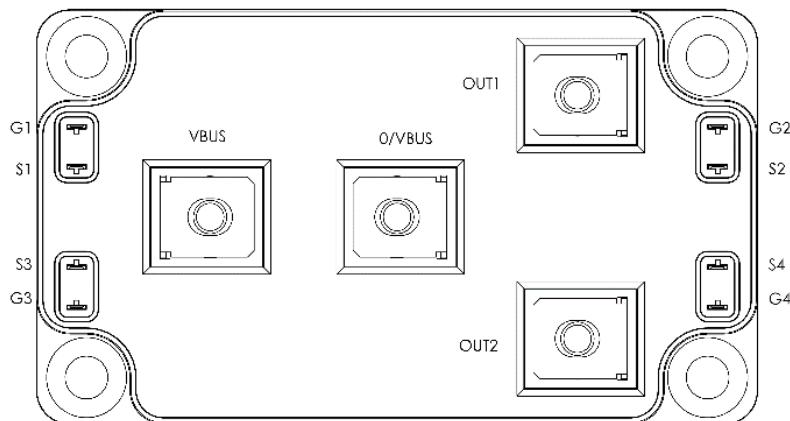
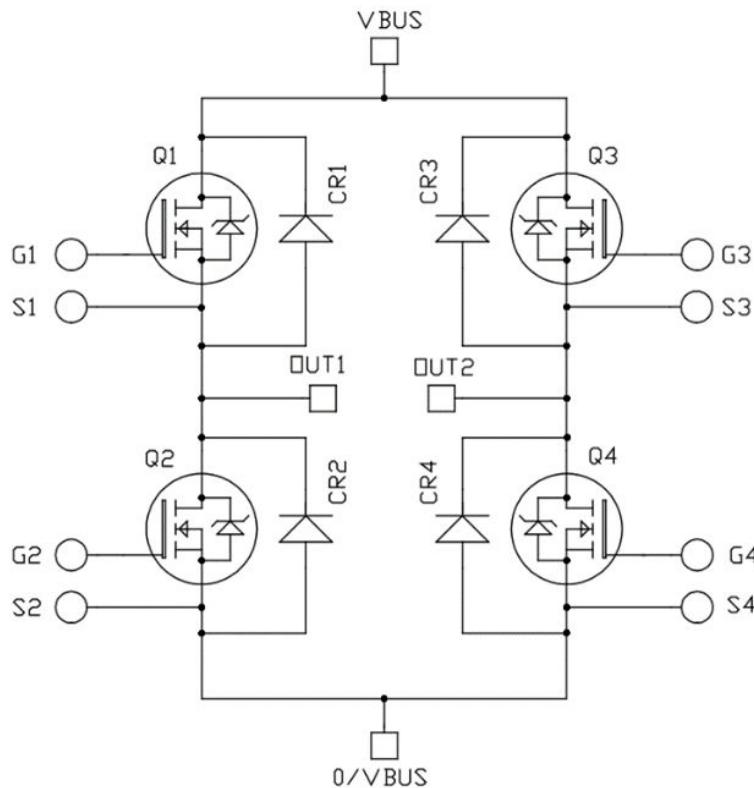


Full Bridge SiC Power Module

Product Overview

The MSCSM120HM083CAG device is a 1200 V, 251 A full bridge silicon carbide (SiC) 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

The following are the key features of MSCSM120HM083CAG 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 MSCSM120HM083CAG 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

Application

The following are the applications of MSCSM120HM083CAG 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 MSCSM120HM083CAG device.

1.1 SiC MOSFET Characteristics (per SiC MOSFET)

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120HM083CAG device.

Table 1-1. Absolute Maximum Ratings

| Symbol | Parameter | Maximum Ratings | Unit |
|--------------|----------------------------|--------------------------|------------------|
| V_{DSS} | Drain-source voltage | 1200 | V |
| I_D | Continuous drain current | $T_C = 25^\circ\text{C}$ | 251 |
| | | $T_C = 80^\circ\text{C}$ | 200 |
| I_{DM} | Pulsed drain current | 500 | |
| V_{GS} | Gate-source voltage | -10/25 | V |
| $R_{DS(on)}$ | Drain-source ON resistance | 10.4 | $\text{m}\Omega$ |
| P_D | Power dissipation | $T_C = 25^\circ\text{C}$ | 1042 |
| | | | W |

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120HM083CAG device.

Table 1-2. Electrical Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|--------------|---------------------------------|--|---------------------------|------|------|------------------|
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$; $V_{DS} = 1200\text{ V}$ | — | 30 | 300 | μA |
| $R_{DS(on)}$ | Drain-Source on resistance | $V_{GS} = 20\text{ V}$ | $T_J = 25^\circ\text{C}$ | 8.3 | 10.4 | $\text{m}\Omega$ |
| | | $I_D = 120\text{ A}$ | $T_J = 175^\circ\text{C}$ | 13.3 | — | |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{GS} = V_{DS}$; $I_D = 3\text{ mA}$ | 1.8 | 2.8 | — | 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 MSCSM120HM083CAG device.

Table 1-3. Dynamic Characteristics

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|--------------|-------------------------------------|---|------------------------------------|-----|------|-------|------|
| C_{iss} | Input capacitance | $V_{GS} = 0 \text{ V}$ $V_{DS} = 1000 \text{ V}$ $f = 1 \text{ MHz}$ | | — | 9 | — | nF |
| C_{oss} | Output capacitance | | | — | 0.81 | — | |
| C_{rss} | Reverse transfer capacitance | | | — | 0.07 | — | |
| Q_g | Total gate charge | $V_{GS} = -5 \text{ V}/20 \text{ V}$ $V_{Bus} = 800 \text{ V}$ $I_D = 120 \text{ A}$ | | — | 696 | — | nC |
| Q_{gs} | Gate-source charge | | | — | 123 | — | |
| Q_{gd} | Gate-drain charge | | | — | 150 | — | |
| $T_{d(on)}$ | Turn-on delay time | $T_J = 150 \text{ }^\circ\text{C}$ $V_{GS} = -5 \text{ V}/20 \text{ V}$ $V_{Bus} = 600 \text{ V}$ $I_D = 150 \text{ A}$ $R_{GON} = 2.7 \Omega$ $R_{GOFF} = 1.6 \Omega$ | | — | 56 | — | ns |
| T_r | Rise time | | | — | 55 | — | |
| $T_{d(off)}$ | Turn-off delay time | | | — | 166 | — | |
| T_f | Fall time | | | — | 67 | — | |
| E_{on} | Turn-on energy | $I_{inductive}$ switching $V_{GS} = -5 \text{ V}/20 \text{ V}$ $V_{Bus} = 600 \text{ V}$ $I_D = 150 \text{ A}$ $R_{GON} = 2.7 \Omega$ $R_{GOFF} = 1.6 \Omega$ | $T_J = 150 \text{ }^\circ\text{C}$ | — | 3 | — | mJ |
| E_{off} | Turn-off energy | | | — | 2.7 | — | |
| R_{Gint} | Internal gate resistance | | | — | 2 | — | |
| R_{thJC} | Junction-to-case thermal resistance | | | — | — | 0.144 | °C/W |

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120HM083CAG device.

Table 1-4. Body Diode Ratings and Characteristics

| Symbol | Characteristic | Test Conditions | | Min | Typ | Max | Unit |
|----------|--------------------------|---|--|-----|------|-----|------|
| V_{SD} | Diode forward voltage | $V_{GS} = 0 \text{ V}; I_{SD} = 120 \text{ A}$ | | — | 4 | — | V |
| | | $V_{GS} = -5 \text{ V}; I_{SD} = 120 \text{ A}$ | | — | 4.2 | — | |
| t_{rr} | Reverse recovery time | $I_{SD} = 120 \text{ A}$ | | — | 90 | — | ns |
| Q_{rr} | | $V_{GS} = -5 \text{ V}$ | | — | 1650 | — | nC |
| I_{rr} | Reverse recovery current | $V_R = 800 \text{ V}$ $di_F/dt = 3000 \text{ A}/\mu\text{s}$ | | — | 41 | — | A |

1.2**SiC Schottky Diode Characteristics (per SiC Diode)**

The following table lists the SiC Schottky diode ratings and characteristics of the MSCSM120HM083CAG 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 | | | — | — | 1200 | V |
| I_{RRM} | Reverse leakage current | $V_R = 1200$ V | $T_J = 25$ °C | — | 30 | 600 | μA |
| | | | $T_J = 175$ °C | — | 450 | — | |
| I_F | DC forward current | — | $T_C = 100$ °C | — | 90 | — | A |
| V_F | Diode forward voltage | $I_F = 90$ A | $T_J = 25$ °C | — | 1.5 | 1.8 | V |
| | | | $T_J = 175$ °C | — | 2.1 | — | |
| Q_C | Total capacitive charge | $V_R = 600$ V | | — | 390 | — | nC |
| C | Total capacitance | $f = 1$ MHz, $V_R = 400$ V | | — | 423 | — | pF |
| | | $f = 1$ MHz, $V_R = 800$ V | | — | 315 | — | |
| R_{thJC} | Junction-to-case thermal resistance | | | — | — | 0.34 | °C/W |

1.3**Thermal and Package Characteristics**

The following table lists the thermal and package characteristics of the MSCSM120HM083CAG device.

Table 1-6. Thermal and Package Characteristics

| Symbol | Characteristic | 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 case temperature | —40 | 125 | |
| T_C | Operating case temperature | —40 | 125 | |
| Torque | Mounting torque | To heatsink | M6 | 3 |
| | | For terminals | M5 | 2 |
| Wt | Package weight | — | 300 | g |

1.4**Typical SiC MOSFET Performance Curve**

This section shows the typical SiC MOSFET performance curves of the MSCSM120HM083CAG device.

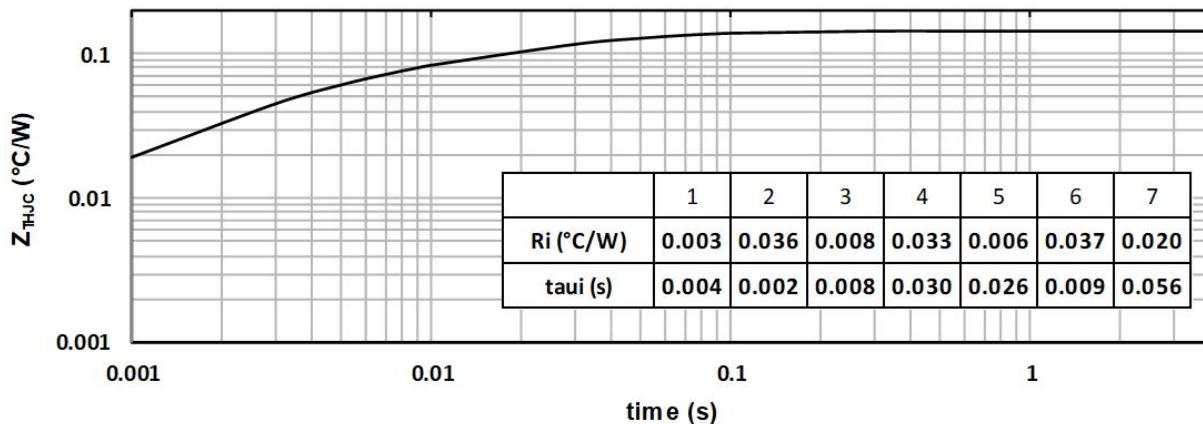
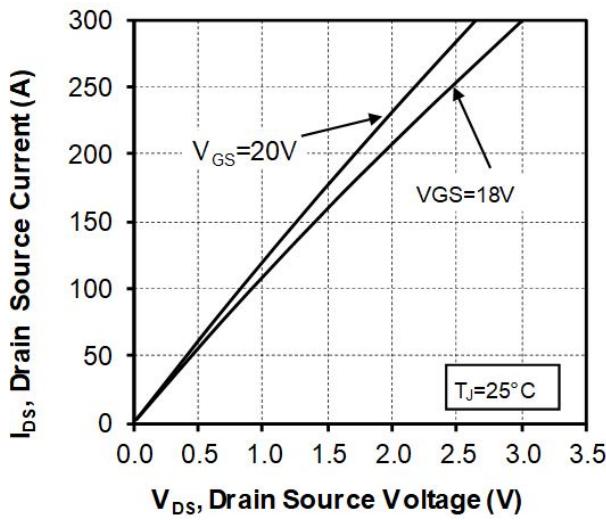
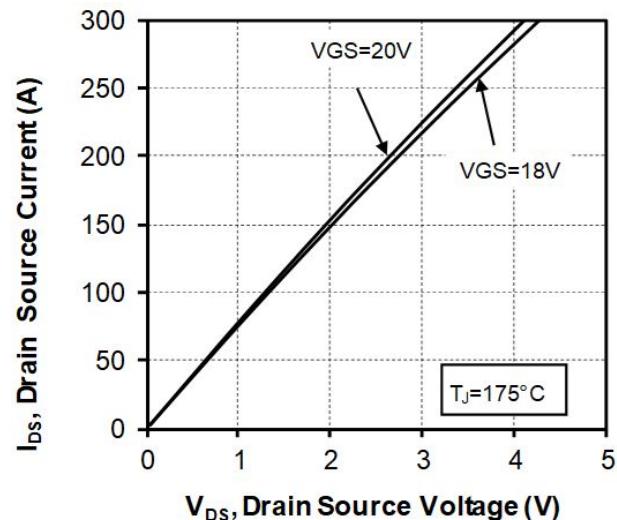
Figure 1-1. Maximum Thermal Impedance**Figure 1-2. Output Characteristics, $T_J = 25^\circ\text{C}$** **Figure 1-3. Output Characteristics, $T_J = 175^\circ\text{C}$** 

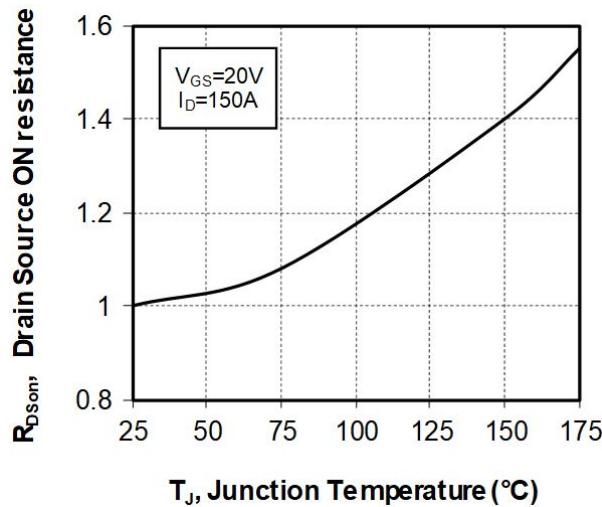
Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

Figure 1-5. Transfer Characteristics

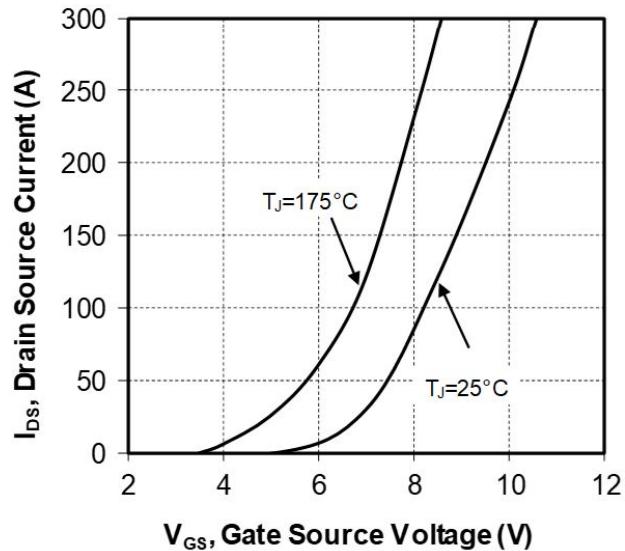
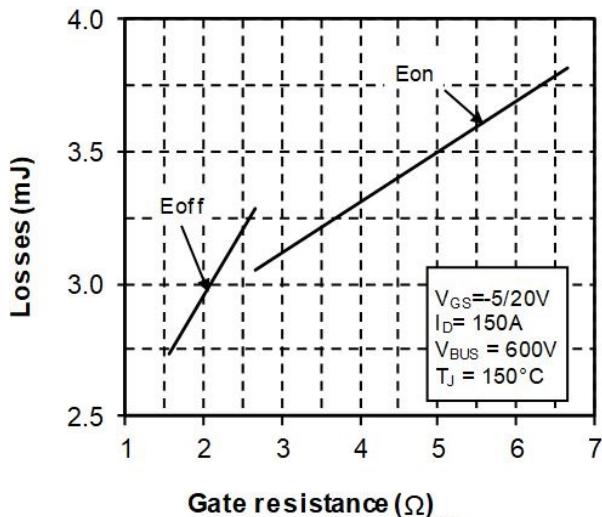
Figure 1-6. Switching Energy vs. R_g 

Figure 1-7. Switching Energy vs. Current

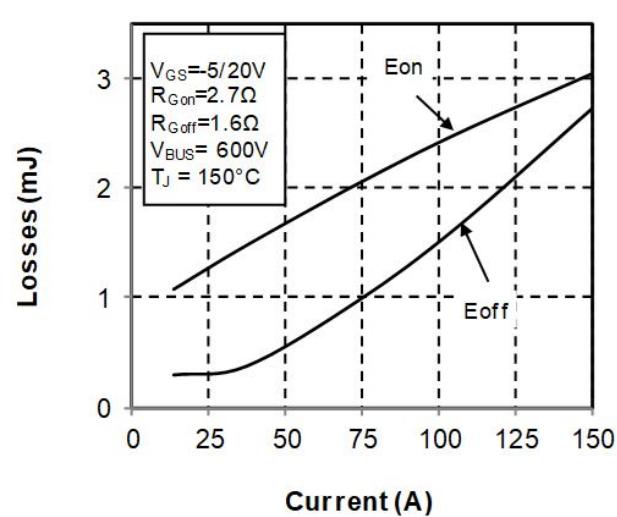


Figure 1-8. Capacitance vs. Drain Source Voltage

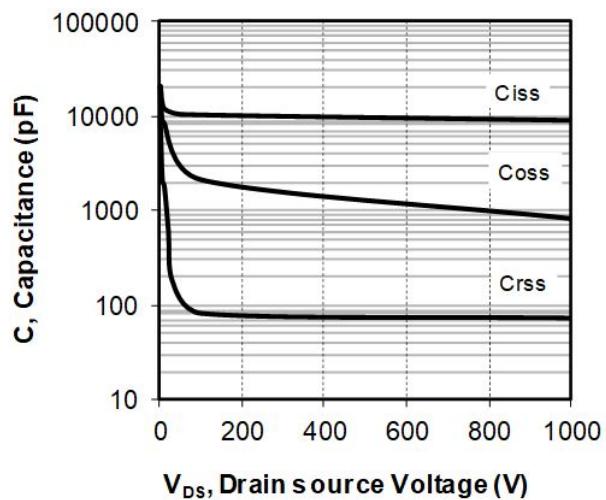


Figure 1-9. Gate Charge vs. Gate Source Voltage

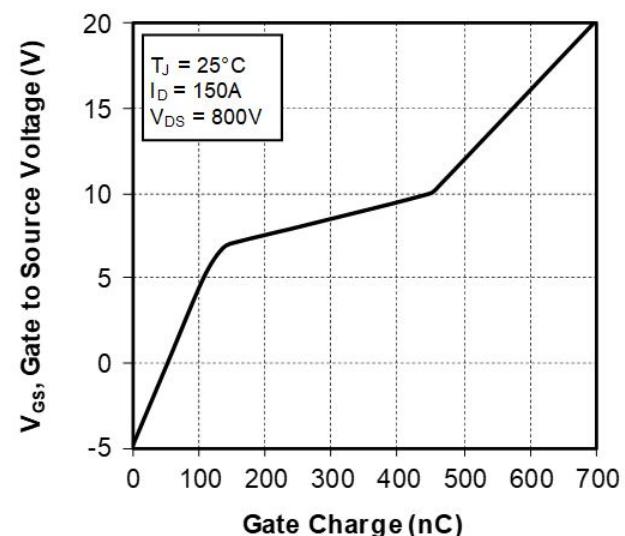
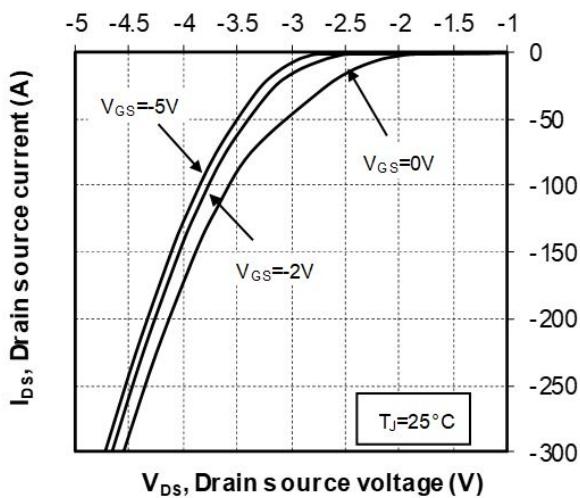
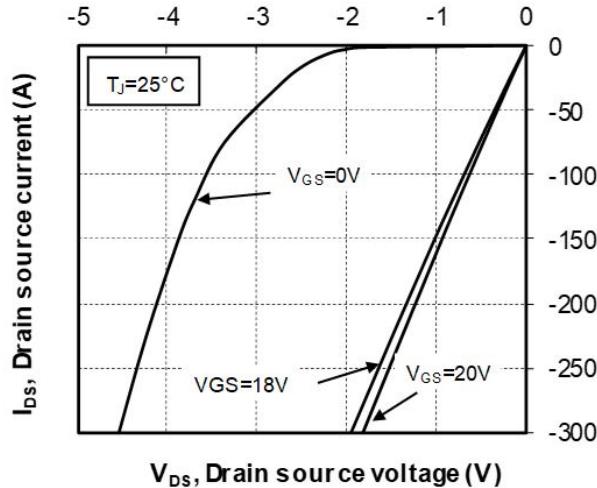
Figure 1-10. Body Diode Characteristics, T_J = 25 °CFigure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

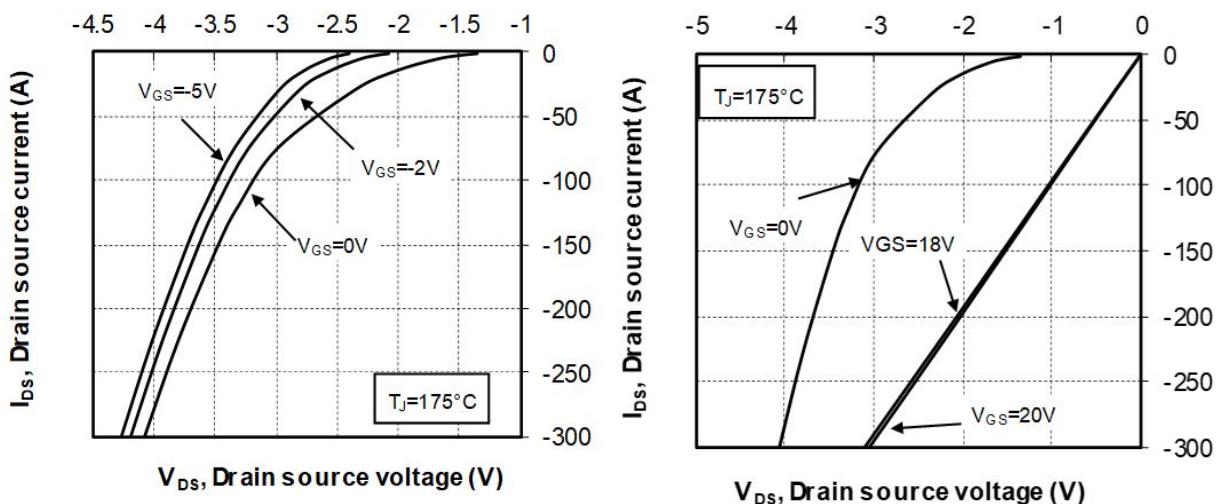
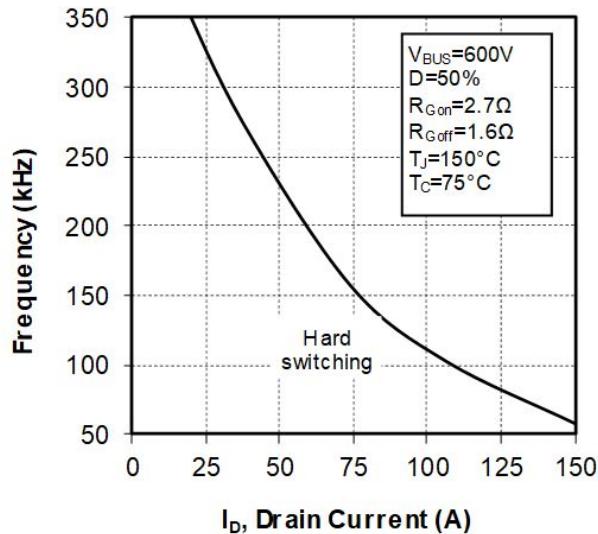
Figure 1-12. Body Diode Characteristics, $T_J = 175^\circ\text{C}$ Figure 1-13. 3rd Quadrant Characteristics, $T_J = 175^\circ\text{C}$ 

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 MSCSM120HM083CAG device.

Figure 1-15. Maximum Thermal Impedance

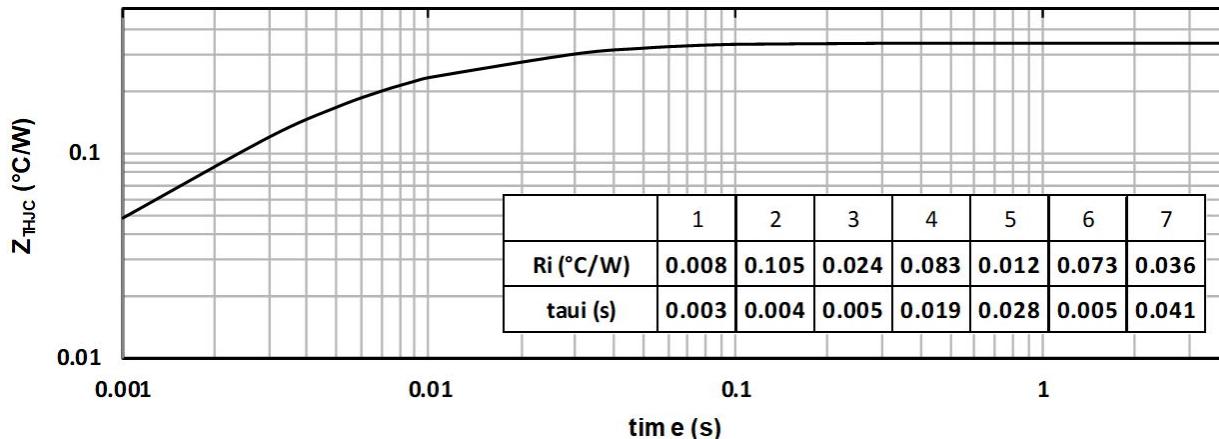


Figure 1-16. Forward Characteristics

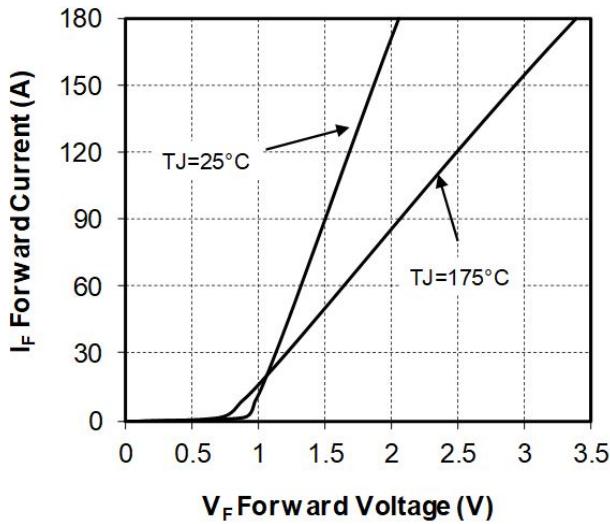
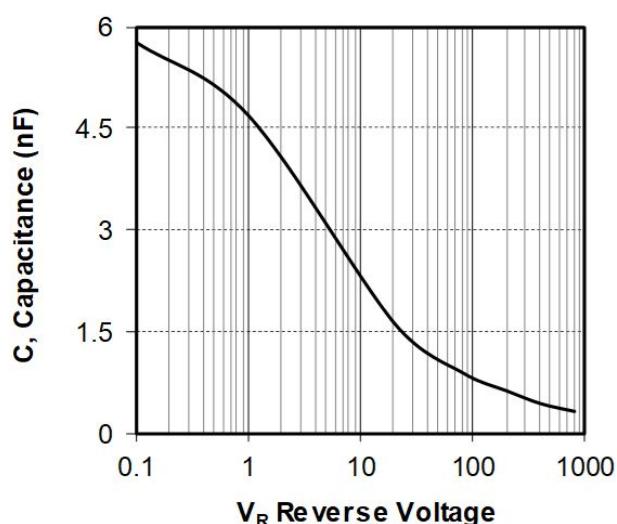


Figure 1-17. Capacitance vs. Reverse Voltage



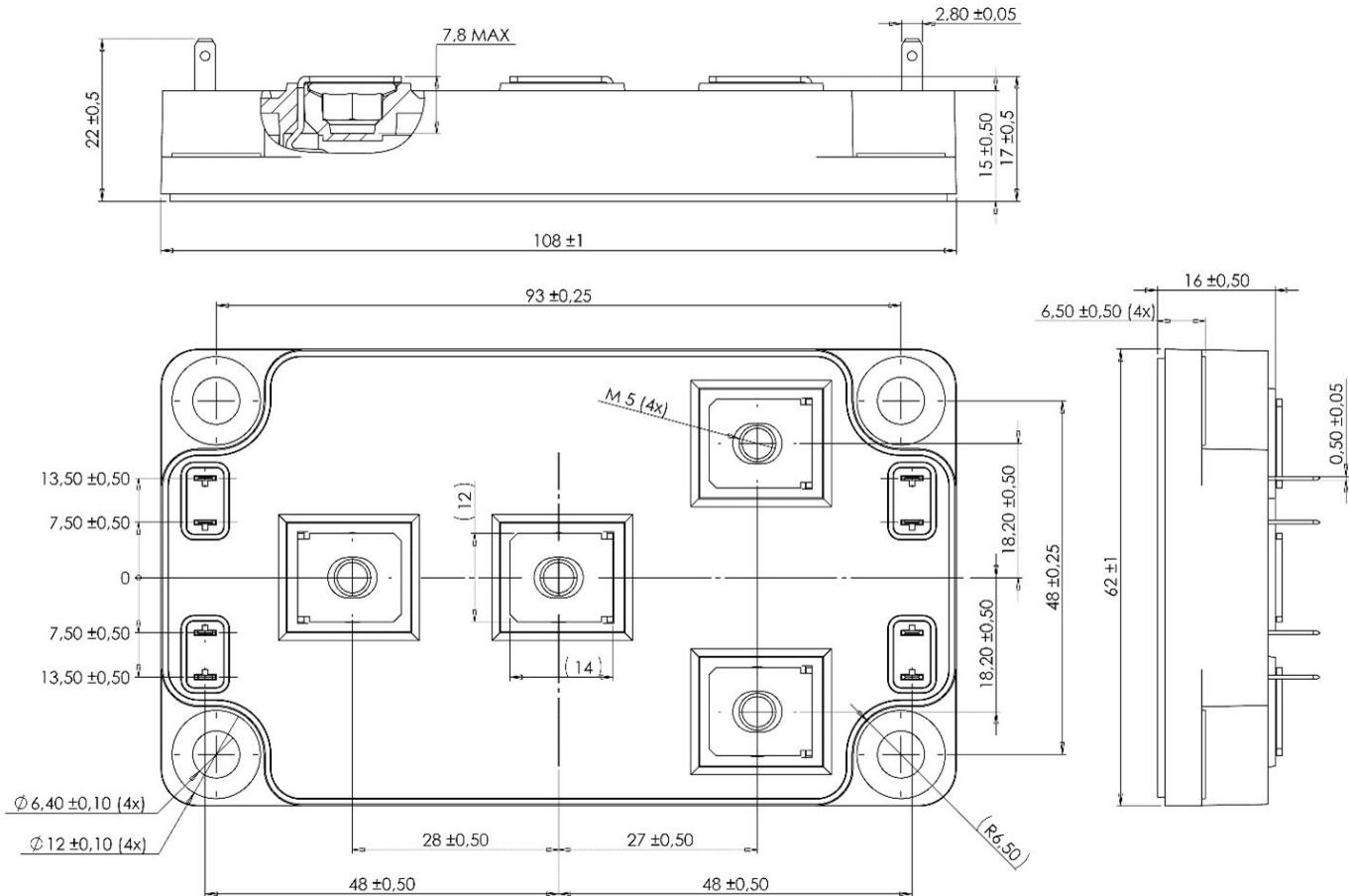
2. Package Specifications

The following section shows the package specification of the MSCSM120HM083CAG device.

2.1 Package Outline Drawing

The following figure shows the package outline drawing of the MSCSM120HM083CAG 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](#).

3. Revision History

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

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