

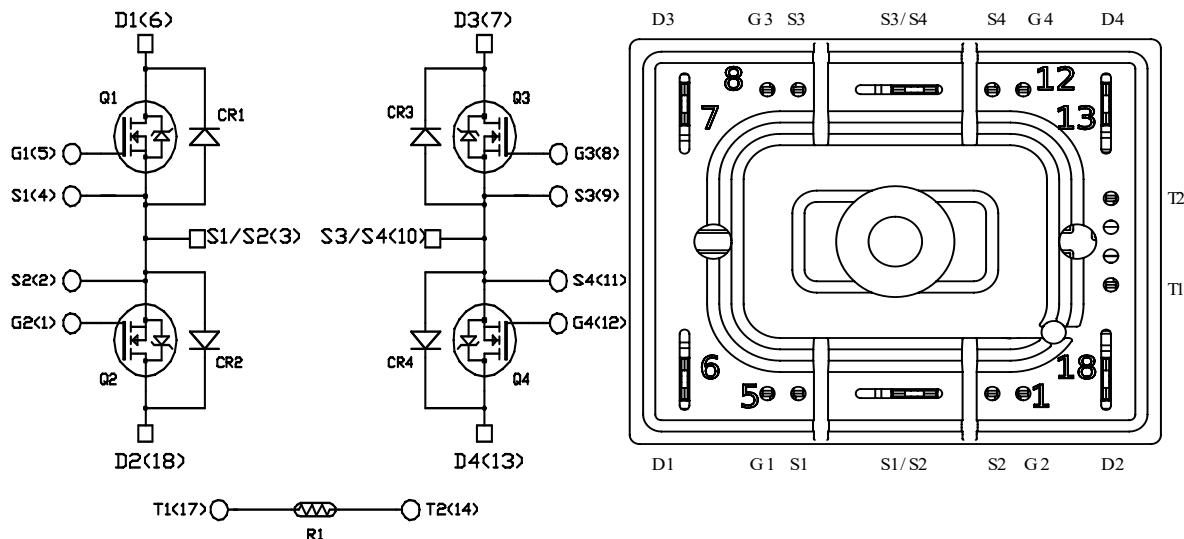
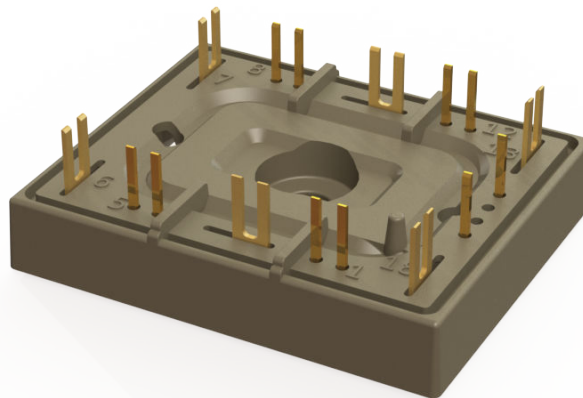


# MICROCHIP MSCSM120DDUM31CTBL2NG

## Double Dual Common Source SiC MOSFET Power Module

### Product Overview

The MSCSM120DDUM31CTBL2NG device is a double dual common source 1200 V/79 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 MSCSM120DDUM31CTBL2NG device:

- SiC Power MOSFET
  - Low  $R_{DS(on)}$
  - High speed switching
- SiC Schottky Diode
  - Zero reverse recovery
  - Zero forward recovery
  - Temperature independent switching behavior
  - Positive temperature coefficient on  $V_F$
- Ultra-low weight and profile
- Kelvin source for easy drive
- $Si_3N_4$  substrate with thick copper for improved thermal performance
- Internal thermistor for temperature monitoring
- Extended temperature range

## Benefits

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The following are the benefits of MSCSM120DDUM31CTBL2NG 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
- Solderable terminals both for power and signal for easy PCB mounting
- Very integrated power conversion system

## Application

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The following are the applications of MSCSM120DDUM31CTBL2NG device:

- High reliability power systems
- AC switches

### 1. Electrical Specifications

This section provides the electrical specifications of MSCSM120DDUM31CTBL2NG device.

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

The following table lists the absolute maximum ratings of MSCSM120DDUM31CTBL2NG device.

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

| Symbol       | Parameter                  |                                    | Maximum Ratings | Unit       |
|--------------|----------------------------|------------------------------------|-----------------|------------|
| $V_{DS}$     | Drain-Source voltage       |                                    | 1200            | V          |
| $I_D$        | Continuous drain current   | $T_H = 25\text{ }^{\circ}\text{C}$ | 79              | A          |
|              |                            | $T_H = 80\text{ }^{\circ}\text{C}$ | 63              |            |
| $I_{DM}$     | Pulsed drain current       |                                    | 160             |            |
| $V_{GS}$     | Gate-Source voltage        |                                    | -10/25          | V          |
| $R_{DS(on)}$ | Drain-Source ON resistance |                                    | 31              | m $\Omega$ |
| $P_D$        | Power dissipation          | $T_H = 25\text{ }^{\circ}\text{C}$ | 310             | W          |

The following table lists the electrical characteristics of MSCSM120DDUM31CTBL2NG device.

**Table 1-2. Electrical Characteristics**

| Symbol       | Characteristic                  | Test Conditions                               |                                     | Min | Typ | Max | Unit          |
|--------------|---------------------------------|-----------------------------------------------|-------------------------------------|-----|-----|-----|---------------|
| $I_{DSS}$    | Zero gate voltage drain current | $V_{GS} = 0\text{ V}; V_{DS} = 1200\text{ V}$ |                                     | —   | 10  | 100 | $\mu\text{A}$ |
| $R_{DS(on)}$ | Drain-Source on resistance      | $V_{GS} = 20\text{ V}$<br>$I_D = 40\text{ A}$ | $T_J = 25\text{ }^{\circ}\text{C}$  | —   | 25  | 31  | m $\Omega$    |
|              |                                 |                                               | $T_J = 175\text{ }^{\circ}\text{C}$ | —   | 40  | —   |               |
| $V_{GS(th)}$ | Gate threshold voltage          | $V_{GS} = V_{DS}; I_D = 1\text{ mA}$          |                                     | 1.8 | 2.8 | —   | V             |
| $I_{GSS}$    | Gate-Source leakage current     | $V_{GS} = 20\text{ V}; V_{DS} = 0\text{ V}$   |                                     | —   | —   | 150 | nA            |

The following table lists the dynamic characteristics of MSCSM120DDUM31CTBL2NG device.

**Table 1-3. Dynamic Characteristics**

| Symbol       | Characteristic                          | Test Conditions                                                                                                  | Min | Typ   | Max | Unit                 |
|--------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------|-----|-------|-----|----------------------|
| $C_{iss}$    | Input capacitance                       | $V_{GS} = 0\text{ V}$                                                                                            | —   | 3020  | —   | pF                   |
| $C_{oss}$    | Output capacitance                      | $V_{DS} = 1000\text{ V}$                                                                                         | —   | 270   | —   |                      |
| $C_{rss}$    | Reverse transfer capacitance            | $f = 1\text{ MHz}$                                                                                               | —   | 25    | —   |                      |
| $Q_g$        | Total gate charge                       | $V_{GS} = -5\text{ V}/20\text{ V}$                                                                               | —   | 232   | —   | nC                   |
| $Q_{gs}$     | Gate-Source charge                      | $V_{Bus} = 800\text{ V}$                                                                                         | —   | 41    | —   |                      |
| $Q_{gd}$     | Gate-Drain charge                       | $I_D = 40\text{ A}$                                                                                              | —   | 50    | —   |                      |
| $T_{d(on)}$  | Turn-on delay time                      | $V_{GS} = -5\text{ V}/20\text{ V}$                                                                               | —   | 30    | —   | ns                   |
| $T_r$        | Rise time                               | $V_{Bus} = 600\text{ V}$                                                                                         | —   | 30    | —   |                      |
| $T_{d(off)}$ | Turn-off delay time                     | $I_D = 50\text{ A}$                                                                                              | —   | 50    | —   |                      |
| $T_f$        | Fall time                               | $R_{Gon} = 8\text{ }\Omega$ ; $R_{Goff} = 4.7\text{ }\Omega$                                                     | —   | 25    | —   |                      |
| $E_{on}$     | Turn-on energy                          | $V_{GS} = -5\text{ V}/20\text{ V}$                                                                               | —   | 0.99  | —   | mJ                   |
| $E_{off}$    | Turn-off energy                         | $V_{Bus} = 600\text{ V}$<br>$I_D = 50\text{ A}$<br>$R_{Gon} = 8\text{ }\Omega$<br>$R_{Goff} = 4.7\text{ }\Omega$ |     |       |     |                      |
| $R_{Gint}$   | Internal gate resistance                |                                                                                                                  | —   | 0.88  | —   | $\Omega$             |
| $R_{thJH}$   | Junction-to-heatsink thermal resistance | $\lambda = 3.4\text{ W/mK}$                                                                                      | —   | 0.483 | —   | $^{\circ}\text{C/W}$ |

The following table lists the body diode ratings and characteristics of MSCSM120DDUM31CTBL2NG device.

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

| Symbol   | Characteristic           | Test Conditions                                              | Min | Typ  | Max | Unit |
|----------|--------------------------|--------------------------------------------------------------|-----|------|-----|------|
| $V_{SD}$ | Diode forward voltage    | $V_{GS} = 0\text{ V}$ ; $I_{SD} = 40\text{ A}$               | —   | 4    | —   | V    |
|          |                          | $V_{GS} = -5\text{ V}$ ; $I_{SD} = 40\text{ A}$              | —   | 4.2  | —   |      |
| $t_{rr}$ | Reverse recovery time    | $I_{SD} = 40\text{ A}$ ; $V_{GS} = -5\text{ V}$              | —   | 90   | —   | ns   |
| $Q_{rr}$ | Reverse recovery charge  | $V_R = 800\text{ V}$ ; $di_F/dt = 1000\text{ A}/\mu\text{s}$ | —   | 550  | —   | nC   |
| $I_{rr}$ | Reverse recovery current |                                                              | —   | 13.5 | —   | A    |

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

The following table lists the SiC diode ratings and characteristics of MSCSM120DDUM31CTBL2NG 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             |
| $I_{RM}$   | Reverse leakage current                 | $V_R = 1200\text{ V}$                  | $T_J = 25\text{ °C}$  | —     | 10   | $\mu\text{A}$ |
|            |                                         |                                        | $T_J = 175\text{ °C}$ | —     | 150  |               |
| $I_F$      | DC forward current                      |                                        | $T_H = 100\text{ °C}$ | —     | 30   | A             |
| $V_F$      | Diode forward voltage                   | $I_F = 30\text{ A}$                    | $T_J = 25\text{ °C}$  | —     | 1.5  | V             |
|            |                                         |                                        | $T_J = 175\text{ °C}$ | —     | 2.1  |               |
| $Q_C$      | Total capacitive charge                 | $V_R = 600\text{ V}$                   | —                     | 130   | —    | nC            |
| C          | Total capacitance                       | $f = 1\text{ MHz}, V_R = 400\text{ V}$ | —                     | 141   | —    | pF            |
|            |                                         | $f = 1\text{ MHz}, V_R = 800\text{ V}$ | —                     | 105   | —    |               |
| $R_{thJH}$ | Junction-to-heatsink thermal resistance | $\lambda_{paste} = 3.4\text{ W/mK}$    | —                     | 0.854 | —    | °C/W          |

### 1.3 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of MSCSM120DDUM31CTBL2NG device.

**Table 1-6. Thermal and Package Characteristics**

| Symbol            | Characteristic                                                     |             |    |     | Min  | Typ  | Max                   | Unit |
|-------------------|--------------------------------------------------------------------|-------------|----|-----|------|------|-----------------------|------|
| V <sub>ISOL</sub> | RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/60 Hz |             |    |     | 2500 | —    | —                     | V    |
| T <sub>J</sub>    | Operating junction temperature range                               |             |    |     | −55  | —    | 175                   | °C   |
| T <sub>JOP</sub>  | Recommended junction temperature under switching conditions        |             |    |     | −55  | —    | T <sub>Jmax</sub> −25 |      |
| T <sub>STG</sub>  | Storage case temperature                                           |             |    |     | −55  | —    | 125                   |      |
| T <sub>C</sub>    | Operating case temperature                                         |             |    |     | −55  | —    | 125                   |      |
| Torque            | Mounting torque                                                    | To heatsink | M4 | 1.5 | —    | 2    | N.m                   |      |
| Wt                | Package weight                                                     |             |    |     | —    | 21.5 | —                     | g    |

The following table lists the temperature sensor NTC of MSCSM120DDUM31CTBL2NG 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    | —   | %    |

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

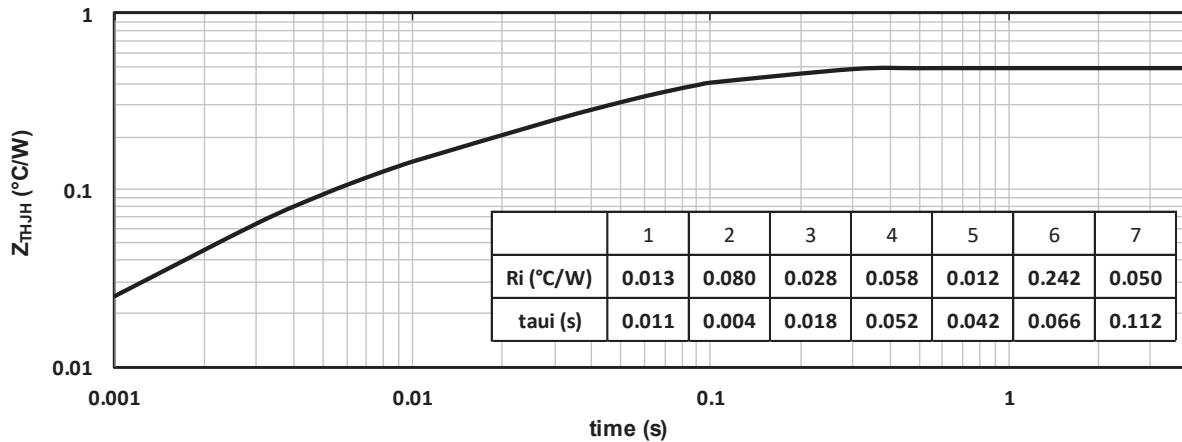
T: Thermistor temperature  
 $R_T$ : Thermistor value at T

**Note:** See [APT0406—Using NTC Temperature Sensor Integrated into Power Module](#) for more information.

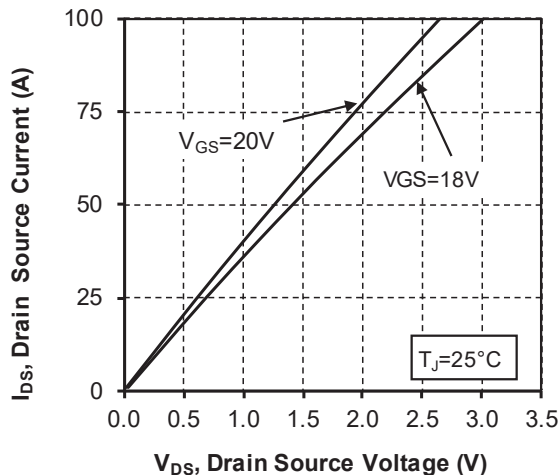
## 1.4 Typical SiC MOSFET Performance Curve

This section shows the typical SiC MOSFET performance curves of MSCSM120DDUM31CTBL2NG device.

**Figure 1-1. Junction-to-Heatsink Thermal Impedance**



**Figure 1-2. Output Characteristics,  $T_J = 25$  °C**



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

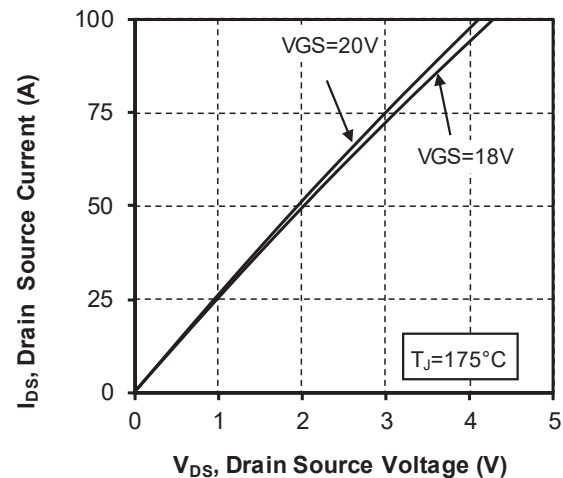


Figure 1-4. Normalized  $R_{DS(on)}$  vs. Temperature

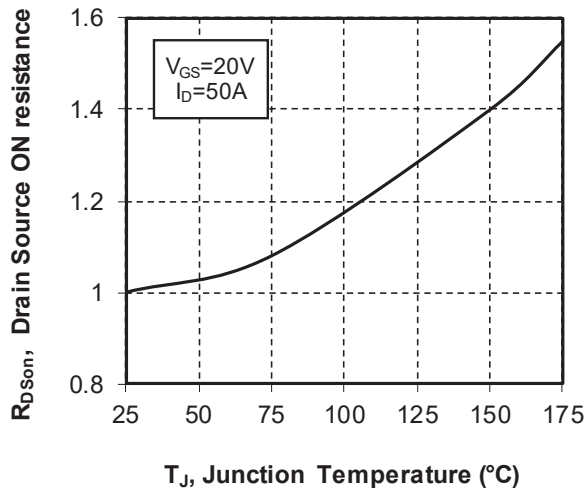


Figure 1-5. Transfer Characteristics

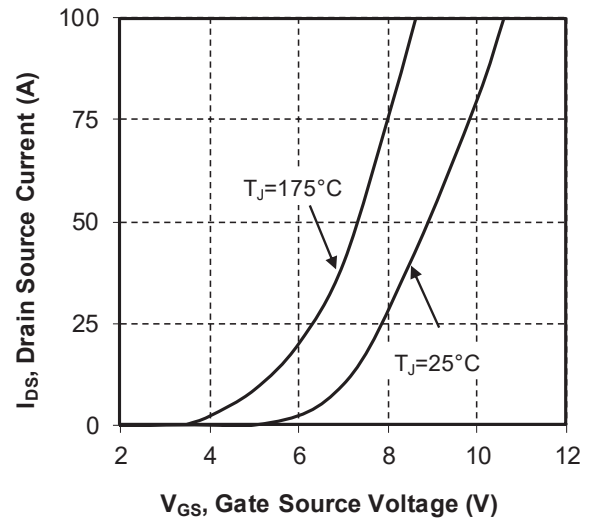


Figure 1-6. Switching Energy vs.  $R_g$

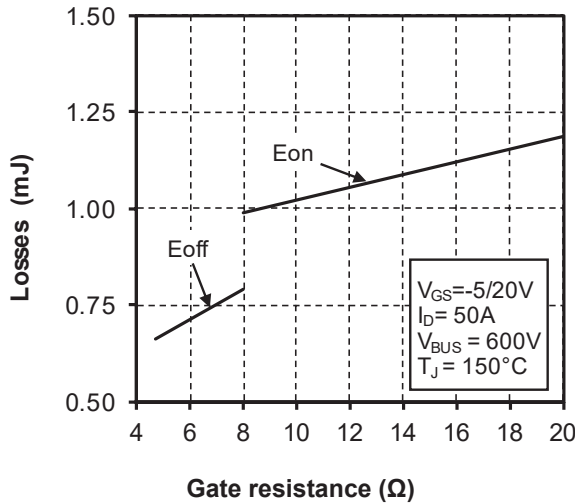


Figure 1-7. Switching Energy vs. Current

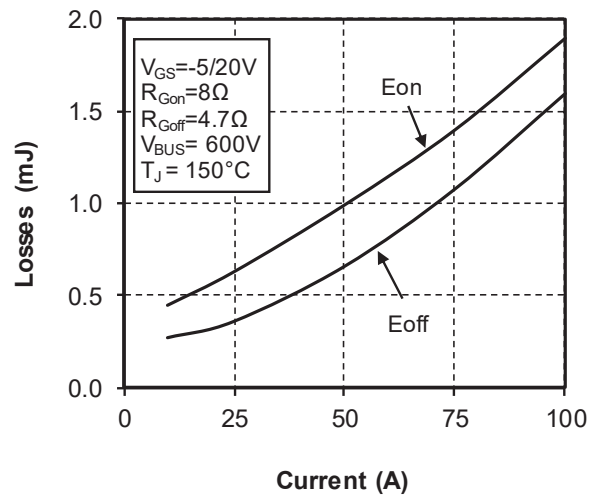


Figure 1-8. Capacitance vs. Drain Source Voltage

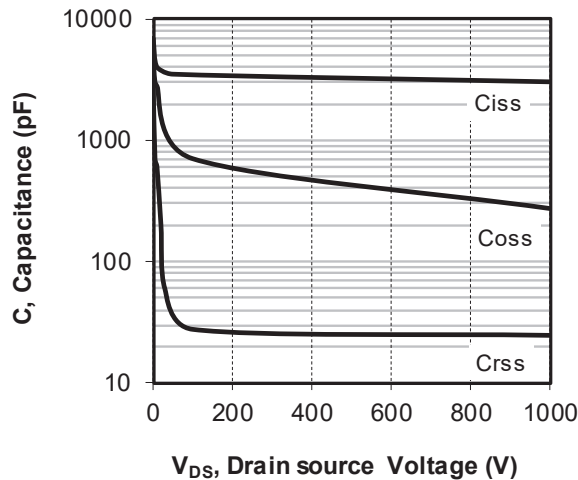


Figure 1-9. Gate Charge vs. Gate Source Voltage

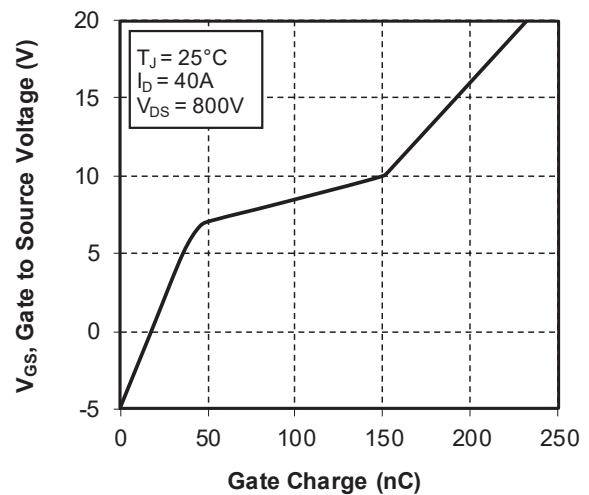


Figure 1-10. Body Diode Characteristics,  $T_J = 25^\circ\text{C}$

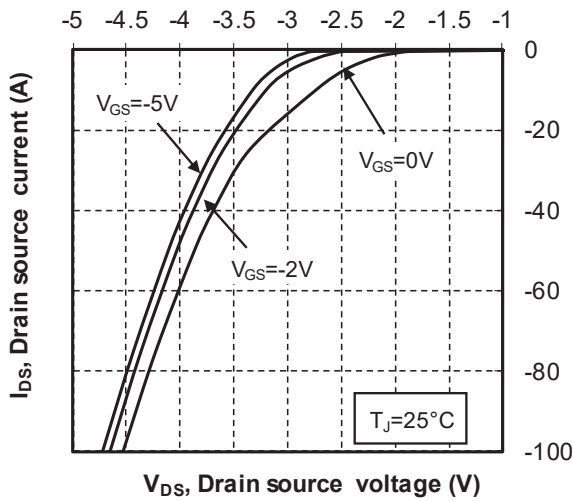


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

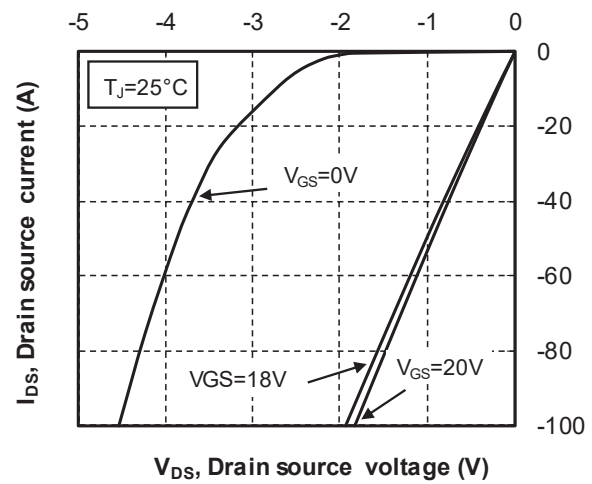


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

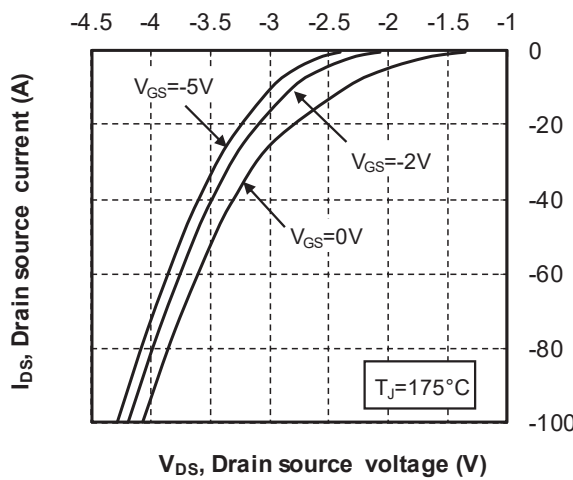


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

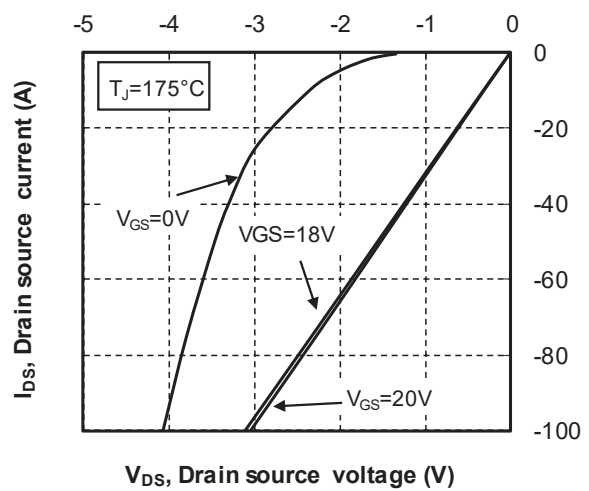
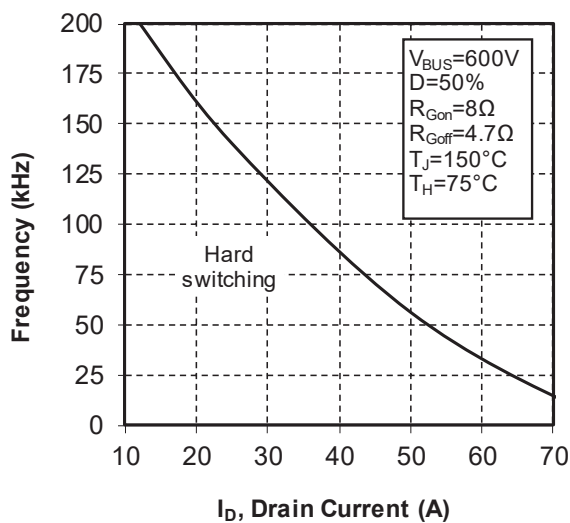


Figure 1-14. Operating Frequency vs. Drain Current





1.5 Typical SiC Diode Performance Curves (per SiC Diode)

This section shows the typical SiC diode performance curves of MSCSM120DDUM31CTBL2NG device.

Figure 1-15. Junction-to-Heatsink Thermal Impedance

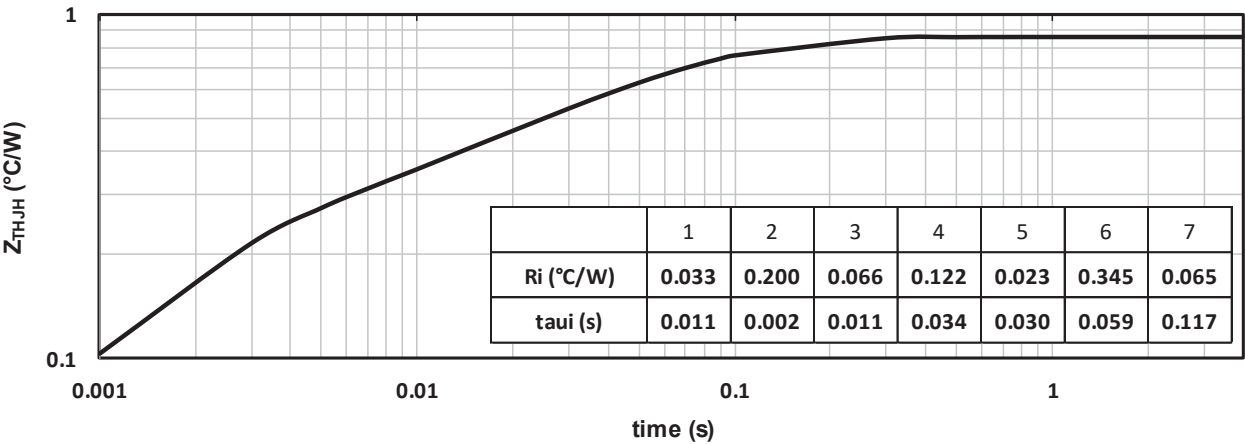


Figure 1-16. Forward Characteristics

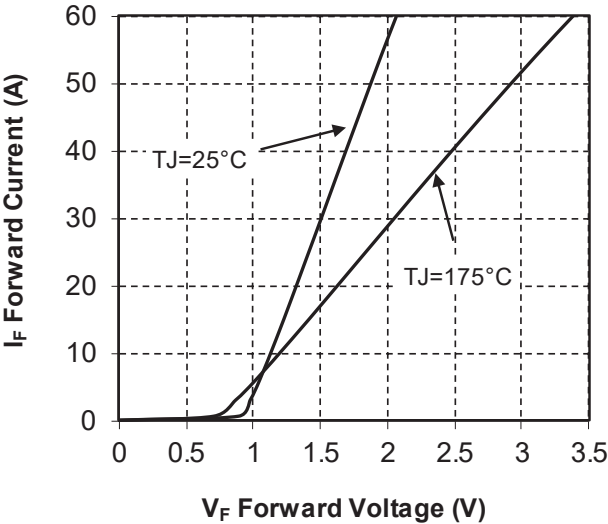
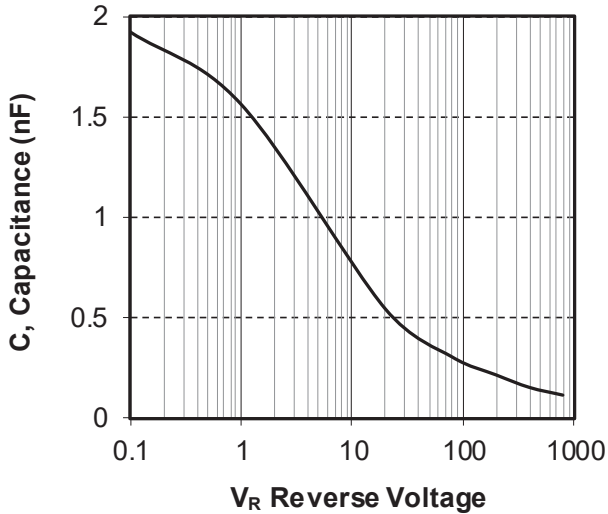
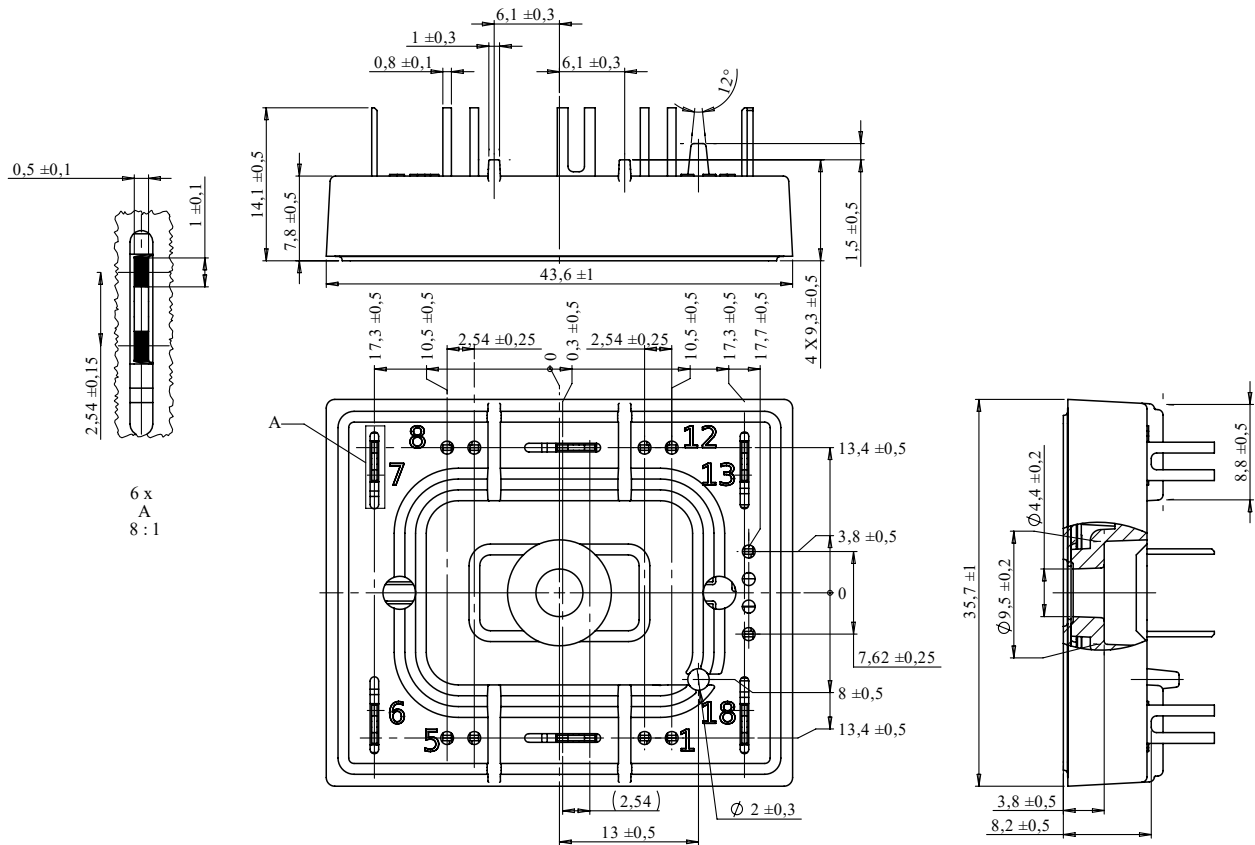


Figure 1-17. Capacitance vs. Reverse Voltage



The following section shows the package specification of MSCSM120DDUM31CTBL2NG device.

### Figure 2-1. Package Outline Drawing



**3. Revision History**

| Revision | Date    | Description      |
|----------|---------|------------------|
| A        | 07/2021 | Initial revision |

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