

MSCMC120AM04CT6LIAG

Datasheet

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

Final

May 2018



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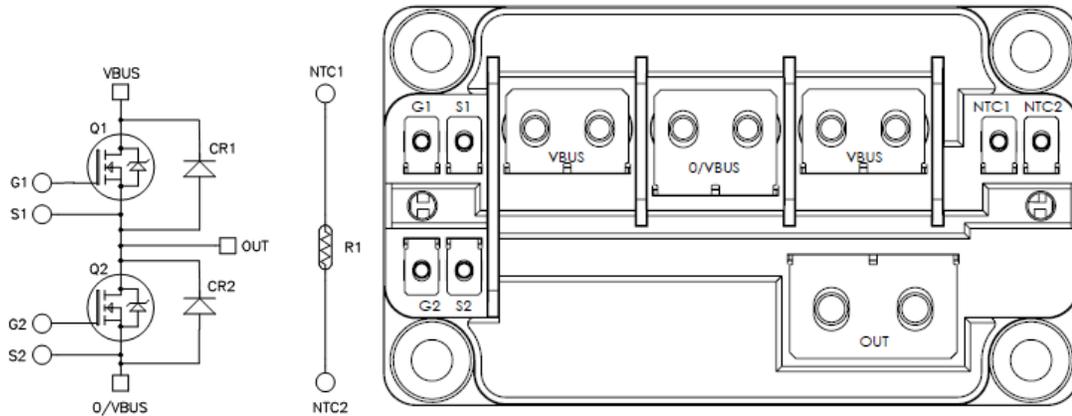
1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision A

Revision A was published in May 2018. It is the first publication of this document.

2 Product Overview



2.1 Features

The following are key features of the MSCMC120AM04CT6LIAG device:

- Very low stray inductance
- Internal thermistor for temperature monitoring
- M4 and M5 power connectors
- M2.5 signals connectors
- AlN substrate for improved thermal performance

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

2.2 Benefits

The following are benefits of the MSCMC120AM04CT6LIAG device:

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

2.3 Applications

The MSCMC120AM04CT6LIAG device is designed for the following applications:

- Motor control

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

Caution: The devices are sensitive to electrostatic discharge. Proper handling precautions should be followed.

3 Electrical Specifications

This section details the electrical specifications for the MSCMC120AM04CT6LIAG device.

3.1 Absolute Maximum Ratings

The following table shows the SiC MOSFET absolute maximum ratings (per SiC MOSFET) for the MSCMC120AM04CT6LIAG device.

Table 1 • Absolute Maximum Ratings

| Symbol | Parameter | | Ratings | Unit |
|-------------------|--|------------------------|-----------|------|
| V _{DSS} | Drain- source voltage | | 1200 | V |
| I _D | Continuous drain current | T _c = 25 °C | 388 | A |
| | | T _c = 80 °C | 307 | |
| I _{DM} | Pulsed drain current | | 780 | |
| V _{GS} | Gate- source voltage | | -10 to 23 | V |
| V _{GSOP} | Gate- source voltage; recommended operation values | | -5 to 18 | |
| R _{DSon} | Drain- source ON resistance | | 5.7 | mΩ |
| P _D | Power dissipation | T _c = 25 °C | 1754 | W |

3.2 Electrical Performance

The following tables show the SiC MOSFET characteristics (per SiC MOSFET) of the MSCMC120AM04CT6LIAG device.

Table 2 • Electrical Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---------------------|---------------------------------|---|-----|-----|-----|------|
| I _{DSS} | Zero gate voltage drain current | V _{GS} = 0 V, V _{DS} = 1200 V | | 100 | 600 | μA |
| R _{DS(on)} | Drain- source on resistance | V _{GS} = 20 V; I _D = 300 A T _J = 25 °C | | 4.2 | 5.7 | mΩ |
| | | V _{GS} = 18 V; I _D = 300 A T _J = 175 °C | | 8.6 | | |
| V _{GS(th)} | Gate threshold voltage | V _{GS} = V _{DS} , I _D = 90 mA | 2 | 2.6 | 4 | V |
| I _{GSS} | Gate- source leakage current | V _{GS} = 20 V, V _{DS} = 0 V | | | 7.2 | μA |

Table 3 • Dynamic Characteristics

| Symbol | Characteristic | Test conditions | Min | Typ | Max | Unit |
|---------------------|-------------------------------------|---|-----|------|-------|------|
| C _{iss} | Input capacitance | V _{GS} = 0 V | | 16.7 | | nF |
| C _{oss} | Output capacitance | V _{DS} = 1000 V | | 1.32 | | |
| C _{rss} | Reverse transfer capacitance | f = 1 MHz | | 0.09 | | |
| Q _g | Total gate charge | V _{GS} = -5 to 20 V | | 966 | | nC |
| Q _{gs} | Gate – source charge | V _{Bus} = 800 V | | 276 | | |
| Q _{gd} | Gate – drain charge | I _D = 300 A | | 300 | | |
| T _{d(on)} | Turn-on delay time | V _{GS} = -5 to 20 V | | 21 | | ns |
| T _r | Rise time | V _{Bus} = 600 V | | 19 | | |
| T _{d(off)} | Turn-off delay time | I _D = 300 A | | 50 | | |
| T _f | Fall time | R _L = 2 Ω ; R _G = 0.5 Ω | | 30 | | |
| E _{on} | Turn on energy | Inductive Switching | | 4.45 | | |
| E _{off} | Turn off energy | V _{GS} = -5 to 20 V T _J = 150 °C | | 2.9 | | mJ |
| | | V _{Bus} = 600 V T _J = 150 °C | | | | |
| | | I _D = 300 A | | | | |
| | | R _G = 0.5 Ω | | | | |
| R _{Gint} | Internal gate resistance | | | 0.85 | | Ω |
| R _{thJC} | Junction-to-case thermal resistance | | | | 0.086 | °C/W |

Table 4 • Body Diode Ratings and Characteristics

| Symbol | Characteristic | Test conditions | | Min | Typ | Max | Unit |
|-----------------|--------------------------|--|-------------------------|-----|------|-----|------|
| V _{SD} | Diode forward voltage | V _{GS} = -5 V | T _J = 25 °C | | 4 | | V |
| | | I _{SD} = 150 A | T _J = 175 °C | | 3.5 | | |
| t _{rr} | Reverse recovery time | I _{SD} = 300 A ; V _{GS} = -5 V | | | 45 | | ns |
| Q _{rr} | Reverse recovery charge | V _R = 800 V ; di _F /dt = 6000 A/μs | | | 2.45 | | μC |
| I _{rr} | Reverse recovery current | | | | 81 | | A |

The following table shows the SiC diode characteristics of the MSCMC120AM04CT6LIAG device.

Table 5 • SiC Diode Characteristics (per SiC diode)

| Symbol | Characteristics | Test conditions | | Min | Typ | Max | Unit |
|-------------------|-------------------------------------|-----------------------------------|-------------------------|------|-----|-------|------|
| V _{RRM} | Peak repetitive reverse voltage | | | | | 1200 | V |
| I _{RM} | Reverse leakage current | V _R = 1200 V | T _J = 25 °C | 0.4 | 2 | | mA |
| | | | T _J = 175 °C | 1.2 | 4 | | |
| I _F | DC forward current | T _C = 100 °C | | | 200 | | A |
| V _F | Diode forward voltage | I _F = 200 A | T _J = 25 °C | 1.6 | 1.8 | | V |
| | | | T _J = 175 °C | 2.25 | 2.7 | | |
| Q _C | Total capacitive charge | V _R = 800 V | | | 984 | | nC |
| C | Total capacitance | f = 1 MHz, V _R = 400 V | | | 920 | | pF |
| | | f = 1 MHz, V _R = 800 V | | | 692 | | |
| R _{thJC} | Junction-to-case thermal resistance | | | | | 0.135 | °C/W |

The following tables show the thermal and package characteristics of the MSCMC120AM04CT6LIAG device.

Table 6 • Package Characteristics

| Symbol | Characteristic | Min | Max | Unit | | |
|-------------------|---|---------------|------------------------|------|-----|-----|
| V _{ISOL} | RMS isolation voltage, any terminal to case t = 1 min, 50 to 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 temperature range | -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 | |
| | | To heatsink | M5 | 2 | 3.5 | |
| | | | M6 | 3 | 5 | |
| L _{DC} | Module stray inductance between V _{BUS} and 0/V _{BUS} | | 3 | nH | | |
| W _t | Package weight | | 320 | g | | |

Table 7 • Temperature Sensor NTC

| Symbol | Characteristic | Min | Typ | Max | Unit |
|-----------------------------------|----------------------------|-----|------|-----|------|
| R ₂₅ | Resistance at 25 °C | | 50 | | kΩ |
| ΔR ₂₅ /R ₂₅ | | | 5 | | % |
| B _{25/85} | T ₂₅ = 298.15 K | | 3952 | | K |
| ΔB/B | T _c = 100 °C | | 4 | | % |

Note: See application note APT0406 on www.microsemi.com

Figure 1 • NTC Formula

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

3.3 Typical Performance Curves

This section shows the typical performance curves for the MSCMC120AM04CT6LIAG device.

The following section details the typical performance curves for SiC MOSFET.

Figure 2 • Maximum Thermal Impedance

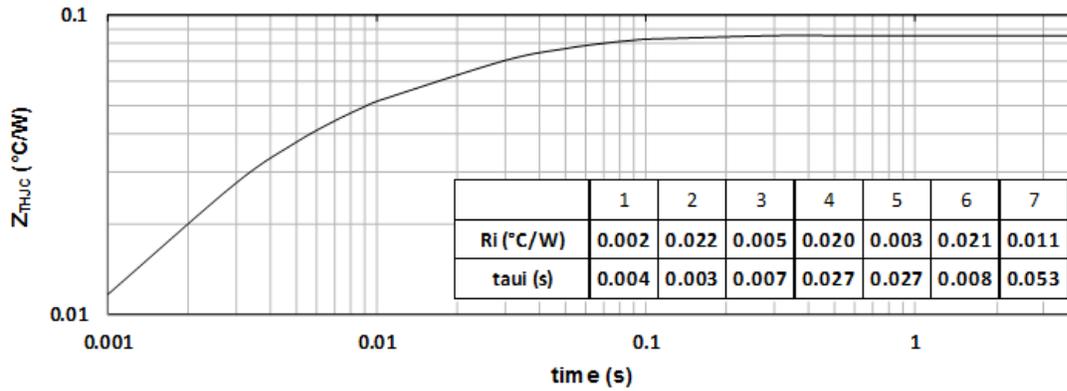


Figure 3 • Output Characteristics

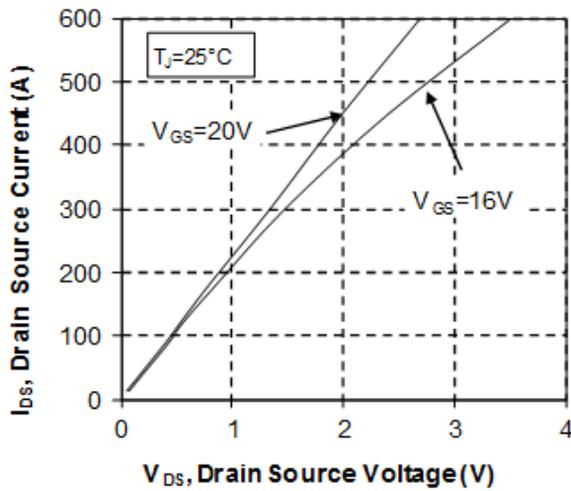


Figure 4 • Output Characteristics II

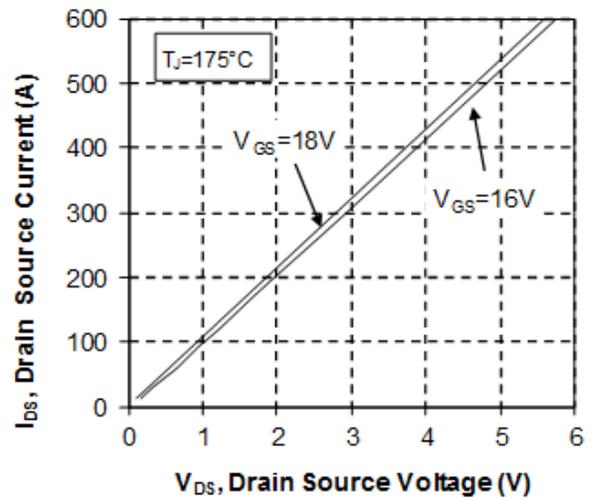


Figure 5 • Normalized $R_{ds(on)}$ vs. Temperature

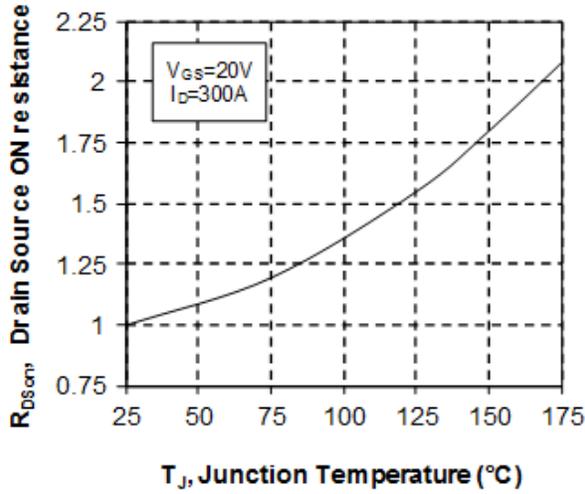


Figure 6 • Transfer Characteristics

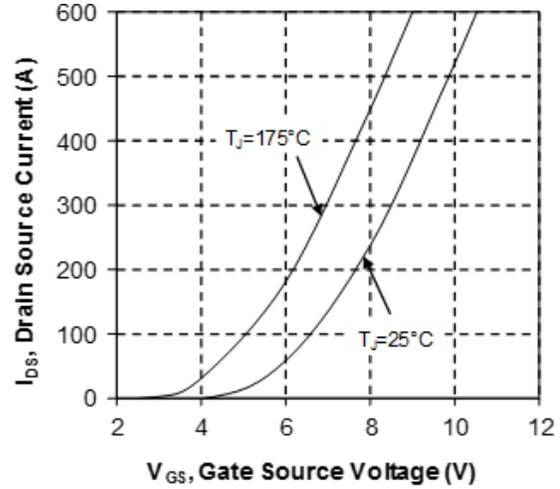


Figure 7 • Switching Energy vs. R_g

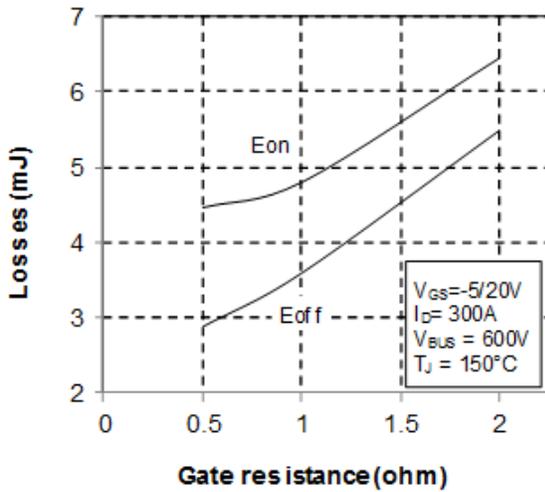


Figure 8 • Switching Energy vs. Current

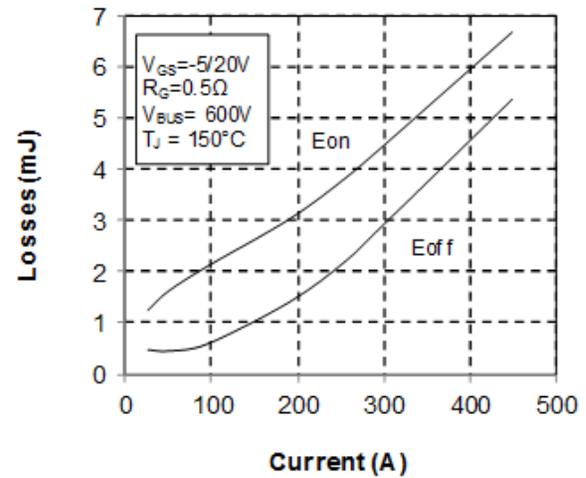


Figure 9 • Capacitance vs. Drain Source Voltage

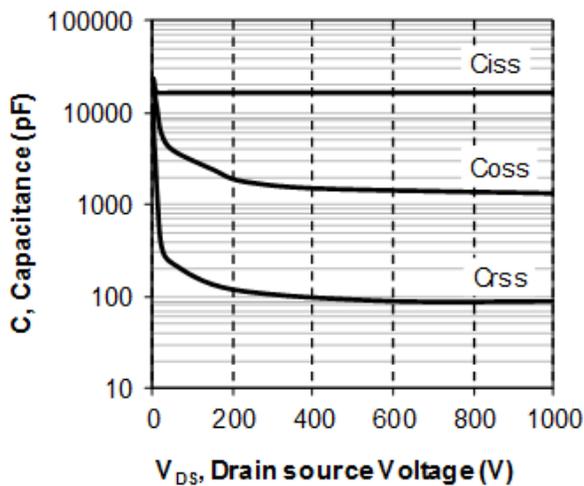


Figure 10 • Gate Charge vs. Gate Source Voltage

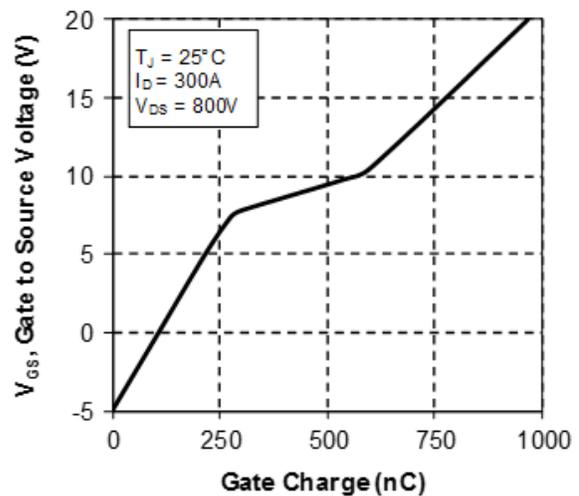


Figure 11 • Body Diode Characteristics

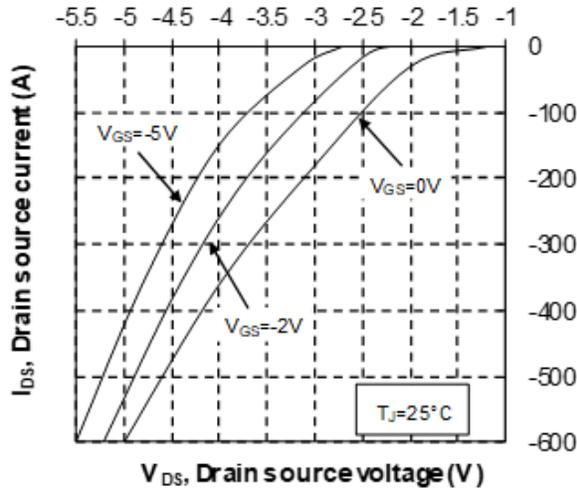


Figure 12 • 3rd Quadrant Characteristics

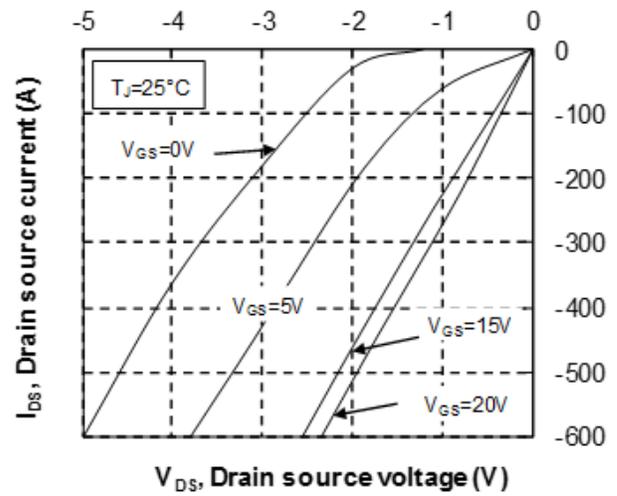


Figure 13 • Body Diode Characteristics II

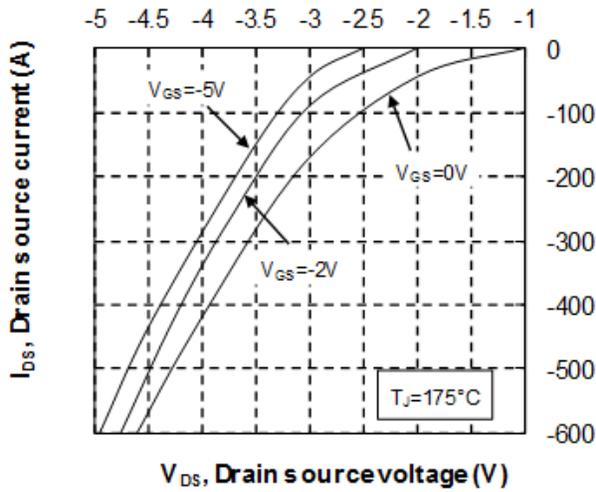


Figure 14 • 3rd Quadrant Characteristics

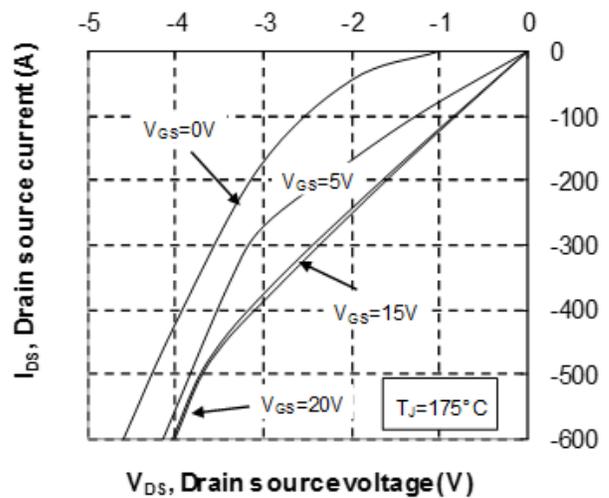
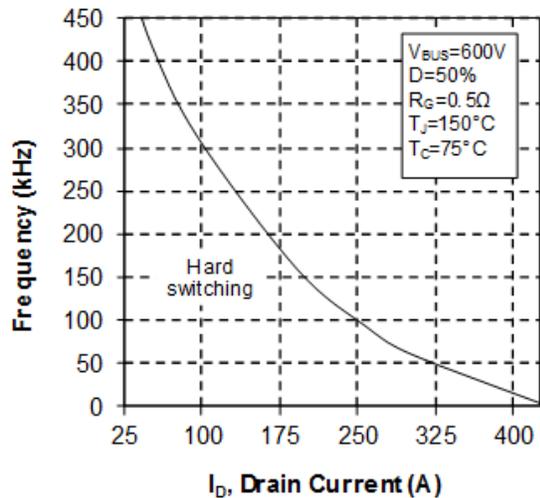


Figure 15 • Operating Frequency vs. Drain Current



The following section details the typical performance curves for SiC Diode.

Figure 16 • SiC Diode Maximum Thermal Impedance

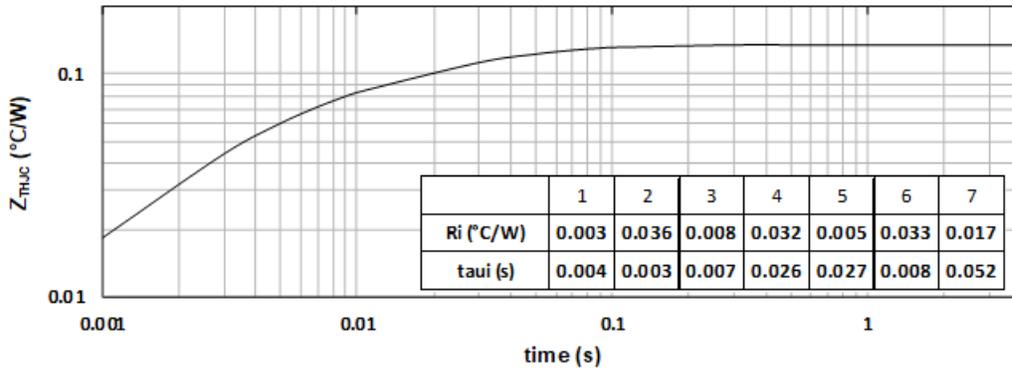


Figure 17 • Forward Characteristics

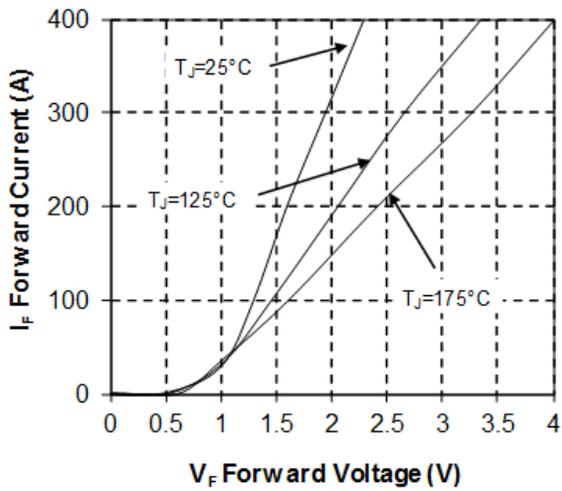


Figure 18 • Reverse Characteristics

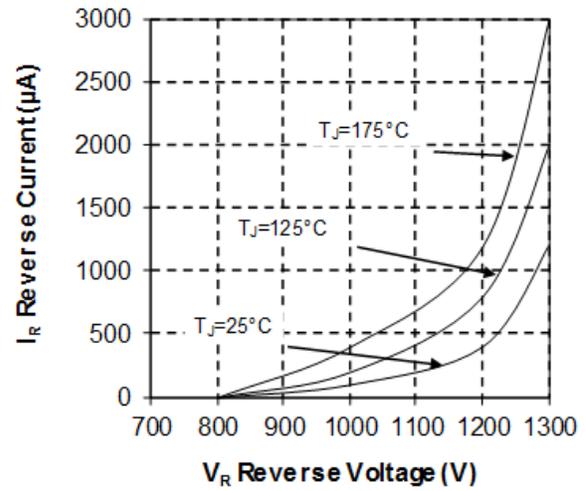
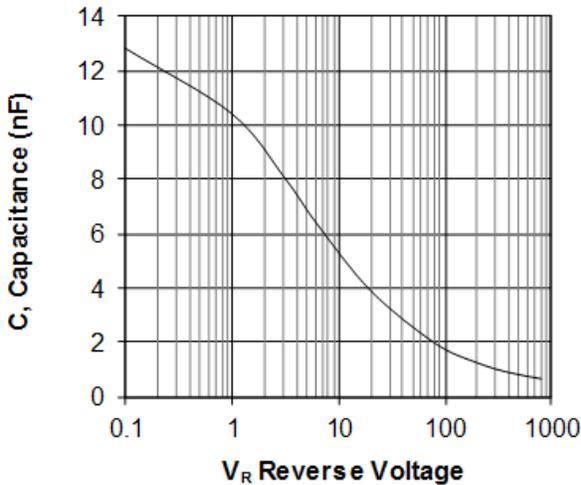


Figure 19 • Capacitance vs. Reverse Voltage



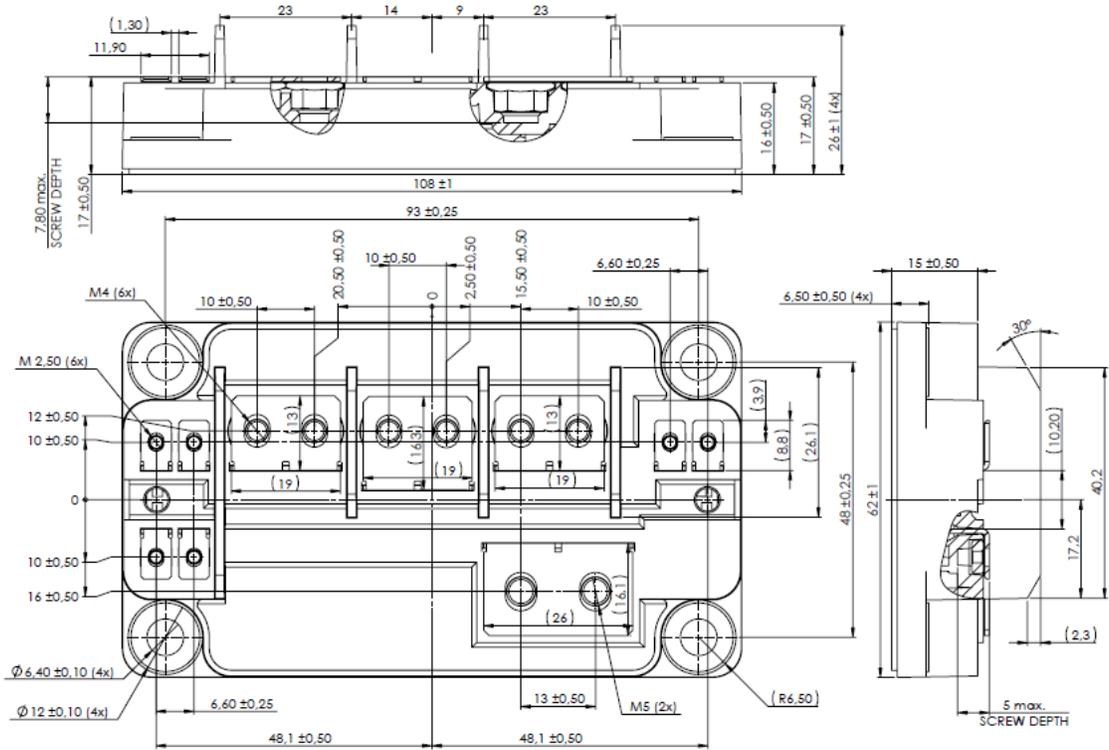
4 Package Specification

This section outlines the package specification for the MSCMC120AM04CT6LIAG device.

4.1 Package Outline Drawing

This section details the package drawing of the MSCMC120AM04CT6LIAG device. Dimensions are in millimeters.

Figure 20 • Package Outline Drawing



Note: See application note AN1911 containing the mounting instructions for SP6 low inductance power module on www.microsemi.com

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