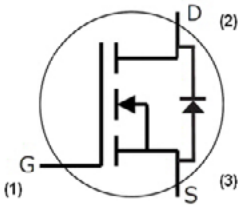
# C3M0016120D

## Silicon Carbide Power MOSFET C3M™ MOSFET Technology
## N-Channel Enhancement Mode




### Features

- C3M™ Silicon Carbide (SiC) MOSFET technology
- High blocking voltage with low On-resistance
- High speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery ($Q_{rr}$)
- Halogen free, RoHS compliant

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| Part Number | Package | Marking |
|---|---|---|
| C3M0016120D | TO 247-3 | C3M0016120D |

### Typical Applications

- Renewable energy
- High voltage DC/DC converters
- Switch Mode Power Supplies
- UPS

### Benefits

- Higher system efficiency
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency

### Key Parameters

| Parameter | Symbol | Min. | Typ. | Max | Unit | Conditions | Note |
|---|---|---|---|---|---|---|---|
| Drain - Source Voltage | $V_{DS}$ | | | 1200 | V | $T_C$ = 25°C | |
| Maximum Gate - Source Voltage | $V_{GS(max)}$ | -8 | | +19 | | Transient | |
| Operational Gate-Source Voltage | $V_{GS\ op}$ | | -4/15 | | | Static | Note 1 |
| DC Continuous Drain Current | $I_D$ | | | 115 | A | $V_{GS}$ = 15 V, $T_C$ = 25 °C, $T_J$ ≤175 °C | Fig. 19 Note 2 |
| | | | | 85 | | $V_{GS}$ = 15 V, $T_C$ = 100 °C, $T_J$ ≤175 °C | |
| Pulsed Drain Current | $I_{DM}$ | | | 250 | | $t_{Pmax}$ limited by $T_{jmax}$ $V_{GS}$ = 15V, $T_C$ = 25 °C | Fig. 22 |
| Power Dissipation | $P_D$ | | | 556 | W | $T_C$ = 25 °C, $T_J$ = 175 °C | Fig. 20 |
| Operating Junction and Storage Temperature | $T_J$, $T_{stg}$ | | | -40 to +175 | °C | | |
| Solder Temperature | $T_L$ | | | 260 | | According to JEDEC J-STD-020 | |
| Mounting Torque | $M_D$ | | | 1<br>8.8 | Nm<br>lbf-in | M3 or 6-32 screw | |

Note (1): Recommended turn-on gate voltage is 15V with ±5% regulation tolerance, see Application Note PRD-04814 for additional details
Note (2): Verified by design

## Electrical Characteristics ($T_C$ = 25℃ unless otherwise specified)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|---|
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | 1200 | — | — | V | $V_{GS}$ = 0 V, $I_D$ = 100 µA | |
| Gate Threshold Voltage | $V_{GS(th)}$ | 1.8 | 2.5 | 3.6 | V | $V_{DS}$ = $V_{GS,}$ $I_D$ = 23 mA | Fig. 11 |
| | | — | 2.0 | — | | $V_{DS}$ = $V_{GS,}$ $I_D$ = 23 mA, $T_J$ = 175℃ | |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | — | 1 | 50 | µA | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | |
| Gate-Source Leakage Current | $I_{GSS}$ | — | 10 | 250 | nA | $V_{GS}$ = 15 V, $V_{DS}$ = 0 V | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | 11.2 | 16 | 22.3 | mΩ | $V_{GS}$ = 15 V, $I_D$ = 75 A | Fig. 4, 5, 6 |
| | | — | 28.8 | — | | $V_{GS}$ = 15 V, $I_D$ = 75 A, $T_J$ = 175°C | |
| Transconductance | $g_{fs}$ | — | 53 | — | S | $V_{DS}$ = 20 V, $I_{DS}$ = 75 A | Fig. 7 |
| | | | 47 | | | $V_{DS}$ = 20 V, $I_{DS}$ = 75 A, $T_J$ = 175°C | |
| Input Capacitance | $C_{iss}$ | — | 6085 | — | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 1000 V $f$ = 100 khz $V_{AC}$ = 25 mV | Fig. 17, 18 |
| Output Capacitance | $C_{oss}$ | — | 230 | — | | | |
| Reverse Transfer Capacitance | $C_{rss}$ | — | 13 | — | | | |
| $C_{oss}$ Stored Energy | $E_{oss}$ | — | 130 | — | µJ | | Fig. 16 |
| Turn-On Switching Energy (Body Diode) | $E_{on}$ | — | 4.64 | — | mJ | $V_{DS}$ = 800 V, $V_{GS}$ = -4/+15 V, $I_D$ = 75 A, $R_{G(ext)}$ = 5Ω, L= 65.7 µH, $T_J$ = 175°C | Fig. 25 |
| Turn Off Switching Energy (Body Diode) | $E_{off}$ | — | 2.93 | — | | | |
| Turn-On Switching Energy (External Diode) | $E_{on}$ | — | 7.79 | — | | | |
| Turn Off Switching Energy (External Diode) | $E_{off}$ | — | 2.95 | — | | | |
| Turn-On Delay Time | $t_{d(on)}$ | — | 174 | — | ns | $V_{DS}$ = 800 V, $V_{GS}$ = -4/25 V $R_{G(ext)}$ = 5 Ω, $I_D$ = 75 A, L= 65.7 µH Timing relative to $V_{DS}$, Inductive load | Fig. 27 |
| Rise Time | $t_r$ | — | 28 | — | | | |
| Turn-Off Delay Time | $t_{d(off)}$ | — | 84 | — | | | |
| Fall Time | $t_f$ | — | 27 | — | | | |
| Internal Gate Resistance | $R_{G(int)}$ | — | 2.6 | — | Ω | $f$ = 1 MHz, $V_{AC}$ = 25 mV | |
| Gate to Source Charge | $Q_{gs}$ | — | 70 | — | nC | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/25 V $I_D$ = 75 A Per IEC60747-8-4 pg 21 | Fig. 12 |
| Gate to Drain Charge | $Q_{gd}$ | — | 60 | — | | | |
| Total Gate Charge | $Q_g$ | — | 207 | — | | | |

## Reverse Diode Characteristics ($T_C$ = 25℃ unless otherwise specified)

| Parameter | Symbol | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| Diode Forward Voltage | $V_{SD}$ | 4.6 | — | V | $V_{GS}$ = -4 V, $I_{SD}$ = 37.5 A, $T_J$ = 25°C | Fig. 8, 9, 10 |
| | | 4.2 | — | | $V_{GS}$ = -4 V, $I_{SD}$ = 37.5 A, $T_J$ = 175°C | |
| Continuous Diode Forward Current | $I_S$ | — | 112 | A | $V_{GS}$ = -4 V, $T_C$ = 25°C | |
| Diode Pulse Current | $I_{SM}$ | — | 250 | | $V_{GS}$ = -4 V, pulse width $t_P$ limited by $T_{j\,max}$ | |
| Reverse Recover Time | $t_{rr}$ | 96 | — | nS | $V_{GS}$ = -4 V, $I_{SD}$ = 75 A, $V_R$ = 800 V<br>$di_F/dt$ = 900, A/µs, $T_J$ = 175°C | |
| Reverse Recovery Charge | $Q_{rr}$ | 604 | — | nC | | |
| Peak Reverse Recovery Current | $I_{rrm}$ | 15 | — | A | | |
| Reverse Recovery time | $t_{rr}$ | 58 | — | nS | $V_{GS}$ = -5 V, $I_{SD}$ = 75 A, $V_R$ = 800 V<br>$di_F/dt$ = 1400 A/µs, $T_J$ = 175°C | |
| Reverse Recovery Charge | $Q_{rr}$ | 672 | — | nC | | |
| Peak Reverse Recovery Current | $I_{rrm}$ | 22 | — | A | | |

## Thermal Characteristics

| Parameter | Symbol | Typ. | Unit | Note |
|---|---|---|---|---|
| Thermal Resistance from Junction to Case | $R_{\theta JC}$ | 0.27 | °C/W | Fig. 21 |
| Thermal Resistance from Junction to Ambient | $R_{\theta JA}$ | 40 | | |

## Typical Performance

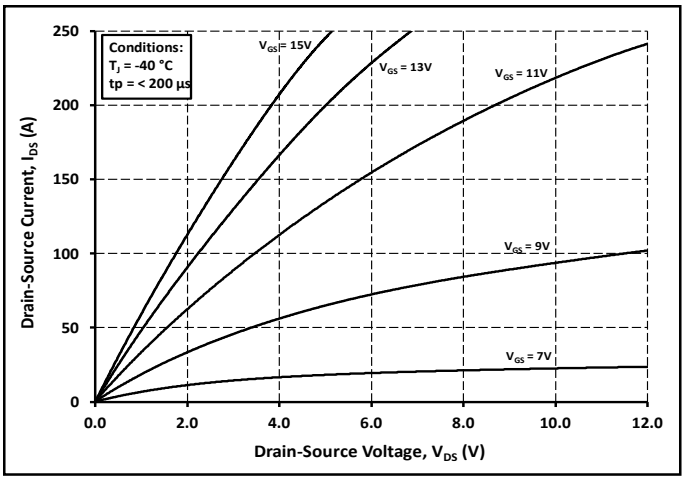



**Figure 1.** Output Characteristics $T_J$ = -40°C

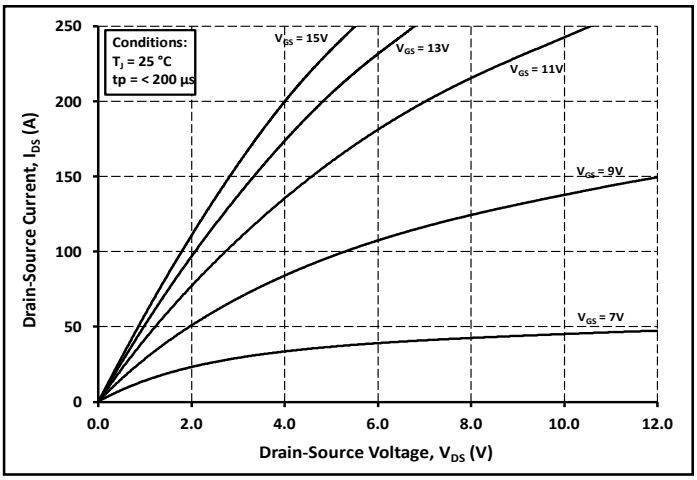



**Figure 2.** Output Characteristics $T_J$ = 25°C

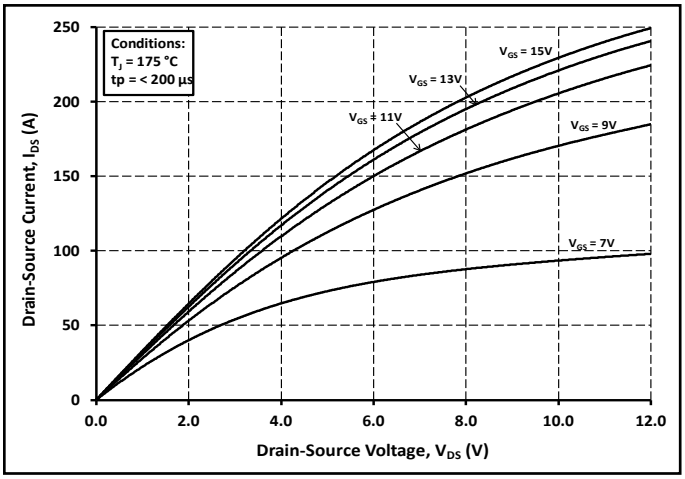



**Figure 3.** Output Characteristics $T_J$ = 175°C

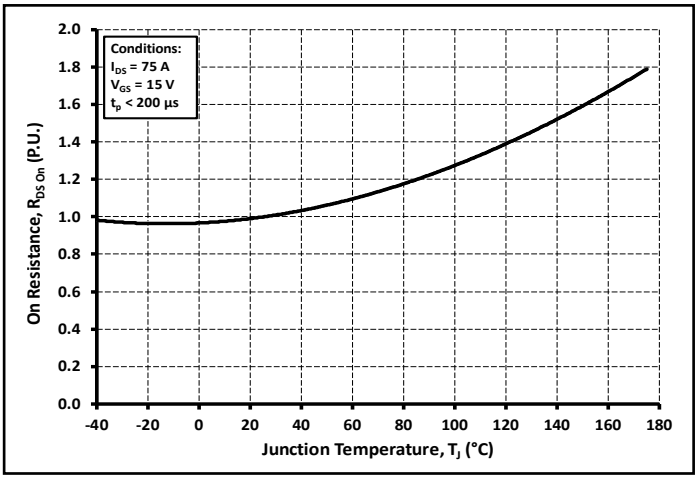



**Figure 4.** Normalized On-Resistance vs. Temperature

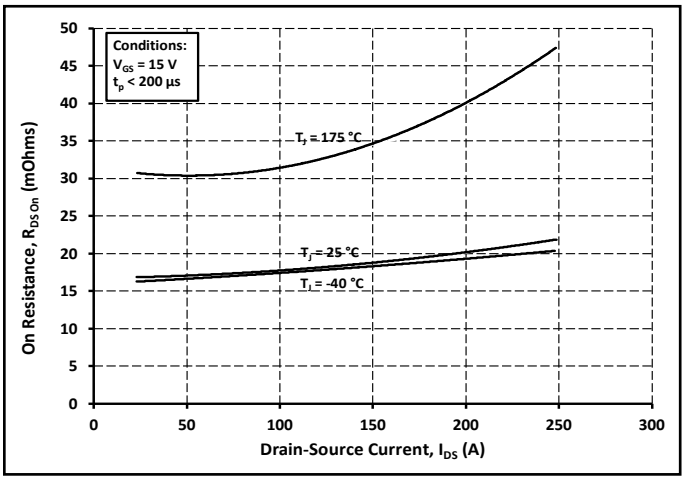



**Figure 5.** On-Resistance vs. Drain Current For Various Temperatures

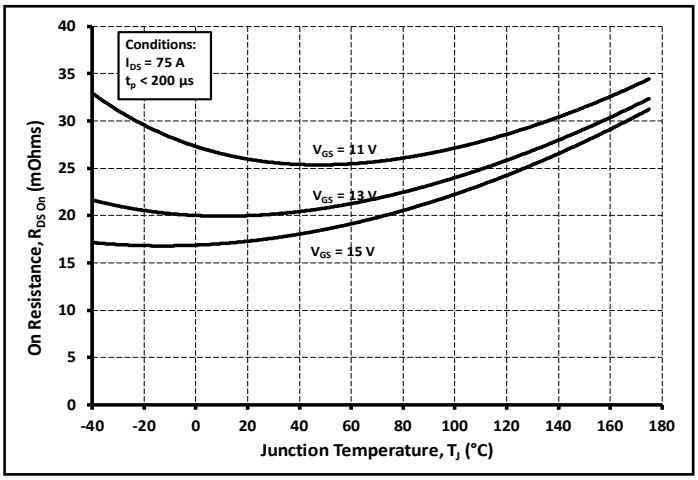



**Figure 6.** On-Resistance vs. Temperature For Various Gate Voltage

## Typical Performance

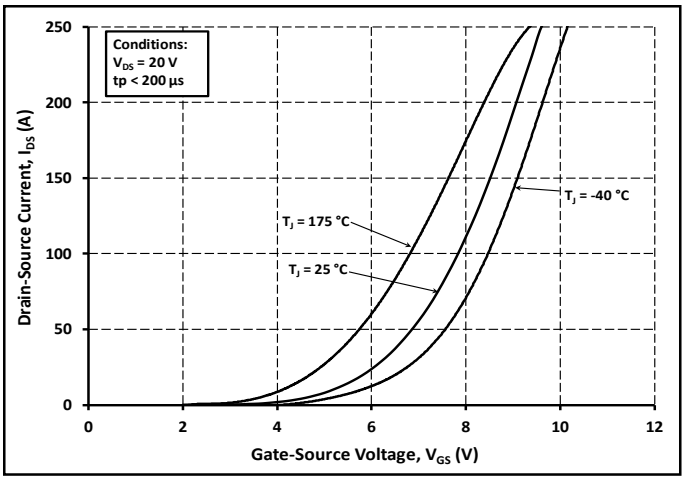



**Figure 7.** Transfer Characteristic for Various Junction Temperatures

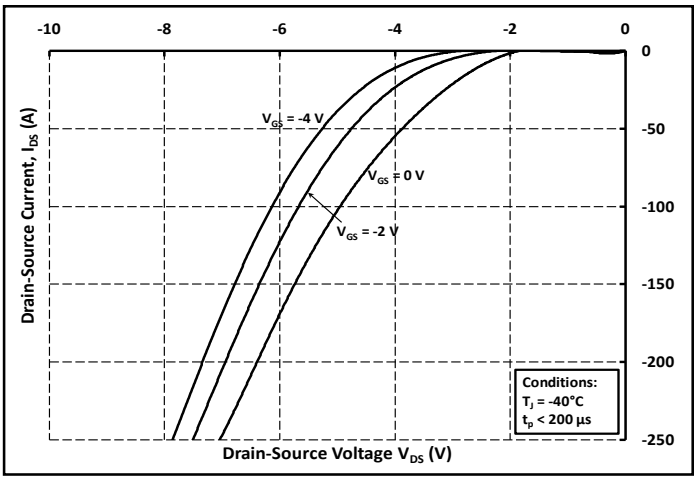



**Figure 8.** Body Diode Characteristic at -40°C

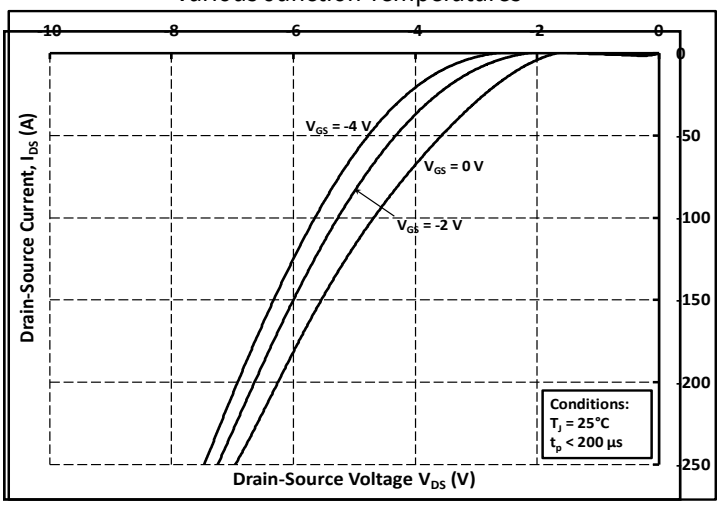



**Figure 9.** Body Diode Characteristic at 25°C

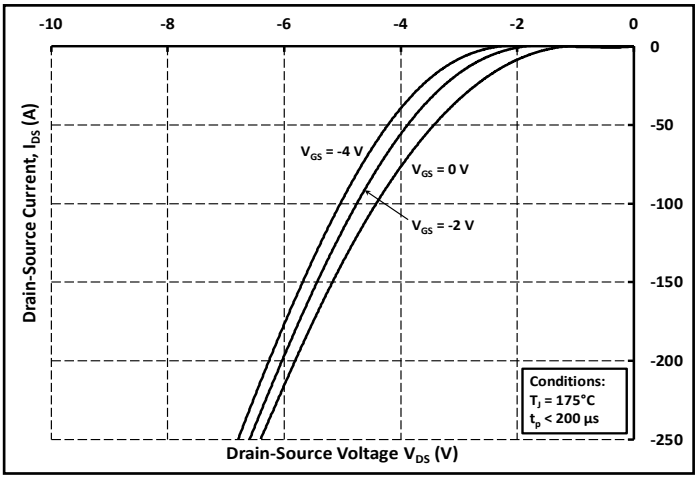



**Figure 10.** Body Diode Characteristic at 175°C

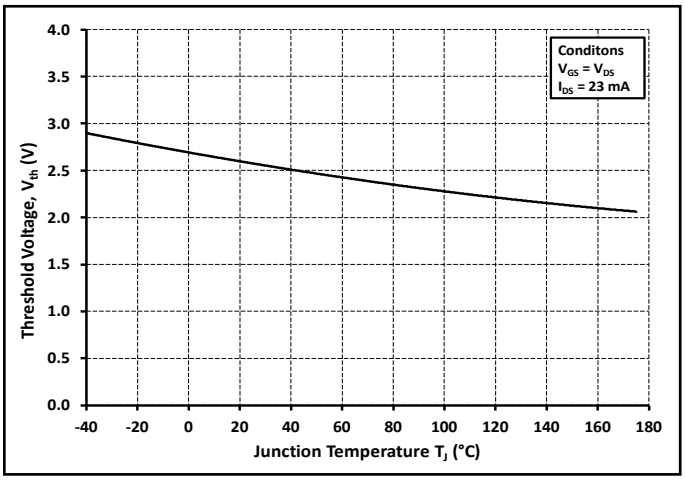



**Figure 11.** Threshold Voltage vs. Temperature

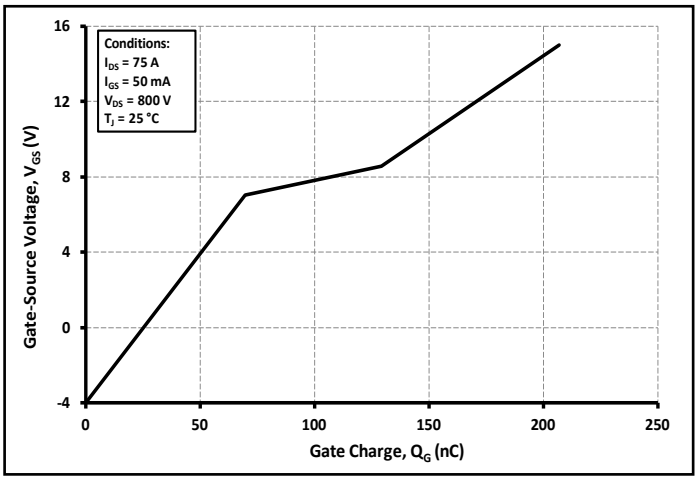



**Figure 12.** Gate Charge Characteristics

## Typical Performance

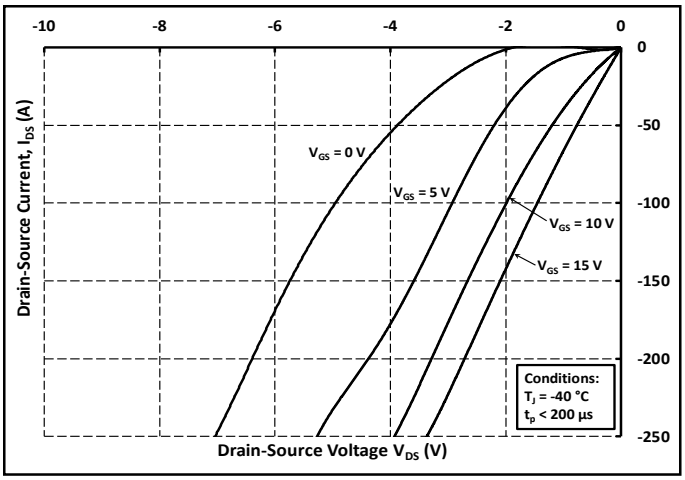



**Figure 13.** 3rd Quadrant Characteristic at -40°C

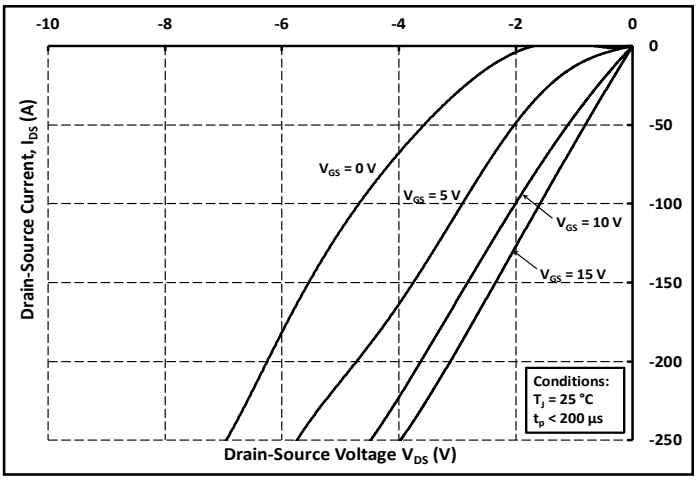



**Figure 14.** 3rd Quadrant Characteristic at 25°C

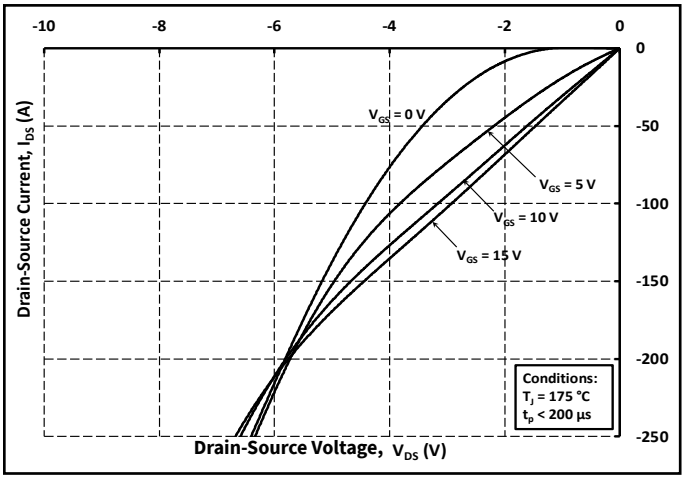



**Figure 15.** 3rd Quadrant Characteristic at 175°C

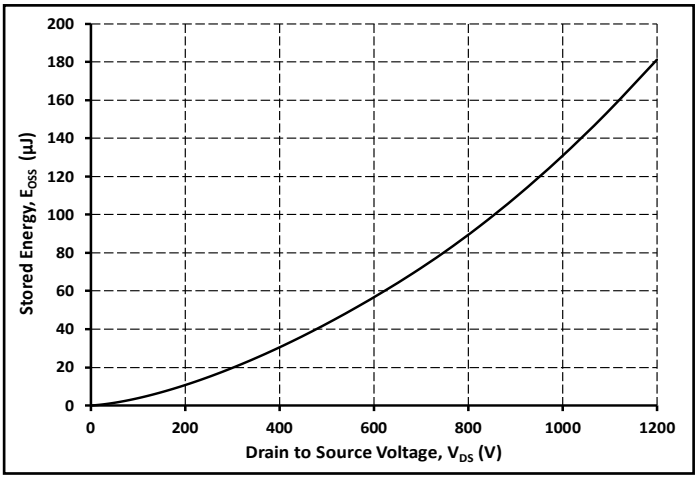



**Figure 16.** Output Capacitor Stored Energy

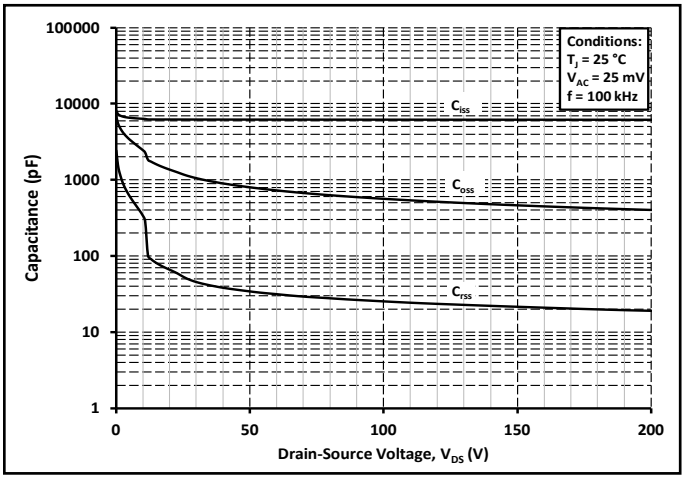



**Figure 17.** Capacitances vs. Drain-Source Voltage (0 - 200 V)

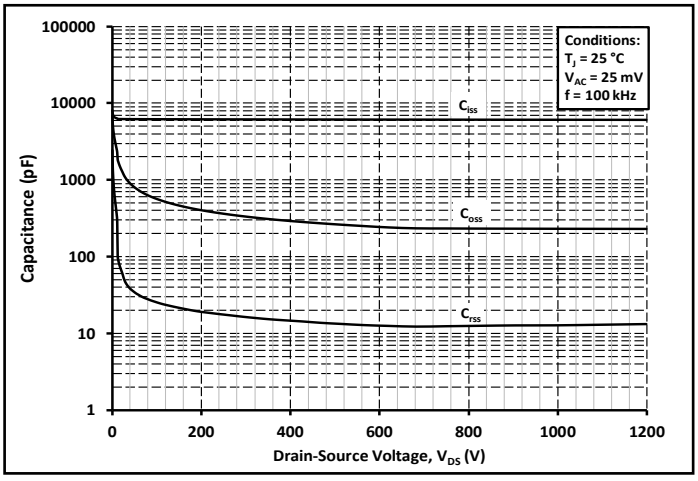



**Figure 18.** Capacitances vs. Drain-Source Voltage (0 - 1200 V)

## Typical Performance

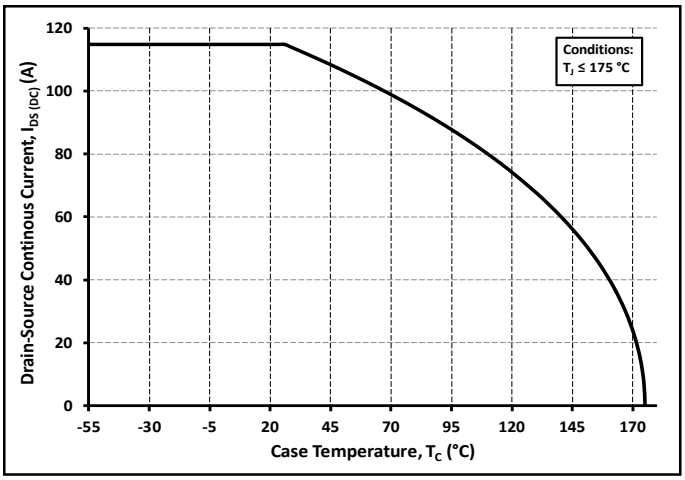



**Figure 19.** Continuous Drain Current Derating vs. Case Temperature

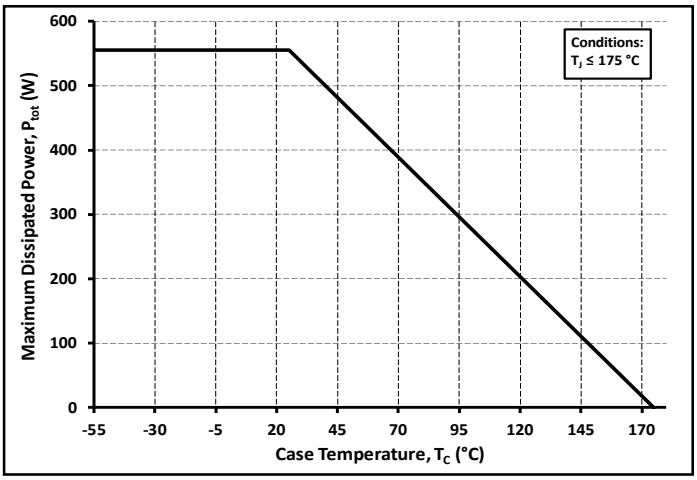



**Figure 20.** Maximum Power Dissipation Derating vs. Case Temperature

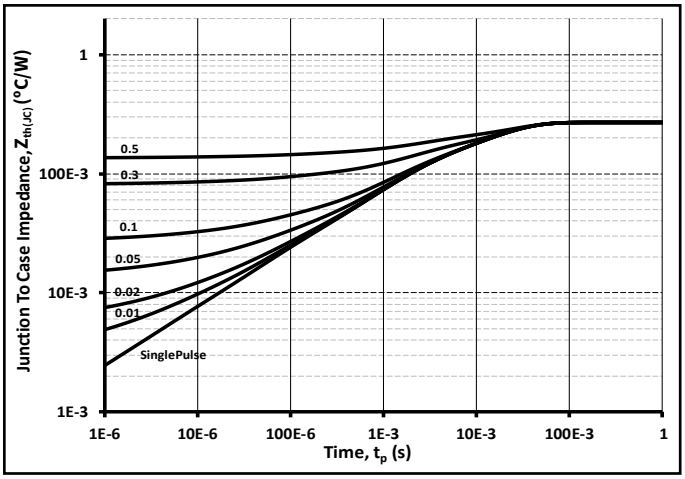



**Figure 21.** Transient Thermal Impedance (Junction - Case)

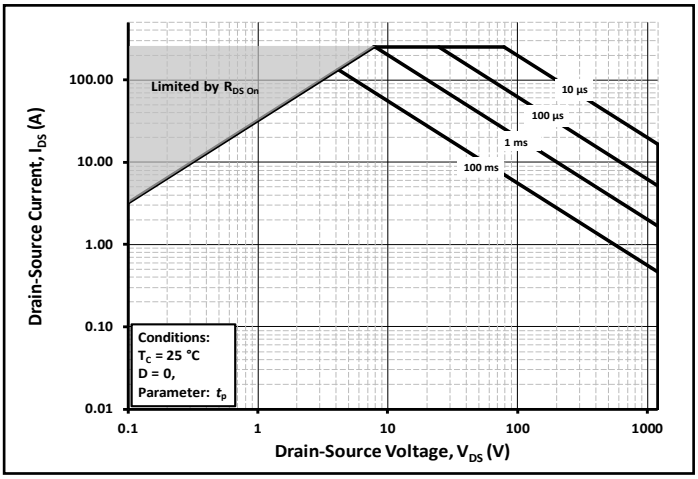



**Figure 22.** Safe Operating Area

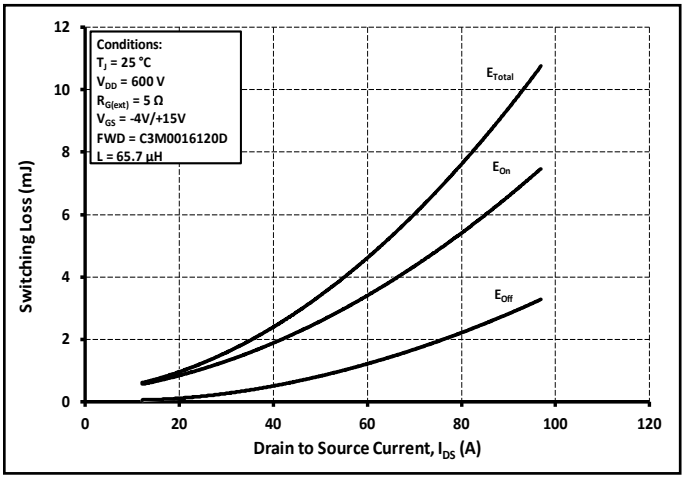



**Figure 23.** Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 600 V)

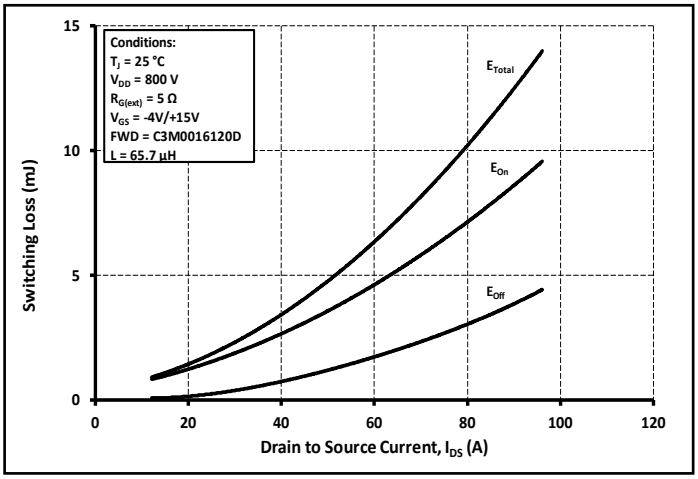



**Figure 24.** Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 800 V)

## Typical Performance

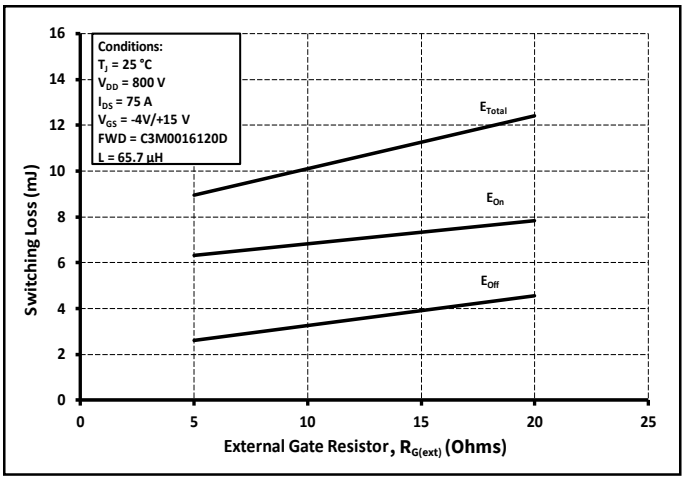



**Figure 25.** Clamped Inductive Switching Energy vs. $R_{G(ext)}$

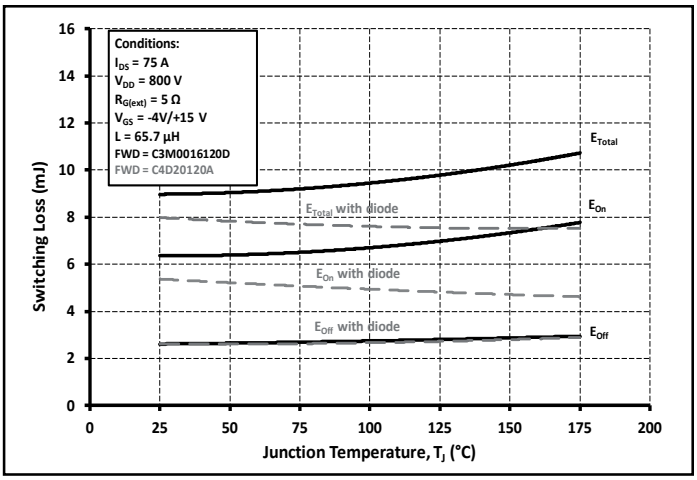



**Figure 26.** Clamped Inductive Switching Energy vs. Temperature

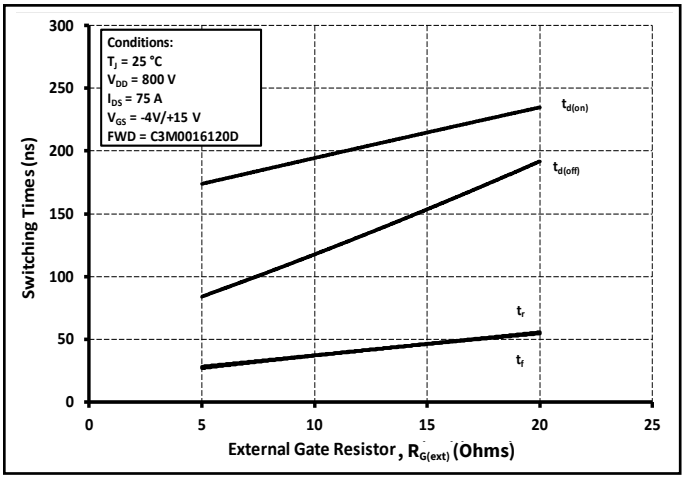



**Figure 27.** Switching Times vs. $R_{G(ext)}$

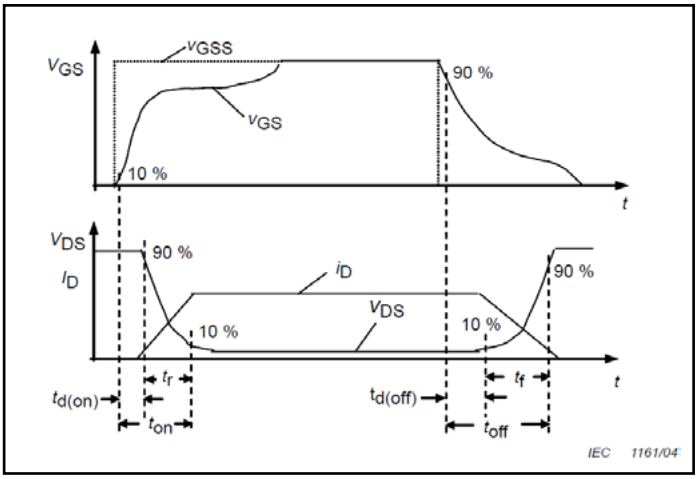



**Figure 28.** Switching Times Definition

## Test Circuit Schematic

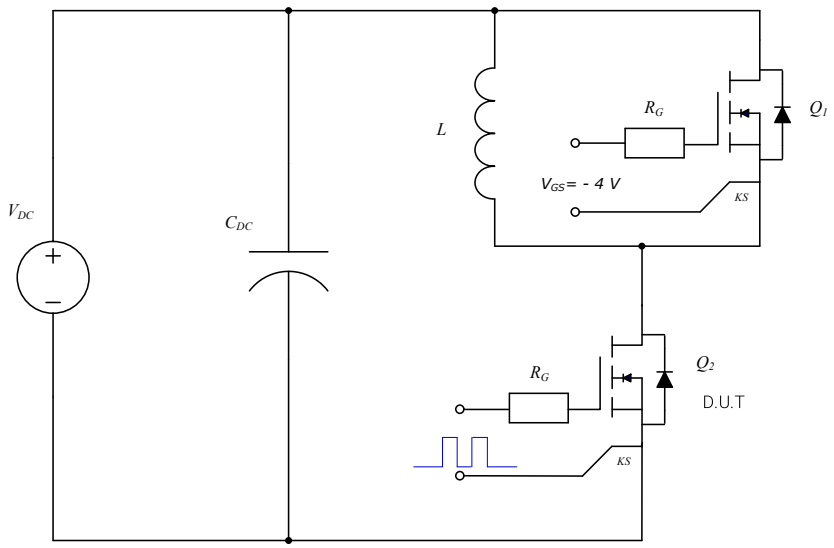
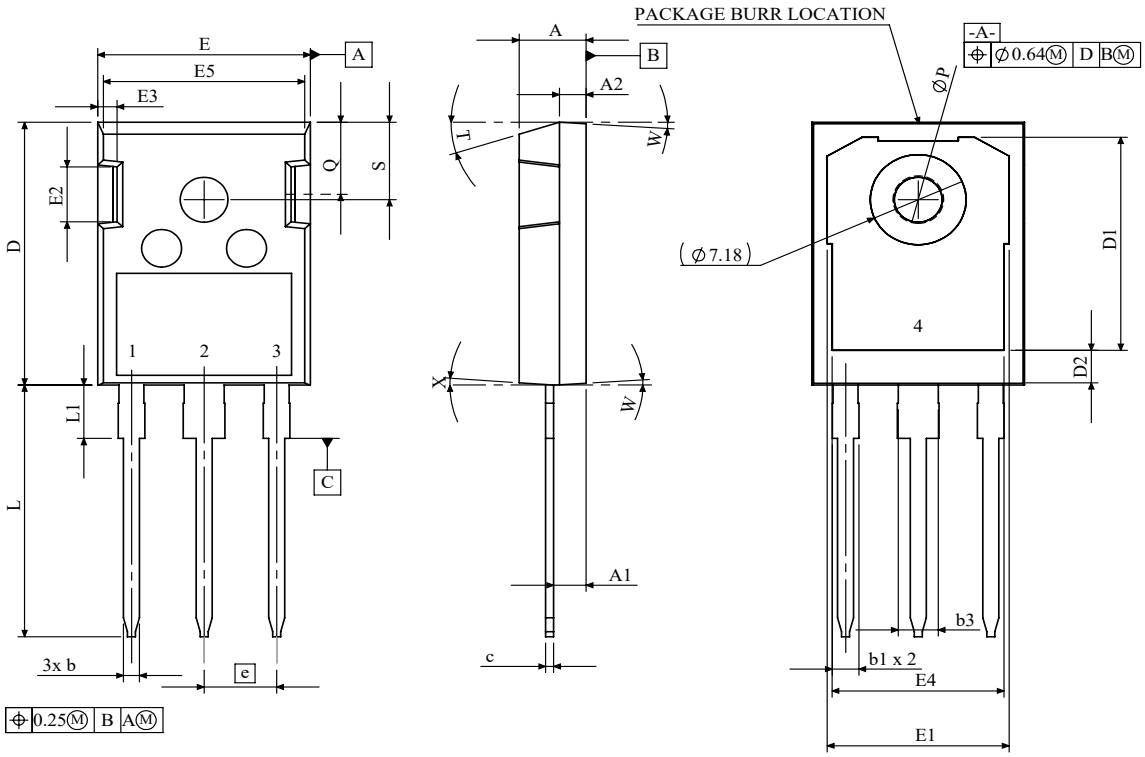



**Figure 29.** Clamped Inductive Switching Waveform Test Circuit

Note:
[3] Turn-off and Turn-on switching energy and timing values measured using SiC MOSFET Body Diode as shown above.

## Package Dimensions – Package TO-247-3




| SYMBOL | MIN (mm) | MAX (mm) |
|---|---|---|
| A | 4.83 | 5.21 |
| A1 | 2.27 | 2.52 |
| A2 | 1.91 | 2.16 |
| b | 1.07 | 1.33 |
| b1 | 1.91 | 2.41 |
| b3 | 2.87 | 3.38 |
| c | 0.55 | 0.74 |
| D | 20.75 | 21.05 |
| D1 | 16 | 17.4 |
| D2 | 2.86 | 3.26 |
| E | 15.75 | 16.13 |
| E1 | 13.5 | 14.55 |
| E2 | 3.68 | 5.1 |
| E3 | 1 | 1.9 |
| E4 | 12.38 | 13.43 |
| E5 | 14.65 | 15.05 |
| e | 5.44 BSC | |
| L | 19.73 | 20.48 |
| L1 | 3.97 | 4.69 |
| ØP | 3.18 | 4.06 |
| Q | 5.42 | 5.96 |
| S | 5.85 | 6.49 |
| T | 17.5° REF. | |
| W | 3.5° REF. | |
| X | 4° REF. | |

| | |
|---|---|
| 1 | GATE |
| 2 | DRAIN |
| 3 | SOURCE |
| 4 | DRAIN |

NOTES:
1. ALL METAL SURFACES ARE TIN PLATED (MATTE), EXCEPT AREA OF CUT.
2. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE LISTED IN MILLIMETERS. ANGLES ARE IN DEGREES.
4. BURR OR MOLD FLASH SIZE (0.5 mm) IS NOT INCLUDED IN THE DIMENSIONS

Wolfspeed

TITLE: PACKAGE OUTLINE DRAWING: TO-247-3L(MOSFET)

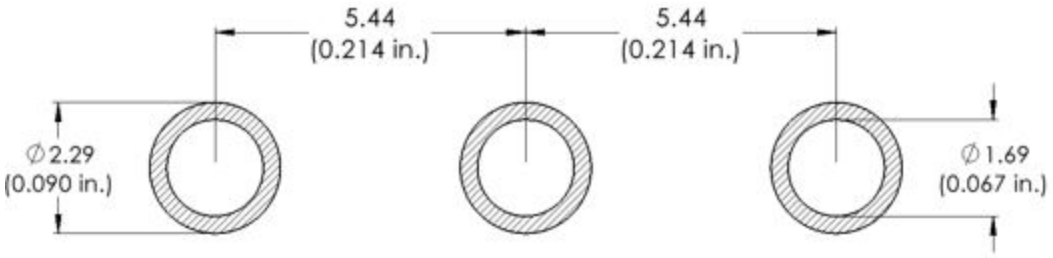
Date: 3/4/24

REVISION NO. 02

A4

PRD 05964 SCALE:1:1 SHEET 1 OF 1

## Recommended Solder Pad Layout




## Revision History

| Current Revision | Date of Release | Description of Changes |
|---|---|---|
| - | August-2019 | N/A |
| 1 | January-2024 | Updated Wolfspeed branding, package drawing, package image, and solder pad layout, added Revision History Table, Table 1 layout revised |
| 2 | September - 2024 | Legal Disclaimer, POD, Diode Pulse Current Symbol |

## Related Links

- SPICE Models
- SiC MOSFET Isolated Gate Driver reference design
- SiC MOSFET Evaluation Board

## Notes & Disclaimer

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