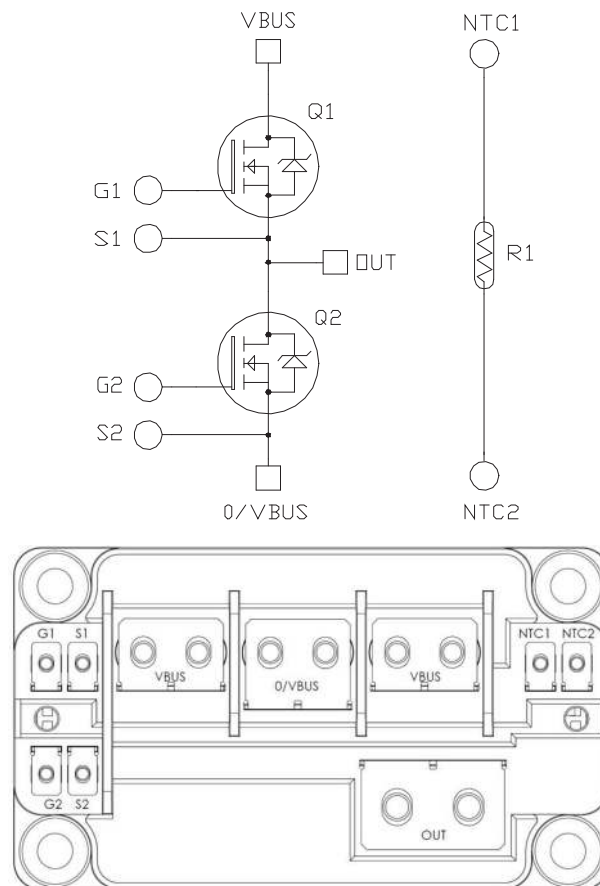


## Very Low Stray Inductance Phase Leg SiC MOSFET Power Module

### Product Overview

The MSCSM120AM03T6LIAG device is a very low stray inductance phase leg 1200V, 805A silicon carbide (SiC) MOSFET power module.



**Note:** All ratings at  $T_j = 25\text{ }^\circ\text{C}$ , unless otherwise specified.



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

## Features

The following are key features of the MSCSM120AM03T6LIAG device:

- SiC Power MOSFET
  - Low  $R_{DS(on)}$
  - High temperature performance
- M2.5 signals connectors
- Very low stray inductance
- M4 and M5 power connectors
- Internal thermistor for temperature monitoring
- Aluminum Nitride (AlN) substrate for improved thermal performance

## Benefits

The following are the benefits of MSCSM120AM03T6LIAG 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

The MSCSM120AM03T6LIAG device is designed for the following applications:

- 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 MSCSM120AM03T6LIAG device.

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

The following table lists the absolute maximum ratings per SiC MOSFET of the MSCSM120AM03T6LIAG device.

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

| Symbol       | Parameter                  | Maximum Ratings                  | Unit             |
|--------------|----------------------------|----------------------------------|------------------|
| $V_{DSS}$    | Drain-Source voltage       | 1200                             | V                |
| $I_D$        | Continuous drain current   | $T_C = 25\text{ }^\circ\text{C}$ | 805 <sup>1</sup> |
|              |                            | $T_C = 80\text{ }^\circ\text{C}$ | 640 <sup>1</sup> |
| $I_{DM}$     | Pulsed drain current       | 1600                             |                  |
| $V_{GS}$     | Gate-Source voltage        | -10/23                           | V                |
| $R_{DS(on)}$ | Drain-Source ON resistance | 3.1                              | m $\Omega$       |
| $P_D$        | Power dissipation          | $T_C = 25\text{ }^\circ\text{C}$ | 3215             |

**Note:**

- SiC MOSFET device specification, but the output current must be limited due to the size of the power connectors.

The following table lists the electrical characteristics per SiC MOSFET of the MSCSM120AM03T6LIAG device.

**Table 1-2. Electrical Characteristics**

| Symbol       | Characteristic                  | Test Conditions                           | Min                               | Typ | Max  | Unit    |            |
|--------------|---------------------------------|---|-----------------------------------|-----|------|---------|------------|
| $I_{DSS}$    | Zero gate voltage drain current | $V_{GS} = 0V$<br>$V_{DS} = 1200V$         | —                                 | 150 | 1000 | $\mu A$ |            |
| $R_{DS(on)}$ | Drain-Source on resistance      | $V_{GS} = 20V$<br>$I_D = 400A$            | $T_J = 25\text{ }^\circ\text{C}$  | —   | 2.5  | 3.1     | m $\Omega$ |
|              |                                 |   | $T_J = 175\text{ }^\circ\text{C}$ | —   | 4    | —       |            |
| $V_{GS(th)}$ | Gate threshold voltage          | $V_{GS} = V_{DS}$<br>$I_D = 30\text{ mA}$ | 1.8                               | 2.8 | —    | V       |            |
| $I_{GSS}$    | Gate-Source leakage current     | $V_{GS} = 20V; V_{DS} = 0V$               | —                                 | —   | 1    | $\mu A$ |            |

# MSCSM120AM03T6LIAG

## Electrical Specifications

The following table lists the dynamic characteristics per SiC MOSFET of the MSCSM120AM03T6LIAG device.

**Table 1-3. Dynamic Characteristics**

| Symbol       | Characteristic                      | Test Conditions                                       | Min | Typ  | Max   | Unit          |
|--------------|-------------------------------------|---|-----|------|-------|---------------|
| $C_{iss}$    | Input capacitance                   | $V_{GS} = 0V$   | —   | 30.2 | —     | nF            |
| $C_{oss}$    | Output capacitance                  | $V_{DS} = 1000V$                                      | —   | 2.7  | —     |               |
| $C_{rss}$    | Reverse transfer capacitance        | $f = 1\text{ MHz}$                                    | —   | 0.25 | —     |               |
| $Q_g$        | Total gate charge                   | $V_{GS} = -5V/20V$                                    | —   | 2320 | —     | nC            |
| $Q_{gs}$     | Gate-Source charge                  | $V_{Bus} = 800V$                                      | —   | 410  | —     |               |
| $Q_{gd}$     | Gate-Drain charge                   | $I_D = 400A$  | —   | 500  | —     |               |
| $T_{d(on)}$  | Turn-on delay time                  | $V_{GS} = -5V/20V$                                    | —   | 56   | —     | ns            |
| $T_r$        | Rise time                           | $V_{Bus} = 600V$                                      |     |      |       |               |
| $T_{d(off)}$ | Turn-off delay time                 | $I_D = 500A$  |     |      |       |               |
| $T_f$        | Fall time                           | $R_G = 0.6\Omega$                                     |     |      |       |               |
| $E_{on}$     | Turn-on energy                      | $V_{GS} = -5V/20V$                                    | —   | 12.2 | —     | mJ            |
| $E_{off}$    | Turn-off energy                     | $V_{Bus} = 600V$<br>$I_D = 500A$<br>$R_G = 0.6\Omega$ |     |      |       |               |
| $R_{Gint}$   | Internal gate resistance            |   | —   | 0.98 | —     | $\Omega$      |
| $R_{thJC}$   | Junction-to-case thermal resistance |   | —   | —    | 0.047 | $^{\circ}C/W$ |

The following table lists the body diode ratings and characteristics per SiC MOSFET of the MSCSM120AM03T6LIAG device.

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

| Symbol   | Characteristic           | Test Conditions                                    | Min | Typ | Max | Unit          |
|----------|--------------------------|--|-----|-----|-----|---------------|
| $V_{SD}$ | Diode forward voltage    | $V_{GS} = 0V; I_{SD} = 400A$                       | —   | 4   | —   | V             |
|          |                          | $V_{GS} = -5V; I_{SD} = 400A$                      | —   | 4.2 | —   |               |
| $t_{rr}$ | Reverse recovery time    | $I_{SD} = 400A; V_{GS} = -5V$                      | —   | 90  | —   | ns            |
| $Q_{rr}$ | Reverse recovery charge  | $V_R = 800V; di_F/dt = 10000\text{ A}/\mu\text{s}$ | —   | 5.5 | —   | $\mu\text{C}$ |
| $I_{rr}$ | Reverse recovery current |  | —   | 135 | —   | A             |

### 1.2 Thermal and Package Characteristics

The following table lists the thermal and package characteristics of the MSCSM120AM03T6LIAG device.

**Table 1-5. Thermal and Package Characteristics**

| Symbol            | Characteristics   | Min           | Max                   | Unit |     |     |
|-------------------|---|---------------|-----------------------|------|-----|-----|
| V <sub>ISOL</sub> | RMS isolation voltage, any terminal to case t =1 min, 50 Hz/60 Hz | 4000          | —                     | V    |     |     |
| T <sub>J</sub>    | Operating junction temperature range                              | −40           | 175                   | °C   |     |     |
| T <sub>JOP</sub>  | Recommended junction temperature under switching conditions       | −40           | T <sub>Jmax</sub> −25 |      |     |     |
| T <sub>STG</sub>  | Storage temperature range   | −40           | 125                   |      |     |     |
| T <sub>C</sub>    | Operating case temperature  | −40           | 125                   |      |     |     |
| Torque            | Mounting torque   | For terminals | M2.5                  | 0.4  | N.m |     |
|                   |   |               | M4                    | 2    |     | 3   |
|                   |   |               | M5                    | 2    |     | 3.5 |
|                   |   | To heatsink   | M6                    | 3    |     | 5   |
| L <sub>DC</sub>   | Module stray inductance between VBUS and 0/VBUS                   | —             | 3                     | nH   |     |     |
| Wt                | Package weight  | —             | 320                   | g    |     |     |

The following table lists the temperature sensor NTC of the MSCSM120AM03T6LIAG device.

**Table 1-6. 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> = 298.15K | —                       | 3952 | —   | K    |
| ΔB/B                              | —                         | T <sub>C</sub> = 100 °C | 4    | —   | %    |

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

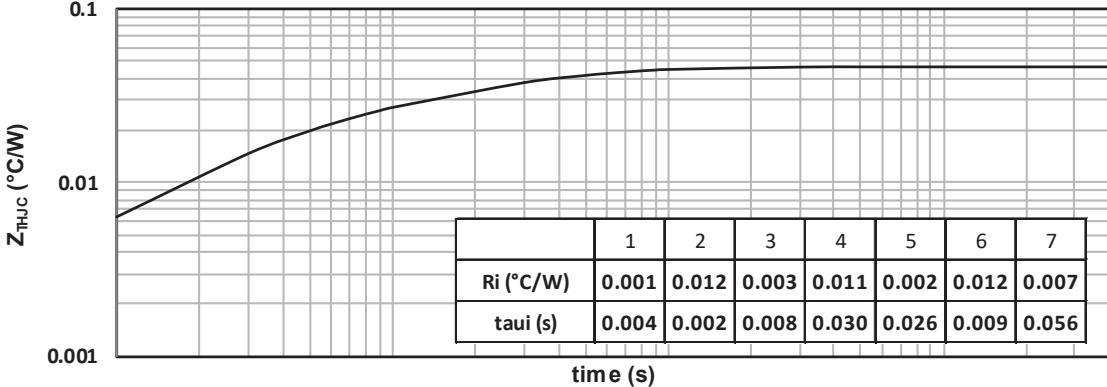
T: Thermistor temperature  
R<sub>T</sub>: Thermistor value at T

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

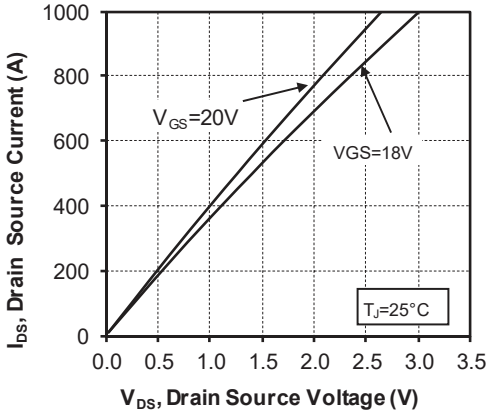
**1.3 Typical SiC MOSFET Performance Curve**

This section shows the typical SiC MOSFET performance curves of the MSCSM120AM03T6LIAG device.

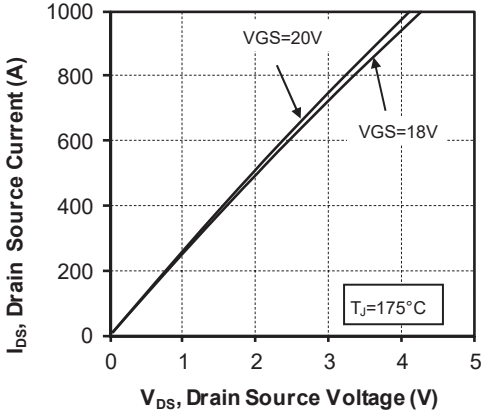
**Figure 1-1. Maximum Thermal Impedance**



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



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



# MSCSM120AM03T6LIAG

## Electrical Specifications

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

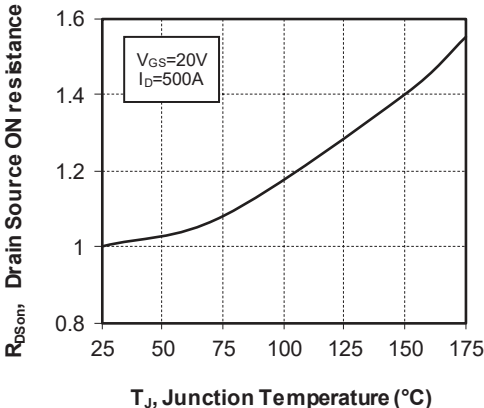


Figure 1-5. Transfer Characteristics

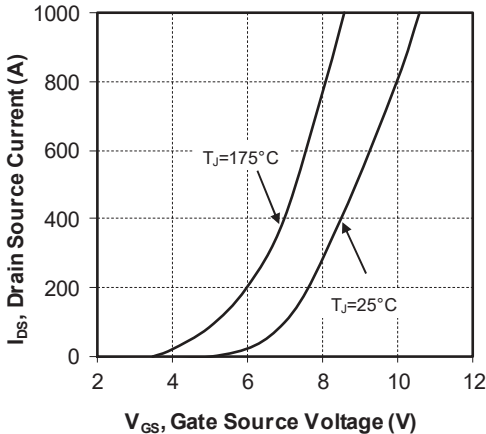


Figure 1-6. Switching Energy vs. Current

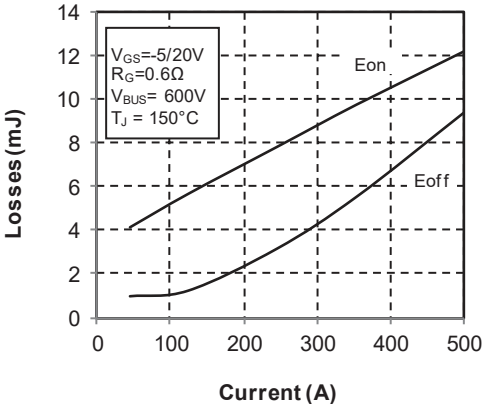


Figure 1-7. Switching Energy vs. Rg

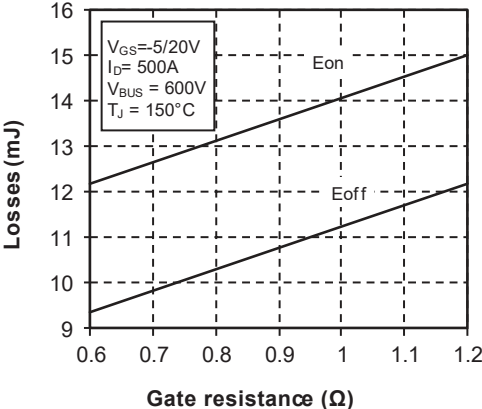


Figure 1-8. Capacitance vs. Drain Source Voltage

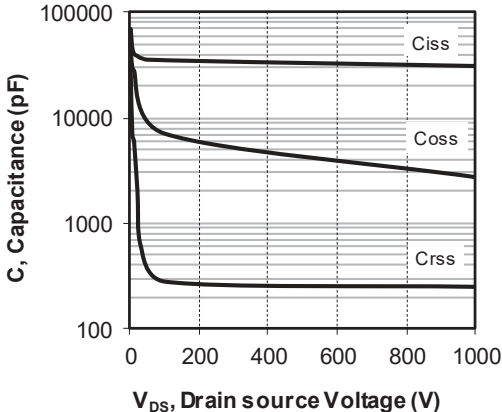
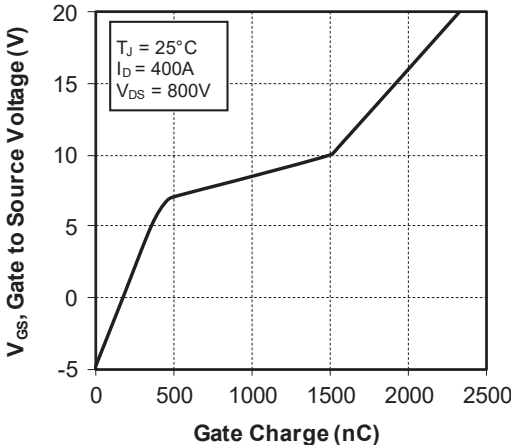


Figure 1-9. Gate Charge vs. Gate Source Voltage



# MSCSM120AM03T6LIAG

## Electrical Specifications

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

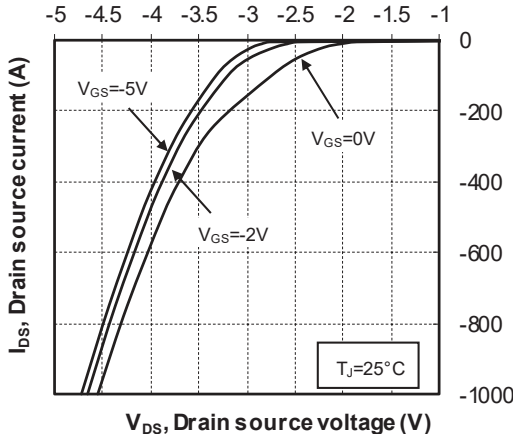


Figure 1-11. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 25^\circ\text{C}$

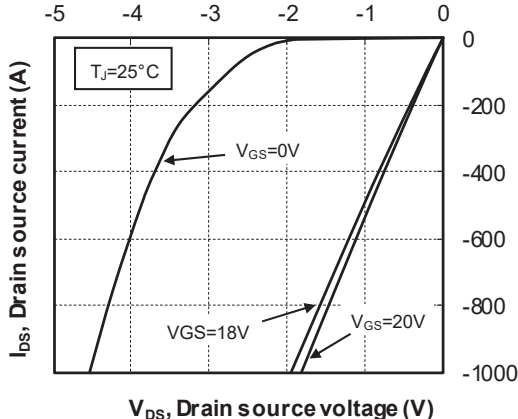


Figure 1-12. Body Diode Characteristics,  $T_J = 175^\circ\text{C}$

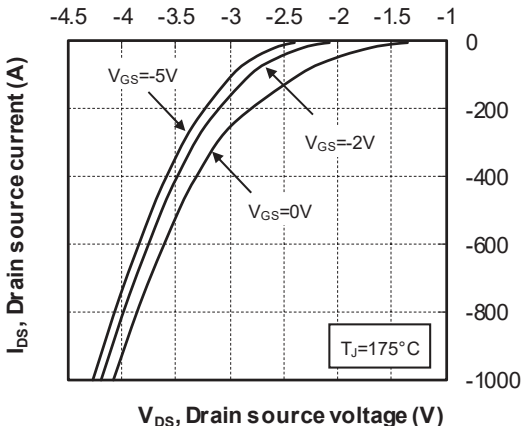


Figure 1-13. 3<sup>rd</sup> Quadrant Characteristics,  $T_J = 175^\circ\text{C}$

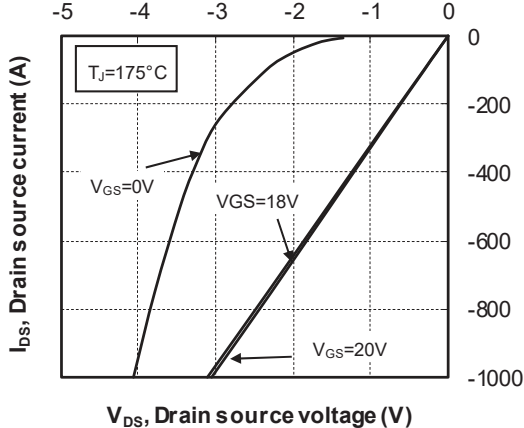
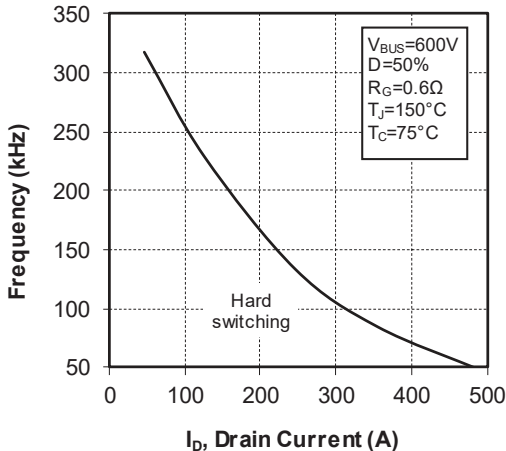


Figure 1-14. Operating Frequency vs Drain Current





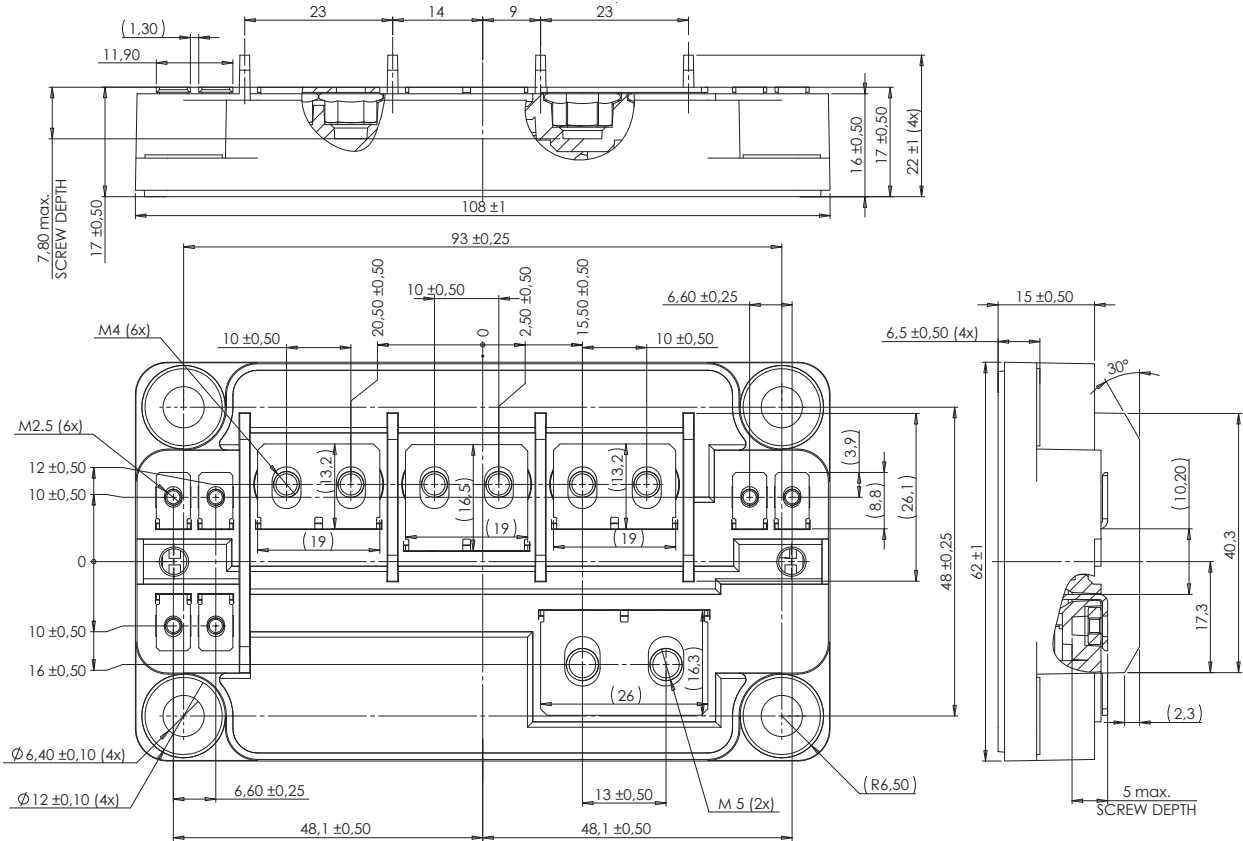
## 2. Package Specifications

The following section shows the package specification of the MSCSM120AM03T6LIAG device.

### 2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120AM03T6LIAG 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        | 06/2022 | Initial Revision |

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