

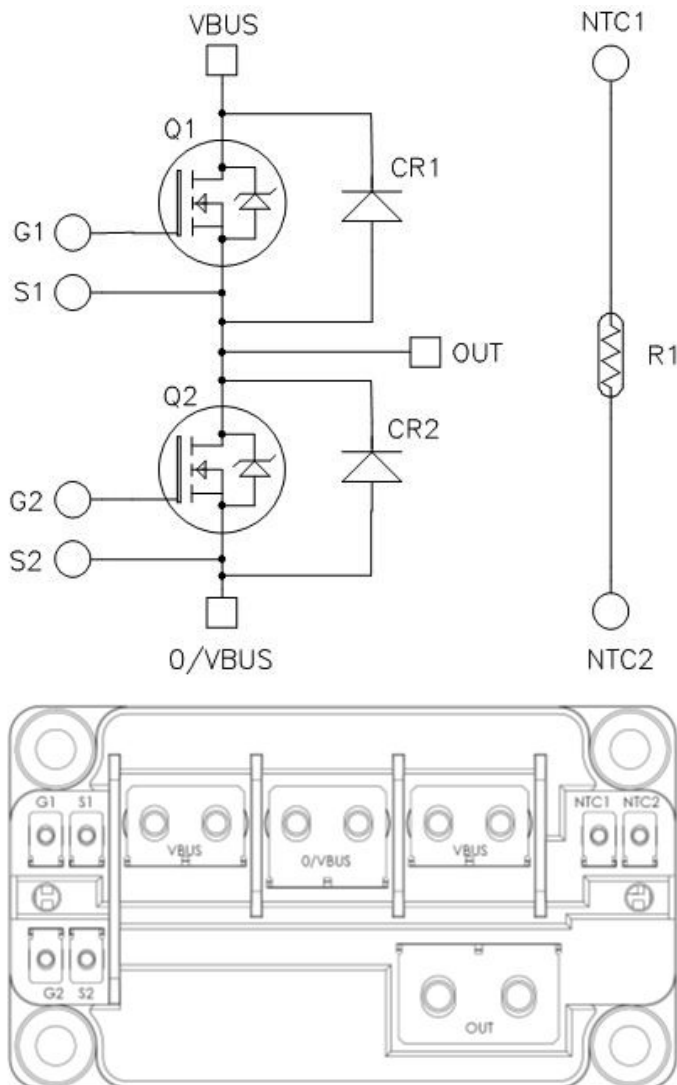


# MSCSM170AM058CT6LIAG

## Very Low Stray Inductance Phase Leg SiC MOSFET Power Module

### Product Overview

The MSCSM170AM058CT6LIAG device is a very low stray inductance phase leg 1700 V, 353 A silicon Carbide (SiC) MOSFET power module.



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

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

## Features

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The following are the key features of MSCSM170AM058CT6LIAG 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
- Very low stray inductance
- Internal thermistor for temperature monitoring
- M4 and M5 power connectors
- M2.5 signal connectors
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

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The following are the benefits of MSCSM170AM058CT6LIAG device:

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

## Application

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The following are the applications of MSCSM170AM058CT6LIAG device:

- 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 MSCSM170AM058CT6LIAG device.

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

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM170AM058CT6LIAG device.

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

| Symbol       | Parameter                  |                                    | Maximum Ratings | Unit       |
|--------------|----------------------------|------------------------------------|-----------------|------------|
| $V_{DS}$     | Drain-Source voltage       |                                    | 1700            | V          |
| $I_D$        | Continuous drain current   | $T_C = 25\text{ }^{\circ}\text{C}$ | 353             | A          |
|              |                            | $T_C = 80\text{ }^{\circ}\text{C}$ | 281             |            |
| $I_{DM}$     | Pulsed drain current       |                                    | 700             |            |
| $V_{GS}$     | Gate-Source voltage        |                                    | –10/23          | V          |
| $R_{DS(on)}$ | Drain-Source ON resistance |                                    | 7.5             | m $\Omega$ |
| $P_D$        | Power dissipation          | $T_C = 25\text{ }^{\circ}\text{C}$ | 1642            | W          |

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM170AM058CT6LIAG device.

**Table 1-2. Electrical Characteristics**

| Symbol       | Characteristic                  | Test Conditions                                |                                     | Min | Typ  | Max | Unit          |
|--------------|---------------------------------|------------------------------------------------|-------------------------------------|-----|------|-----|---------------|
| $I_{DSS}$    | Zero gate voltage drain current | $V_{GS} = 0\text{ V}; V_{DS} = 1700\text{ V}$  |                                     | —   | 60   | 600 | $\mu\text{A}$ |
| $R_{DS(on)}$ | Drain–Source on resistance      | $V_{GS} = 20\text{ V}$<br>$I_D = 180\text{ A}$ | $T_J = 25\text{ }^{\circ}\text{C}$  | —   | 5.8  | 7.5 | m $\Omega$    |
|              |                                 |                                                | $T_J = 175\text{ }^{\circ}\text{C}$ | —   | 10.2 | —   |               |
| $V_{GS(th)}$ | Gate threshold voltage          | $V_{GS} = V_{DS}; I_D = 15\text{ mA}$          |                                     | 1.8 | 3.3  | —   | V             |
| $I_{GSS}$    | Gate–Source leakage current     | $V_{GS} = 20\text{ V}; V_{DS} = 0\text{ V}$    |                                     | —   | —    | 600 | nA            |

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM170AM058CT6LIAG device.

**Table 1-3. Dynamic Characteristics**

| Symbol       | Characteristic                      | Test Conditions                                                               | Min                   | Typ  | Max  | Unit                        |
|--------------|-------------------------------------|-------------------------------------------------------------------------------|-----------------------|------|------|-----------------------------|
| $C_{iss}$    | Input capacitance                   | $V_{GS} = 0\text{ V}$                                                         | —                     | 19.8 | —    | nF                          |
| $C_{oss}$    | Output capacitance                  | $V_{DS} = 1000\text{ V}$                                                      | —                     | 0.9  | —    |                             |
| $C_{rss}$    | Reverse transfer capacitance        | $f = 1\text{ MHz}$                                                            | —                     | 0.06 | —    |                             |
| $Q_g$        | Total gate charge                   | $V_{GS} = -5\text{ V}/20\text{ V}$                                            | —                     | 1068 | —    | nC                          |
| $Q_{gs}$     | Gate-Source charge                  | $V_{Bus} = 850\text{ V}$                                                      | —                     | 294  | —    |                             |
| $Q_{gd}$     | Gate-Drain charge                   | $I_D = 180\text{ A}$                                                          | —                     | 162  | —    |                             |
| $T_{d(on)}$  | Turn-on delay time                  | $T_J = 150\text{ °C}$                                                         | —                     | 41   | —    | ns                          |
| $T_r$        | Rise time                           | $V_{GS} = -5\text{ V}/20\text{ V}$                                            | —                     | 48   | —    |                             |
| $T_{d(off)}$ | Turn-off delay time                 | $V_{Bus} = 900\text{ V}$                                                      | —                     | 114  | —    |                             |
| $T_f$        | Fall time                           | $I_D = 300\text{ A}$<br>$R_G = 0.5\text{ }\Omega$                             | —                     | 30   | —    |                             |
| $E_{on}$     | Turn-on energy                      | $V_{GS} = -5\text{ V}/20\text{ V}$                                            | $T_J = 150\text{ °C}$ | —    | 9.4  | mJ                          |
| $E_{off}$    | Turn-off energy                     | $V_{Bus} = 900\text{ V}$<br>$I_D = 300\text{ A}$<br>$R_G = 0.5\text{ }\Omega$ | $T_J = 150\text{ °C}$ | —    | 3.1  |                             |
| $R_{Gint}$   | Internal gate resistance            |                                                                               | —                     | 1.27 | —    | $\Omega$                    |
| $R_{thJC}$   | Junction-to-case thermal resistance |                                                                               | —                     | —    | 0.09 | $^{\circ}\text{C}/\text{W}$ |

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM170AM058CT6LIAG device.

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

| Symbol   | Characteristic           | Test Conditions                                            | Min | Typ | Max | Unit          |
|----------|--------------------------|------------------------------------------------------------|-----|-----|-----|---------------|
| $V_{SD}$ | Diode forward voltage    | $V_{GS} = 0\text{ V}; I_{SD} = 180\text{ A}$               | —   | 3.7 | —   | V             |
|          |                          | $V_{GS} = -5\text{ V}; I_{SD} = 180\text{ A}$              | —   | 3.9 | —   |               |
| $t_{rr}$ | Reverse recovery time    | $I_{SD} = 180\text{ A}; V_{GS} = -5\text{ V}$              | —   | 27  | —   | ns            |
| $Q_{rr}$ | Reverse recovery charge  | $V_R = 1200\text{ V}; di_F/dt = 6000\text{ A}/\mu\text{s}$ | —   | 3.9 | —   | $\mu\text{C}$ |
| $I_{rr}$ | Reverse recovery current |                                                            | —   | 276 | —   | A             |

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

The following table lists the SiC diode ratings and characteristics of the MSCSM170AM058CT6LIAG device.

**Table 1-5. SiC 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             | $V_R = 1700\text{ V}$                  | $T_J = 25\text{ °C}$  | —   | 60   | 1200 | $\mu\text{A}$        |
|            |                                     |                                        | $T_J = 175\text{ °C}$ | —   | 900  | —    |                      |
| $I_F$      | DC forward current                  | —                                      | $T_C = 125\text{ °C}$ | —   | 180  | —    | A                    |
| $V_F$      | Diode forward voltage               | $I_F = 180\text{ A}$                   | $T_J = 25\text{ °C}$  | —   | 1.5  | 1.8  | V                    |
|            |                                     |                                        | $T_J = 175\text{ °C}$ | —   | 2.3  | —    |                      |
| $Q_C$      | Total capacitive charge             | $V_R = 900\text{ V}$                   |                       | —   | 1380 | —    | nC                   |
| C          | Total capacitance                   | $f = 1\text{ MHz}, V_R = 600\text{ V}$ |                       | —   | 1002 | —    | pF                   |
|            |                                     | $f = 1\text{ MHz}, V_R = 900\text{ V}$ |                       | —   | 828  | —    |                      |
| $R_{thJC}$ | Junction-to-case thermal resistance |                                        |                       | —   | —    | 0.1  | $^{\circ}\text{C/W}$ |

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM170AM058CT6LIAG 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                                                              | For terminals | M2.5 | 0.4  | 0.6             | N.m                |
|            |                                                                              |               | M4   | 2    | 3               |                    |
|            |                                                                              |               | M5   | 2    | 3.5             |                    |
|            |                                                                              | To heatsink   | M6   | 3    | 5               |                    |
| $L_{DC}$   | Module stray inductance between $V_{BUS}$ and $0/V_{BUS}$                    |               |      | —    | 3               | nH                 |
| Wt         | Package weight                                                               |               |      | —    | 320             | g                  |

The following table lists the temperature sensor NTC of the MSCSM170AM058CT6LIAG device.

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

| Symbol                            | Characteristic             | Min                     | Typ  | Max | Unit |
|-----------------------------------|----------------------------|-------------------------|------|-----|------|
| R <sub>25</sub>                   | Resistance at 25 °C        | —                       | 50   | —   | kΩ   |
| ΔR <sub>25</sub> /R <sub>25</sub> | —                          | —                       | 5    | —   | %    |
| B <sub>25/85</sub>                | T <sub>25</sub> = 298.15 K | —                       | 3952 | —   | K    |
| ΔB/B                              | —                          | T <sub>C</sub> = 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<sub>T</sub>: 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 MSCSM170AM058CT6LIAG device.

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

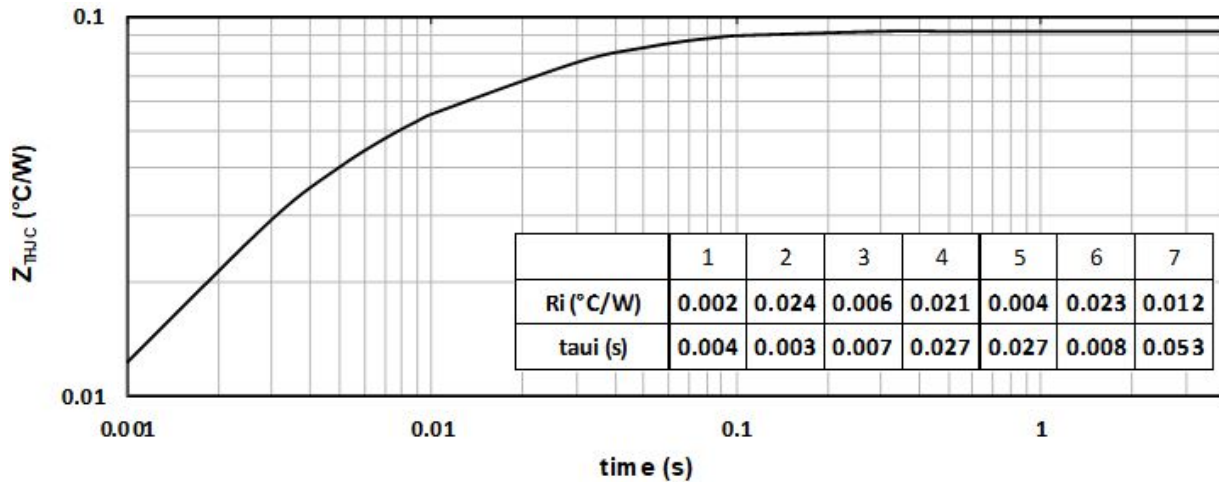


Figure 1-2. Output Characteristics,  $T_J = 25^\circ\text{C}$

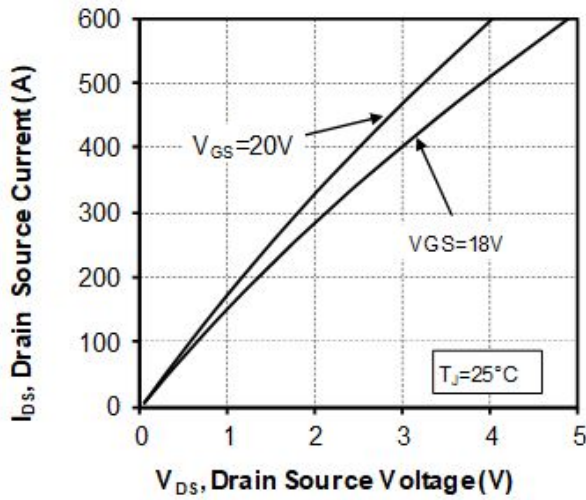


Figure 1-3. Output Characteristics,  $T_J = 175^\circ\text{C}$

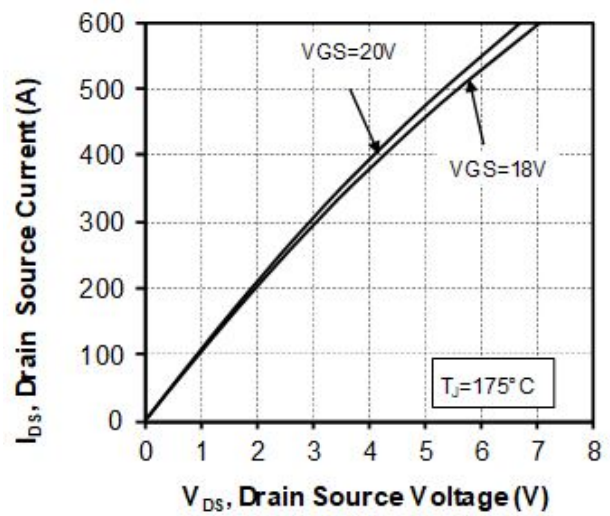


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

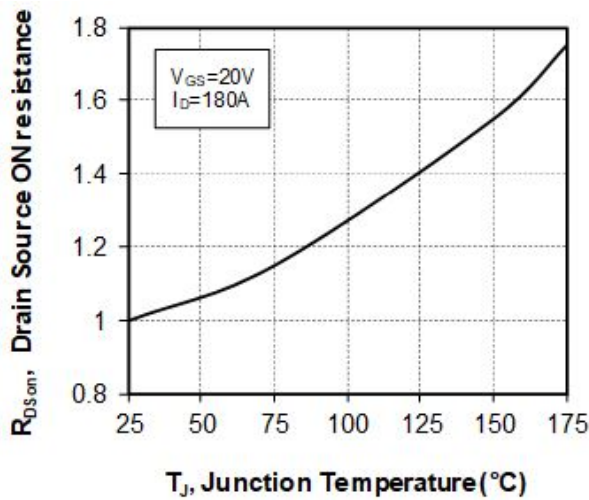


Figure 1-5. Transfer Characteristics

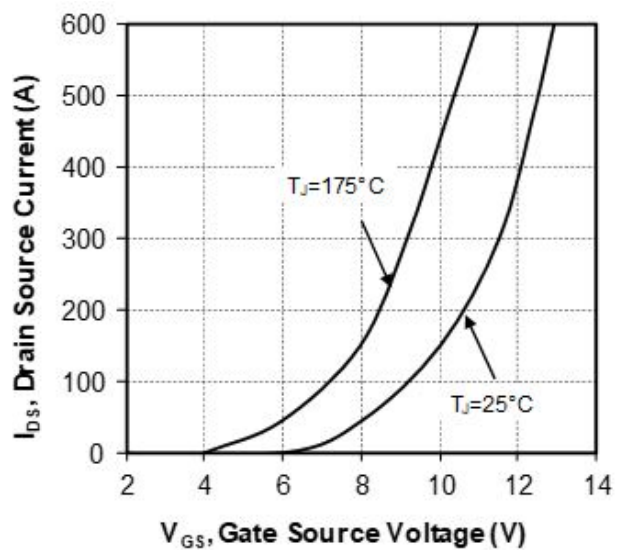


Figure 1-6. Switching Energy vs.  $R_g$

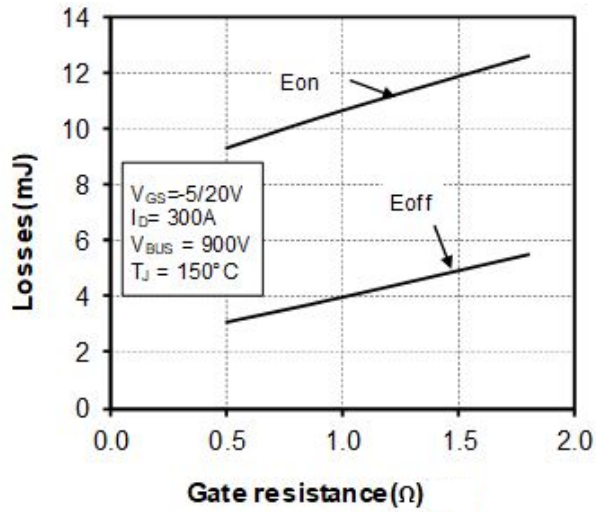


Figure 1-7. Switching Energy vs. Current

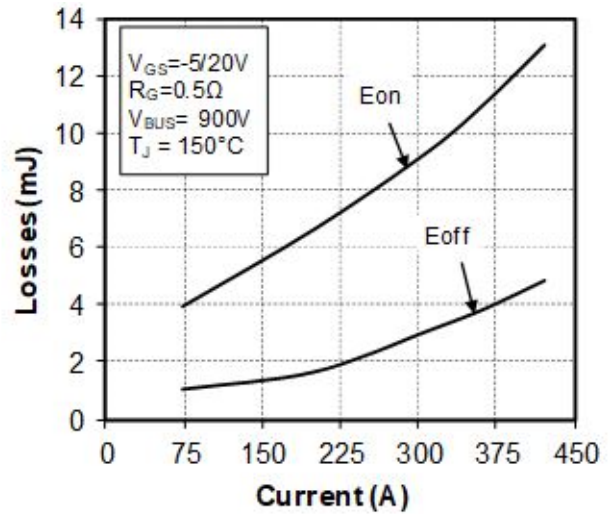


Figure 1-8. Capacitance vs. Drain Source Voltage

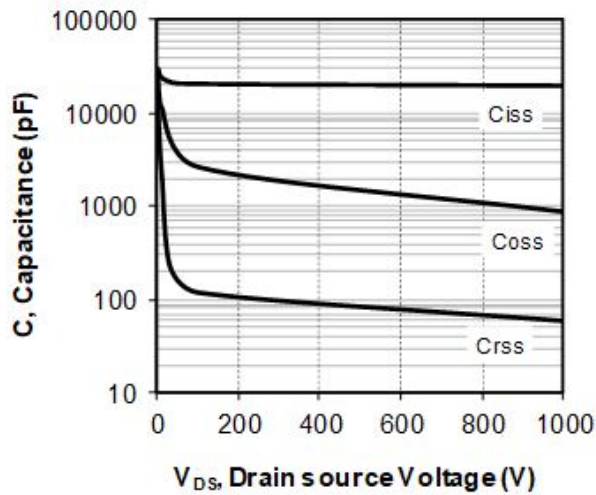


Figure 1-9. Gate Charge vs. Gate Source Voltage

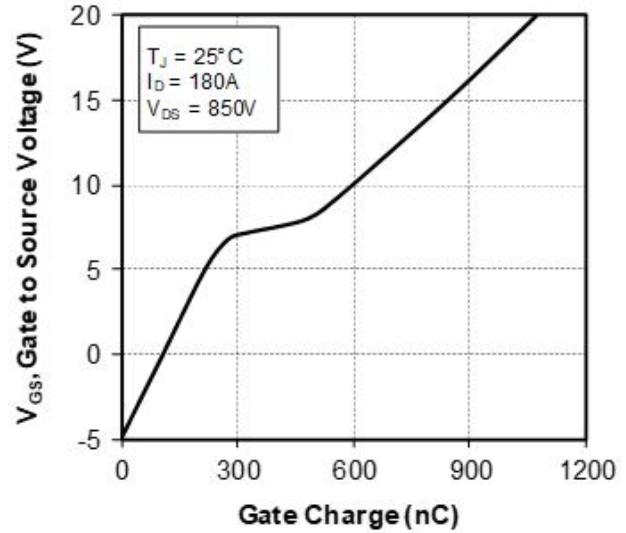


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

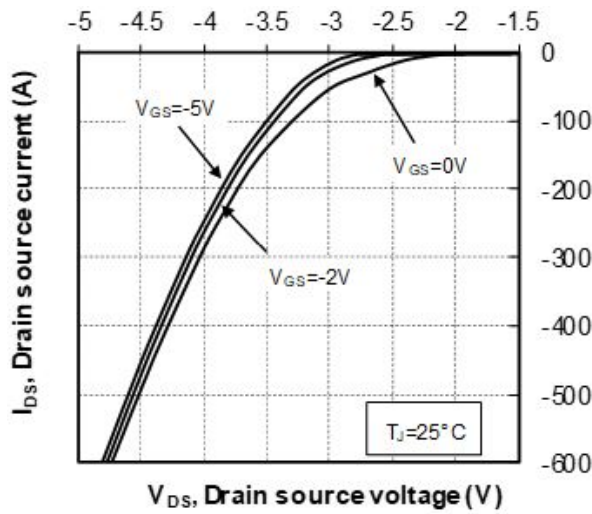


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

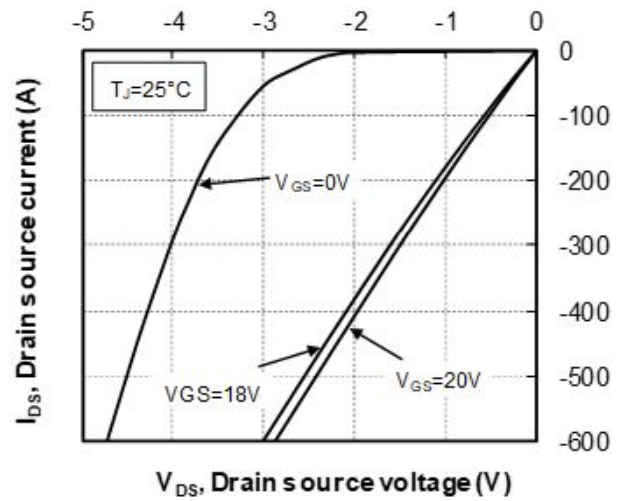


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

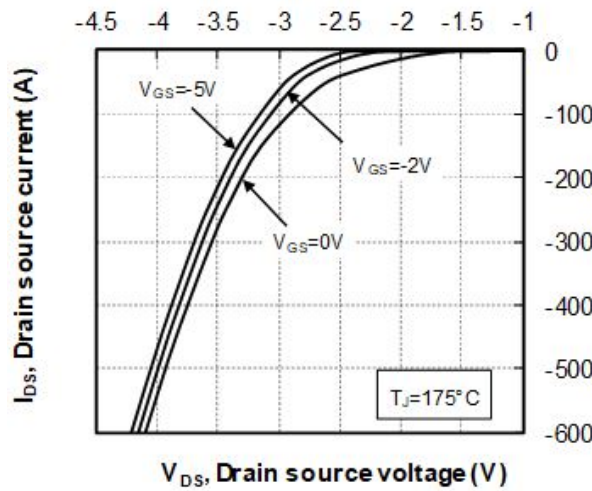


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

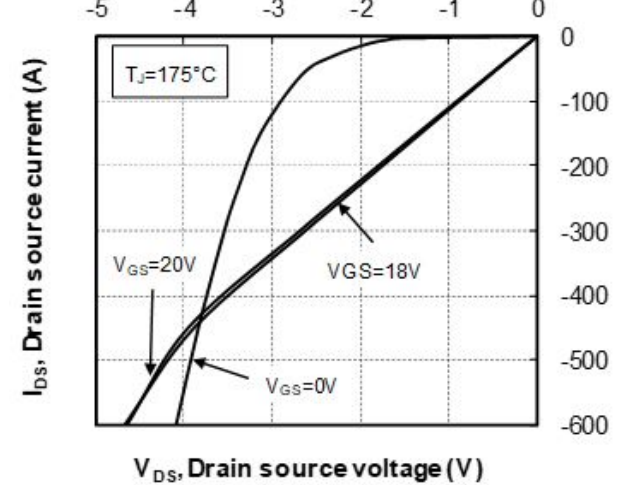
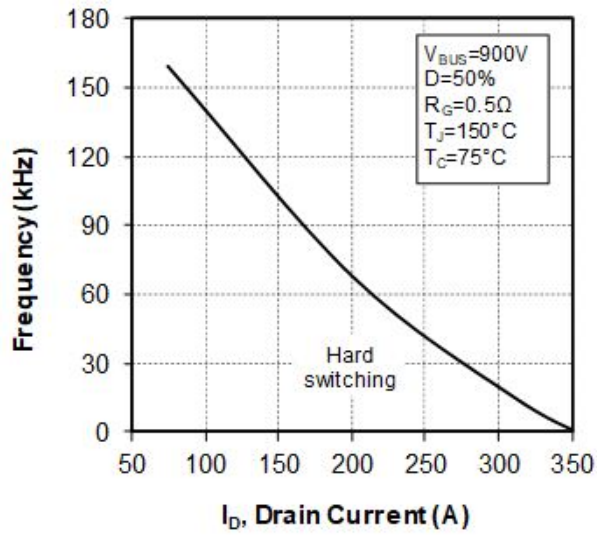


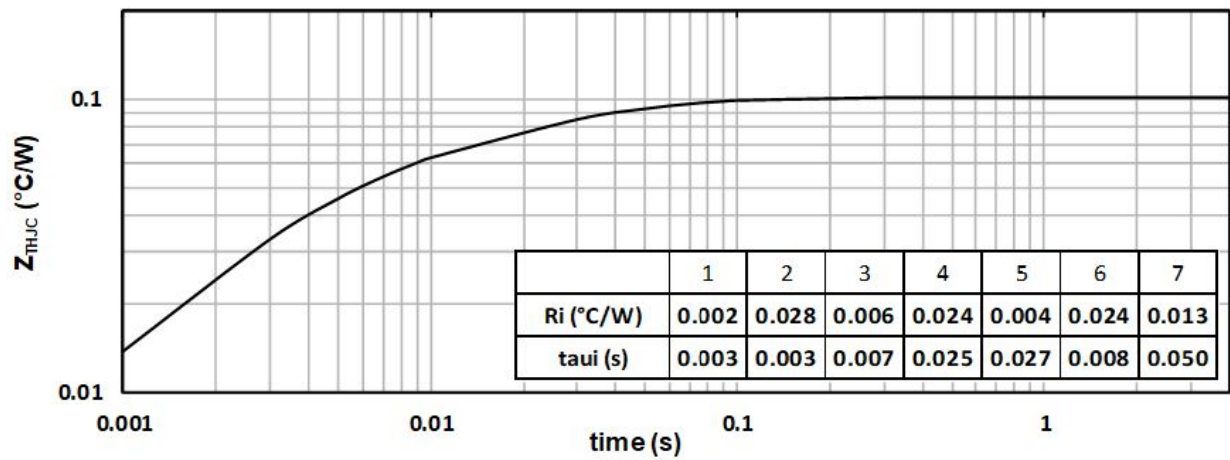
Figure 1-14. Operating Frequency vs Drain Current



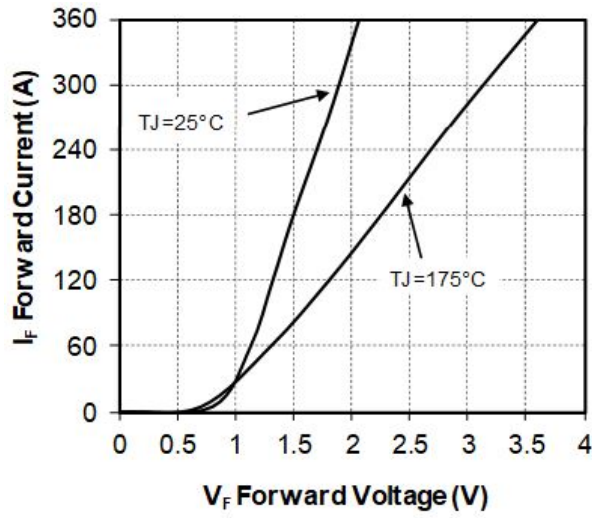
## 1.5 Typical SiC Diode Performance Curves

This section shows the typical SiC diode performance curves of the MSCSM170AM058CT6LIAG device.

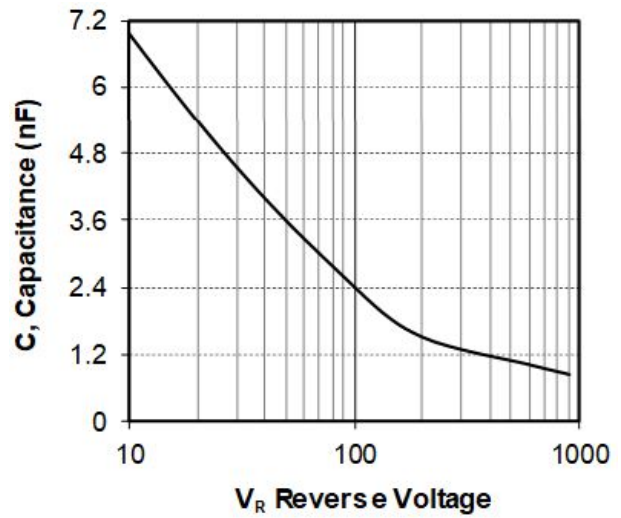
Figure 1-15. Maximum Thermal Impedance



**Figure 1-16. Forward Characteristics**



**Figure 1-17. Capacitance vs. Reverse Voltage**



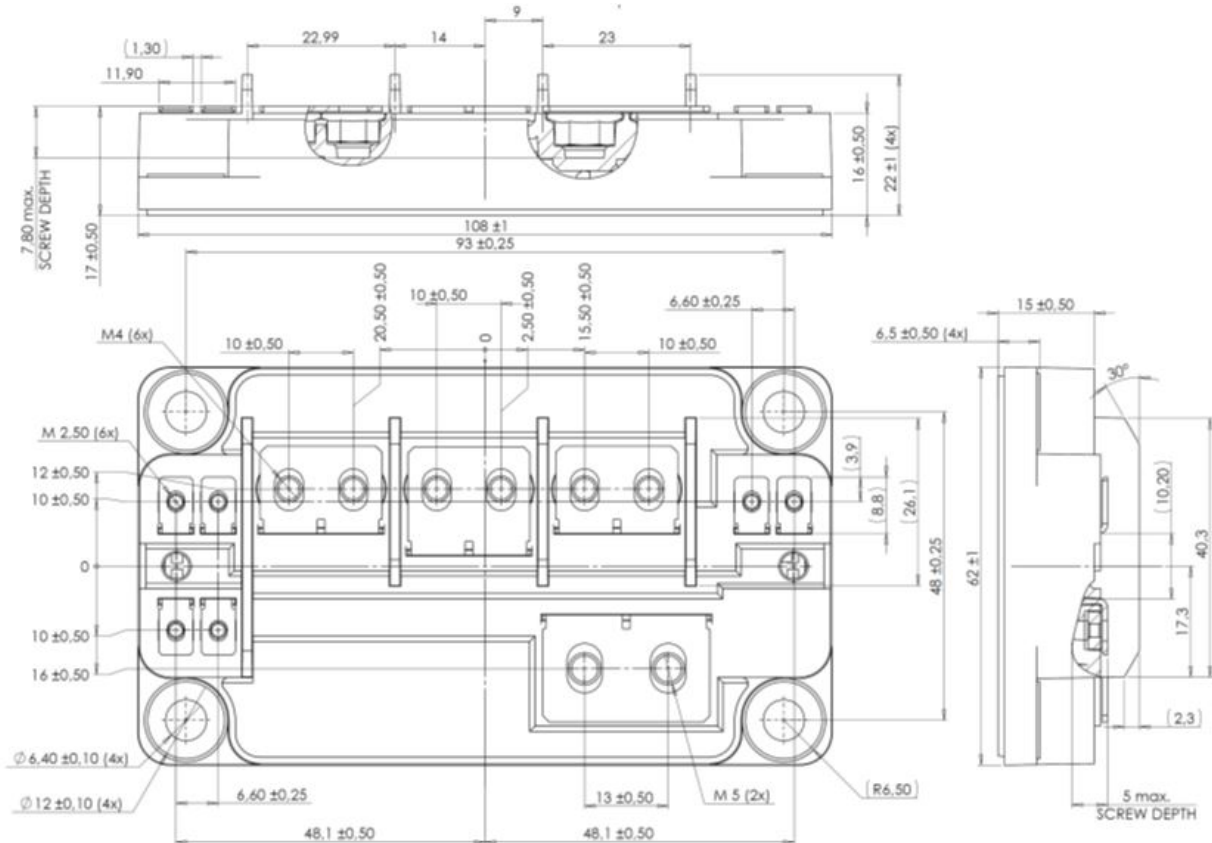
## 2. Package Specifications

The following section shows the package specification of the MSCSM170AM058CT6LIAG device.

### 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM170AM058CT6LIAG device. The dimensions in the following figure are in millimeters.

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



**Note:** See [AN1911—Mounting Instructions for SP6 Low Inductance Power Module](#) for more information.

**3. Revision History**

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

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