_{GS} = 20\text{ V}$ ; $V_{DS} = 0\text{ V}$   |                                     | —   | —    | 300 | nA            |

The following table lists the dynamic characteristics (per SiC MOSFET) of the MSCSM170HM12CAG device.

**Table 1-3. Dynamic Characteristics**

| Symbol       | Characteristic                      | Test Conditions                                                                                                     | Min                                 | Typ  | Max   | Unit                        |
|--------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------------------|------|-------|-----------------------------|
| $C_{iss}$    | Input capacitance                   | $V_{GS} = 0\text{ V}$                                                                                               | —                                   | 9900 | —     | pF                          |
| $C_{oss}$    | Output capacitance                  | $V_{DS} = 1000\text{ V}$                                                                                            | —                                   | 450  | —     |                             |
| $C_{rss}$    | Reverse transfer capacitance        | $f = 1\text{ MHz}$                                                                                                  | —                                   | 30   | —     |                             |
| $Q_g$        | Total gate charge                   | $V_{GS} = -5\text{ V}/20\text{ V}$                                                                                  | —                                   | 534  | —     | nC                          |
| $Q_{gs}$     | Gate-source charge                  | $V_{Bus} = 850\text{ V}$                                                                                            | —                                   | 147  | —     |                             |
| $Q_{gd}$     | Gate-drain charge                   | $I_D = 90\text{ A}$                                                                                                 | —                                   | 81   | —     |                             |
| $T_{d(on)}$  | Turn-on delay time                  | $V_{GS} = -5\text{ V}/20\text{ V}$                                                                                  | —                                   | 75   | —     | ns                          |
| $T_r$        | Rise time                           | $V_{Bus} = 900\text{ V}$                                                                                            | —                                   | 75   | —     |                             |
| $T_{d(off)}$ | Turn-off delay time                 | $I_D = 150\text{ A}$                                                                                                | —                                   | 153  | —     |                             |
| $T_f$        | Fall time                           | $T_J = 150\text{ }^{\circ}\text{C}$<br>$R_{GON} = 9.4\text{ }\Omega$<br>$R_{GOFF} = 5.4\text{ }\Omega$              | —                                   | 56   | —     |                             |
| $E_{on}$     | Turn-on energy                      | $V_{GS} = -5\text{ V}/20\text{ V}$                                                                                  | $T_J = 150\text{ }^{\circ}\text{C}$ | —    | 6.7   | mJ                          |
| $E_{off}$    | Turn-off energy                     | $V_{Bus} = 900\text{ V}$<br>$I_D = 150\text{ A}$<br>$R_{GON} = 9.4\text{ }\Omega$<br>$R_{GOFF} = 5.4\text{ }\Omega$ | $T_J = 150\text{ }^{\circ}\text{C}$ | —    | 3.6   |                             |
| $R_{Gint}$   | Internal gate resistance            |                                                                                                                     | —                                   | 1.95 | —     | $\Omega$                    |
| $R_{thJC}$   | Junction-to-case thermal resistance |                                                                                                                     | —                                   | —    | 0.178 | $^{\circ}\text{C}/\text{W}$ |

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the MSCSM170HM12CAG device.

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

| Symbol   | Characteristic           | Test Conditions                                               | Min | Typ  | Max | Unit |
|----------|--------------------------|---------------------------------------------------------------|-----|------|-----|------|
| $V_{SD}$ | Diode forward voltage    | $V_{GS} = 0\text{ V}; I_{SD} = 90\text{ A}$                   | —   | 3.7  | —   | V    |
|          |                          | $V_{GS} = -5\text{ V}; I_{SD} = 90\text{ A}$                  | —   | 3.9  | —   |      |
| $t_{rr}$ | Reverse recovery time    | $I_{SD} = 90\text{ A}$                                        | —   | 27   | —   | ns   |
| $Q_{rr}$ | Reverse recovery charge  | $V_{GS} = -5\text{ V}$                                        | —   | 1950 | —   | nC   |
| $I_{rr}$ | Reverse recovery current | $V_R = 900\text{ V}$<br>$di_F/dt = 3000\text{ A}/\mu\text{s}$ | —   | 138  | —   | A    |

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

The following table lists the SiC Schottky diode ratings and characteristics of the MSCSM170HM12CAG device.

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

| Symbol     | Characteristic                      | Test Conditions                        |                                     | Min | Typ | Max   | Unit                 |
|------------|-------------------------------------|----------------------------------------|-------------------------------------|-----|-----|-------|----------------------|
| $V_{RRM}$  | Peak repetitive reverse voltage     |                                        |                                     | —   | —   | 1700  | V                    |
| $I_{RRM}$  | Reverse leakage current             | $V_R = 1700\text{ V}$                  | $T_J = 25\text{ }^{\circ}\text{C}$  | —   | 30  | 600   | $\mu\text{A}$        |
|            |                                     |                                        | $T_J = 175\text{ }^{\circ}\text{C}$ | —   | 450 | —     |                      |
| $I_F$      | DC forward current                  | —                                      | $T_C = 125\text{ }^{\circ}\text{C}$ | —   | 90  | —     | A                    |
| $V_F$      | Diode forward voltage               | $I_F = 90\text{ A}$                    | $T_J = 25\text{ }^{\circ}\text{C}$  | —   | 1.5 | 1.8   | V                    |
|            |                                     |                                        | $T_J = 175\text{ }^{\circ}\text{C}$ | —   | 2.3 | —     |                      |
| $Q_C$      | Total capacitive charge             | $V_R = 900\text{ V}$                   |                                     | —   | 690 | —     | nC                   |
| C          | Total capacitance                   | $f = 1\text{ MHz}, V_R = 600\text{ V}$ |                                     | —   | 501 | —     | pF                   |
|            |                                     | $f = 1\text{ MHz}, V_R = 900\text{ V}$ |                                     | —   | 414 | —     |                      |
| $R_{thJC}$ | Junction-to-case thermal resistance |                                        |                                     | —   | —   | 0.197 | $^{\circ}\text{C/W}$ |

### 1.3 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM170HM12CAG device.

**Table 1-6. Thermal and 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 case temperature                                                     |               |    | −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                  |

### 1.4 Typical SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the MSCSM170HM12CAG device.

Figure 1-1. Maximum Thermal Impedance

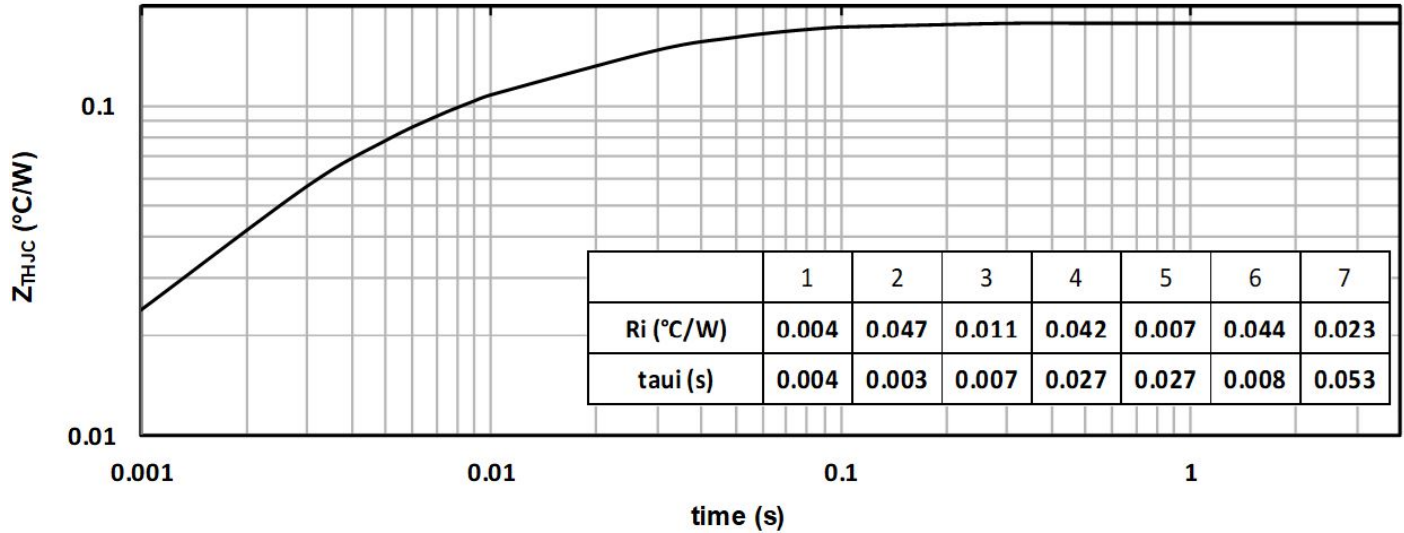


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

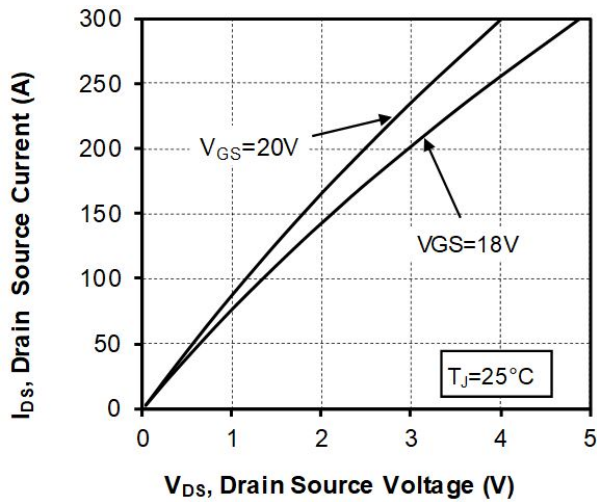
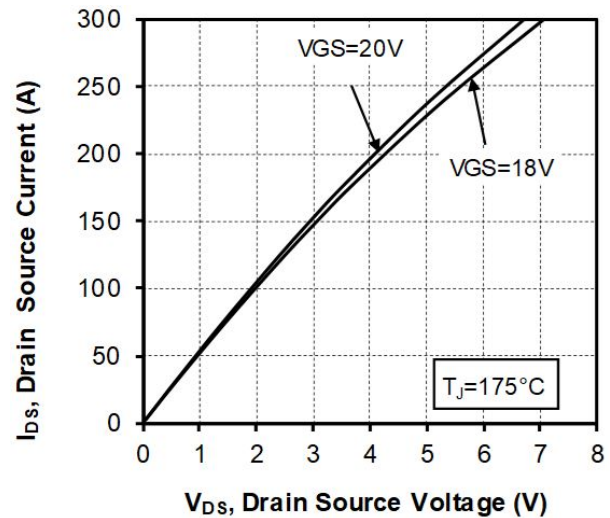


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$



# MSCSM170HM12CAG

## Electrical Specifications

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

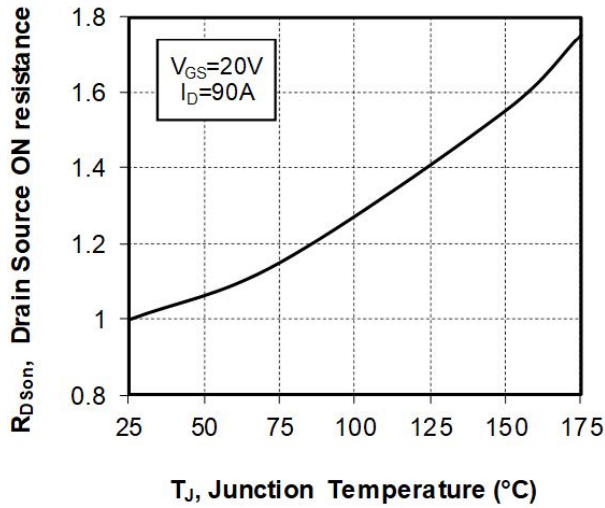


Figure 1-5. Transfer Characteristics

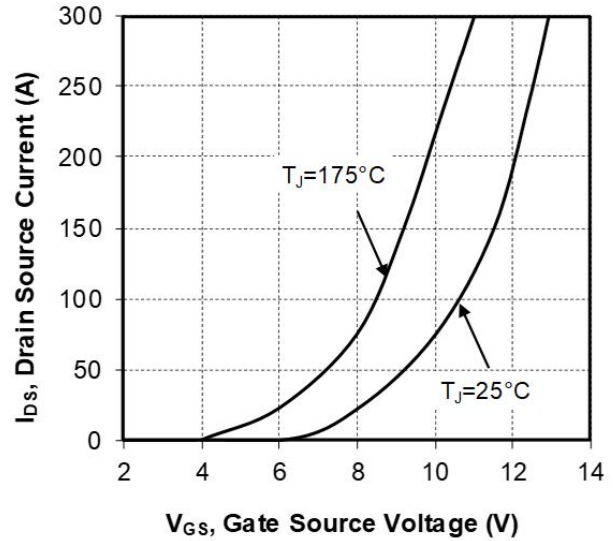


Figure 1-6. Switching Energy vs.  $R_g$

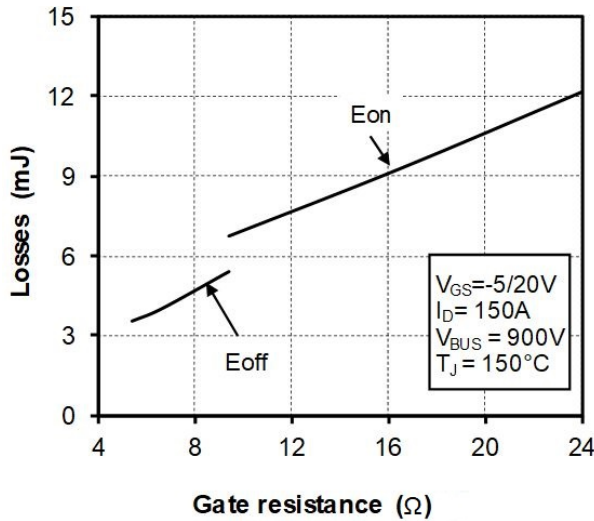


Figure 1-7. Switching Energy vs. Current

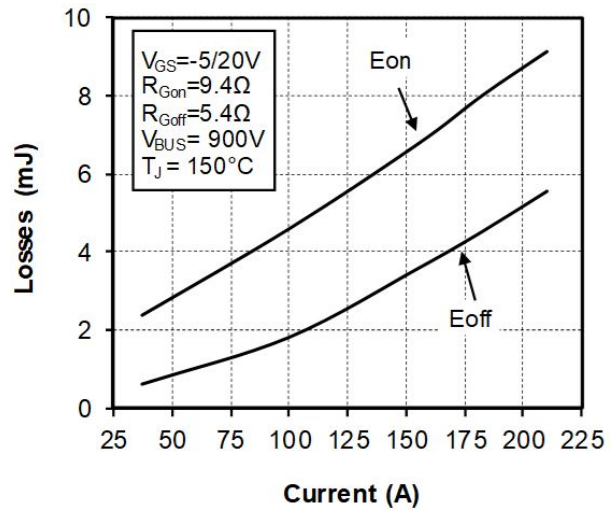


Figure 1-8. Capacitance vs. Drain Source Voltage

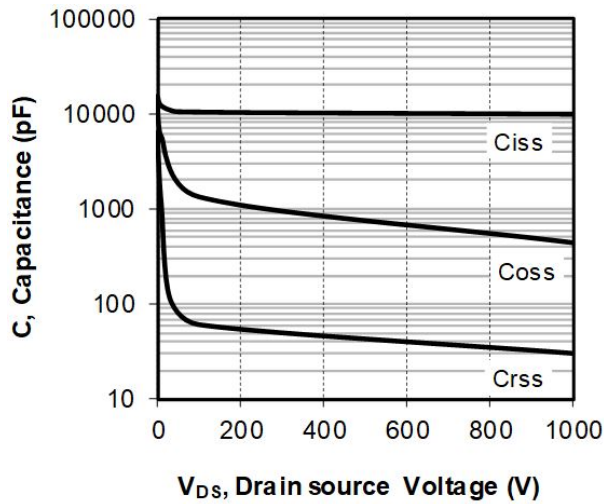


Figure 1-9. Gate Charge vs. Gate Source Voltage

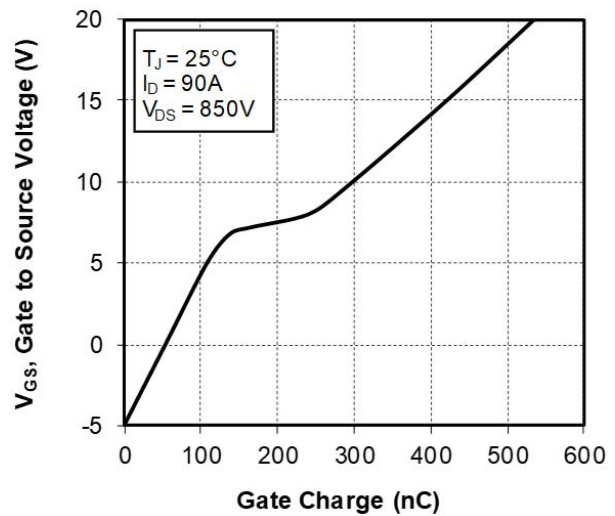


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

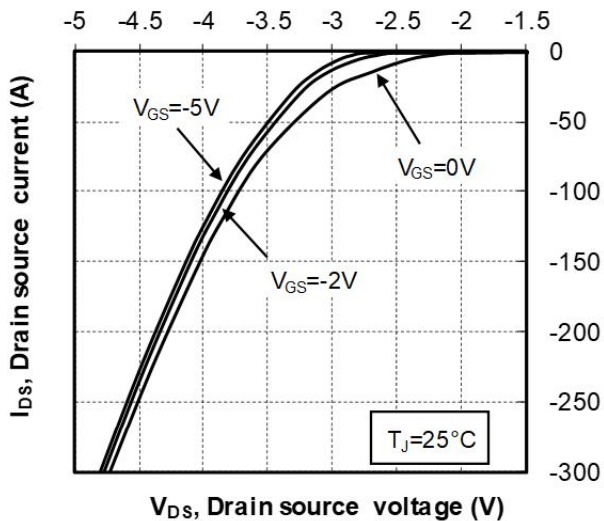


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

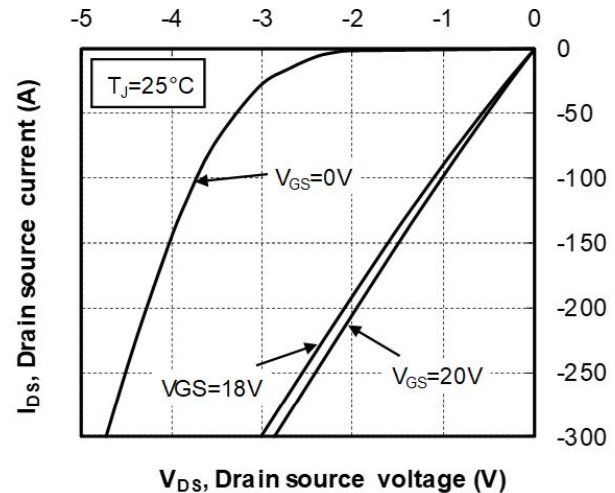


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

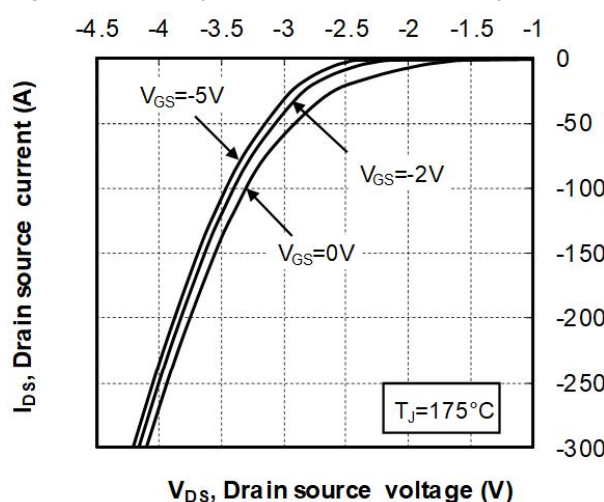


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

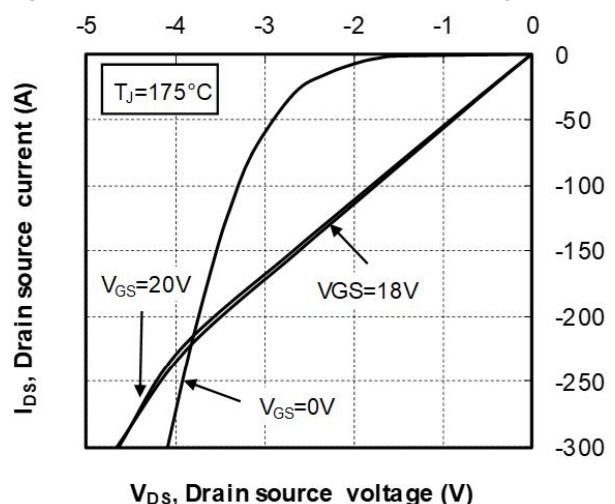
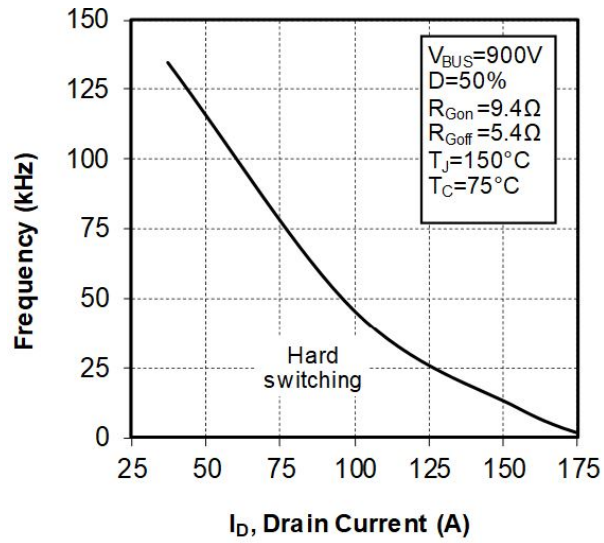


Figure 1-14. Operating Frequency vs. Drain Current



### 1.5 Typical SiC Diode Performance Curve

The following figures show the SiC diode performance curves of the MSCSM170HM12CAG device.

Figure 1-15. Maximum Thermal Impedance

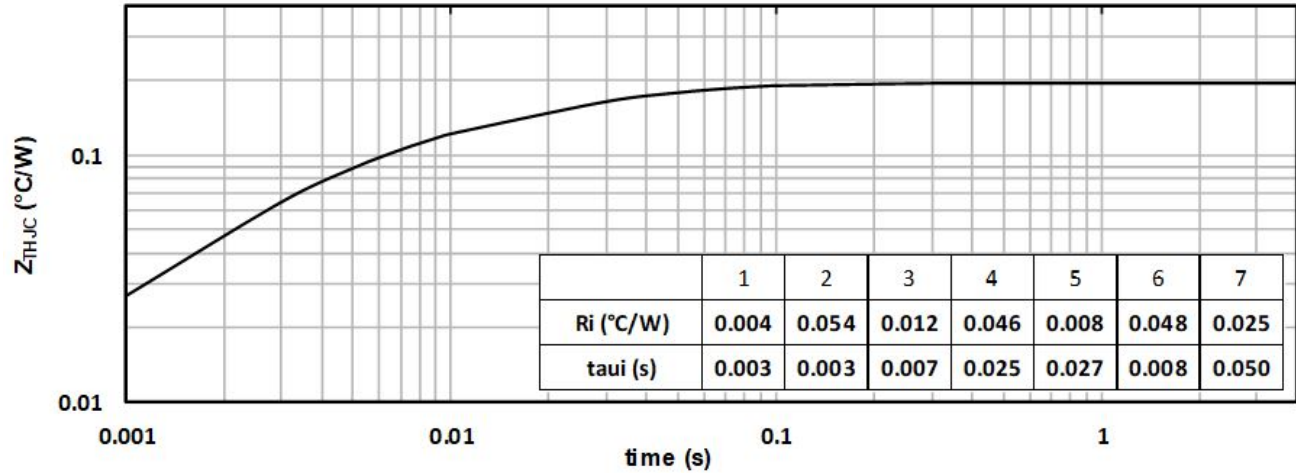


Figure 1-16. Forward Characteristics

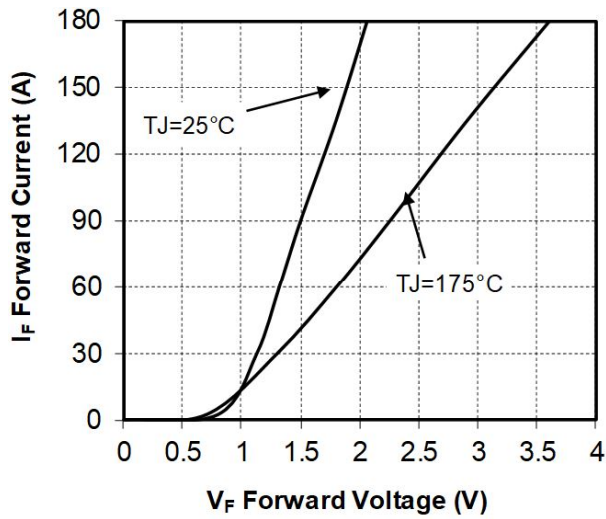
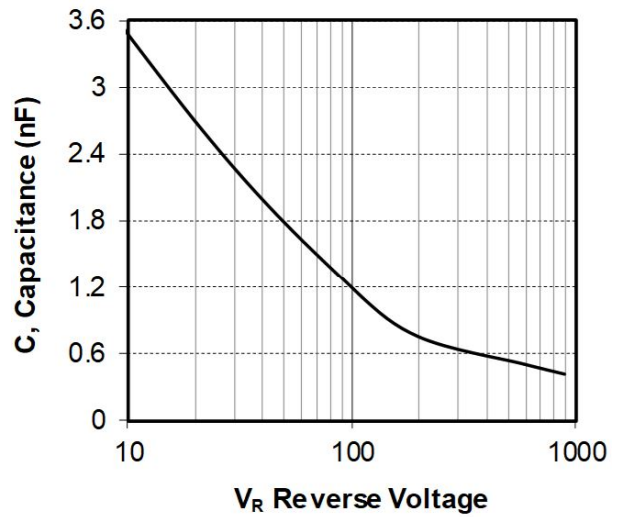


Figure 1-17. Capacitance vs. Reverse Voltage



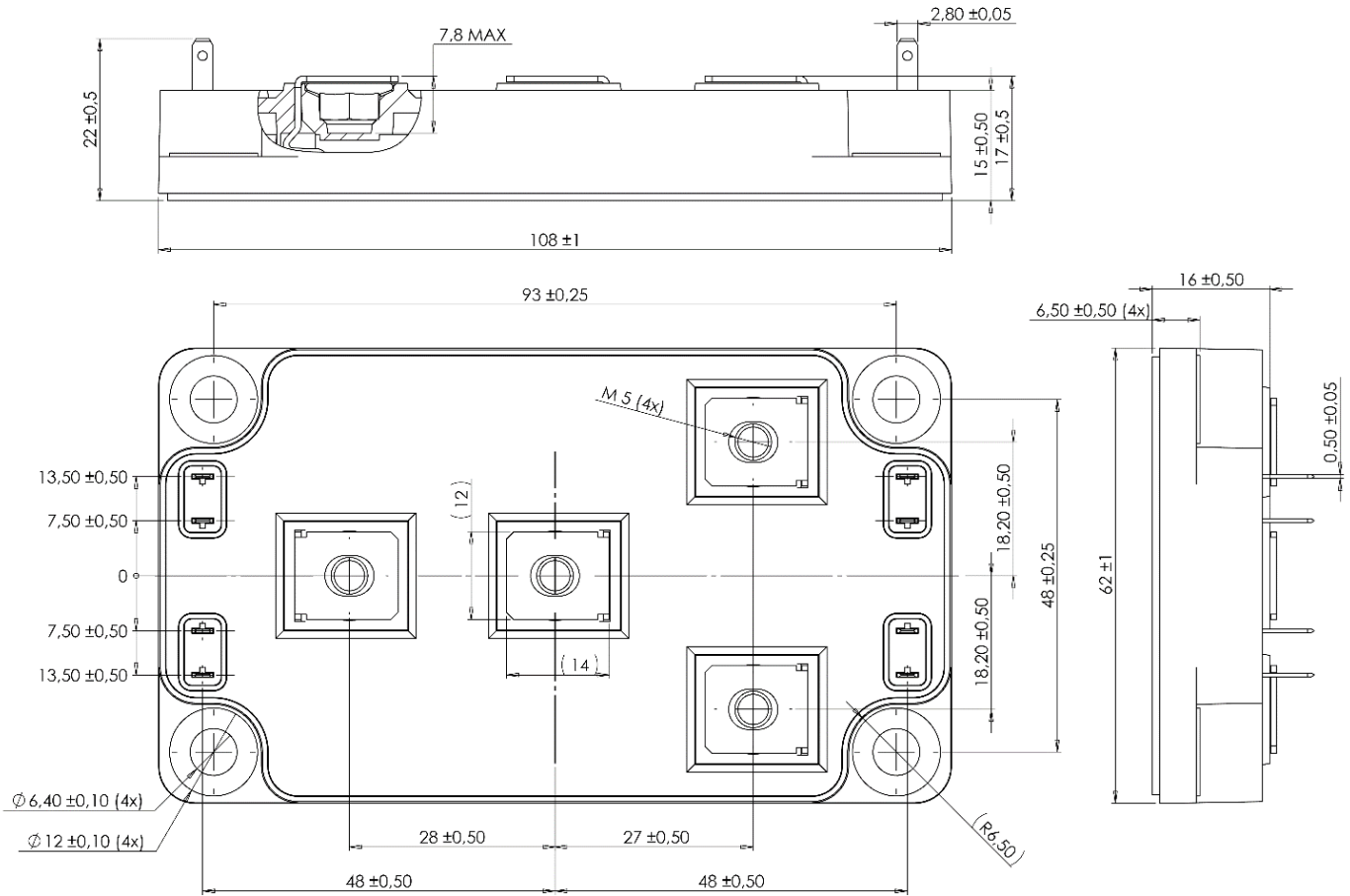
## 2. Package Specifications

The following section shows the package specification of the MSCSM170HM12CAG device.

### 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170HM12CAG device. The dimensions in the following figure are in millimeters.

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



**Note:** See application note [APT0601—Mounting Instructions for SP6 Power Modules](#) for more information.

**3. Revision History**

| Revision | Date    | Description                                     |
|----------|---------|-------------------------------------------------|
| A        | 05/2021 | This is the first publication of this document. |

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