

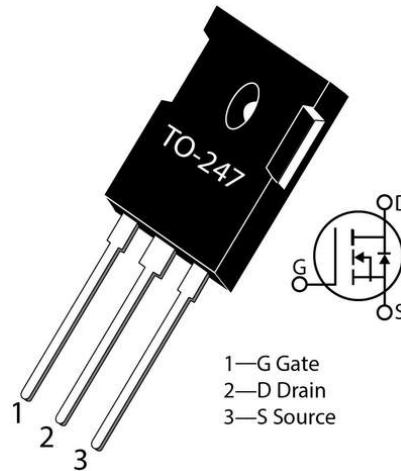
1700V, 35 mΩ N-Channel mSiC™ MOSFET

MSC035SMA170B



Product Overview

1700V, 35 mΩ typical at 20 V_{GS}, 41 mΩ typical at 18 V_{GS}, Silicon Carbide (SiC) N-Channel MOSFET, TO-247.



Features

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

Benefits

- High efficiency to enable lighter and 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

- Photovoltaic (PV) inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- Hybrid Electric Vehicle (HEV) powertrain and Electric Vehicle (EV) charger
- Power supply and distribution

1. Device Specifications

This section shows the specifications of this device.

1.1 Absolute Maximum Ratings

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

Table 1-1. Absolute Maximum Ratings

| Symbol | Parameter | Ratings | Unit |
|-----------|---|-----------|---------------------|
| V_{DSS} | Drain source voltage | 1700 | V |
| I_D | Continuous drain current at $T_C = 25\text{ }^\circ\text{C}$ | 71 | A |
| | Continuous drain current at $T_C = 100\text{ }^\circ\text{C}$ | 50 | |
| I_{DM} | Pulsed drain current ¹ | 200 | |
| V_{GS} | Gate-source voltage | 23 to -10 | V |
| | Transient gate-source voltage | 25 to -12 | |
| P_D | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 427 | W |
| | Linear derating factor | 2.85 | W/ $^\circ\text{C}$ |

Note:

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

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

Table 1-2. Thermal and Mechanical Characteristics

| Symbol | Characteristic/Test Conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------------|------|------|------|---------------------------|
| $R_{\theta JC}$ | Junction-to-case thermal resistance | — | 0.27 | 0.35 | $^\circ\text{C}/\text{W}$ |
| T_J | Operating junction temperature | -55 | — | 175 | $^\circ\text{C}$ |
| T_{STG} | Storage temperature | -55 | — | 150 | $^\circ\text{C}$ |
| T_L | Lead temperature for 10 seconds | — | — | 300 | $^\circ\text{C}$ |
| — | Mounting torque, 6-32 or M3 screw | — | — | 10 | lbf-in |
| | | — | — | 1.1 | N-m |
| Wt | Package weight | — | 0.22 | — | oz |
| | | — | 6.2 | — | g |

ESD practices should comply with JESD-625.

1.2 Electrical Performance

The following table shows the static characteristics of this 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 | $V_{GS} = 0\text{V}, I_D = 100\text{ }\mu\text{A}$ | 1700 | — | — | V |
| $R_{DS(on)}$ | Drain-source on resistance ¹ | $V_{GS} = 20\text{V}, I_D = 30\text{A}$ | — | 35 | 45 | $\text{m}\Omega$ |
| | | $V_{GS} = 18\text{V}, I_D = 30\text{A}$ | — | 41 | — | |
| $V_{GS(th)}$ | Gate-source threshold voltage | $V_{GS} = V_{DS}, I_D = 2.5\text{ mA}$ | 1.9 | 3.2 | — | V |
| I_{DSS} | Zero gate voltage drain current | $V_{DS} = 1700\text{V}, V_{GS} = 0\text{V}$ | — | 0.3 | 35 | μA |
| | | $V_{DS} = 1700\text{V}, V_{GS} = 0\text{V}, T_J = 175\text{ }^\circ\text{C}$ | — | 3.5 | — | |
| I_{GSS} | Gate-source leakage current | $V_{GS} = 20\text{V}/-10\text{V}$ | — | — | ± 100 | nA |

Note:

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

The following table shows the dynamic characteristics of this device. $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified. The dynamic characteristics are characterized, not 100% tested, at the recommended operating $V_{GS} = 20\text{V}/-5\text{V}$.

Table 1-4. Dynamic Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|--------------|-----------------------------------|---|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{GS} = 0\text{V}$ | — | 3300 | — | pF |
| C_{rss} | Reverse transfer capacitance | $V_{DD} = 1000\text{V}$ | — | 13 | — | |
| C_{oss} | Output capacitance | $V_{AC} = 25\text{ mV}$ $f = 200\text{ KHz}$ | — | 155 | — | |
| Q_G | Total gate charge | $V_{GS} = -5\text{V}/20\text{V}$ | — | 178 | — | nC |
| Q_{GS} | Gate-source charge | $V_{DD} = 850\text{V}$ | — | 49 | — | |
| Q_{GD} | Gate-drain charge | $I_D = 30\text{A}$ | — | 27 | — | |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 1360\text{V}$ | — | 65 | — | ns |
| t_r | Voltage rise time | $V_{GS} = -5\text{V}/20\text{V}$ | — | 28 | — | |
| $t_{d(off)}$ | Turn-off delay time | $I_D = 50\text{A}$ | — | 28 | — | |
| t_f | Voltage fall time | $R_{G(ext)} = 4\Omega$ | — | 15 | — | |
| E_{ON} | Turn-on switching energy | Freewheeling diode = MSC035SMA170B ($V_{GS} = -5\text{V}$); reference Figure 1-18 | — | 5645 | — | μ J |
| E_{OFF} | Turn-off switching energy | | — | 176 | — | |
| ESR | Gate equivalent series resistance | $f = 1\text{ MHz}$, 25 mV, drain short | — | 0.85 | — | Ω |
| SCWT | Short circuit withstand time | $V_{DS} = 1200\text{V}$, $V_{GS} = 20\text{V}$ | — | 3.1 | — | μ s |
| E_{AS} | Avalanche energy, single pulse | $I_D = 30\text{A}$ | — | 4000 | — | mJ |

The following table shows the body diode characteristics of this device. $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Table 1-5. Body Diode Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|---|------|------|------|------|
| V_{SD} | Diode forward voltage | $I_{SD} = 30\text{A}$, $V_{GS} = 0\text{V}$ | — | 3.7 | — | V |
| | | $I_{SD} = 30\text{A}$, $V_{GS} = -5\text{V}$ | — | 3.9 | 5 | |
| t_{rr} | Reverse recovery time | $I_{SD} = 50\text{A}$, $V_{GS} = -5\text{V}$, Drive $R_G = 4\Omega$, $V_{DD} = 1360\text{V}$, $di/dt = -15000\text{ A}/\mu\text{s}$ | — | 72 | — | ns |
| Q_{rr} | Reverse recovery charge | | — | 1234 | — | nC |
| I_{RRM} | Reverse recovery current | | — | 34 | — | A |

1.3 Typical Performance Curves

Data for performance curves are characterized, not 100% tested.

Figure 1-1. Drain Current vs. V_{DS} at T_J

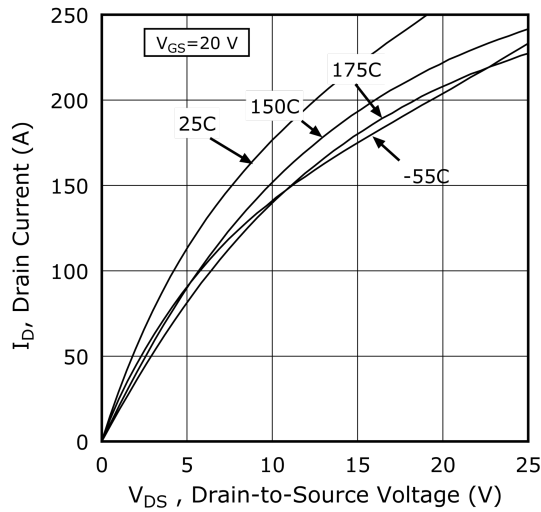


Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

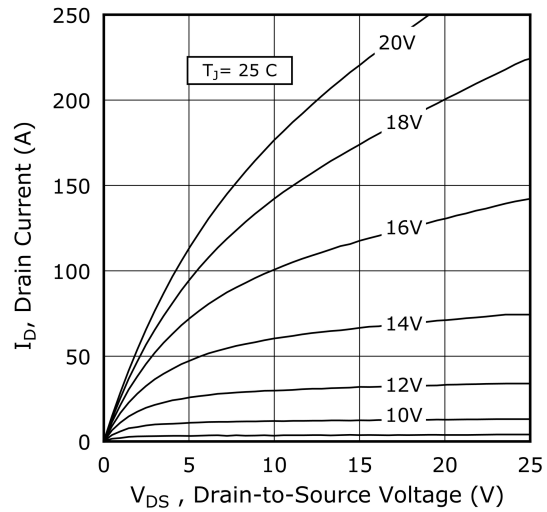


Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

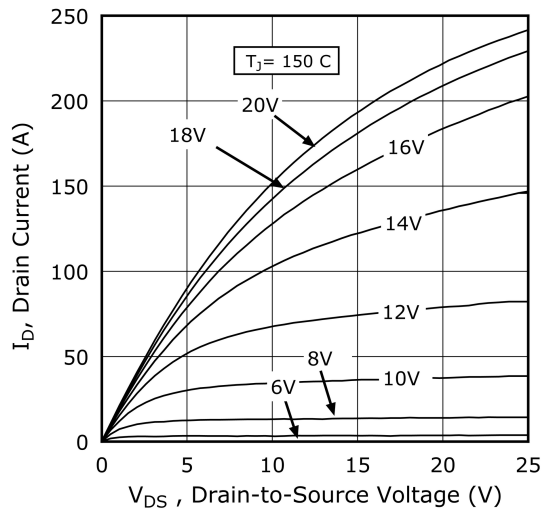


Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

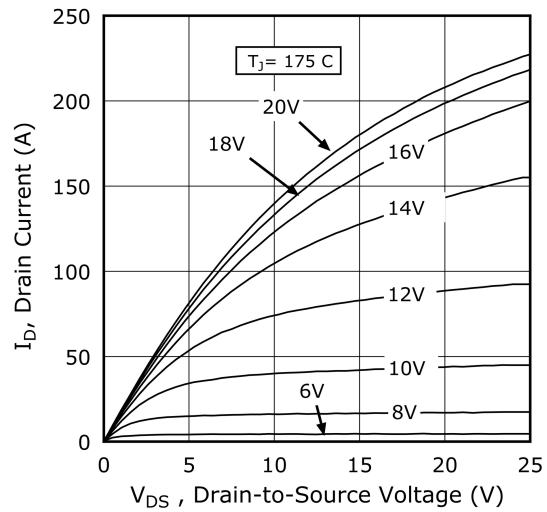


Figure 1-5. $R_{DS(on)}$ vs. Junction Temperature

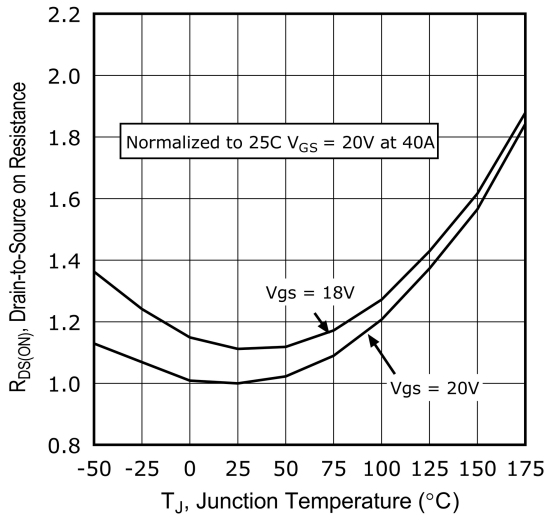


Figure 1-6. Gate Charge Characteristics

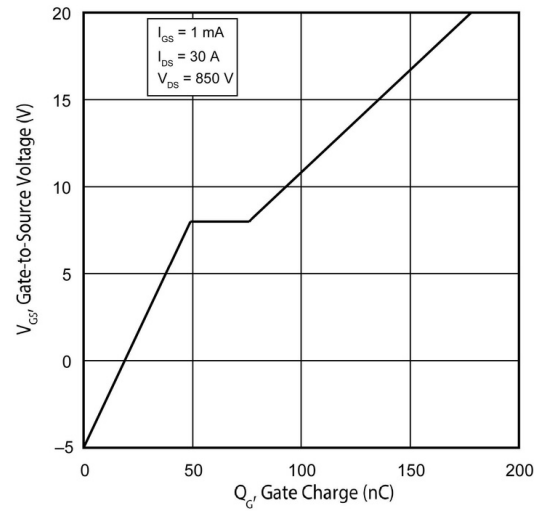


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

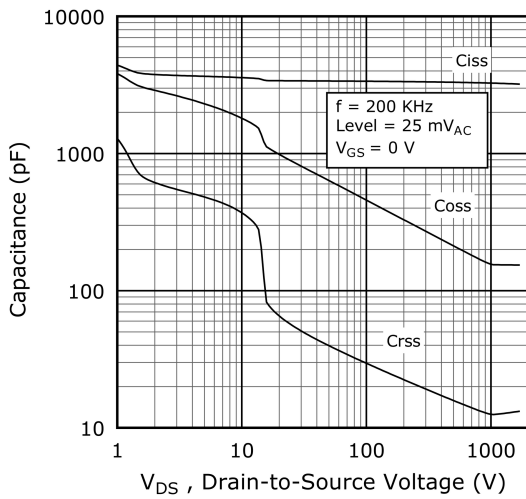


Figure 1-8. Output Charge vs. Drain-to-Source Voltage

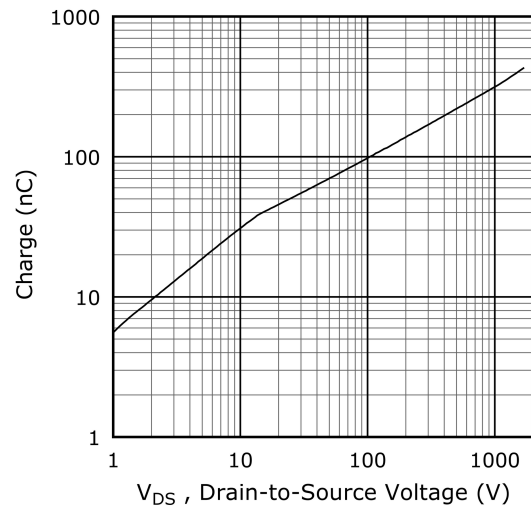


Figure 1-9. I_D vs. V_{DS} 3rd Quadrant Conduction

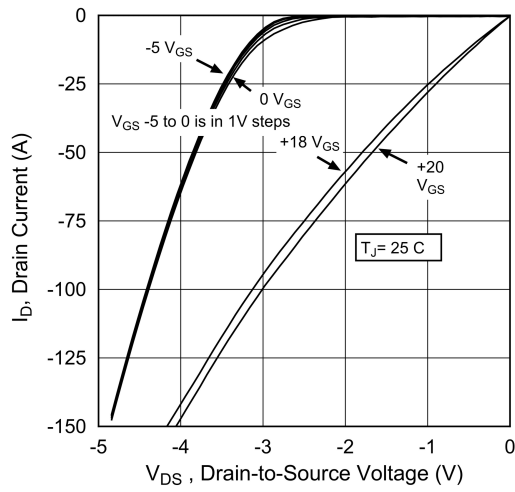


Figure 1-10. I_D vs. V_{DS} 3rd Quadrant Conduction

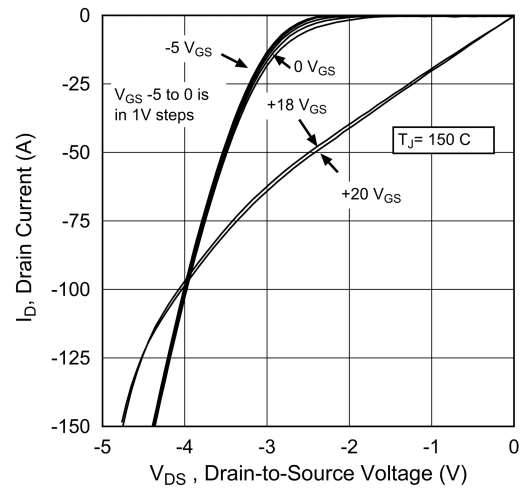


Figure 1-11. Switching Energy E_{ON} vs. V_{DS} & I_D

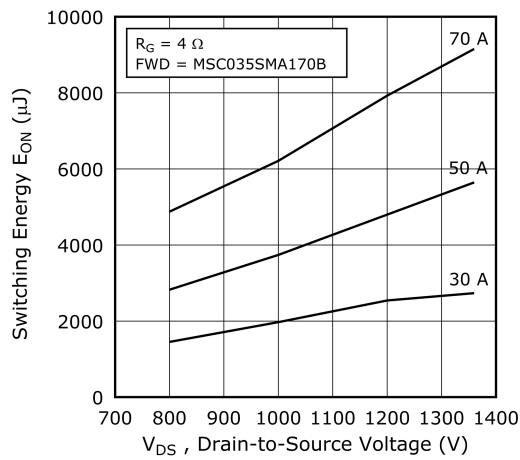


Figure 1-12. Switching Energy E_{OFF} vs. V_{DS} & I_D

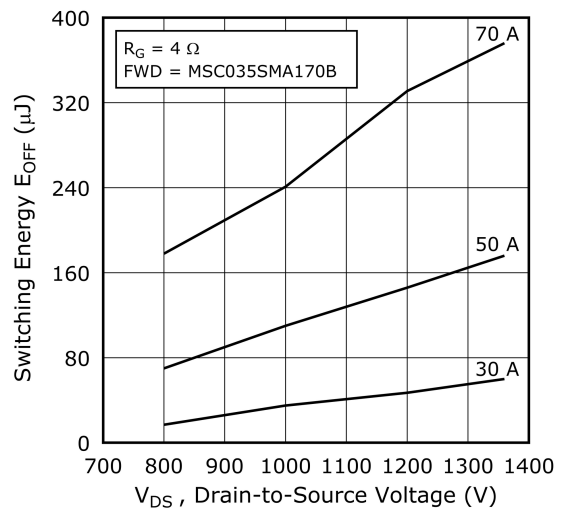


Figure 1-13. Switching Energy vs. R_G

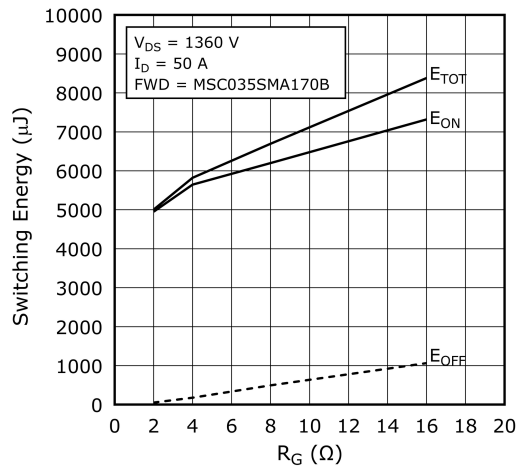


Figure 1-14. Switching Energy vs. Junction Temperature

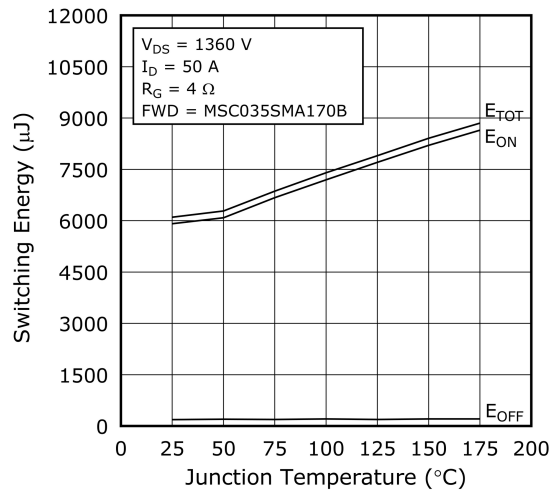


Figure 1-15. Threshold Voltage vs. Junction Temperature

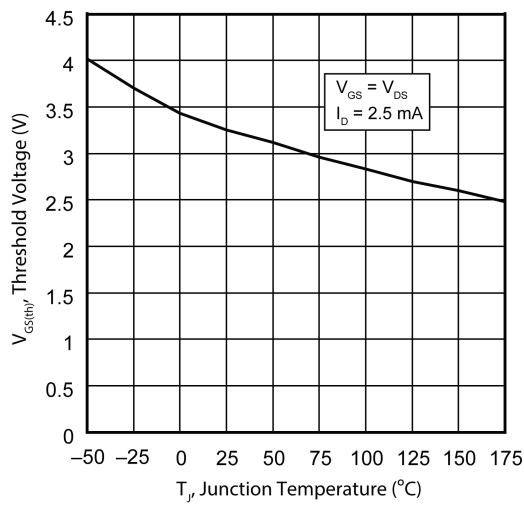


Figure 1-16. Forward Safe Operating Area

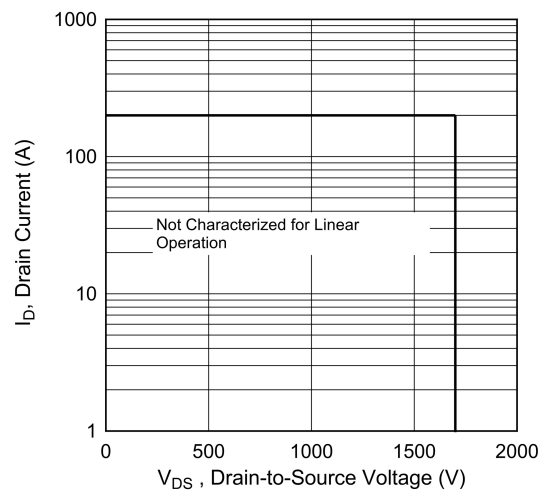
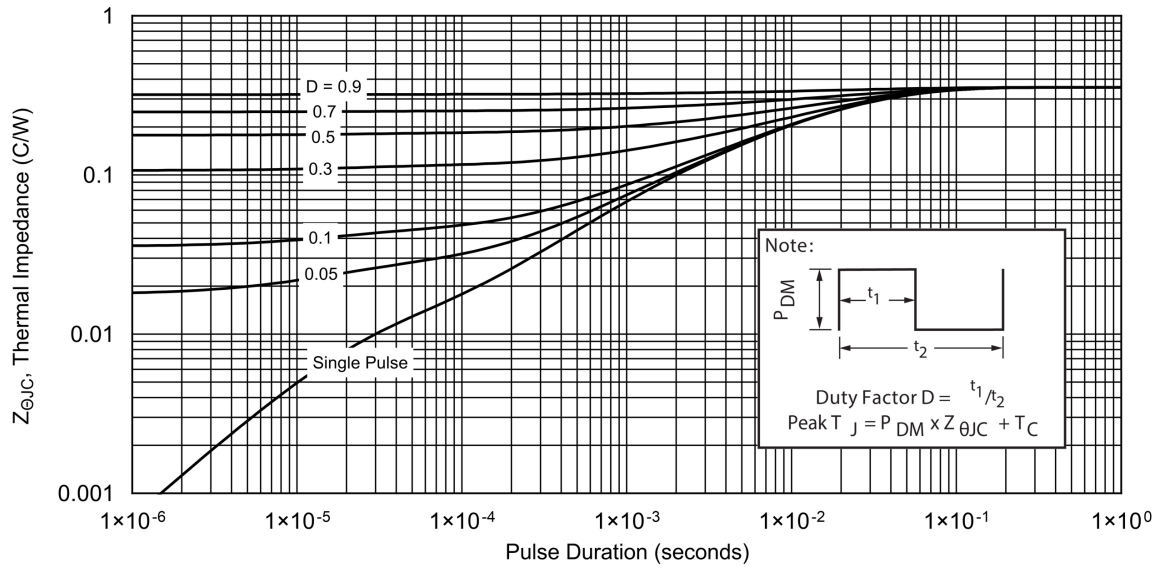
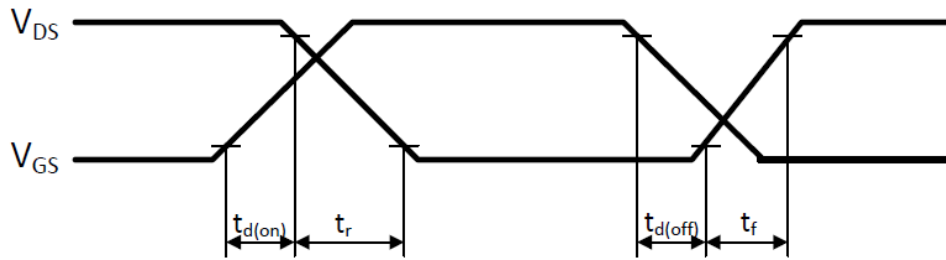


Figure 1-17. Maximum Transient Thermal Impedance



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

Figure 1-18. Switching Waveform



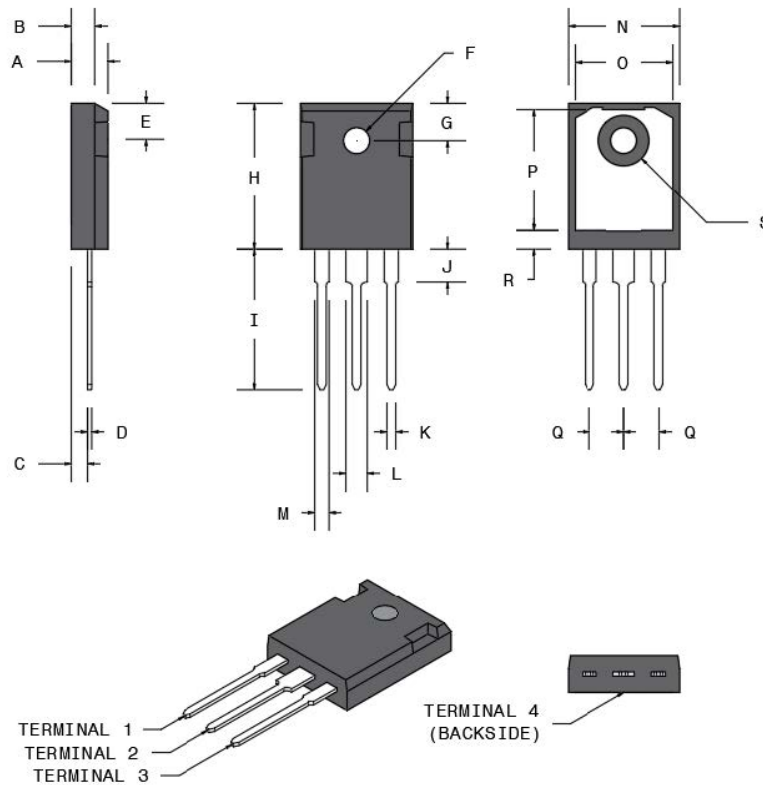
2. Package Specification

This section shows the package specification of this device.

2.1 Package Outline Drawing

The following figure illustrates the TO-247 package outline of this device.

Figure 2-1. Package Outline Drawing



The following table shows the TO-247 dimensions and should be used in conjunction with the package outline drawing.

Table 2-1. TO-247 Dimensions

| Symbol | Min. (mm) | Max. (mm) | Min. (in.) | Max. (in.) |
|--------|-----------|-----------|------------|------------|
| A | 4.69 | 5.31 | 0.185 | 0.209 |
| B | 1.49 | 2.49 | 0.059 | 0.098 |
| C | 2.21 | 2.59 | 0.087 | 0.102 |
| D | 0.40 | 0.79 | 0.016 | 0.031 |
| E | 5.38 | 6.20 | 0.212 | 0.244 |
| F | 3.50 | 3.81 | 0.138 | 0.150 |
| G | 6.15 BSC | | 0.242 BSC | |
| H | 20.80 | 21.46 | 0.819 | 0.845 |
| I | 19.81 | 20.32 | 0.780 | 0.800 |
| J | 4.00 | 4.50 | 0.157 | 0.177 |
| K | 1.01 | 1.40 | 0.040 | 0.055 |
| L | 2.87 | 3.12 | 0.113 | 0.123 |

.....continued

| Symbol | Min. (mm) | Max. (mm) | Min. (in.) | Max. (in.) |
|------------|-----------|-----------|------------|------------|
| M | 1.65 | 2.13 | 0.065 | 0.084 |
| N | 15.49 | 16.26 | 0.610 | 0.640 |
| O | 13.50 | 14.50 | 0.531 | 0.571 |
| P | 16.50 | 17.50 | 0.650 | 0.689 |
| Q | 5.45 BSC | | 0.215 BSC | |
| R | 2.00 | 2.75 | 0.079 | 0.108 |
| S | 7.10 | 7.50 | 0.280 | 0.295 |
| Terminal 1 | Gate | | | |
| Terminal 2 | Drain | | | |
| Terminal 3 | Source | | | |
| Terminal 4 | Drain | | | |

3. 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.

Table 3-1. Revision History

| Revision | Date | Description |
|--|---------|--|
| A | 11/2023 | The following changes are made in this revision of the document: <ul style="list-style-type: none">• Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00005159A, which replaces the previous Microsemi literature number 050-7769.• Updated figures in 1.3. Typical Performance Curves. |
| Initial release (Microsemi Revision A) | 03/2020 | Initial release |

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