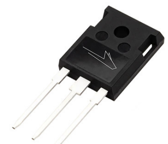
# THE DATASHEET OF

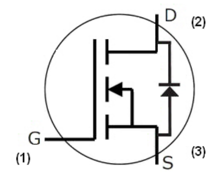
# C2M0045170D

# C2M0045170D

## Silicon Carbide Power MOSFET
## C2M$^{TM}$ MOSFET Technology
## N-Channel Enhancement Mode



TO-247-3L




Package Types: TO-247-3L
PN's: C2M0045170D

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### Features

- 2nd generation SiC MOSFET technology
- High blocking voltage with low on-resistance
- High speed switching with low capacitances
- Resistant to latch-up
- Halogen free, RoHS compliant

### Applications

- Solar inverters
- Switch mode power supplies
- High voltage DC/DC converters
- Motor drive
- Pulsed power applications

### Benefits

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

### **Maximum Ratings** ($T_C$ = 25 °C Unless Otherwise Specified)

| Parameter | Symbol | Value | Unit | Test Conditions | Note |
|---|---|---|---|---|---|
| Drain - Source Voltage | $V_{DSmax}$ | 1700 | V | $V_{GS}$ = 0 V, $I_D$ = 100 µA | |
| Gate - Source Voltage | $V_{GSmax}$ | -10/+25 | V | Absolute Maximum Values, AC (f >1 Hz) | Note: 1 |
| Gate - Source Voltage | $V_{GSop}$ | -5/+20 | V | Recommended Operational Values | Note: 2 |
| Continuous Drain Current | $I_D$ | 75 | A | $V_{GS}$ = 20 V, $T_C$ = 25 °C | Fig. 19 |
| | | 48 | A | $V_{GS}$ = 20 V, $T_C$ = 100 °C | |
| Pulsed Drain Current | $I_{D\,(pulse)}$ | 160 | A | Pulse Width $t_P$ Limited by $T_{jmax}$ | Fig. 22 |
| Power Dissipation | $P_D$ | 338 | W | $T_C$ = 25 °C, $T_J$ = 150 °C | Fig. 20 |
| Operating Junction and Storage Temperature | $T_J$, $T_{stg}$ | -40 to +150 | °C | | |
| Solder Temperature | $T_L$ | 260 | °C | According to JEDEC J-STD-020 | |
| Mounting Torque | $M_d$ | 1<br>8.8 | Nm<br>Ibf-in | M3 or 6-32 Screw | |

Note (1): When using MOSFET body diode $V_{GSmax}$ = -5 V/+25 V.
Note (2): MOSFET can also safely operate at 0/+20 V.

## Electrical Characteristics ($T_C$ = 25 °C Unless Otherwise Specified)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|---|
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | 1700 | | | V | $V_{GS}$ = 0 V, $I_D$ = 100 µA | |
| Gate Threshold Voltage | $V_{GS(th)}$ | 2.0 | 3.0 | 4 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 18 mA | Fig. 11 |
| | | | 2.5 | | | $V_{DS}$ = $V_{GS}$, $I_D$ = 18 mA, $T_J$ = 150 °C | |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | | 2 | 100 | µA | $V_{DS}$ = 1700 V, $V_{GS}$ = 0 V | |
| Gate-Source Leakage Current | $I_{GSS}$ | | | 600 | nA | $V_{GS}$ = 20 V, $V_{DS}$ = 0 V | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | | 40 | 70 | mΩ | $V_{GS}$ = 20 V, $I_D$ = 50 A | Fig. 4,5,6 |
| | | | 80 | | | $V_{GS}$ = 20 V, $I_D$ = 50 A, $T_J$ = 150 °C | |
| Transconductance | $g_{fs}$ | | 24.7 | | S | $V_{DS}$ = 20 V, $I_{DS}$ = 50 A | Fig. 7 |
| | | | 23.4 | | | $V_{DS}$ = 20 V, $I_{DS}$ = 50 A, $T_J$ = 150 °C | |
| Input Capacitance | $C_{iss}$ | | 3455 | | pF | $V_{GS}$ = 0 V<br>$V_{DS}$ = 1200 V<br>f = 1 MHz<br>$V_{AC}$ = 25 mV | Fig. 17,18 |
| Output Capacitance | $C_{oss}$ | | 171 | | | | |
| Reverse Transfer Capacitance | $C_{rss}$ | | 6.7 | | | | |
| $C_{oss}$ Stored Energy | $E_{oss}$ | | 139 | | µJ | | Fig. 16 |
| Effective Output Capacitance (Energy Related) | $C_{o(er)}$ | | 188 | | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 0... 1200 V | Note: 3 |
| Effective Output Capacitance (Time Related) | $C_{o(tr)}$ | | 255 | | pF | | |
| Turn-On Switching Energy (SiC Diode FWD) | $E_{ON}$ | | 2.5 | | mJ | $V_{DS}$ = 1200 V, $V_{GS}$ = -5/20 V, $I_D$ = 50 A, $R_{G(ext)}$ = 2.5 Ω, L = 99 µH, $T_J$ = 150 °C, Using SiC Diode as FWD | Fig. 26, 29b Note 2 |
| Turn Off Switching Energy (SiC Diode FWD) | $E_{OFF}$ | | 1.4 | | | | |
| Turn-On Switching Energy (Body Diode FWD) | $E_{ON}$ | | 4.9 | | mJ | $V_{DS}$ = 1200 V, $V_{GS}$ = -5/20 V, $I_D$ = 50 A, $R_{G(ext)}$ = 2.5 Ω, L = 99 µH, $T_J$ = 150 °C, Using MOSFET as FWD | Fig. 26, 29a Note 2 |
| Turn Off Switching Energy (Body Diode FWD) | $E_{OFF}$ | | 1.1 | | | | |
| Turn-On Delay Time | $t_{d(on)}$ | | 68 | | ns | $V_{DD}$ = 1200 V, $V_{GS}$ = -5/20 V<br>$I_D$ = 50 A,<br>$R_{G(ext)}$ = 2.5 Ω, Timing Relative to $V_{DS}$ Inductive Load | Fig. 27, 29 Note 2 |
| Rise Time | $t_r$ | | 19 | | | | |
| Turn-Off Delay Time | $t_{d(off)}$ | | 35 | | | | |
| Fall Time | $t_f$ | | 19 | | | | |
| Internal Gate Resistance | $R_{G(int)}$ | | 1.3 | | Ω | f = 1 MHz, $V_{AC}$ = 25 mV | |
| Gate to Source Charge | $Q_{gs}$ | | 43 | | nC | $V_{DS}$ = 1200 V, $V_{GS}$ = -5/20 V<br>$I_D$ = 50 A<br>Per IEC60747-8-4 pg 21 | Fig. 12 |
| Gate to Drain Charge | $Q_{gd}$ | | 74 | | | | |
| Total Gate Charge | $Q_g$ | | 200 | | | | |

Note (3): $C_{o(er)}$, a lumped capacitance that gives same stored energy as coss while $V_{DS}$ is rising from 0 to 1200 V.
$C_{o(tr)}$, a lumped capacitance that gives same charging time as coss while $V_{DS}$ is rising from 0 to 1200 V.

## Reverse Diode Characteristics

| Parameter | Symbol | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| Diode Forward Voltage | $V_{SD}$ | 3.8 | | V | $V_{GS}$ = -5 V, $I_{SD}$ = 25 A | Fig. 8, 9, 10 Note 1 |
| | | 3.4 | | | $V_{GS}$ = -5 V, $I_{SD}$ = 25 A, $T_J$ = 150 °C | |
| Continuous Diode Forward Current | $I_S$ | | 76 | A | $V_{GS}$ = -5 V, $T_C$ = 25 °C | Note 1 |
| Diode Pulse Current | $I_{S,\ pulse}$ | | 160 | | $V_{GS}$ = -5 V, Pulse Width $t_P$ Limited by $T_{jmax}$ | Note 1 |
| Reverse Recovery Time | $t_{rr}$ | 53 | | ns | $V_{GS}$ = -5 V, $I_{SD}$ = 50 A , $V_R$ = 1200 V dif/dt = 1000 A/µs, $T_J$ = 150 °C | |
| Reverse Recovery Charge | $Q_{rr}$ | 461 | | nC | | |
| Peak Reverse Recovery Current | $I_{rrm}$ | 14 | | A | | |
| Reverse Recovery Time | $t_{rr}$ | 40 | | ns | $V_{GS}$ = -5 V, $I_{SD}$ = 50 A , $V_R$ = 1200 V dif/dt = 3040 A/µs, $T_J$ = 150 °C | |
| Reverse Recovery Charge | $Q_{rr}$ | 481 | | nC | | |
| Peak Reverse Recovery Current | $I_{rrm}$ | 22 | | A | | |

## Thermal Characteristics

| Parameter | Symbol | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| Thermal Resistance from Junction to Case | $R_{\theta JC}$ | 0.25 | 0.37 | °C/W | | Fig. 21 |
| Thermal Resistance from Junction to Ambient | $R_{\theta JA}$ | | 40 | | | |

## Typical Performance

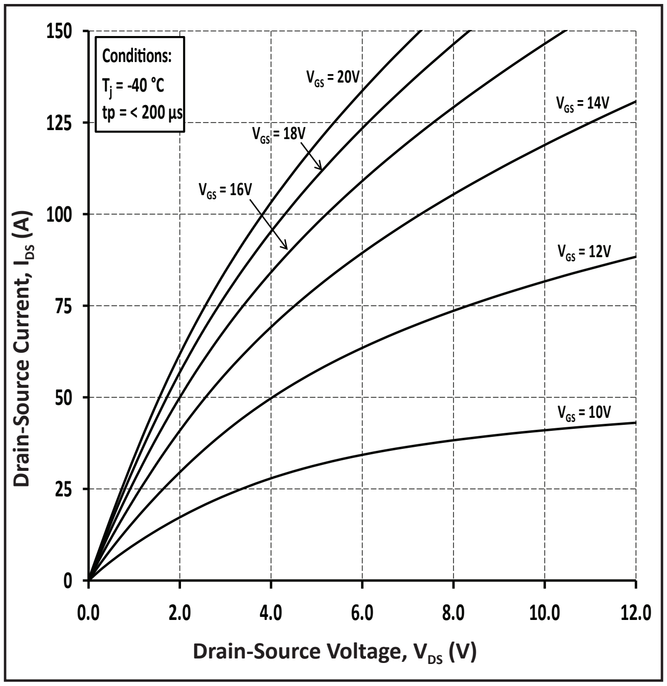



Figure 1. Output Characteristics $T_J$ = -40 °C

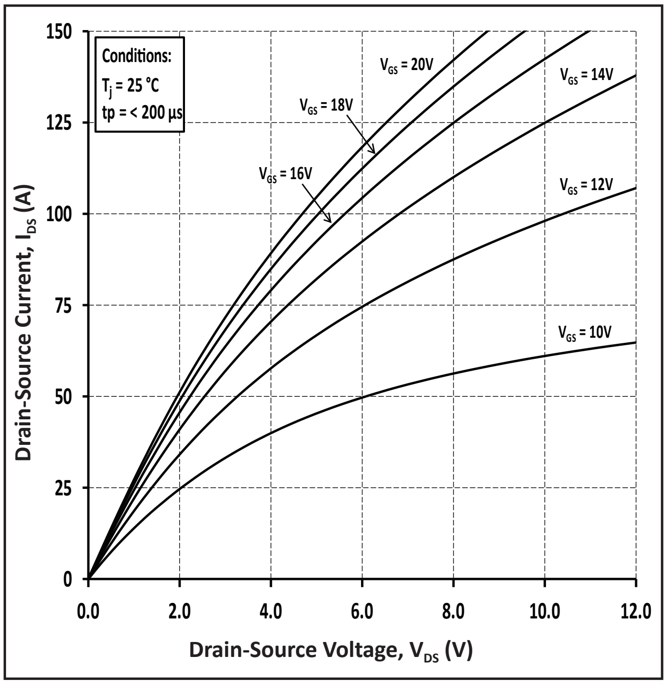



Figure 2. Output Characteristics $T_J$ = 25 °C

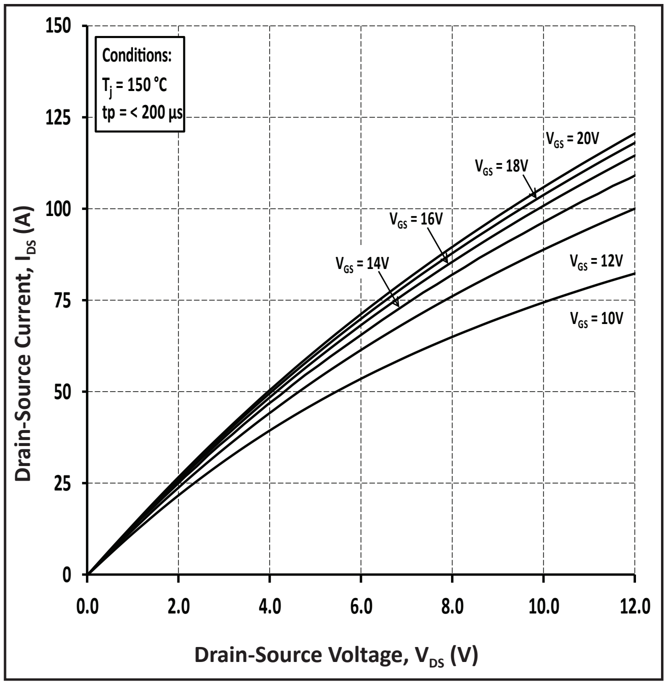



Figure 3. Output Characteristics $T_J$ = 150 °C

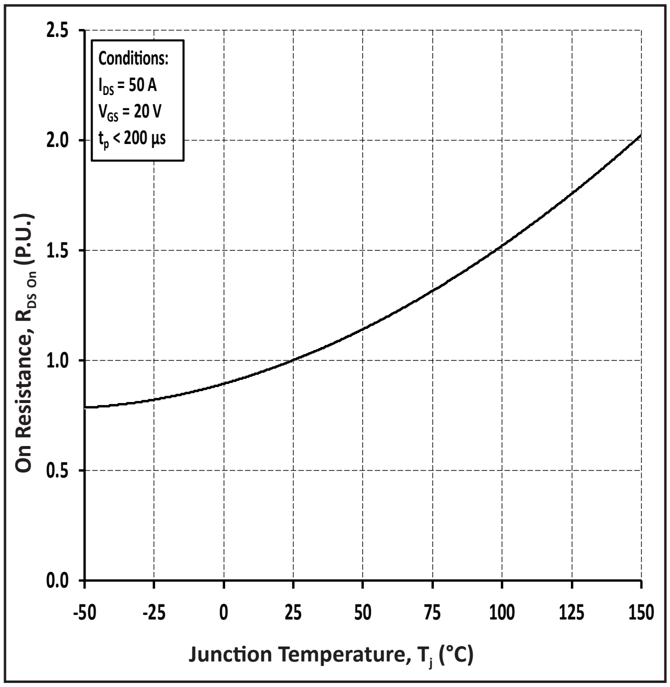



Figure 4. Normalized On-Resistance vs Temperature

## Typical Performance

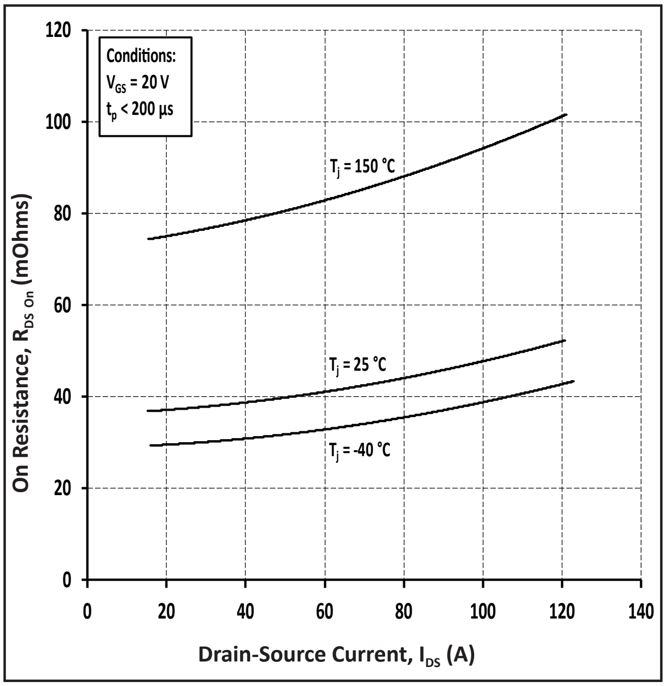



Figure 5. On-Resistance vs Drain Current for Various Temperatures

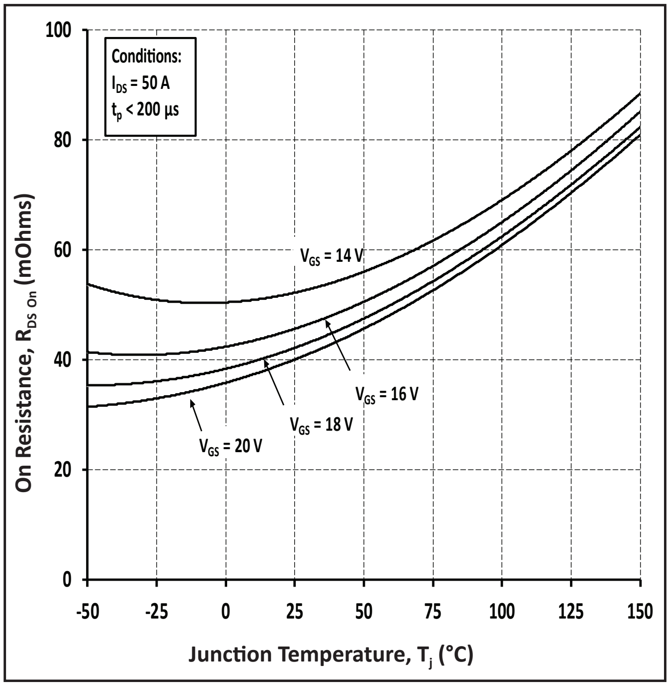



Figure 6. On-Resistance vs Temperature for Various Gate Voltage

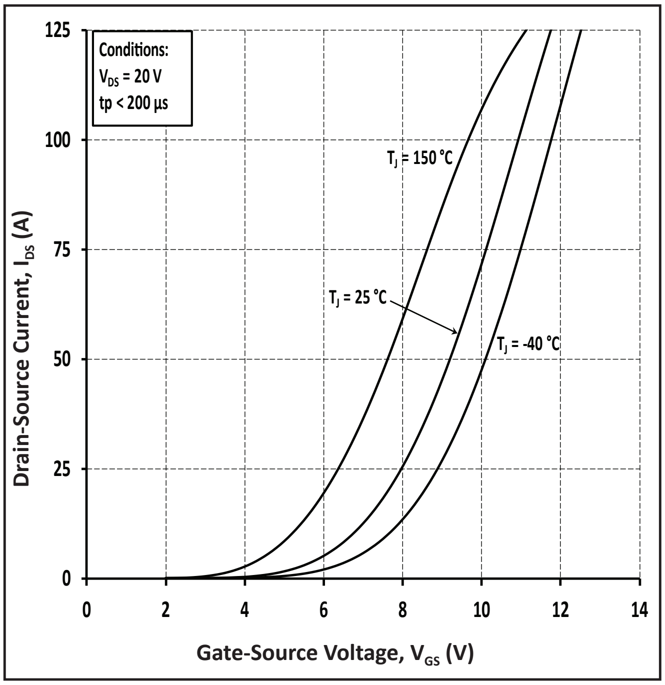



Figure 7. Transfer Characteristic for Various Junction Temperatures

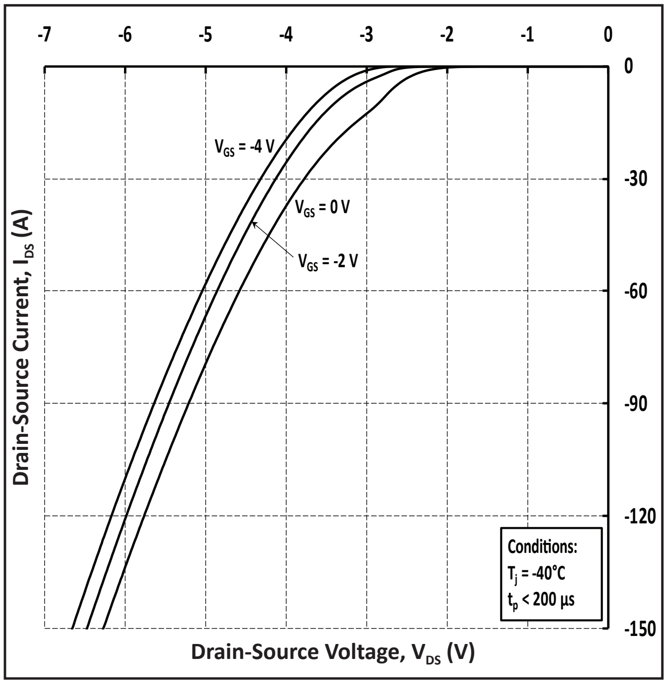



Figure 8. Body Diode Characteristic at -40 °C

## Typical Performance

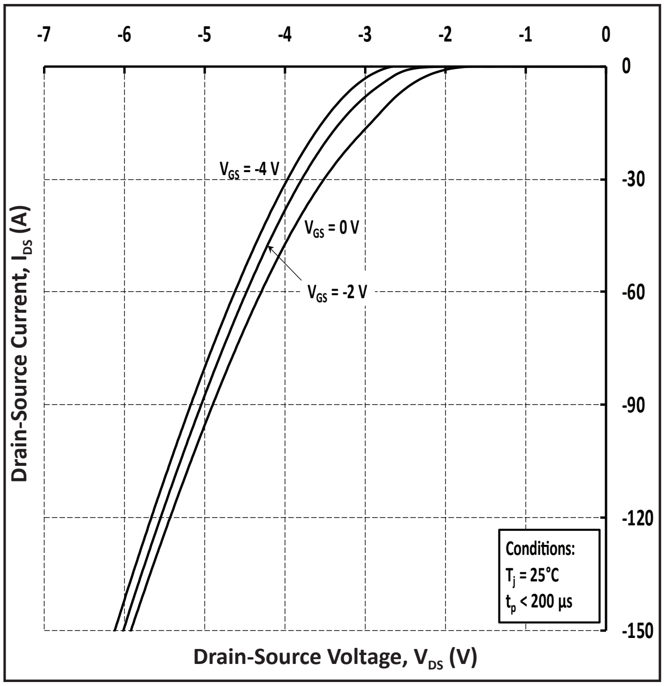



Figure 9. Body Diode Characteristic at 25 °C

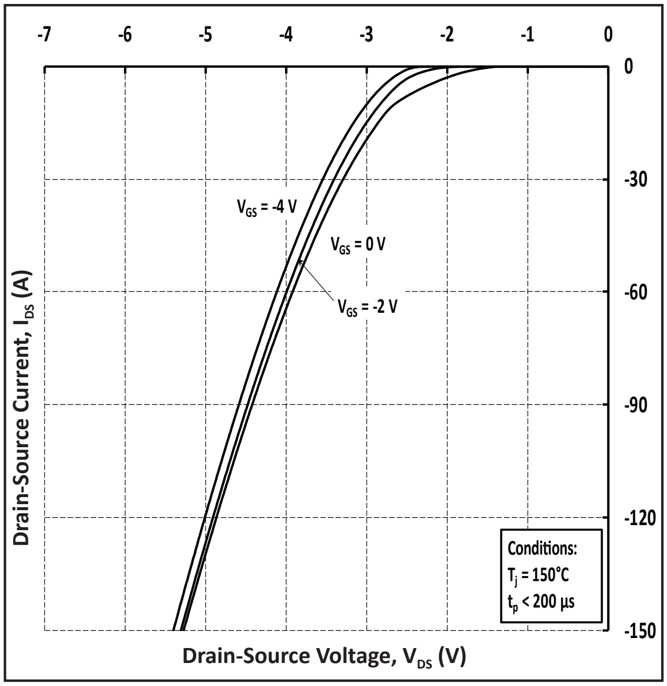



Figure 10. Body Diode Characteristic at 150 °C

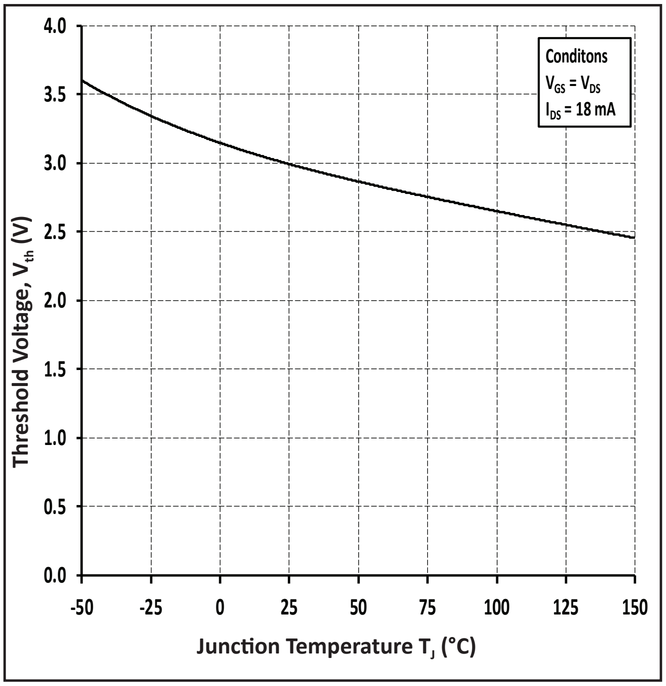



Figure 11. Threshold Voltage vs Temperature

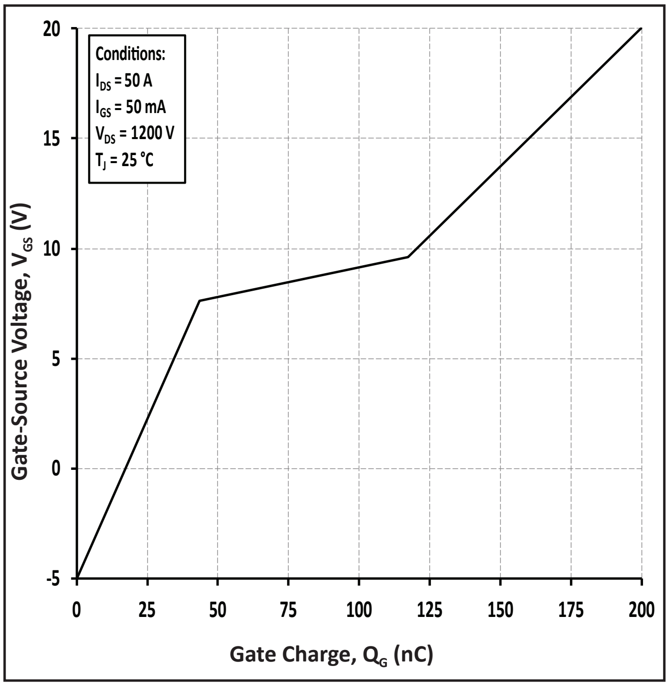



Figure 12. Gate Charge Characteristic

## Typical Performance

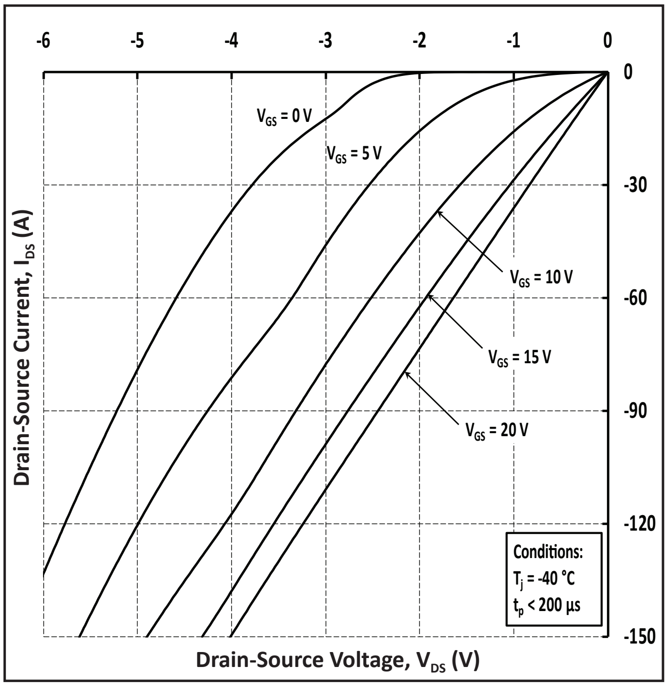



Figure 13. 3rd Quadrant Characteristic at -40 °C

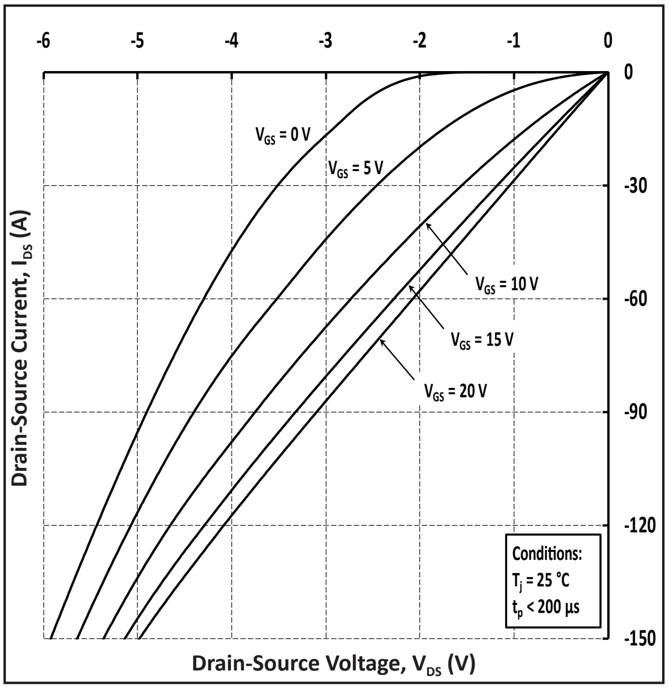



Figure 14. 3rd Quadrant Characteristic at 25 °C

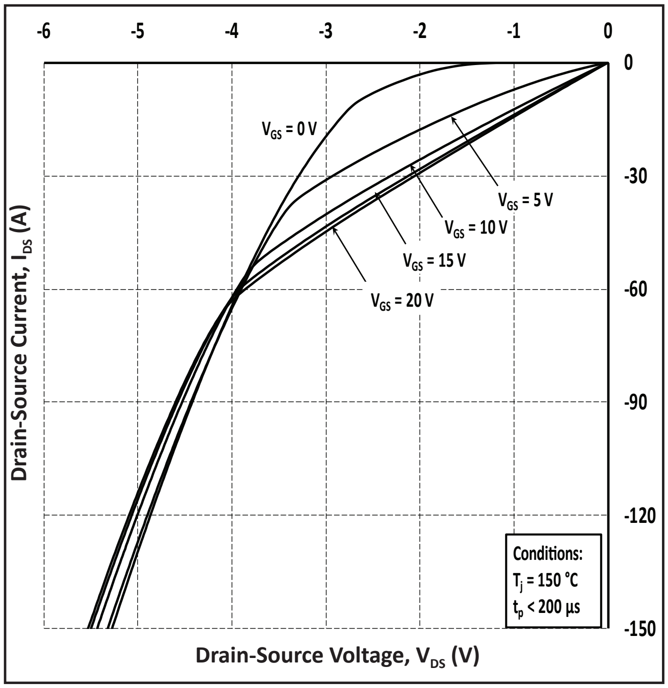



Figure 15. 3rd Quadrant Characteristic at 150 °C

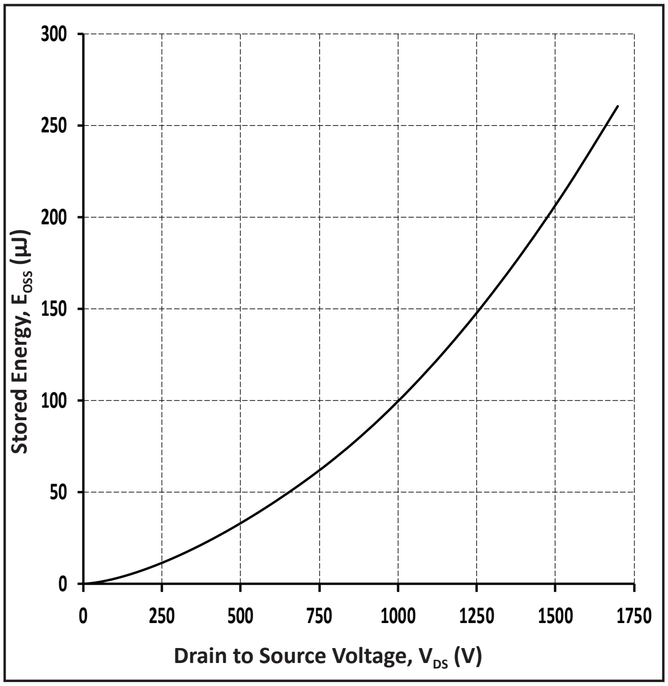



Figure 16. Output Capacitor Stored Energy

## Typical Performance

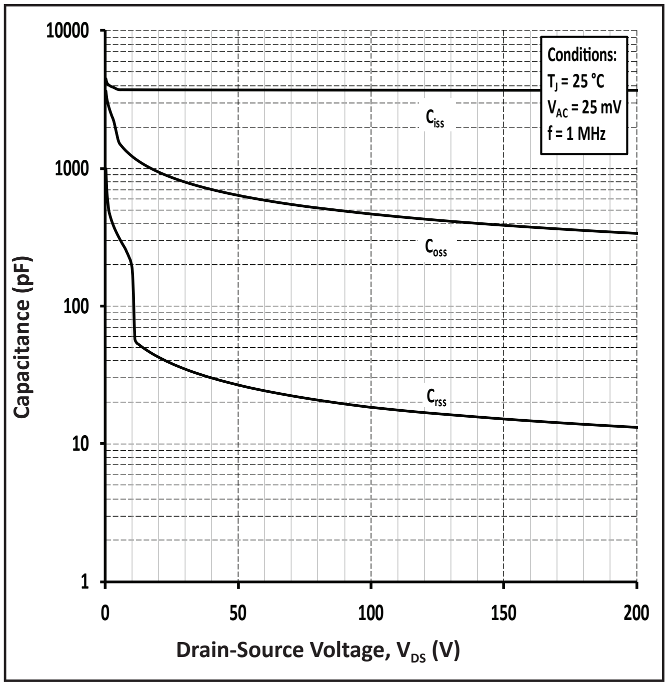



Figure 17. Capacitances vs Drain-Source Voltage (0-200 V)

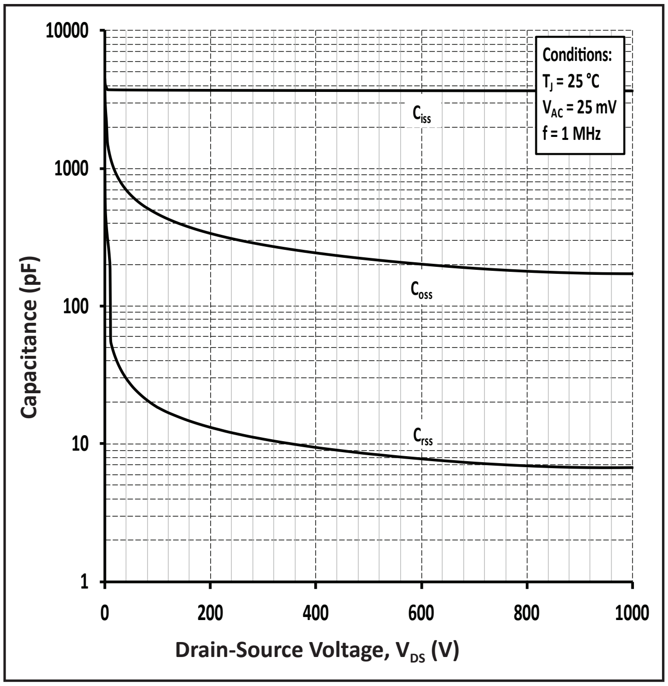



Figure 18. Capacitances vs Drain-Source Voltage (0-1000 V)

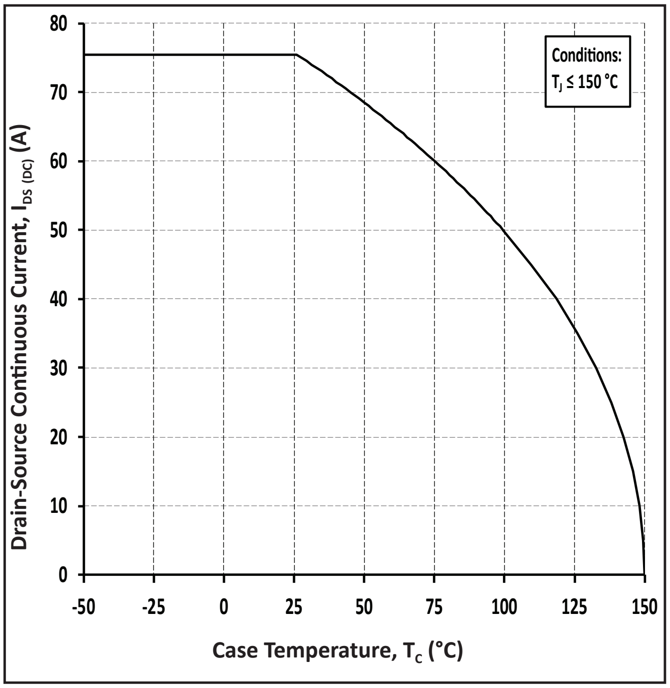



Figure 19. Continuous Drain Current Derating vs Case Temperature

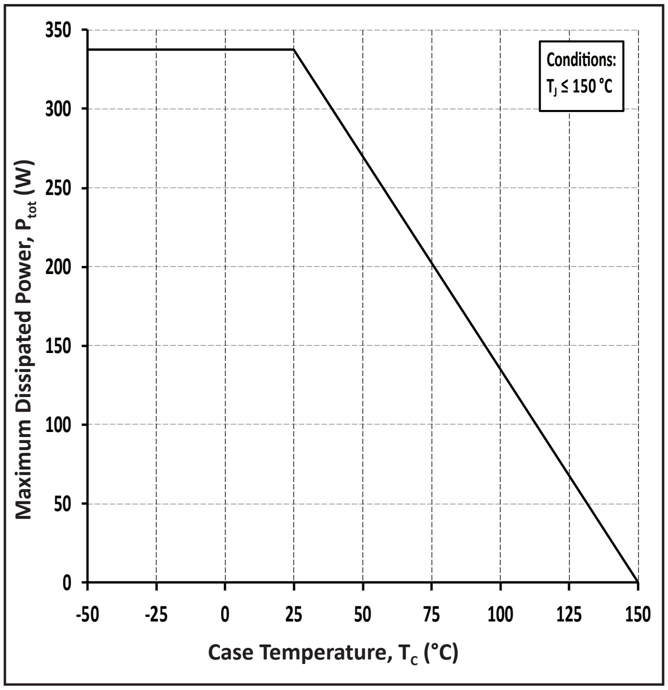



Figure 20. Maximum Power Dissipation Derating vs Case Temperature

## Typical Performance

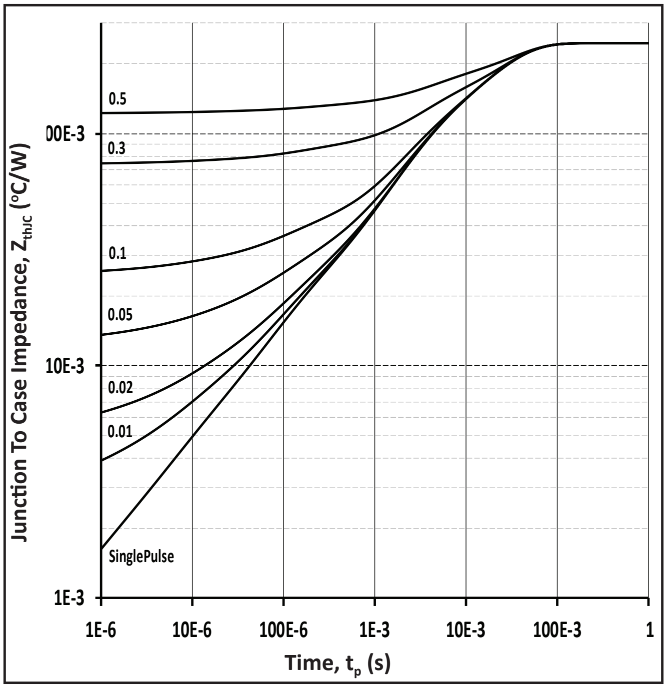



Figure 21. Transient Thermal Impedance (Junction - Case)

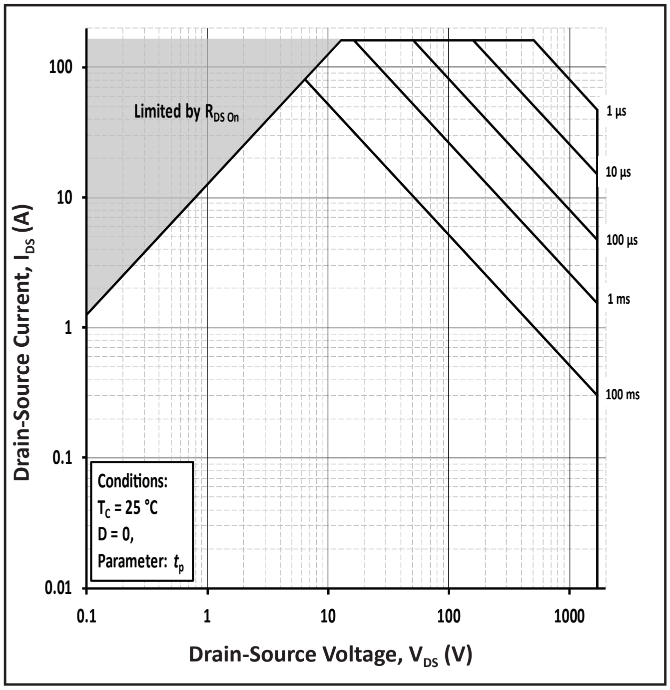



Figure 22. Safe Operating Area

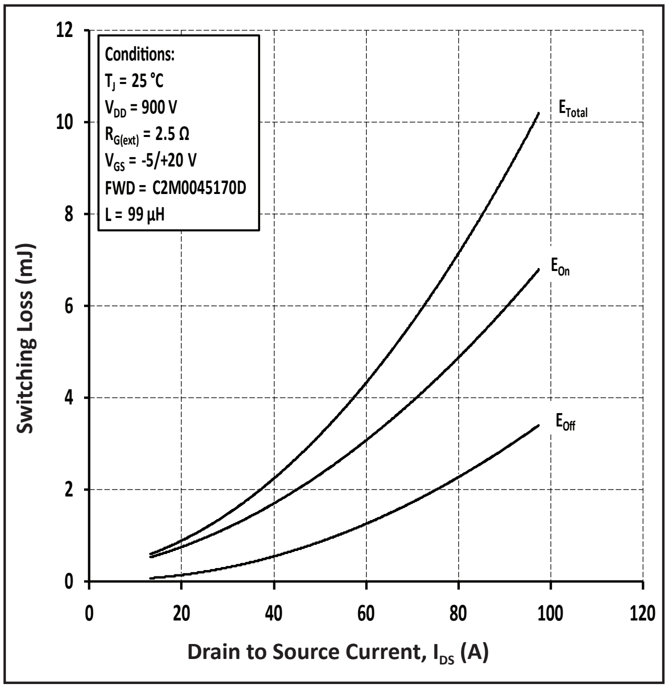



Figure 23. Clamped Inductive Switching Energy vs Drain Current ($V_{DD}$ = 900 V)

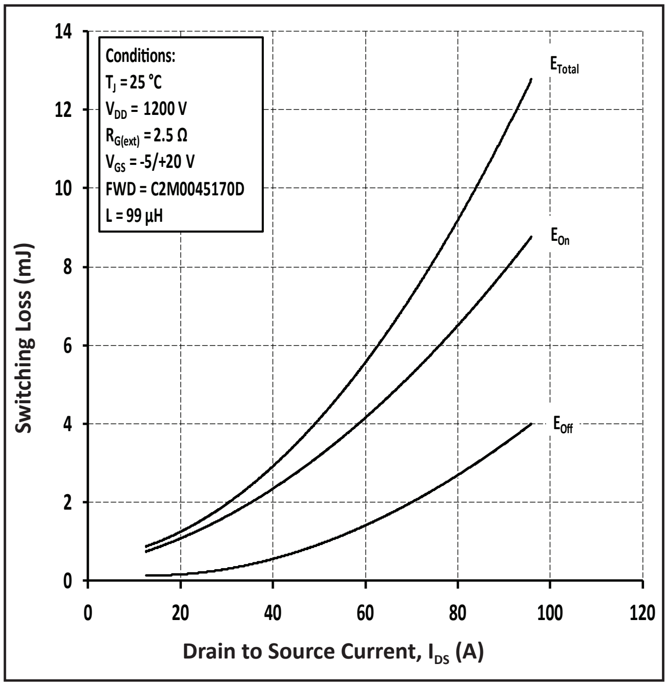



Figure 24. Clamped Inductive Switching Energy vs Drain Current ($V_{DD}$ = 1200 V)

## Typical Performance

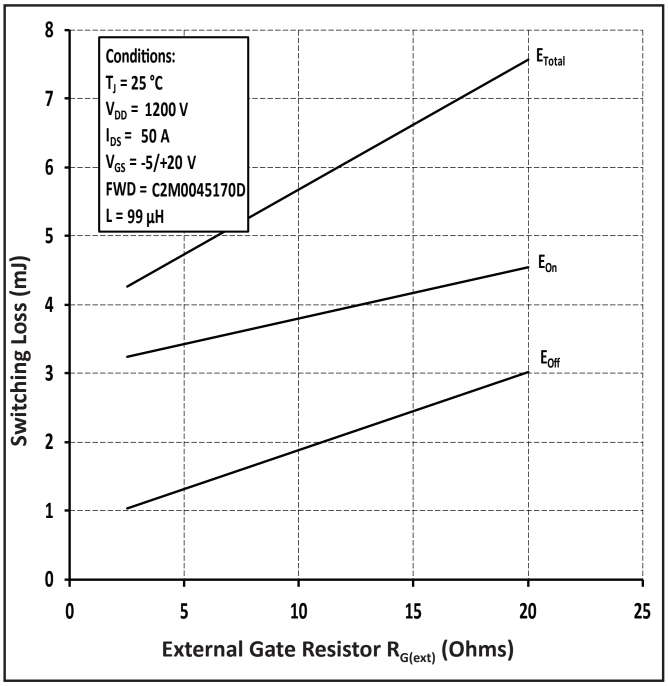



Figure 25. Clamped Inductive Switching Energy vs $R_{G(ext)}$

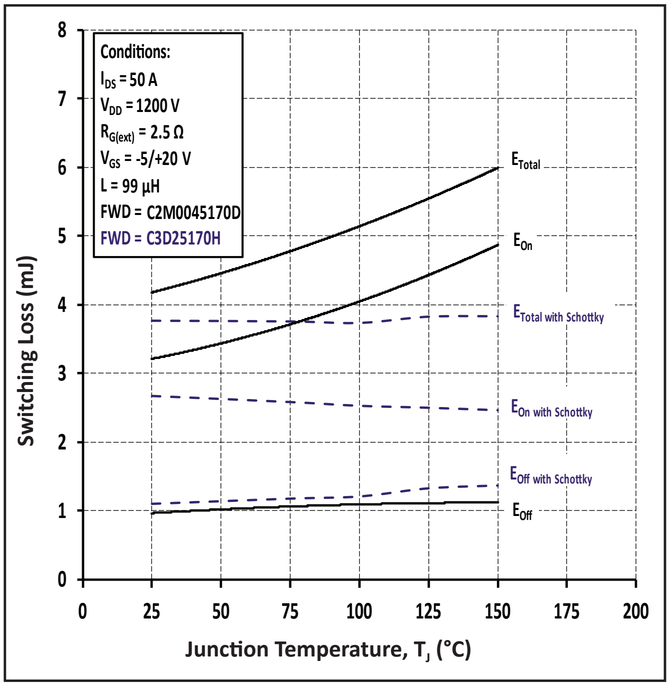



Figure 26. Clamped Inductive Switching Energy vs Temperature

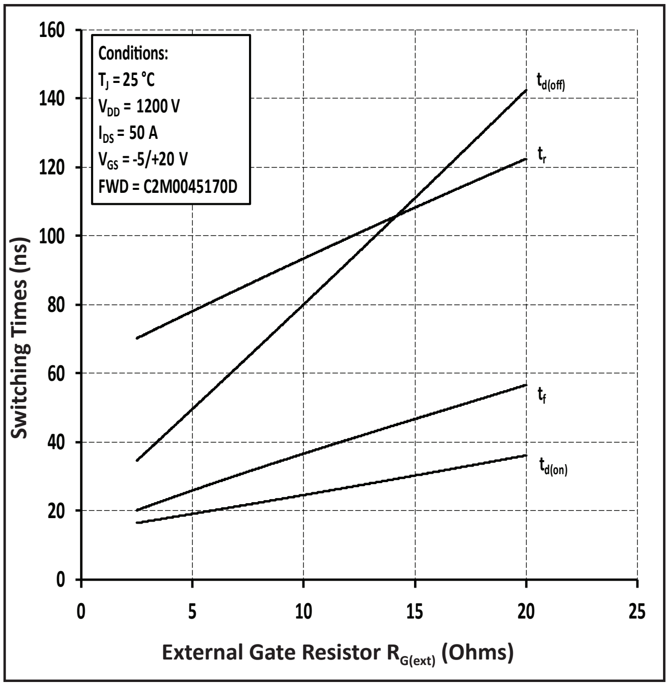



Figure 27. Switching Times vs $R_{G(ext)}$

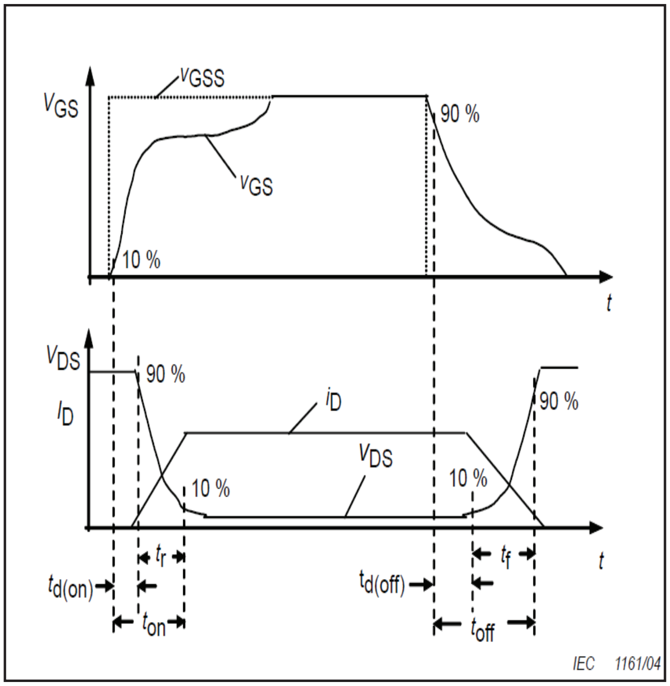



Figure 28. Switching Times Definition

## Test Circuit Schematic

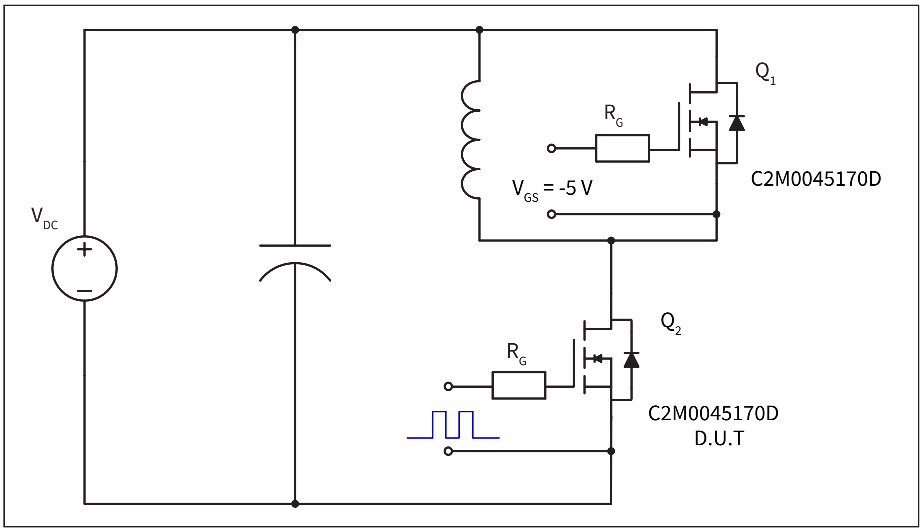



Figure 29a. Clamped Inductive Switching Test Circuit Using MOSFET Intristic Body Diode

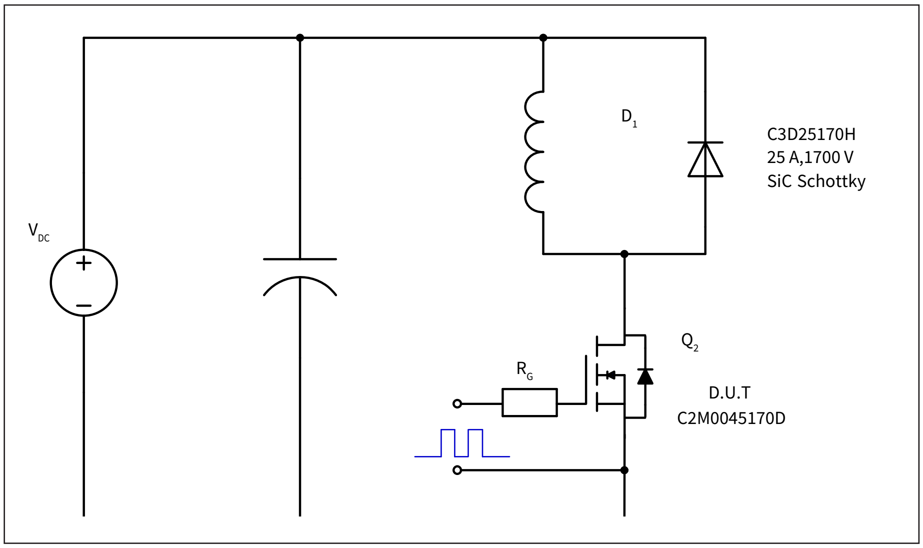
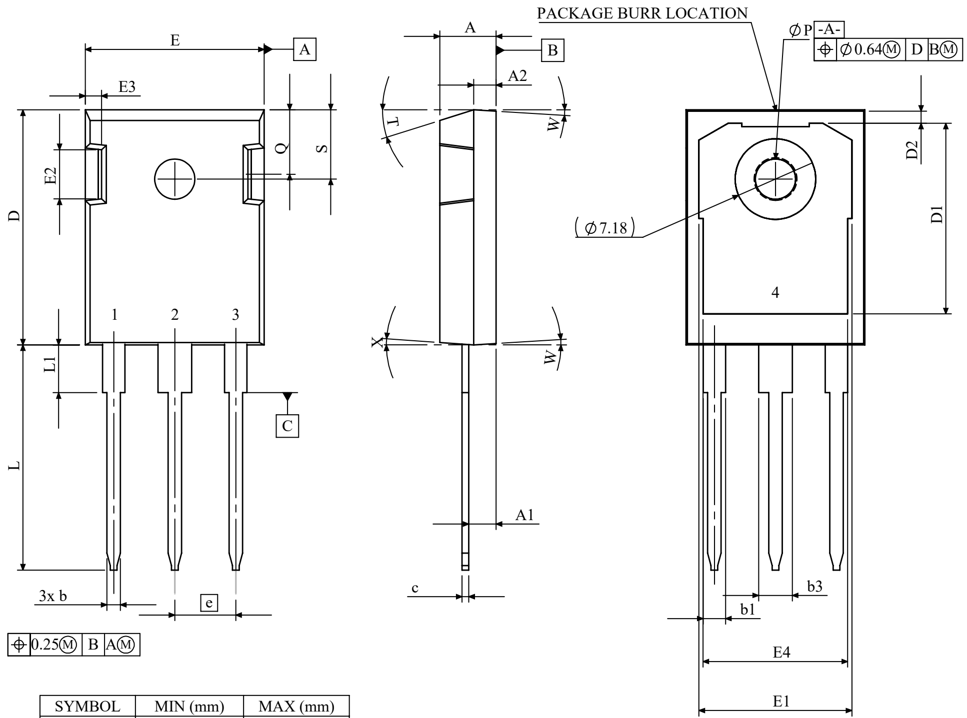



Figure 29b. Clamped Inductive Switching Test Circuit Using SiC Schottky Diode

## Package Dimensions

Package: TO-247-3L




| SYMBOL | MIN (mm) | MAX (mm) |
|---|---|---|
| A | 4.83 | 5.21 |
| A1 | 2.29 | 2.54 |
| A2 | 1.91 | 2.16 |
| b | 1.07 | 1.33 |
| b1 | 1.91 | 2.41 |
| b3 | 2.87 | 3.38 |
| c | 0.55 | 0.68 |
| D | 20.8 | 21.1 |
| D1 | 16.25 | 17.65 |
| D2 | 0.95 | 1.25 |
| E | 15.75 | 16.13 |
| E1 | 13.1 | 14.15 |
| E2 | 3.68 | 5.1 |
| E3 | 1 | 1.9 |
| E4 | 12.38 | 13.43 |
| e | 5.44 BSC | |
| L | 19.81 | 20.32 |
| L1 | 4.1 | 4.4 |
| ØP | 3.51 | 3.65 |
| Q | 5.49 | 6 |
| S | 6.04 | 6.3 |
| T | 17.5° REF. | |
| W | 3.5° REF. | |
| X | 4° REF. | |

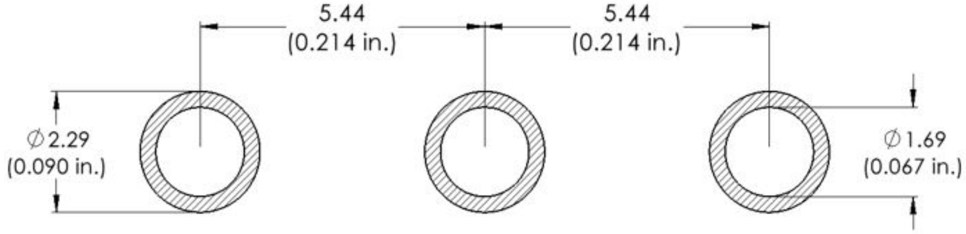
| | |
|---|---|
| 1 | GATE |
| 2 | DRAIN |
| 3 | SOURCE |
| 4 | DRAIN |

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: 04/13/22 | REVISION NO. 01 | | A4 |
| | SCALE:1:1 | SHEET 1 OF 1 | |

**Recommended Solder Pad Layout**



## Revision History

| Current Revision | Date of Release | Description of Changes |
|---|---|---|
| 1 | May-2022 | Initial Release |
| 2 | November-2023 | Updated Wolfspeed branding, package drawing, and solder pad layout |

## Notes & Disclaimer

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**Contact info:**

4600 Silicon Drive
Durham, NC 27703 USA
Tel: +1.919.313.5300
www.wolfspeed.com/power





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