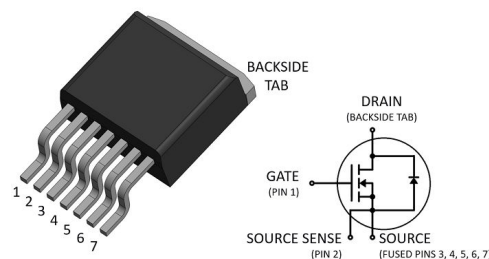


700 V 60 mΩ SiC N-Channel Power MOSFET

Product Overview

The silicon carbide (SiC) power MOSFET product line from Microchip increases the performance over silicon MOSFET and silicon IGBT solutions while lowering the total cost of ownership for high-voltage applications. The MSC060SMA070SA device is a 700 V, 60 mΩ SiC MOSFET in a TO-263 7-lead package with a source sense.



Features

The following are key features of the MSC060SMA070SA device:

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature, $T_{J(max)} = 175\text{ }^{\circ}\text{C}$
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

Benefits

The following are benefits of the MSC060SMA070SA device:

- High efficiency to enable lighter, more compact system
- Simple to drive and easy to parallel
- Improved thermal capabilities and lower switching losses
- Eliminates the need for external freewheeling diode
- Lower system cost of ownership

Applications

The MSC060SMA070SA device is designed for the following applications:

- PV inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- H/EV powertrain and EV charger
- Power supply and distribution

1. Device Specifications

This section shows the specifications of the MSC060SMA070SA device.

1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC060SMA070SA device.

Table 1-1. Absolute Maximum Ratings

| Symbol | Parameter | Ratings | Unit |
|-----------|---|-----------|---------------------|
| V_{DSS} | Drain source voltage | 700 | V |
| I_D | Continuous drain current at $T_C = 25\text{ }^\circ\text{C}$ | 48 | A |
| | Continuous drain current at $T_C = 100\text{ }^\circ\text{C}$ | 34 | |
| I_{DM} | Pulsed drain current ¹ | 100 | |
| V_{GS} | Gate-source voltage | 23 to -10 | V |
| P_D | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 208 | W |
| | Linear derating factor | 1.39 | W/ $^\circ\text{C}$ |

Note:

1. Repetitive rating: pulse width and case temperature limited by maximum junction temperature.

The following table shows the thermal and mechanical characteristics of the MSC060SMA070SA device.

Table 1-2. Thermal and Mechanical Characteristics

| Symbol | Characteristic/Test Conditions | Min | Typ | Max | Unit |
|-----------------|-------------------------------------|-----|------|------|---------------------------|
| $R_{\theta JC}$ | Junction-to-case thermal resistance | | 0.48 | 0.72 | $^\circ\text{C}/\text{W}$ |
| T_J | Operating junction temperature | -55 | | 175 | $^\circ\text{C}$ |
| T_{STG} | Storage temperature | -55 | | 150 | $^\circ\text{C}$ |
| | Reflow temperature | | | 260 | $^\circ\text{C}$ |
| Wt | Package weight | | 0.05 | | oz |
| | | | 1.42 | | g |

1.2 Electrical Performance

The following table shows the static characteristics of the MSC060SMA070SA device. $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Table 1-3. Static Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---------------|---|---|-----|-----|-----|------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$ | 700 | | | V |
| $R_{DS(on)}$ | Drain-source on resistance ¹ | $V_{GS} = 20\text{ V}, I_D = 20\text{ A}$ | | 60 | 75 | m Ω |
| $V_{GS(th)}$ | Gate-source threshold voltage | $V_{GS} = V_{DS}, I_D = 1\text{ mA}$ | 1.9 | 2.4 | | V |

MSC060SMA070SA

Device Specifications

.....continued

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|------------------|---------------------------------|---|-----|-----|------|------|
| I _{DSS} | Zero gate voltage drain current | V _{DS} = 700 V, V _{GS} = 0 V | | | 100 | μA |
| | | V _{DS} = 700 V, V _{GS} = 0 V, T _J = 125 °C | | | 500 | |
| I _{GSS} | Gate-source leakage current | V _{GS} = 20 V/–10 V | | | ±100 | nA |

Note:

1. Pulse test: pulse width < 380 μs, duty cycle < 2%.

The following table shows the dynamic characteristics of the MSC060SMA070SA device. T_J = 25 °C unless otherwise specified.

Table 1-4. Dynamic Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit | |
|---------------------|-----------------------------------|---|-----|------|-----|------|----|
| C _{iss} | Input capacitance | V _{GS} = 0 V, V _{DD} = 700 V, V _{AC} = 25 mV, f = 1 MHz | | 1175 | | pF | |
| C _{rss} | Reverse transfer capacitance | | | 8 | | | |
| C _{oss} | Output capacitance | | | 130 | | | |
| Q _g | Total gate charge | V _{GS} = –5 V/20 V, V _{DD} = 470 V, I _D = 20 A | | 56 | | nC | |
| Q _{gs} | Gate-source charge | | | 15 | | | |
| Q _{gd} | Gate-drain charge | | | 9 | | | |
| t _{d(on)} | Turn-on delay time | V _{DD} = 470 V, V _{GS} = –5 V/20 V, I _D = 20 A, R _{g(ext)} = 8 Ω, Freewheeling diode = MSC060SMA070SA (V _{GS} = –5 V); reference Fig. 1-16 | | 14 | | ns | |
| t _r | Voltage rise time | | | 11 | | | |
| t _{d(off)} | Turn-off delay time | | | 22 | | | |
| t _f | Voltage fall time | | | 9 | | | |
| E _{on} | Turn-on switching energy | | | 125 | | | μJ |
| E _{off} | Turn-off switching energy | | | 19 | | | |
| ESR | Gate equivalent series resistance | f = 1 MHz, 25 mV, drain short | | 2.6 | | Ω | |
| SCWT | Short circuit withstand time | V _{DS} = 560 V, V _{GS} = 20 V | | 3 | | μs | |
| E _{AS} | Avalanche energy, single pulse | V _{DS} = 150 V, I _D = 20 A | | 1150 | | mJ | |

The following table shows the body diode characteristics of the MSC060SMA070SA device. T_J = 25 °C unless otherwise specified.

Table 1-5. Body Diode Characteristics

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|-----------------|-----------------------|--|-----|-----|-----|------|
| V _{SD} | Diode forward voltage | I _{SD} = 20 A, V _{GS} = 0 V | | 4.0 | | V |
| | | I _{SD} = 20 A, V _{GS} = –5 V | | 4.2 | | |

.....continued

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------------------------|---|-----|-----|-----|------|
| t_{rr} | Reverse recovery time | $I_{SD} = 20\text{ A}$, $V_{GS} = -5\text{ V}$, $V_{DD} = 470\text{ V}$, $dI/dt = -10000\text{ A}/\mu\text{s}$, Drive $R_g = 8\ \Omega$ | | 11 | | ns |
| Q_{rr} | Reverse recovery charge | | | 404 | | nC |
| I_{RRM} | Reverse recovery current | | | 64 | | A |

1.3 Typical Performance Curves

This section shows the typical performance curves of the MSC060SMA070SA device.

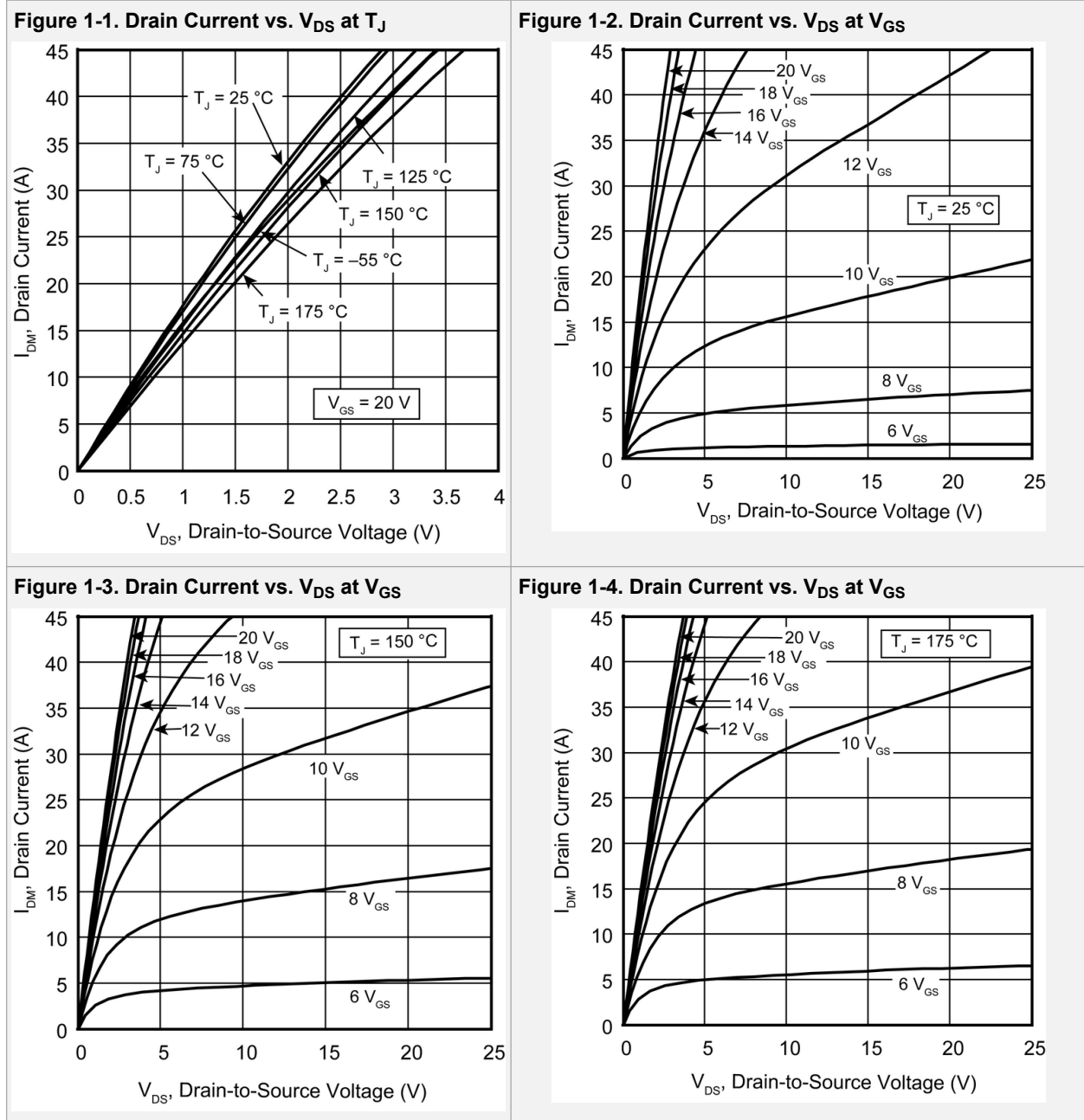


Figure 1-5. $R_{DS(on)}$ vs. Junction Temperature

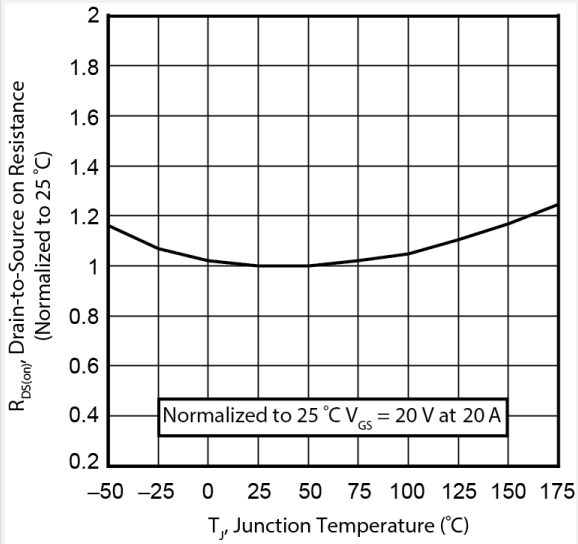


Figure 1-6. Gate Charge Characteristics

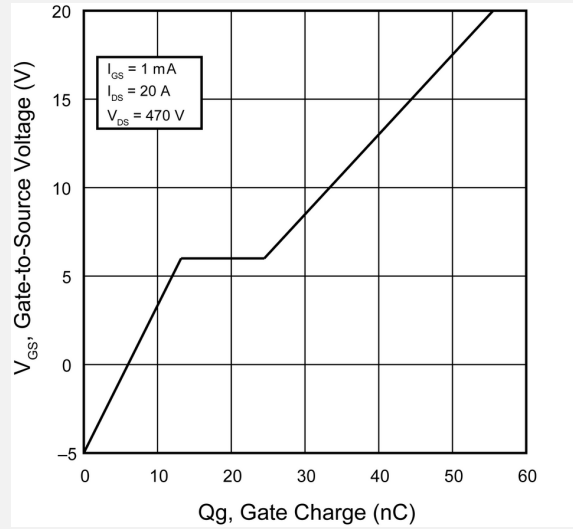


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

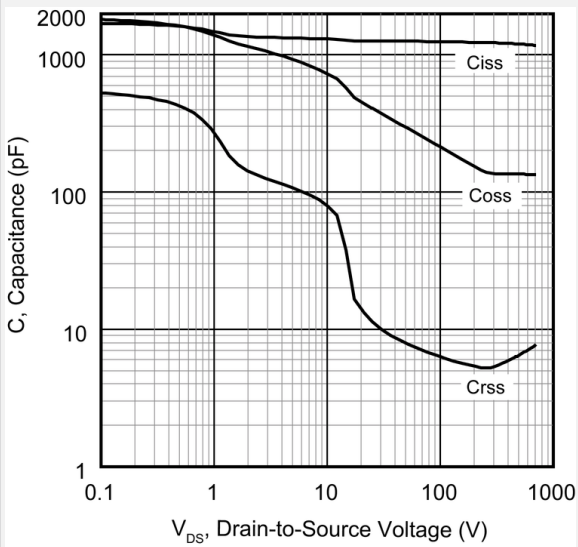


Figure 1-8. I_D vs. V_{DS} 3rd Quadrant Conduction

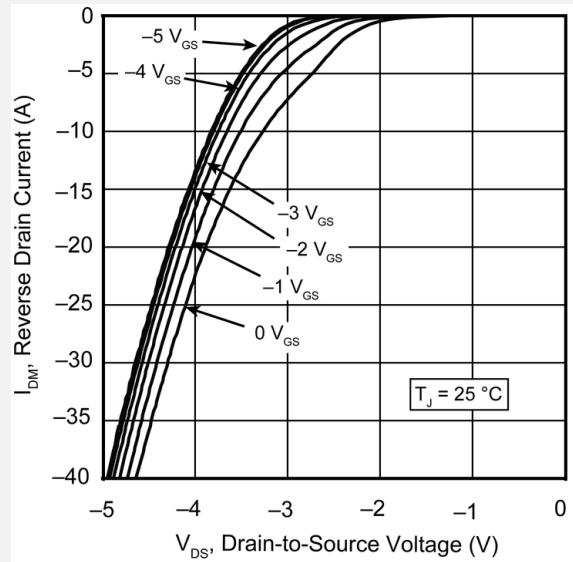


Figure 1-9. I_D vs. V_{DS} 3rd Quadrant Conduction

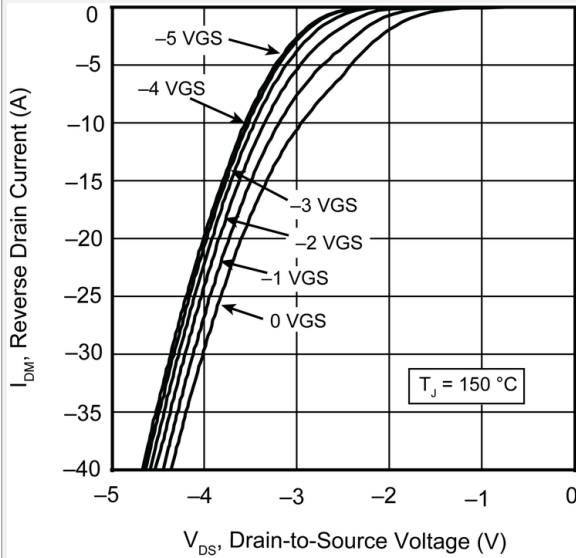


Figure 1-10. Switching Energy vs. V_{DS} & I_D

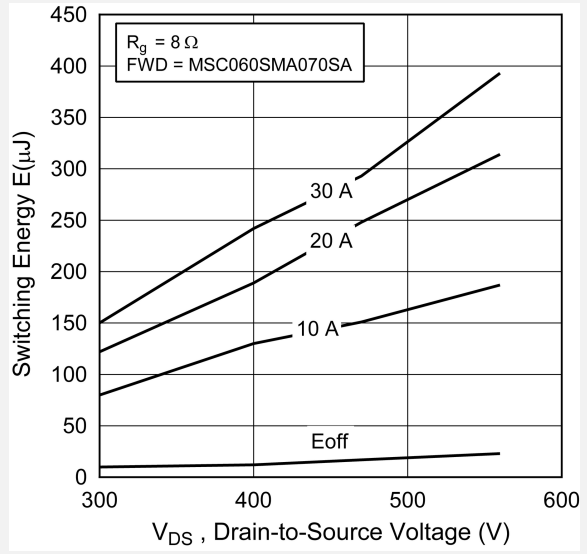


Figure 1-11. Switching Energy vs. R_g

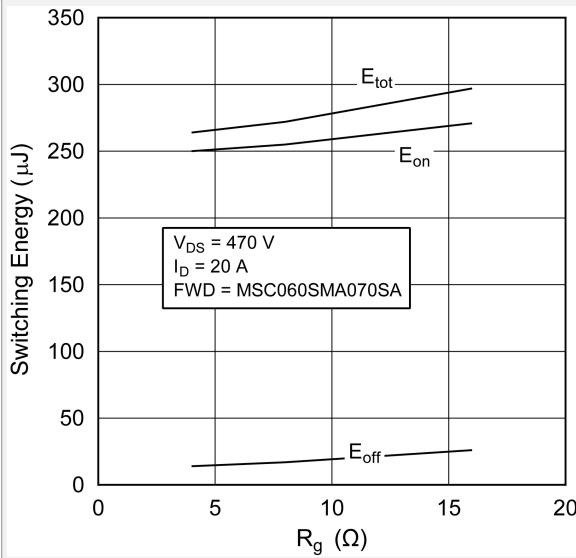


Figure 1-12. Switching Energy vs. Temperature

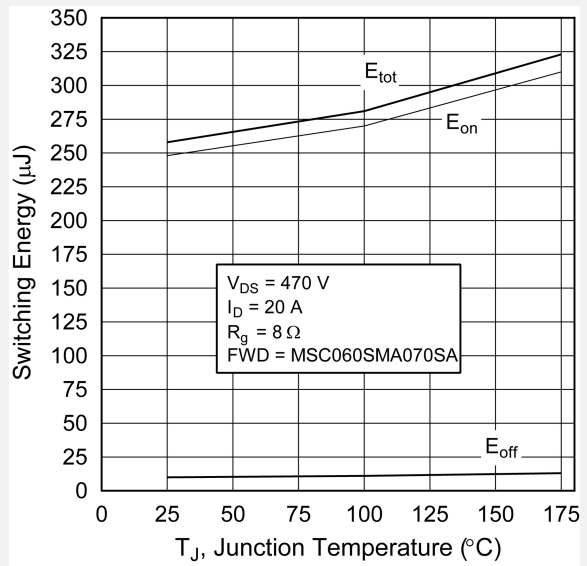


Figure 1-13. Threshold Voltage vs. Junction Temp.

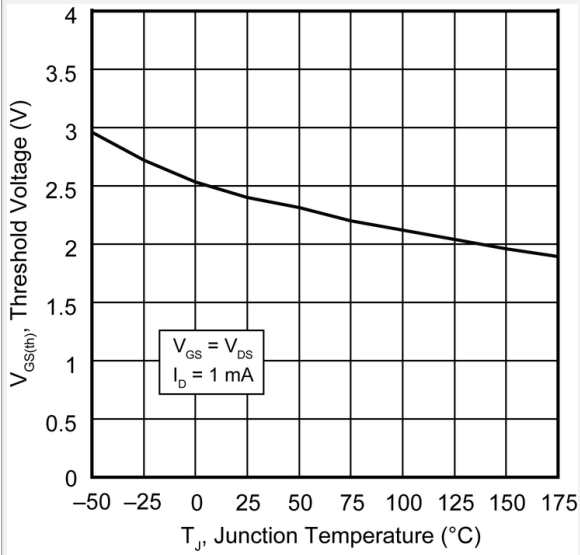


Figure 1-14. Forward Safe Operating Area

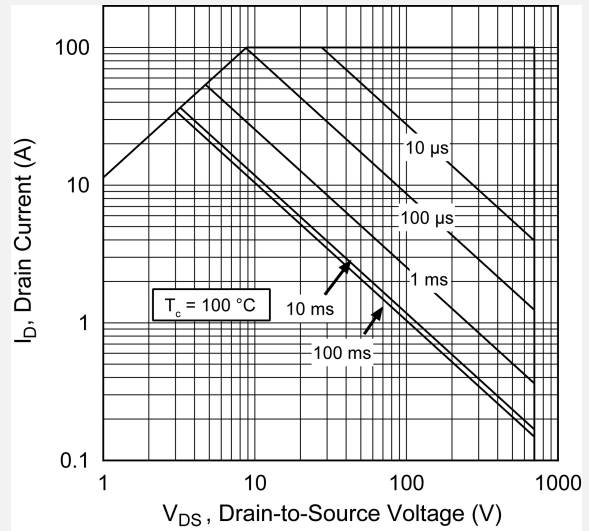
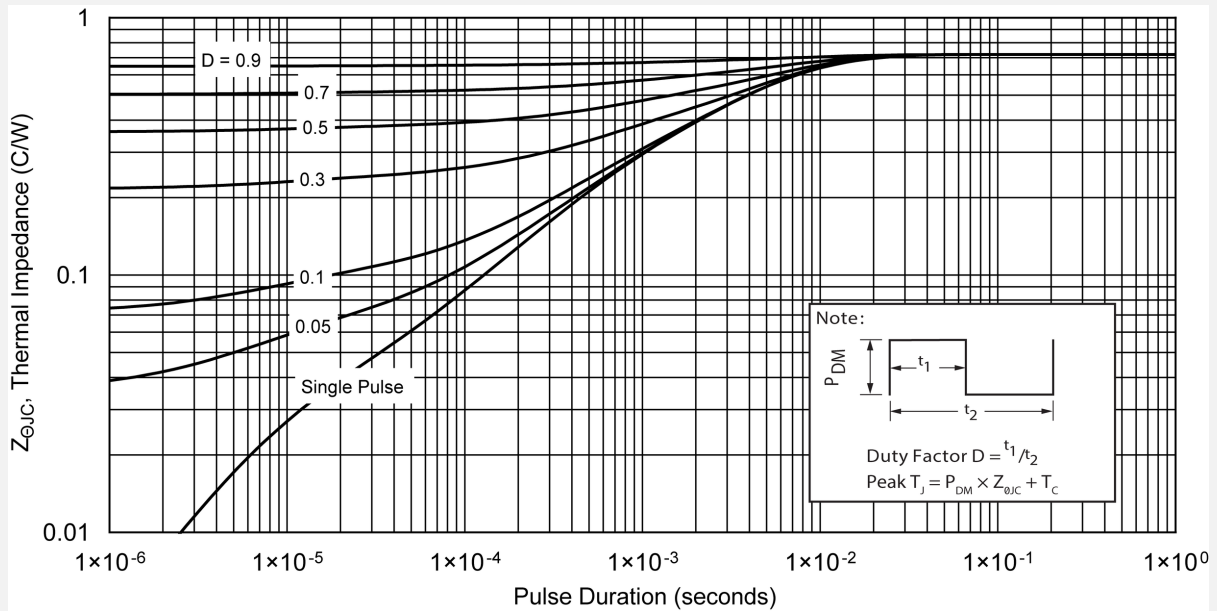
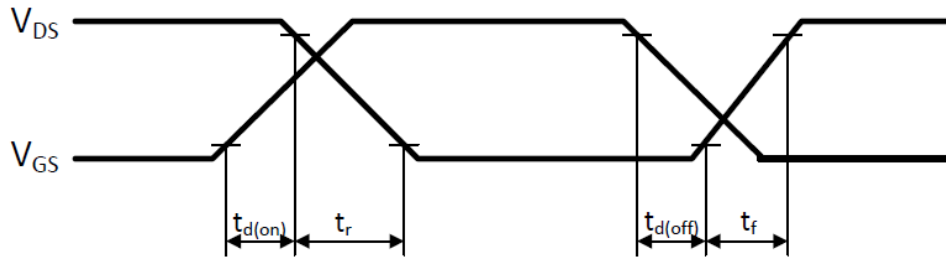


Figure 1-15. Maximum Transient Thermal Impedance



The following figure shows the switching waveform diagram of the MSC060SMA070SA device.

Figure 1-16. Switching Waveform



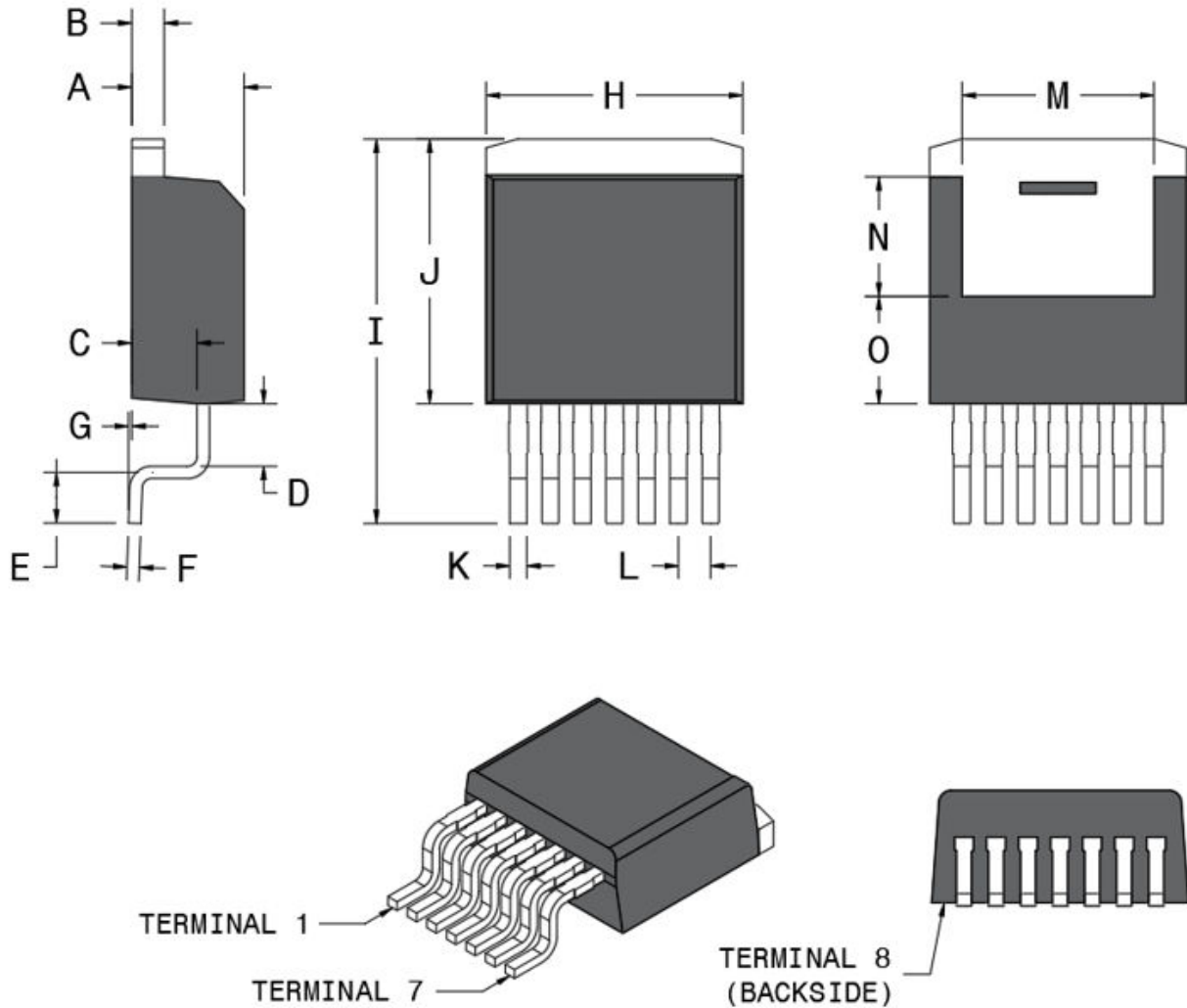
2. Package Specification

This section shows the package specification of the MSC060SMA070SA device.

2.1 Package Outline Drawing

The following figure illustrates the TO-263 7-lead package outline of the MSC060SMA070SA device.

Figure 2-1. Package Outline Drawing



The following table shows the TO-263 7-lead dimensions and should be used in conjunction with the package outline drawing.

Table 2-1. TO-263 Dimensions

| Symbol | Min (mm) | Max (mm) | Min (in.) | Max (in.) |
|--------|----------|----------|-----------|-----------|
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| B | 1.17 | 1.40 | 0.046 | 0.055 |
| C | 2.50 | 2.70 | 0.098 | 0.106 |

MSC060SMA070SA

Package Specification

|continued | | | | |
|----------------|--------------|----------|-----------|-----------|
| Symbol | Min (mm) | Max (mm) | Min (in.) | Max (in.) |
| D | 2.85 | 2.95 | 0.112 | 0.116 |
| E | 2.32 | 2.70 | 0.091 | 0.106 |
| F | 0.33 | 0.65 | 0.013 | 0.026 |
| G | 0.00 | 0.25 | 0.00 | 0.010 |
| H | 10.13 | 10.23 | 0.399 | 0.403 |
| I | 15.04 | 17.12 | 0.592 | 0.674 |
| J | 10.19 | 10.80 | 0.401 | 0.425 |
| K | 0.50 | 0.70 | 0.020 | 0.028 |
| L | 1.27 BSC | | 0.050 BSC | |
| M | 6.78 | 7.67 | 0.267 | 0.302 |
| N | 4.66 | 4.81 | 0.183 | 0.189 |
| O | 4.20 | 4.30 | 0.165 | 0.169 |
| Terminal 1 | Gate | | | |
| Terminal 2 | Source sense | | | |
| Terminal 3 | Source | | | |
| Terminal 4 | Source | | | |
| Terminal 5 | Source | | | |
| Terminal 6 | Source | | | |
| Terminal 7 | Source | | | |
| Terminal 8 | Drain | | | |

3. Revision History

Table 3-1. Revision History

| Revision | Date | Description |
|----------|---------|-------------------|
| A | 03/2022 | Document created. |

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