CREE

# E3M0075120K

## Silicon Carbide Power MOSFET
## E-Series Automotive

N-Channel Enhancement Mode

### Features

- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- 8mm of creepage distance between drain and source
- 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
- Automotive Qualified (AEC-Q101) and PPAP Capable

### Benefits

- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

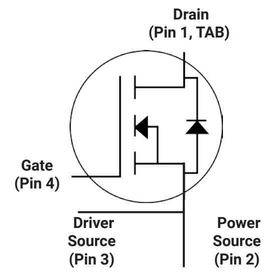
### Applications

- EV battery chargers
- High Voltage DC/DC converters

### Package


Halogen-Free

RoHS




| Ordering Part Number | Package | Marking |
|---|---|---|
| E3M0075120K | TO 247-4 | E3M0075120K |

**Maximum Ratings** ($T_C$ = 25 ˚C unless otherwise specified)
Stress beyond those listed under absolute maximum ratings may cause permanent damage to the device.

| Symbol | Parameter | | Value | Unit | Note |
|---|---|---|---|---|---|
| $V_{DSmax}$ | Drain - Source Voltage | | 1200 | V | |
| $V_{GSmax}$ | Gate - Source Voltage | | -8/+19 | V | Note: 1 |
| $I_D$ | Continuous Drain Current, $V_{GS}$ = 15 V | $T_C$ = 25˚C | 32 | A | Fig. 19, Note: 2 |
| | | $T_C$ = 100˚C | 23 | | |
| $I_{D(pulse)}$ | Pulsed Drain Current, Pulse width $t_P$ limited by $T_{jmax}$ | | 80 | A | Fig. 22 |
| $P_D$ | Power Dissipation, $T_C$=25˚C, $T_J$ = 175 ˚C | | 145 | W | Fig. 20 Note: 2 |
| $T_J$ , $T_{stg}$ | Operating Junction and Storage Temperature | | -55 to +175 | ˚C | |
| $T_L$ | Solder Temperature, 1.6mm (0.063") from case for 10s | | 260 | ˚C | |
| $M_d$ | Mounting Torque , M3 or 6-32 screw | | 1<br>8.8 | Nm<br>lbf-in | |

Note (1): Recommended turn off / turn on gate voltage $V_{GS}$ -4V...0V / +15V
Note (2): Verified by design

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

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | 1200 | | | V | $V_{GS}$ = 0 V, $I_D$ = 100 μA | |
| $V_{GS(th)}$ | Gate Threshold Voltage | 1.8 | 2.6 | 3.6 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 5 mA | Fig. 11 |
| | | | 2.1 | | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 5 mA, $T_J$ = 175ºC | |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | | 1 | 50 | μA | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | |
| $I_{GSS}$ | Gate-Source Leakage Current | | 10 | 250 | nA | $V_{GS}$ = 15 V, $V_{DS}$ = 0 V | |
| $R_{DS(on)}$ | Drain-Source On-State Resistance | | 75 | 97.5 | mΩ | $V_{GS}$ = 15 V, $I_D$ = 17.9 A | Fig. 4, 5, 6 |
| | | | 135 | | | $V_{GS}$ = 15 V, $I_D$ = 17.9 A, $T_J$ = 175ºC | |
| $g_{fs}$ | Transconductance | | 11 | | S | $V_{DS}$= 20 V, $I_{DS}$= 17.9 A | Fig. 7 |
| | | | 10.5 | | | $V_{DS}$= 20 V, $I_{DS}$= 17.9 A, $T_J$ = 175ºC | |
| $C_{iss}$ | Input Capacitance | | 1480 | | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 1000 V<br>f = 1 MHz<br>$V_{AC}$ = 25 mV | Fig. 17, 18 |
| $C_{oss}$ | Output Capacitance | | 58 | | | | |
| $C_{rss}$ | Reverse Transfer Capacitance | | 2.7 | | | | |
| $E_{oss}$ | $C_{oss}$ Stored Energy | | 32 | | μJ | | Fig. 16 |
| $C_{o(er)}$ | Effective Output Capacitance (Energy Related) | | 67 | | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 0... 800V | Note (2) |
| $C_{o(tr)}$ | Effective Output Capacitance (Time Related) | | 96 | | pF | | |
| $E_{ON}$ | Turn-On Switching Energy (External Diode) | | 280 | | μJ | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/15 V, $I_D$ = 20 A,<br>$R_{G(ext)}$ = 2.5 Ω, L= 98 μH,<br>FWD = External SiC Diode | Fig. 26, 29 |
| $E_{OFF}$ | Turn Off Switching Energy (External Diode) | | 56 | | | | |
| $E_{ON}$ | Turn-On Switching Energy (Body Diode FWD) | | 280 | | μJ | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/15 V, $I_D$ = 20 A,<br>$R_{G(ext)}$ = 2.5 Ω, L= 156 μH,<br>FWD = Body Diode of MOSFET | Fig. 26, 29 |
| $E_{OFF}$ | Turn-Off Switching Energy (Body Diode FWD) | | 63 | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | | 8 | | ns | $V_{DD}$ = 800 V, $V_{GS}$ = -4 V/15 V<br>$I_D$ = 20 A, $R_{G(ext)}$ = 2.5 Ω,<br>Timing relative to $V_{DS}$<br>Inductive load | Fig. 27, 28 |
| $t_r$ | Rise Time | | 22 | | | | |
| $t_{d(off)}$ | Turn-Off Delay Time | | 29 | | | | |
| $t_f$ | Fall Time | | 11 | | | | |
| $R_{G(int)}$ | Internal Gate Resistance | | 9.0 | | Ω | f = 1 MHz, $V_{AC}$ = 25 mV | |
| $Q_{gs}$ | Gate to Source Charge | | 17 | | nC | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/15 V<br>$I_D$ = 17.9 A<br>Per IEC60747-8-4 pg 21 | Fig. 12 |
| $Q_{gd}$ | Gate to Drain Charge | | 18 | | | | |
| $Q_g$ | Total Gate Charge | | 55 | | | | |

Note (2): $C_{o(er)}$, a lumped capacitance that gives same stored energy as Coss while Vds is rising from 0 to 800V
$C_{o(tr)}$, a lumped capacitance that gives same charging time as Coss while Vds is rising from 0 to 800V

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

| Symbol | Parameter | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode Forward Voltage | 4.8 | | V | $V_{GS}$ = -4 V, $I_{SD}$ = 9 A | Fig. 8, 9, 10 |
| | | 4.2 | | V | $V_{GS}$ = -4 V, $I_{SD}$ = 9 A, $T_J$ = 175 °C | |
| $I_S$ | Continuous Diode Forward Current | | 27 | A | $V_{GS}$ = -4 V, $T_J$ = 25 ˚C | |
| $I_{S, pulse}$ | Diode pulse Current | | 80 | A | $V_{GS}$ = -4 V, Pulse width $t_P$ limited by $T_{jmax}$ | |
| $t_{rr}$ | Reverse Recover time | 20 | | ns | $V_{GS}$ = -4 V, $I_{SD}$ = 20 A, $V_R$ = 800 V dif/dt = 5280 A/µs, $T_J$ = 175 °C | |
| $Q_{rr}$ | Reverse Recovery Charge | 376 | | nC | | |
| $I_{rrm}$ | Peak Reverse Recovery Current | 25 | | A | | |
| $t_{rr}$ | Reverse Recover time | 28 | | ns | $V_{GS}$ = -4 V, $I_{SD}$ = 20 A, $V_R$ = 800 V dif/dt = 1305 A/µs, $T_J$ = 175 °C | |
| $Q_{rr}$ | Reverse Recovery Charge | 338 | | nC | | |
| $I_{rrm}$ | Peak Reverse Recovery Current | 16 | | A | | |

## Thermal Characteristics

| Symbol | Parameter | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance from Junction to Case | 0.88 | 1.03 | °C/W | | Fig. 21 |

CREE

## Typical Performance

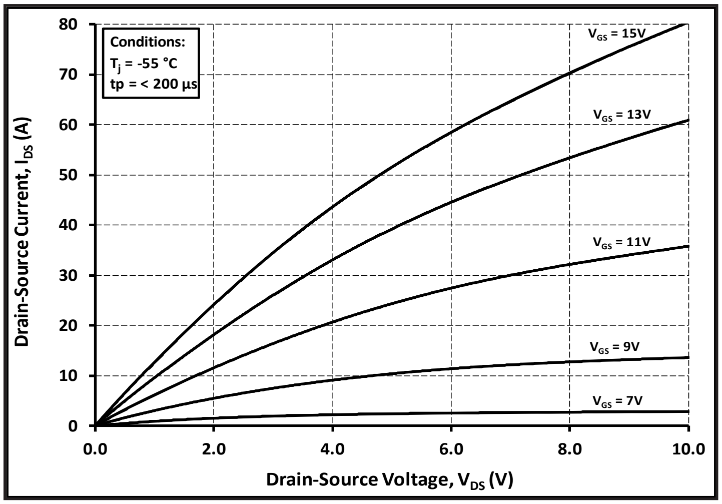



Figure 1. Output Characteristics $T_J$ = -55 °C

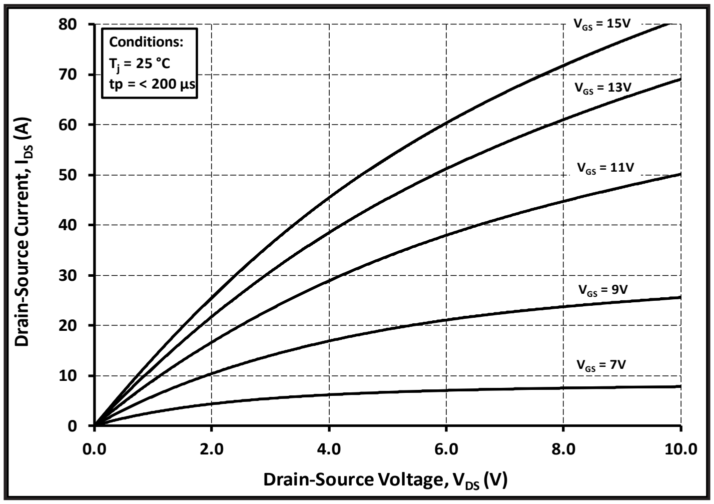



Figure 2. Output Characteristics $T_J$ = 25 °C

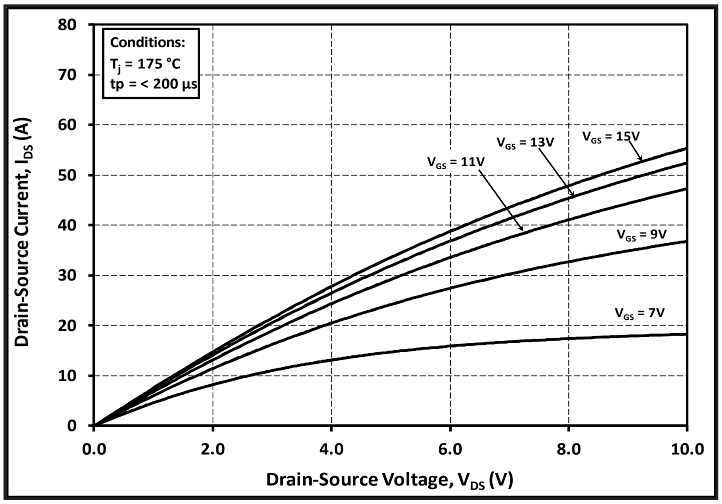



Figure 3. Output Characteristics $T_J$ = 175 °C

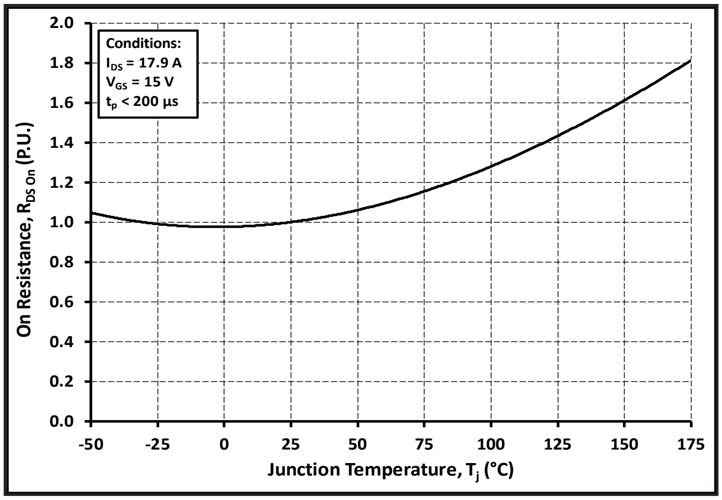



Figure 4. Normalized On-Resistance vs. Temperature

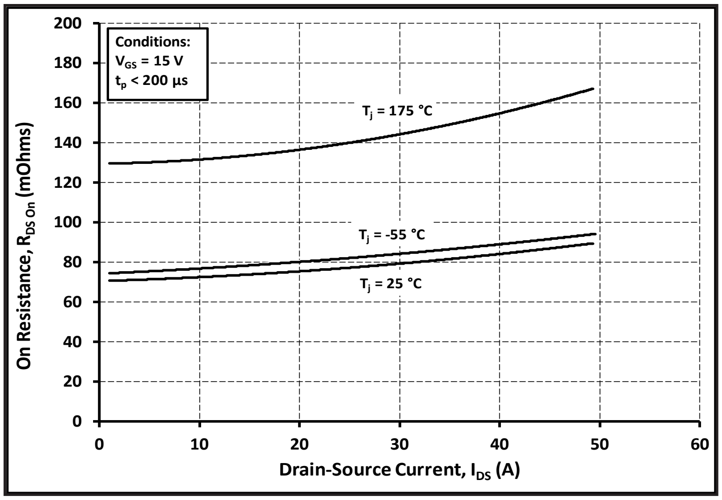



Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

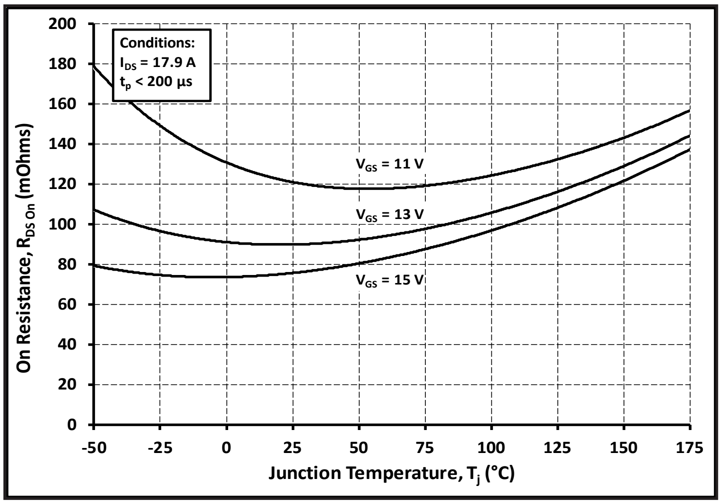



Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

CREE

## Typical Performance

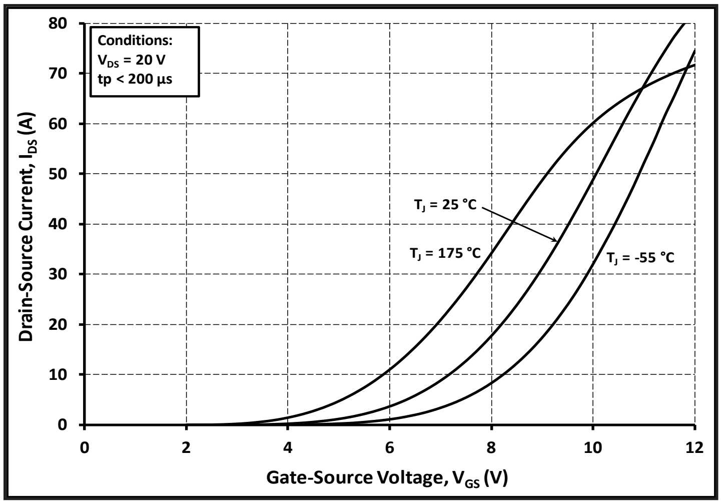



Figure 7. Transfer Characteristic for Various Junction Temperatures

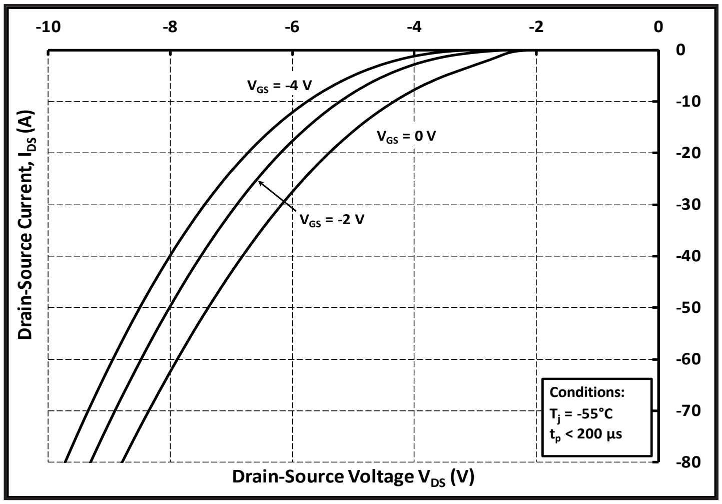



Figure 8. Body Diode Characteristic at -55 ºC

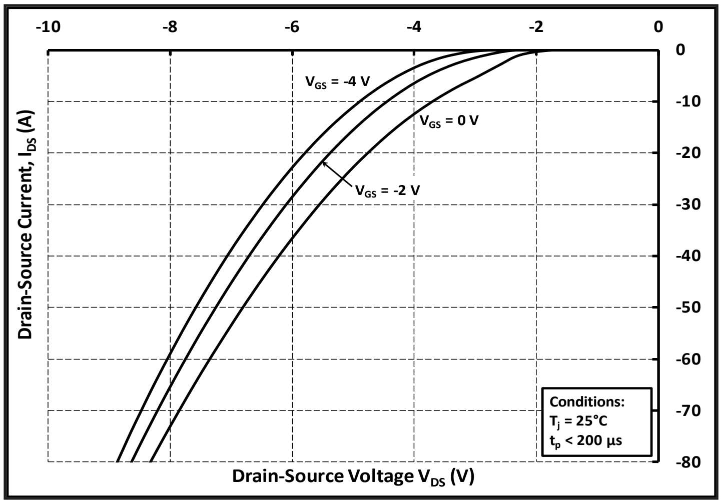



Figure 9. Body Diode Characteristic at 25 ºC

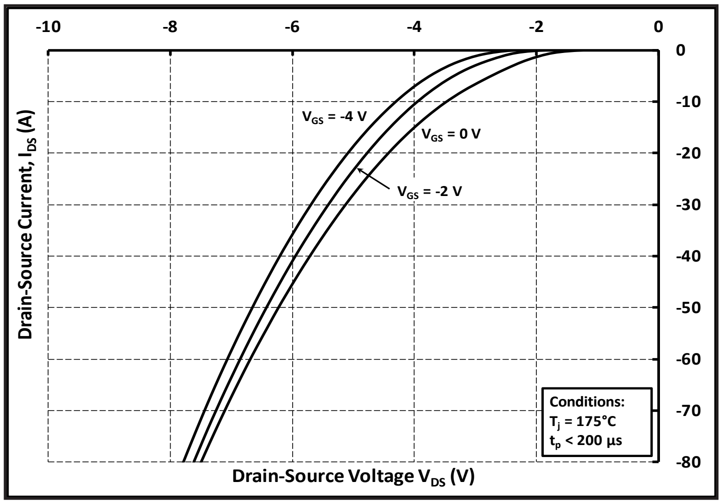



Figure 10. Body Diode Characteristic at 175 ºC

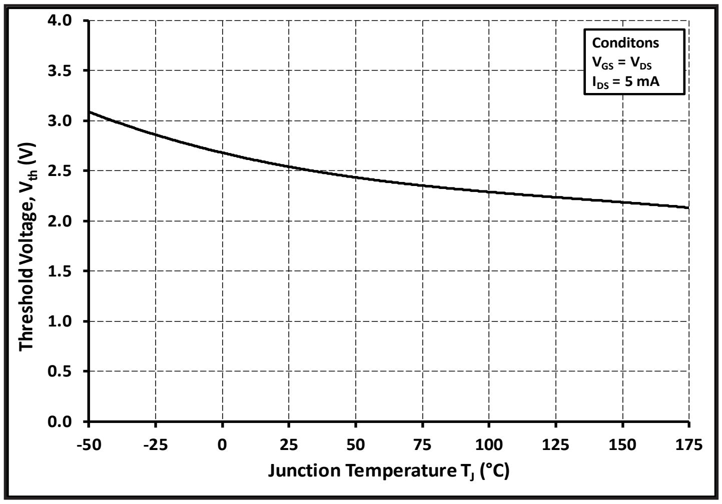



Figure 11. Threshold Voltage vs. Temperature

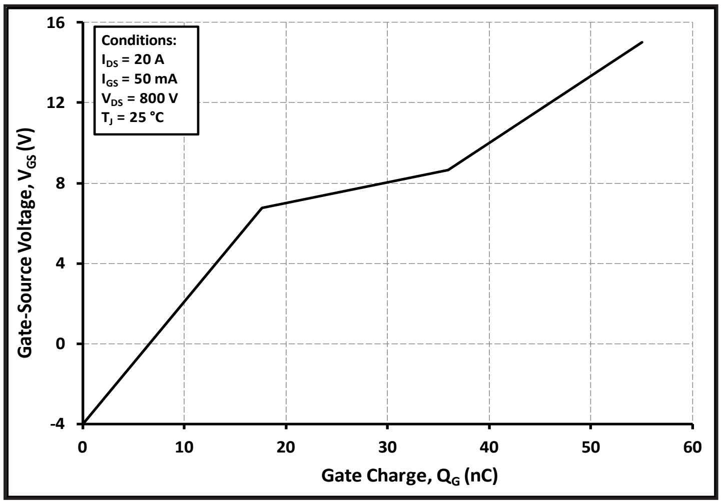



Figure 12. Gate Charge Characteristics

CREE

## Typical Performance

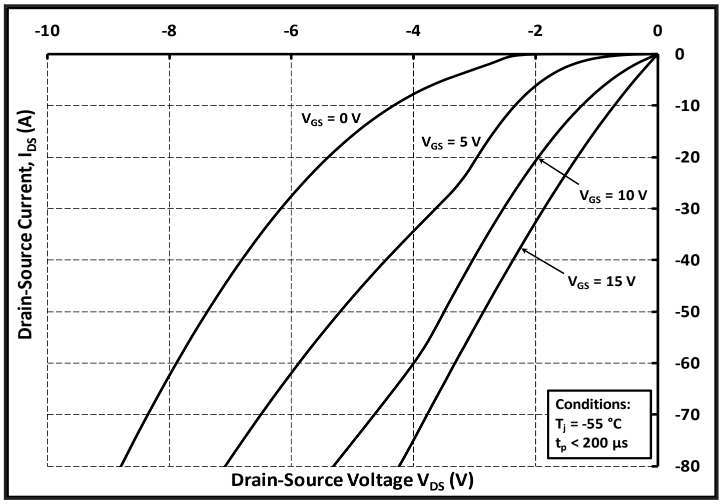



Figure 13. 3rd Quadrant Characteristic at -55 °C

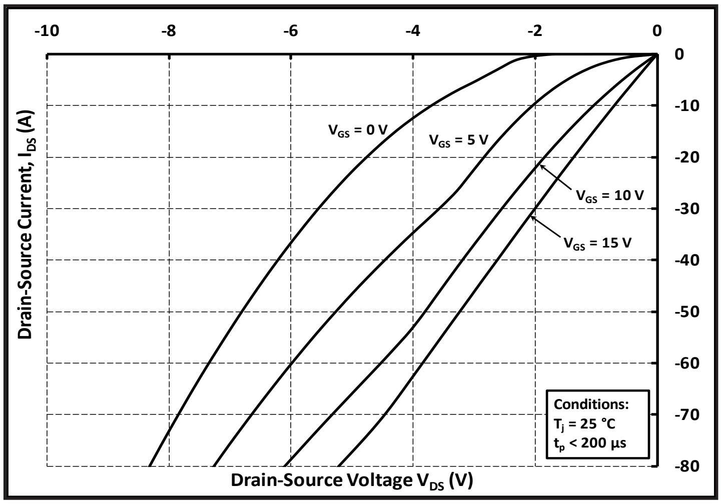



Figure 14. 3rd Quadrant Characteristic at 25 °C

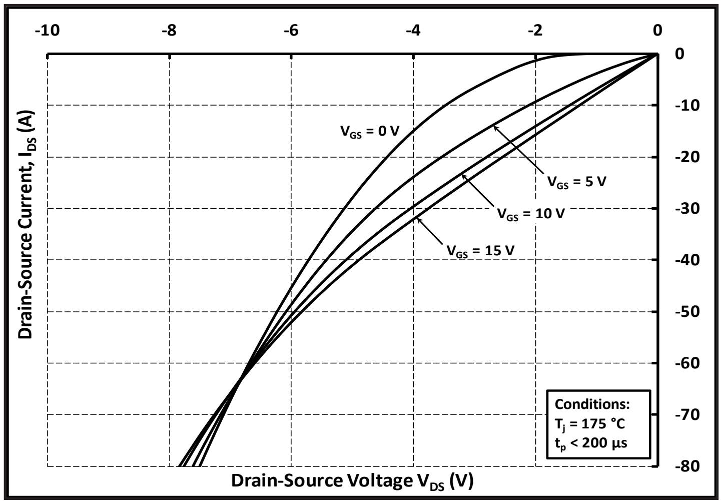



Figure 15. 3rd Quadrant Characteristic at 175 °C

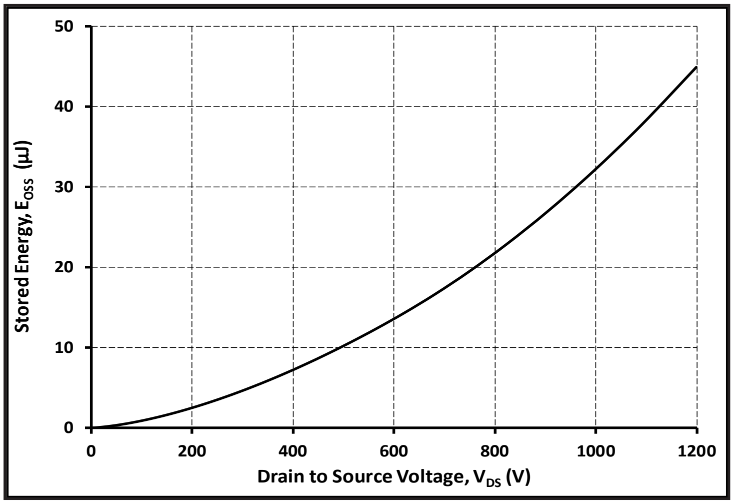



Figure 16. Output Capacitor Stored Energy

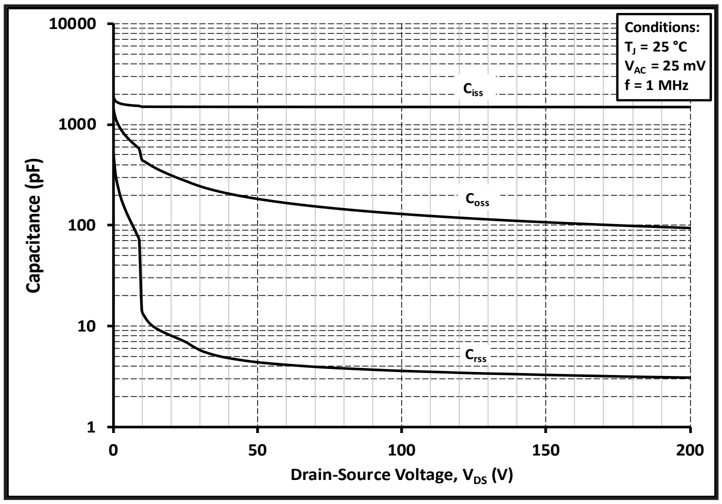



Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

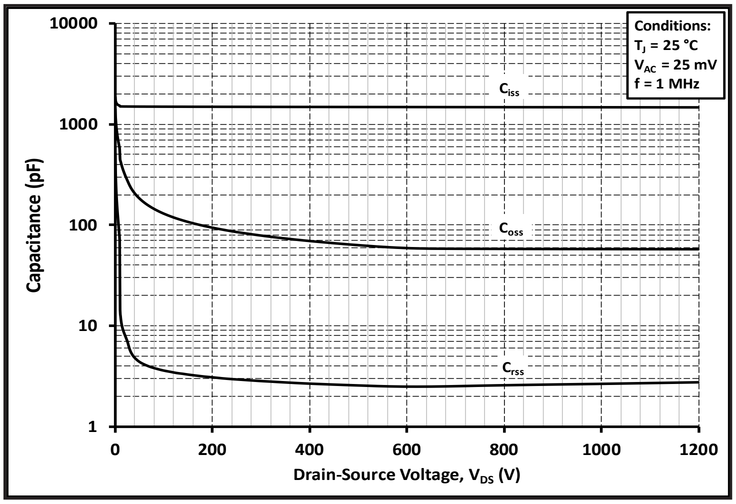



Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1000V)

## Typical Performance

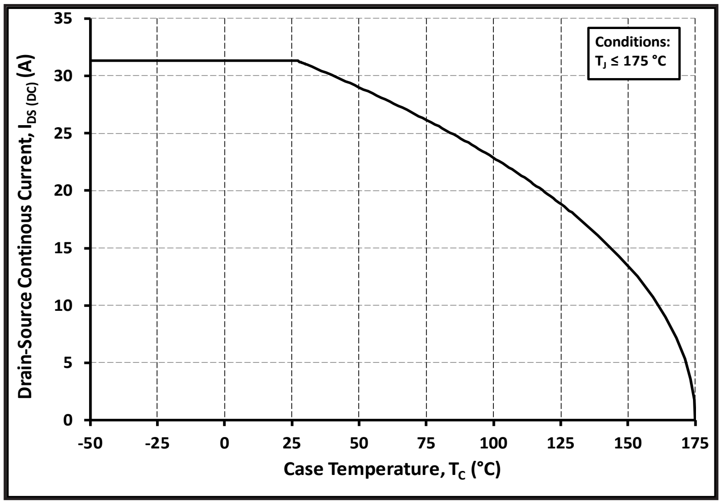



Figure 19. Continuous Drain Current Derating vs. Case Temperature

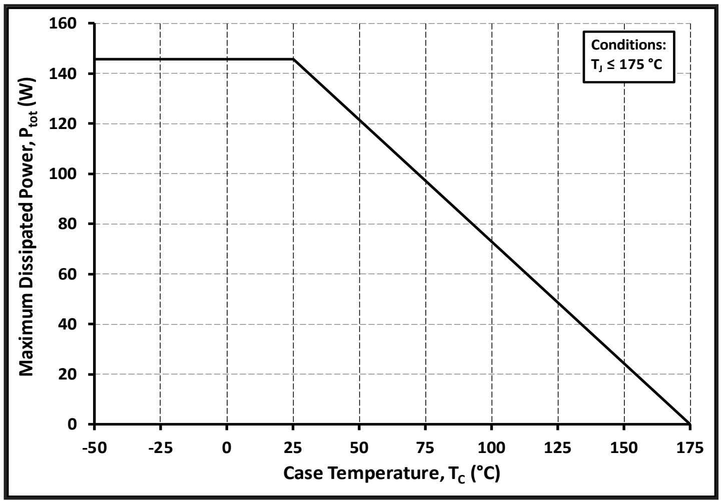



Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

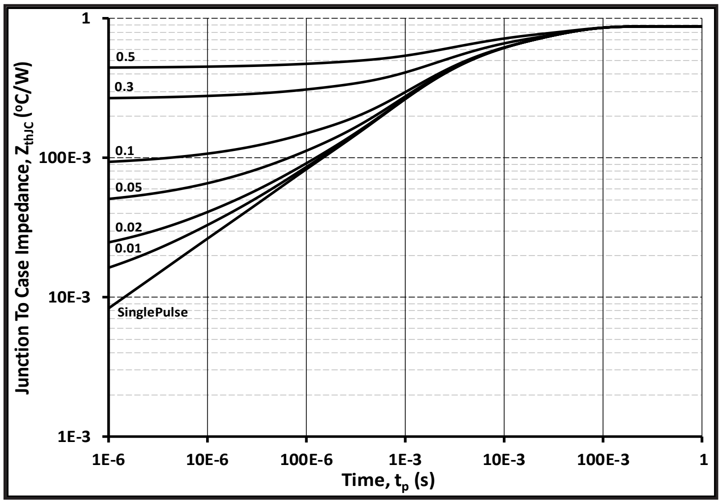



Figure 21. Transient Thermal Impedance (Junction - Case)

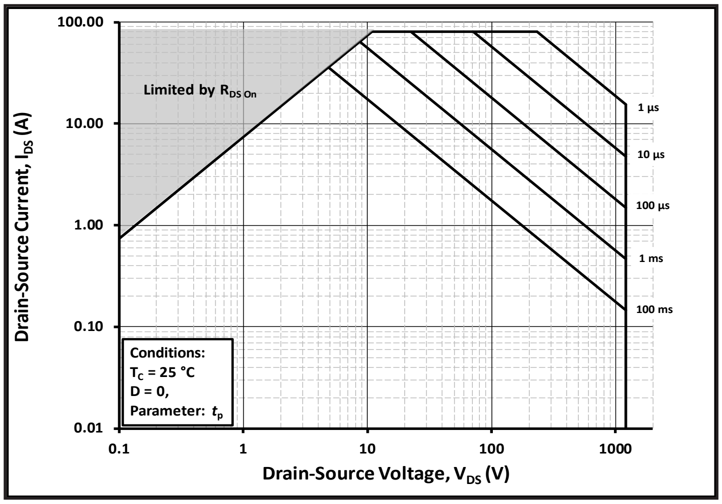



Figure 22. Safe Operating Area

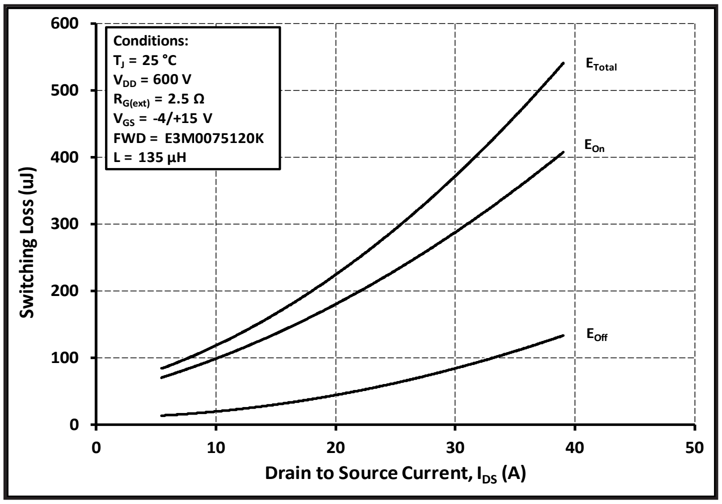



Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 600V)

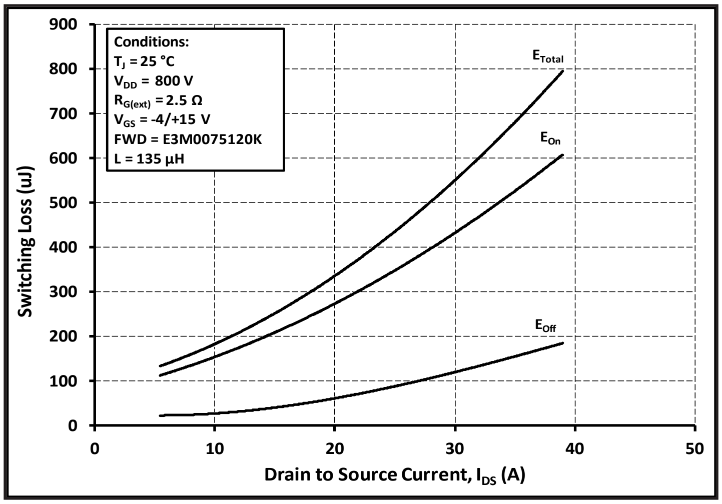



Figure 24. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 800V)

## Typical Performance

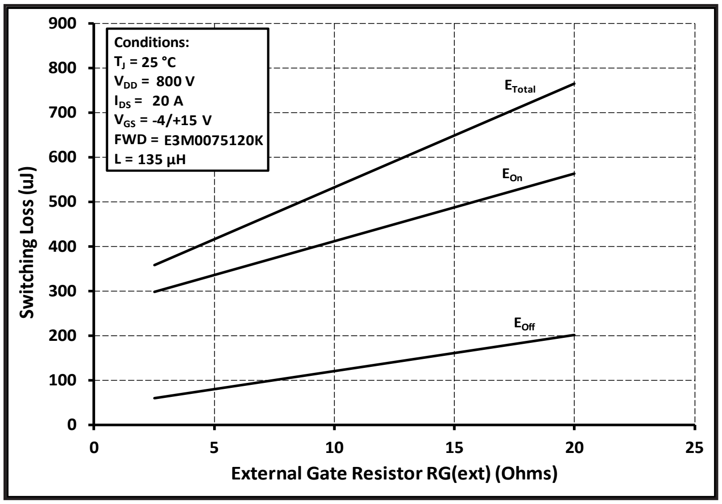



Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

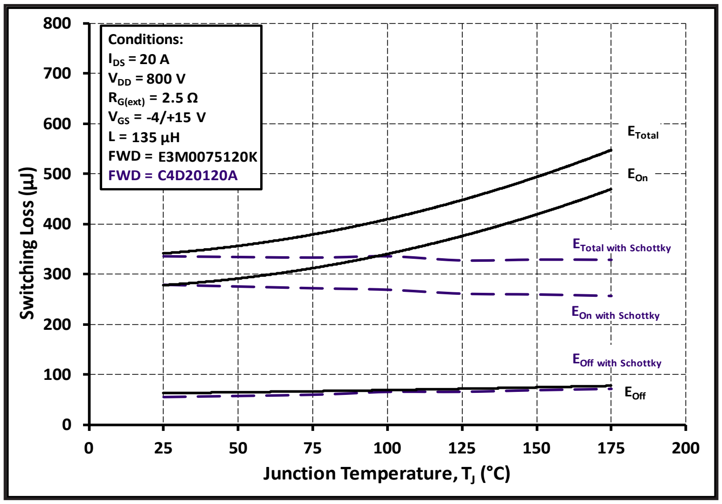



Figure 26. Clamped Inductive Switching Energy vs. Temperature

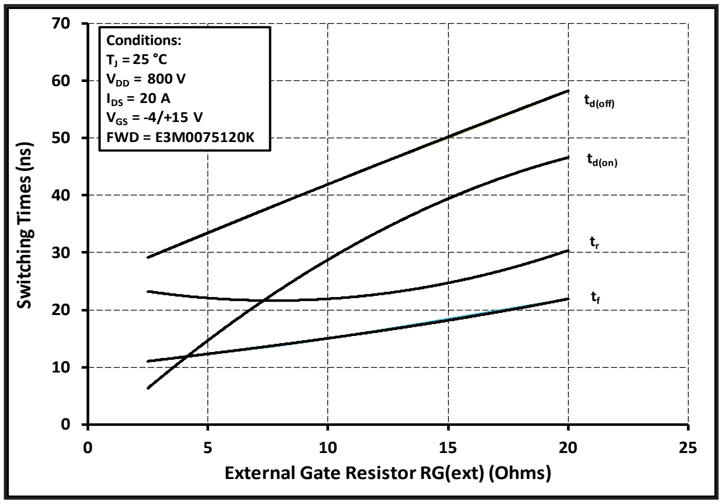



Figure 27. Switching Times vs. $R_{G(ext)}$

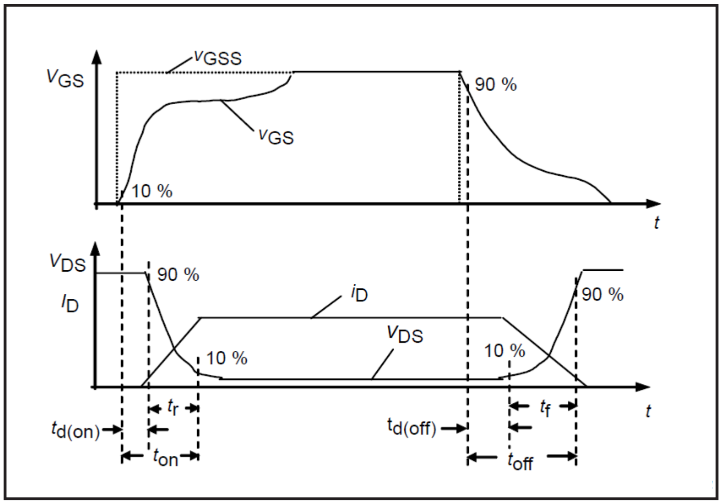



Figure 28. Switching Times Definition

## Test Circuit Schematic

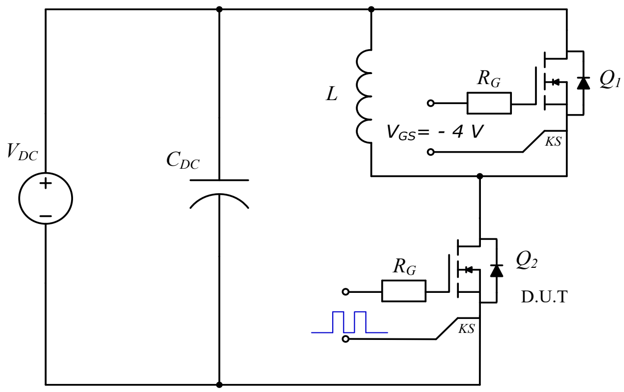
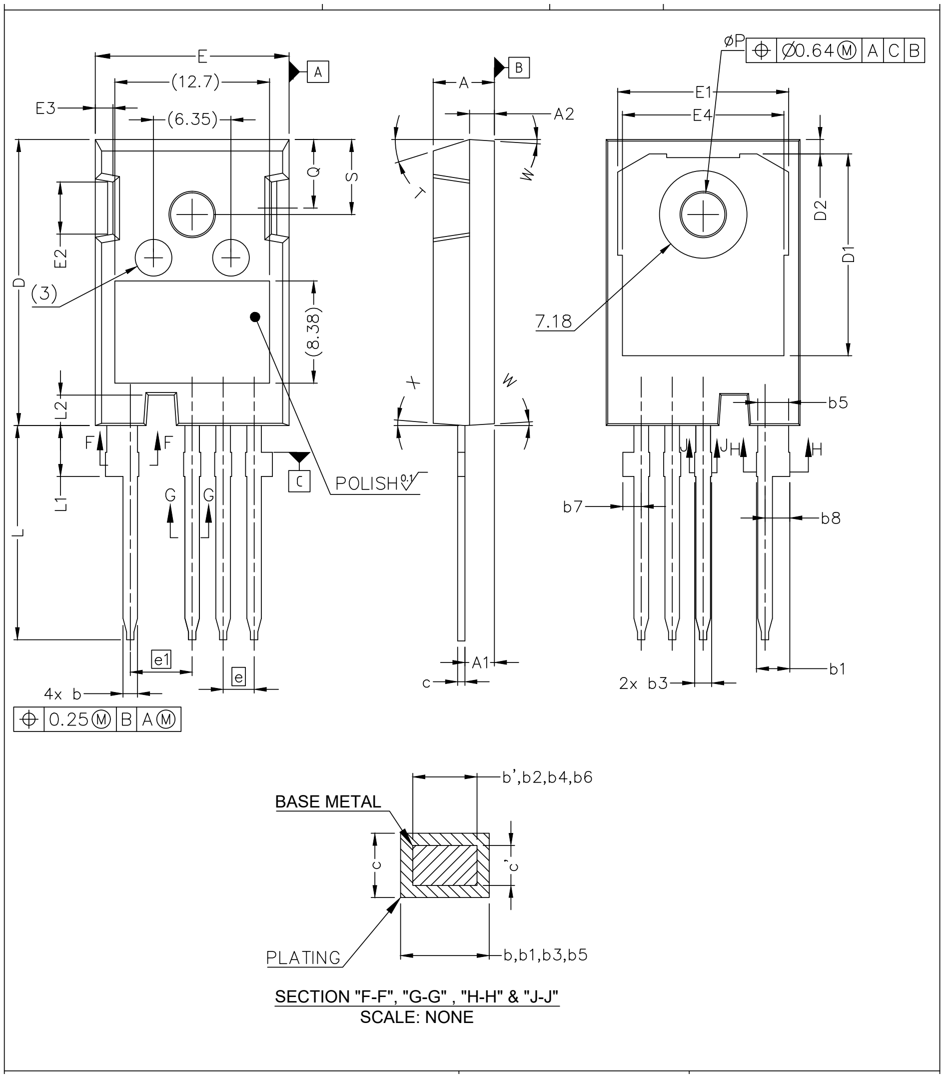



Figure 29. Clamped Inductive Switching
Waveform Test Circuit

## Package Dimensions TO-247-4L

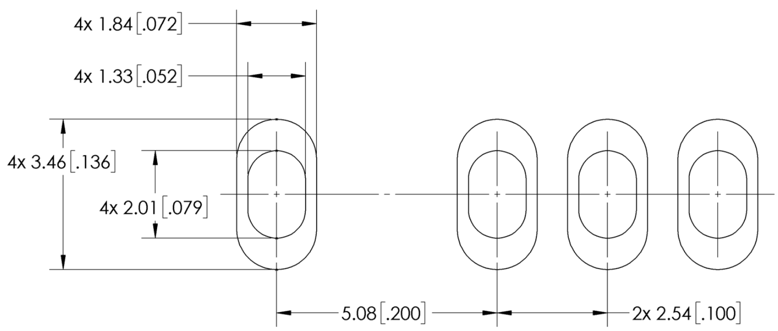


## Package Dimensions TO-247-4L

NOTE ;
1. ALL METAL SURFACES: TIN PLATED,EXCEPT AREA OF CUT .
2. DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
4. 'N' IS THE NUMBER OF TERMINAL POSITIONS .
5. DIMENSION DO NOT INCLUDE BURR OR MOLD FLASH.

| SYM | MILLIMETERS | |
|---|---|---|
| | MIN | MAX |
| A | 4.83 | 5.21 |
| A1 | 2.29 | 2.54 |
| A2 | 1.91 | 2.16 |
| b' | 1.07 | 1.28 |
| b | 1.07 | 1.33 |
| b1 | 2.39 | 2.94 |
| b2 | 2.39 | 2.84 |
| b3 | 1.07 | 1.60 |
| b4 | 1.07 | 1.50 |
| b5 | 2.39 | 2.69 |
| b6 | 2.39 | 2.64 |
| b7 | 1.30 | 1.70 |
| b8 | 1.80 | 2.20 |
| c' | 0.55 | 0.65 |
| c | 0.55 | 0.68 |
| D | 23.30 | 23.60 |
| D1 | 16.25 | 17.65 |
| D2 | 0.95 | 1.25 |
| E | 15.75 | 16.13 |
| E1 | 13.10 | 14.15 |
| E2 | 3.68 | 5.10 |
| E3 | 1.00 | 1.90 |
| E4 | 12.38 | 13.43 |
| e | 2.54 BSC | |
| e1 | 5.08 BSC | |
| N* | 4 | |
| L | 17.31 | 17.82 |
| L1 | 3.97 | 4.37 |
| L2 | 2.35 | 2.65 |
| øP | 3.51 | 3.65 |
| Q | 5.49 | 6.00 |
| S | 6.04 | 6.30 |
| T | 17.5° REF. | |
| W | 3.5 ° REF. | |
| X | 4° REF. | |

## Recommended Solder Pad Layout



## Revision history

| Document Version | Date of release | Descriptiion of changes |
|---|---|---|
| 2.0 | March-2021 | Final Datasheet |

## Notes

- **RoHS Compliance**
  The levels of RoHS restricted materials in this product are below the maximum concentration values (also referred to as the threshold limits) permitted for such substances, or are used in an exempted application, in accordance with EU Directive 2011/65/EC (RoHS2), as implemented January 2, 2013. RoHS Declarations for this product can be obtained from your Cree representative or from the Product Documentation sections of www.cree.com.

- **REACh Compliance**
  REACh substances of high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future,please contact a Cree representative to insure you get the most up-to-date REACh SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

- This product has not been designed or tested for use in, and is not intended for use in, applications implanted into the human body nor in applications in which failure of the product could lead to death, personal injury or property damage, including but not limited to equipment used in the operation of nuclear facilities, life-support machines, cardiac defibrillators or similar emergency medical equipment, aircraft navigation or communication or control systems, air traffic control systems.

## Related Links

- **SPICE Models: http://wolfspeed.com/power/tools-and-support**
- **SiC MOSFET Isolated Gate Driver reference design: http://wolfspeed.com/power/tools-and-support**
- **SiC MOSFET Evaluation Board: http://wolfspeed.com/power/tools-and-support**



Cree, Inc.
4600 Silicon Drive
Durham, NC 27703
USA Tel: +1.919.313.5300
Fax: +1.919.313.5451
www.wolfspeed.com/power