# C3M0040120J1

Silicon Carbide Power MOSFET
C3M™ MOSFET Technology
N-Channel Enchancement Mode

## Features

- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- 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

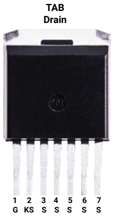
## Benefits

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

## Applications

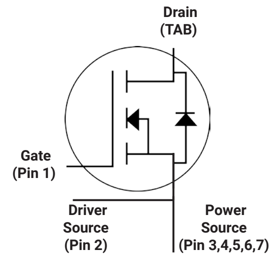
- Datacenter and Telecom Power Supplies
- EV Battery Chargers
- High voltage DC/DC converters
- Energy Storage Systems
- Solar Inverters

## Package




Halogen-Free

RoHS




| Part Number | Package | Marking |
|---|---|---|
| C3M0040120J1 | TO-263-7L XL | C3M0040120J1 |

**Maximum Ratings** ($T_C$ = 25 ˚C unless otherwise specified)

| Symbol | Parameter | Value | Unit | Test Conditions | Note |
|---|---|---|---|---|---|
| $V_{DSmax}$ | Drain - Source Voltage | 1200 | V | $V_{GS}$ = 0 V, $I_D$ = 100 μA | |
| $V_{GSmax}$ | Gate - Source Voltage (dynamic) | -8/+19 | V | AC (f >1 Hz) | Note 1 |
| $V_{GSop}$ | Gate - Source Voltage (static) | -4/+15 | V | Static | Note 2 |
| $I_D$ | Continuous Drain Current | 64 | A | $V_{GS}$ = 15 V, $T_C$ = 25˚C | Fig. 19 |
| | | 42 | | $V_{GS}$ = 15 V, $T_C$ = 100˚C | |
| $I_{D(pulse)}$ | Pulsed Drain Current | 100 | A | Pulse width $t_P$ limited by $T_{jmax}$ | |
| $P_D$ | Power Dissipation | 272 | W | $T_C$=25˚C, $T_J$ = 150 ˚C | Fig. 20 |
| $T_J$ , $T_{stg}$ | Operating Junction and Storage Temperature | -40 to +150 | ˚C | | |
| $T_L$ | Solder Temperature | 260 | ˚C | 1.6mm (0.063”) from case for 10s | |

Note (1): When using MOSFET Body Diode $V_{GSmax}$ = -4V/+19V
Note (2): MOSFET can also safely operate at 0/+15 V

**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 | 2.7 | 3.6 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 9.2 mA | Fig. 11 |
| | | | 2.2 | | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 9.2 mA, $T_J$ = 150ºC | |
| $I_{DSS}$ | 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 | | 40 | 53.5 | mΩ | $V_{GS}$ = 15 V, $I_D$ = 33.3 A | Fig. 4, 5, 6 |
| | | | 60 | | | $V_{GS}$ = 15 V, $I_D$ = 33.3 A, $T_J$ = 150ºC | |
| $g_{fs}$ | Transconductance | | 21 | | S | $V_{DS}$= 20 V, $I_{DS}$= 33.3 A | Fig. 7 |
| | | | 20 | | | $V_{DS}$= 20 V, $I_{DS}$= 33.3 A, $T_J$ = 150ºC | |
| $C_{iss}$ | Input Capacitance | | 2900 | | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 1000 V<br>f = 100 kHz<br>$V_{AC}$ = 25 mV | Fig. 17, 18 |
| $C_{oss}$ | Output Capacitance | | 103 | | | | |
| $C_{rss}$ | Reverse Transfer Capacitance | | 5 | | | | |
| $E_{oss}$ | $C_{oss}$ Stored Energy | | 60 | | μJ | | Fig. 16 |
| $E_{ON}$ | Turn-On Switching Energy (Body Diode FWD) | | 339 | | μJ | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/+15 V,<br>$I_D$ = 33.3 A,<br>$R_{G(ext)}$ = 2.5Ω, L= 99 μH, | Fig. 26 |
| $E_{OFF}$ | Turn Off Switching Energy (Body Diode FWD) | | 67 | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | | 13 | | ns | $V_{DD}$ = 800 V, $V_{GS}$ = -4 V/15 V<br>$R_{G(ext)}$ = 2.5 Ω, $I_D$ = 33.3 A, L= 99<br>Timing relative to $V_{DS}$, Inductive load | Fig. 27 |
| $t_r$ | Rise Time | | 18 | | | | |
| $t_{d(off)}$ | Turn-Off Delay Time | | 22 | | | | |
| $t_f$ | Fall Time | | 8 | | | | |
| $R_{G(int)}$ | Internal Gate Resistance | | 3.5 | | Ω | f = 1 MHz, $V_{AC}$ = 25 mV | |
| $Q_{gs}$ | Gate to Source Charge | | 35 | | nC | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/15 V<br>$I_D$ = 33.3 A<br>Per IEC60747-8-4 pg 21 | Fig. 12 |
| $Q_{gd}$ | Gate to Drain Charge | | 27 | | | | |
| $Q_g$ | Total Gate Charge | | 94 | | | | |

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

| Symbol | Parameter | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode Forward Voltage | 5.5 | | V | $V_{GS}$ = -4 V, $I_{SD}$ = 20 A, $T_J$ = 25°C | Fig. 8, 9, 10 |
| | | 4.5 | | V | $V_{GS}$ = -4 V, $I_{SD}$ = 20 A, $T_J$ = 150°C | |
| $I_S$ | Continuous Diode Forward Current | | 44 | A | $V_{GS}$ = -4 V, $T_C$ = 25˚C | Note 1 |
| $I_{S, pulse}$ | Diode pulse Current | | 100 | A | $V_{GS}$ = -4 V, pulse width $t_P$ limited by $T_{jmax}$ | Note 1 |
| $t_{rr}$ | Reverse Recover time | 11 | | ns | $V_{GS}$ = -4 V, $I_{SD}$ = 33.3 A, $V_R$ = 800 V dif/dt = 9890 A/µs | Note 1 |
| $Q_{rr}$ | Reverse Recovery Charge | 323 | | nC | | |
| $I_{rrm}$ | Peak Reverse Recovery Current | 52 | | A | | |
| $t_{rr}$ | Reverse Recover time | 17 | | ns | $V_{GS}$ = -4 V, $I_{SD}$ = 33.3 A, $V_R$ = 800 V dif/dt = 1815 A/µs | Note 1 |
| $Q_{rr}$ | Reverse Recovery Charge | 150 | | nC | | |
| $I_{rrm}$ | Peak Reverse Recovery Current | 16 | | A | | |

## Thermal Characteristics

| Symbol | Parameter | Typ. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance from Junction to Case | 0.46 | °C/W | | Fig. 21 |
| $R_{\theta JA}$ | Thermal Resistance From Junction to Ambient | 40 | | | |

## Typical Performance

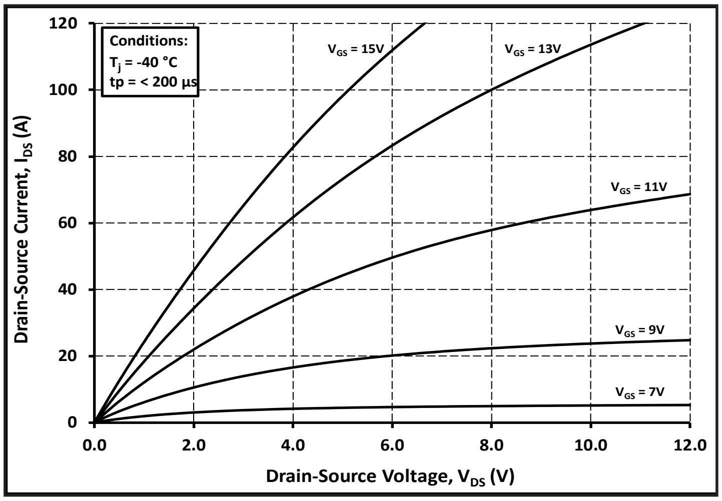



Figure 1. Output Characteristics $T_J$ = -40 °C

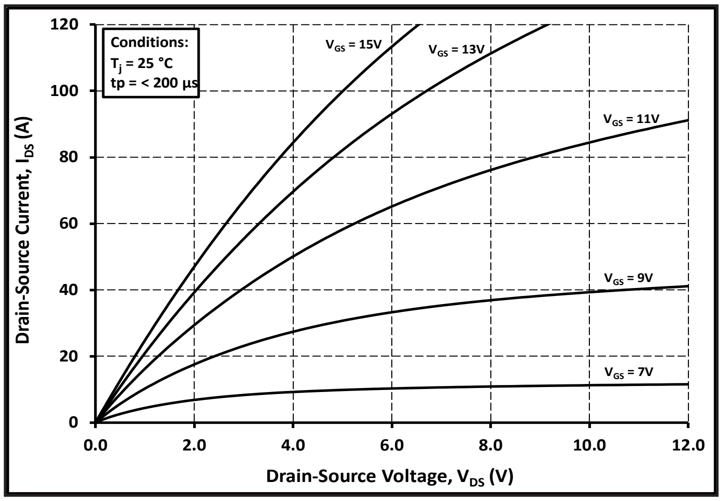



Figure 2. Output Characteristics $T_J$ = 25 °C

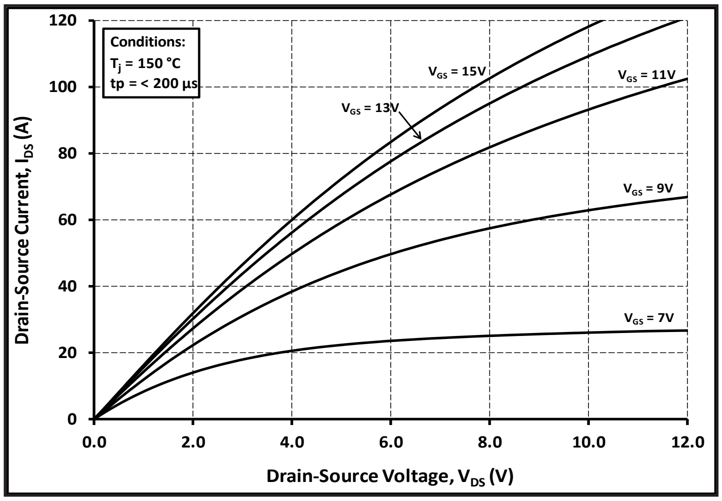



Figure 3. Output Characteristics $T_J$ = 150 °C

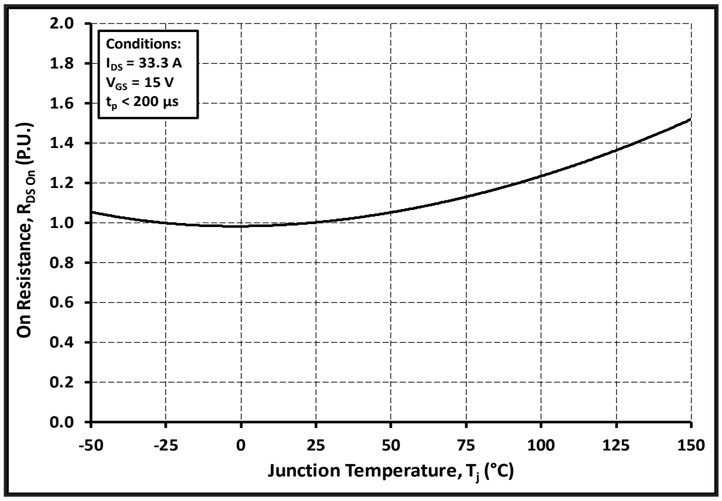



Figure 4. Normalized On-Resistance vs. Temperature

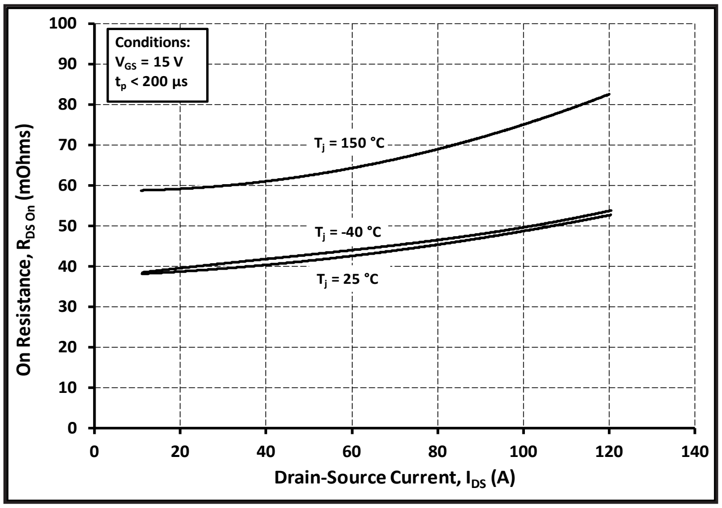



Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

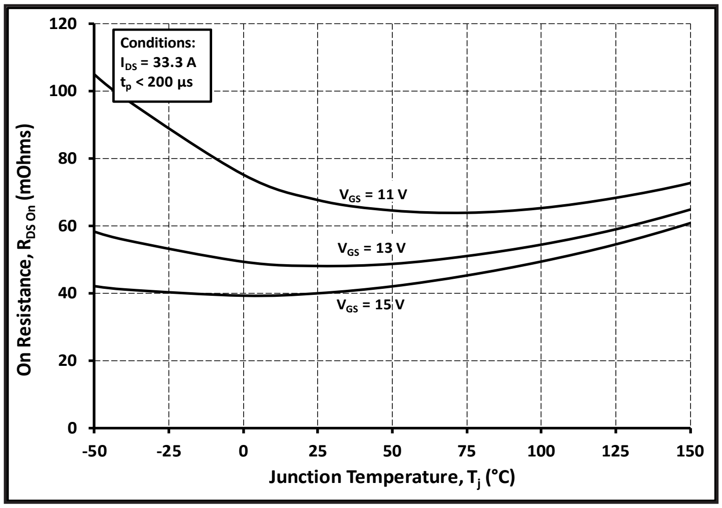



Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

## Typical Performance

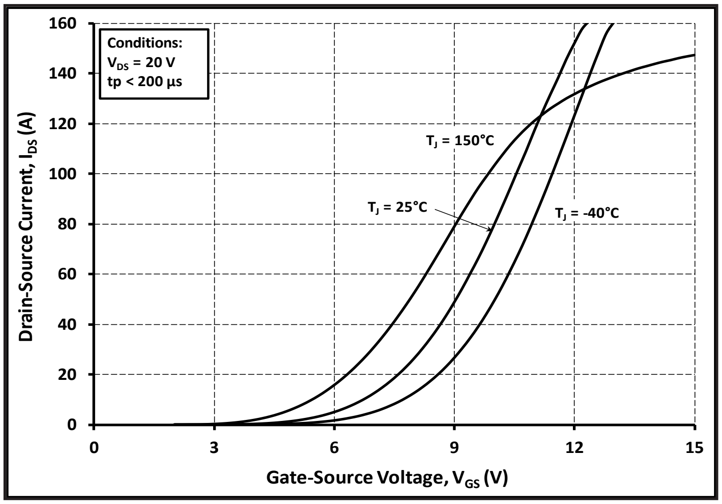



Figure 7. Transfer Characteristic for Various Junction Temperatures

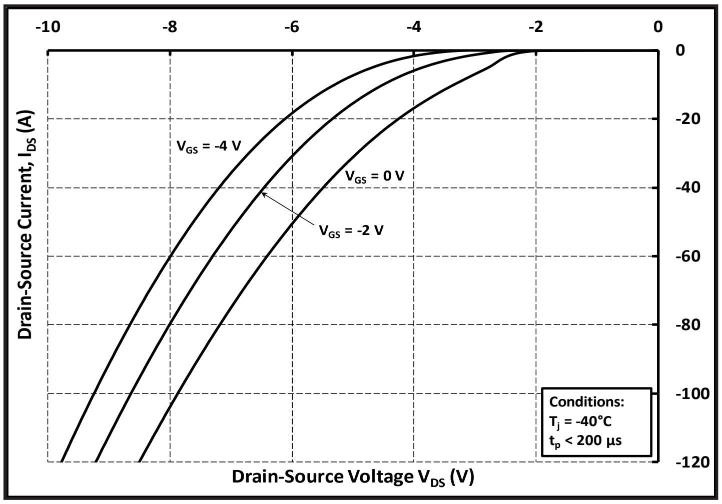



Figure 8. Body Diode Characteristic at -40 °C

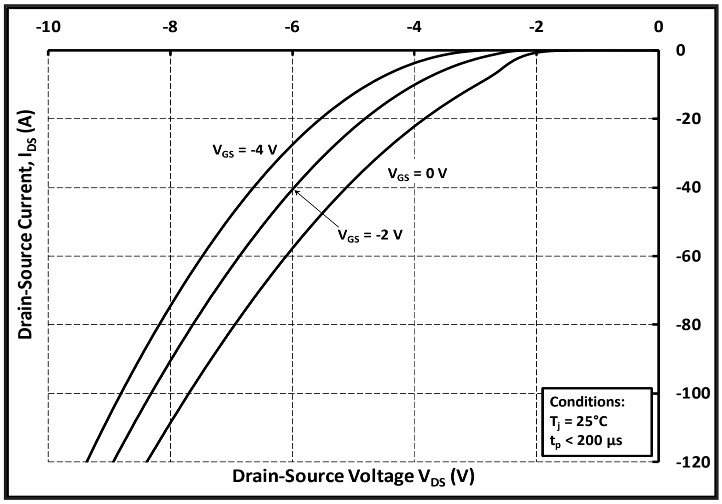



Figure 9. Body Diode Characteristic at 25 °C

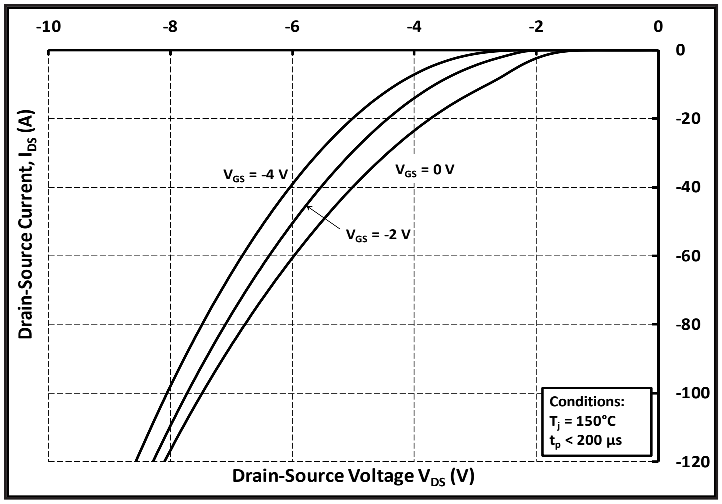



Figure 10. Body Diode Characteristic at 150 °C

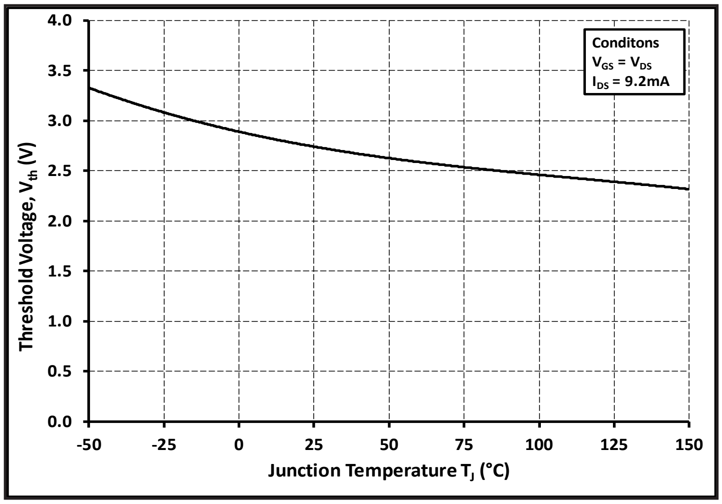



Figure 11. Threshold Voltage vs. Temperature

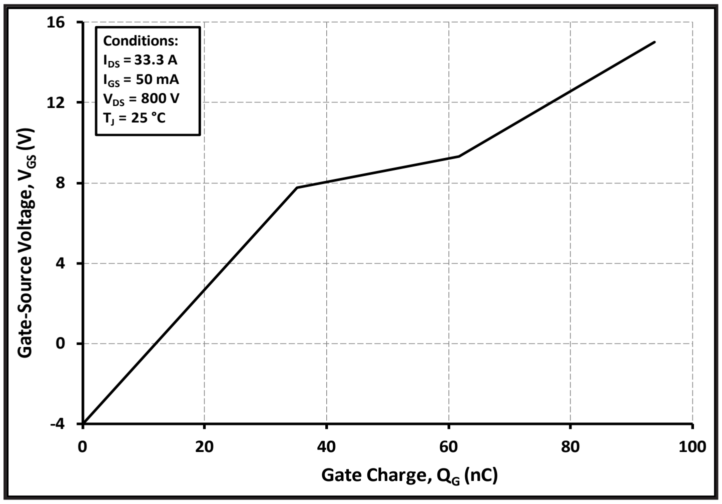



Figure 12. Gate Charge Characteristics

## Typical Performance

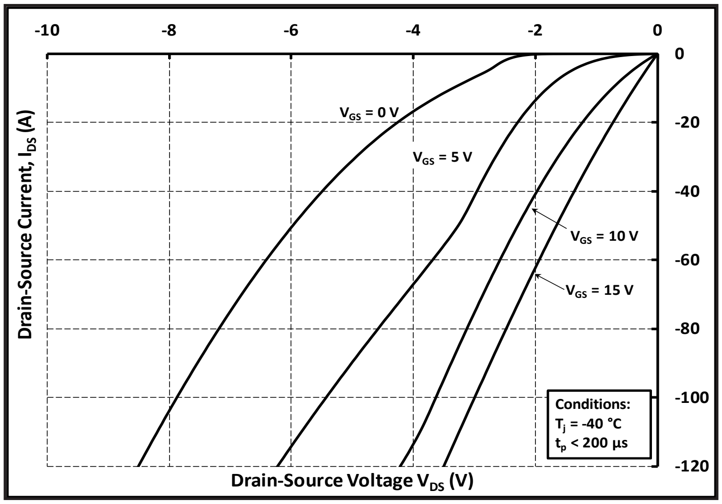



Figure 13. 3rd Quadrant Characteristic at -40 °C

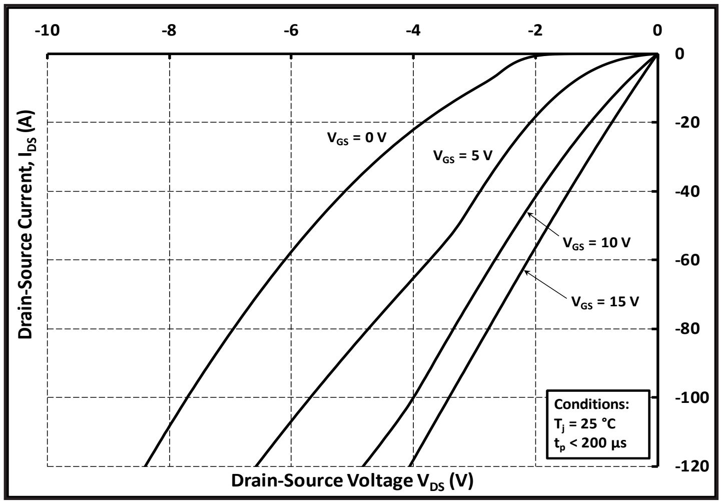



Figure 14. 3rd Quadrant Characteristic at 25 °C

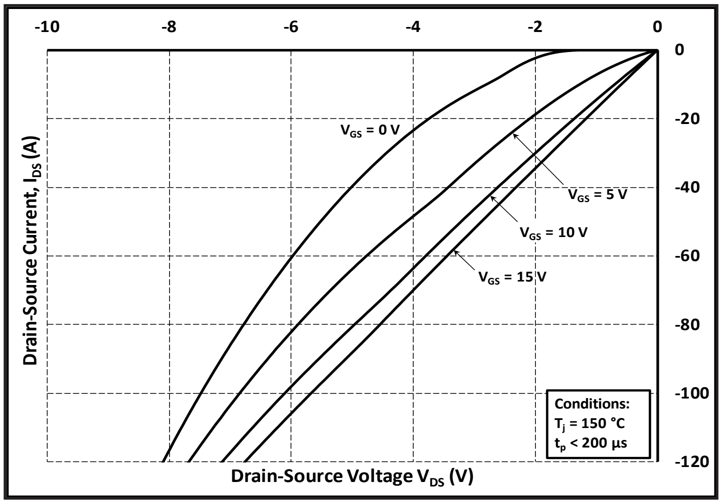



Figure 15. 3rd Quadrant Characteristic at 150 °C

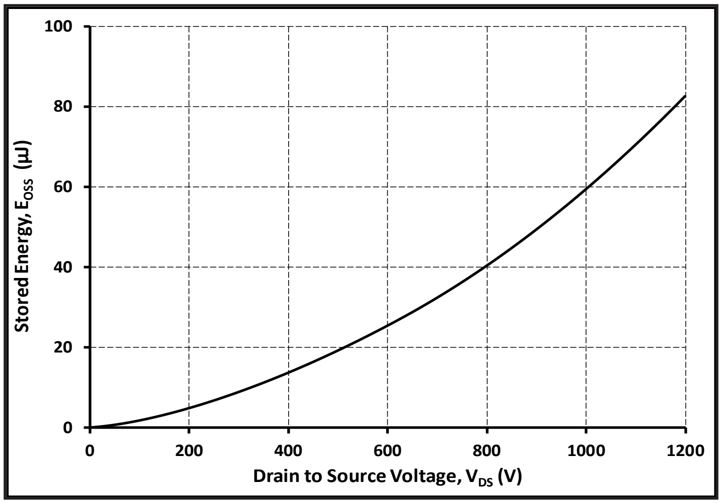



Figure 16. Output Capacitor Stored Energy

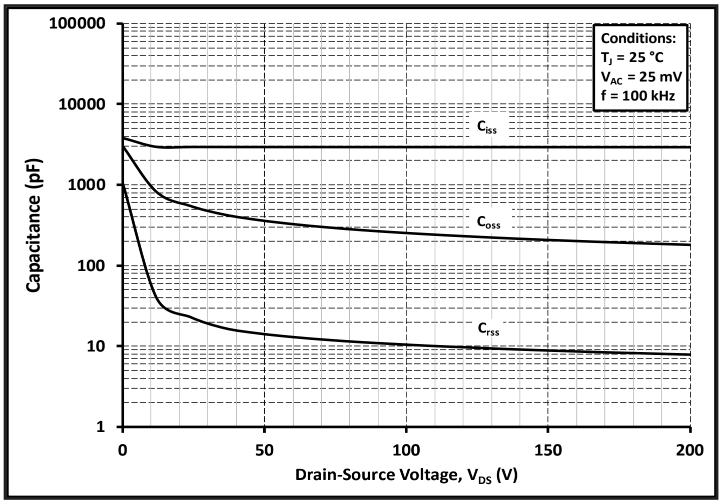



Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

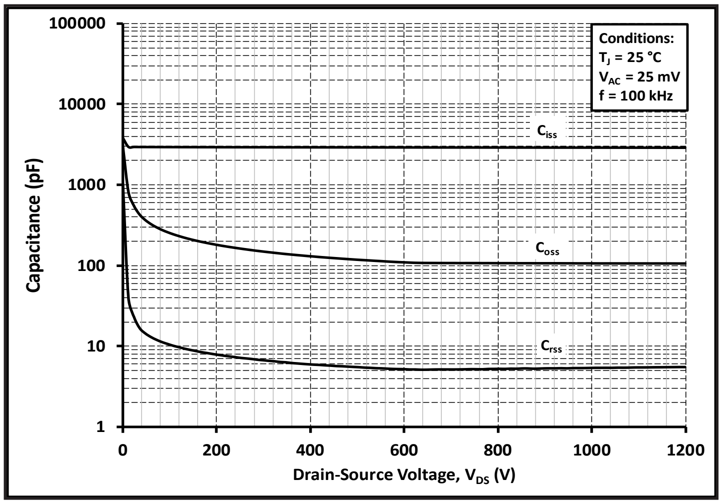



Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1200V)

## Typical Performance

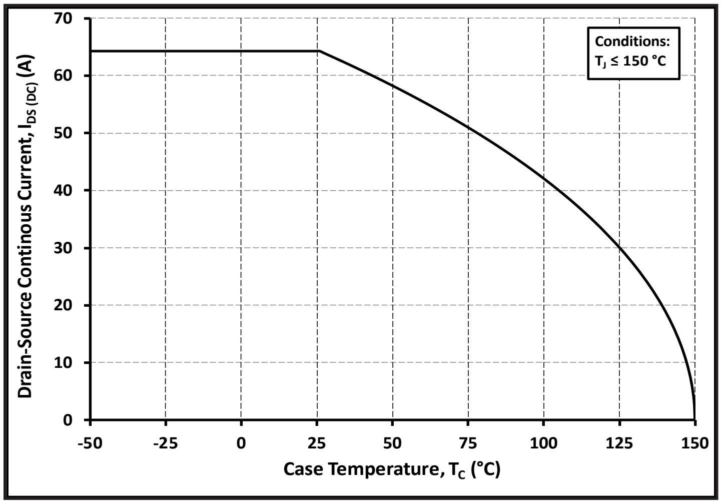



Figure 19. Continuous Drain Current Derating vs. Case Temperature

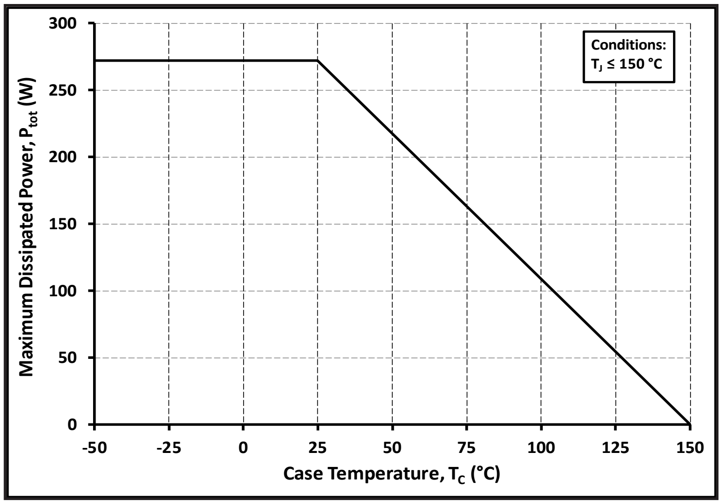



Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

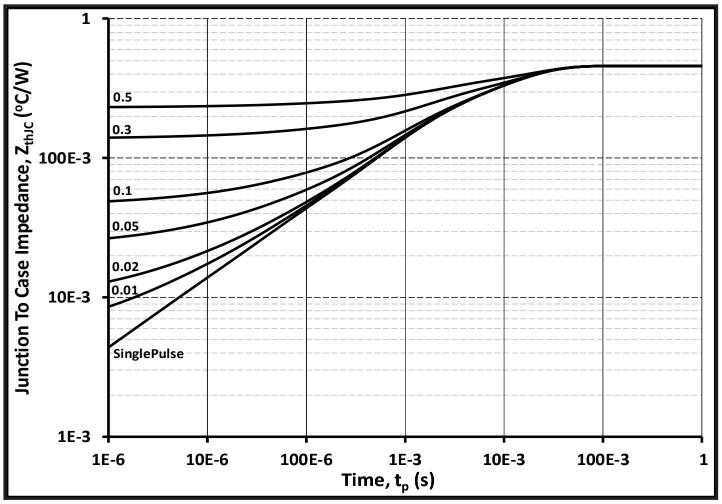



Figure 21. Transient Thermal Impedance (Junction - Case)

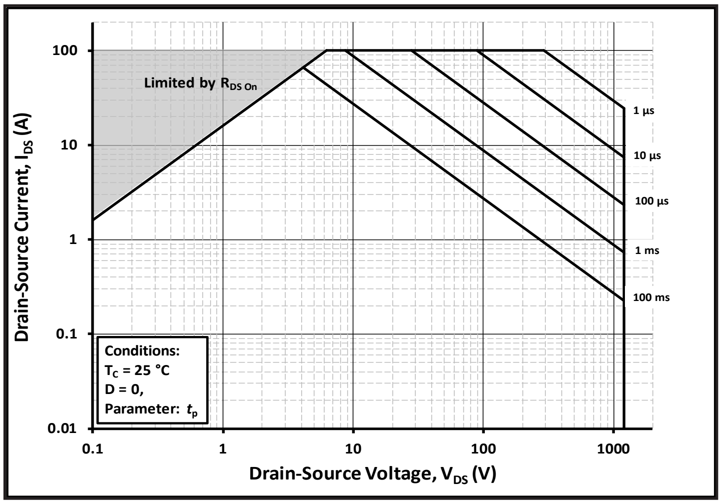



Figure 22. Safe Operating Area

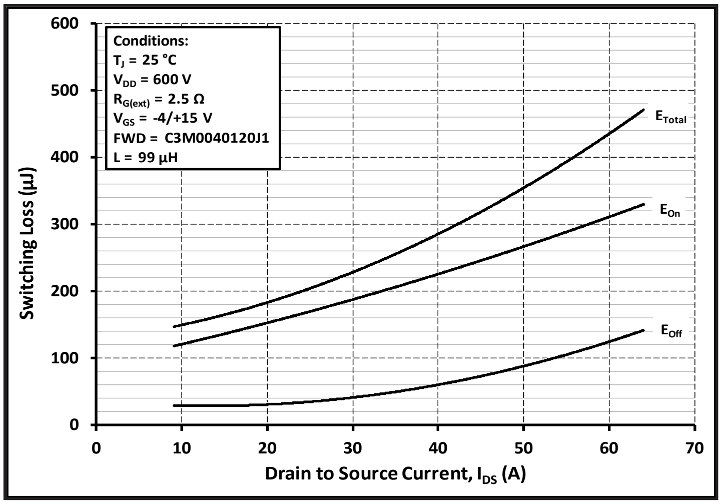



Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 600V)

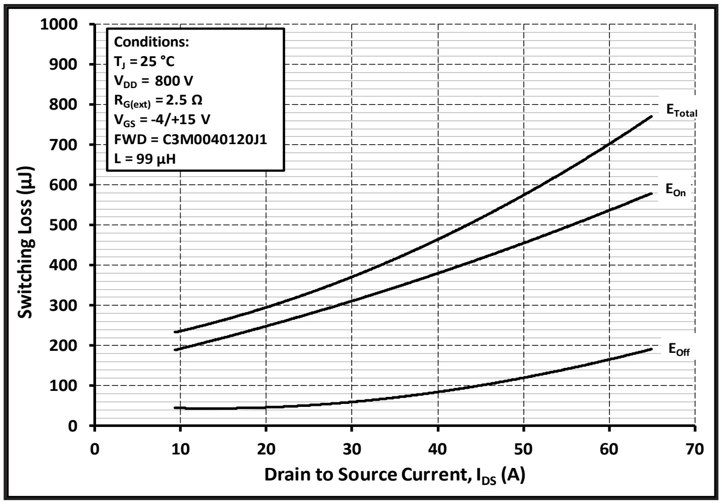



Figure 24. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 800V)

## Typical Performance

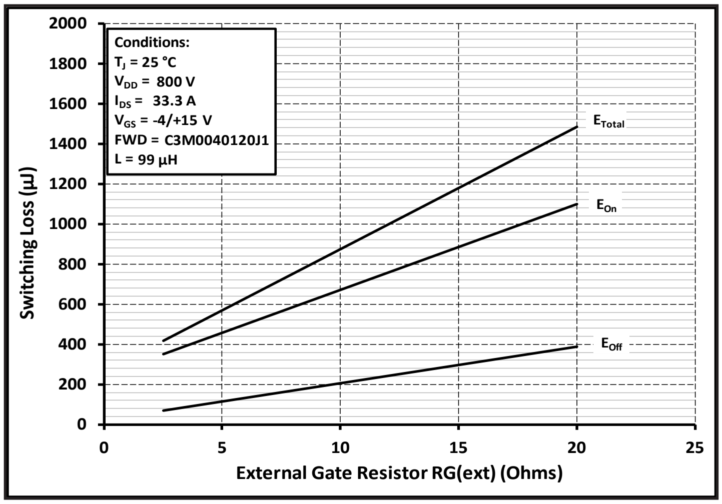



Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

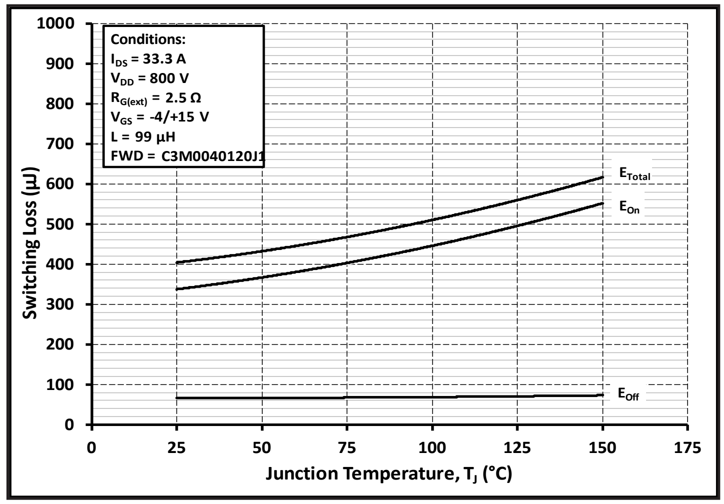



Figure 26. Clamped Inductive Switching Energy vs. Temperature

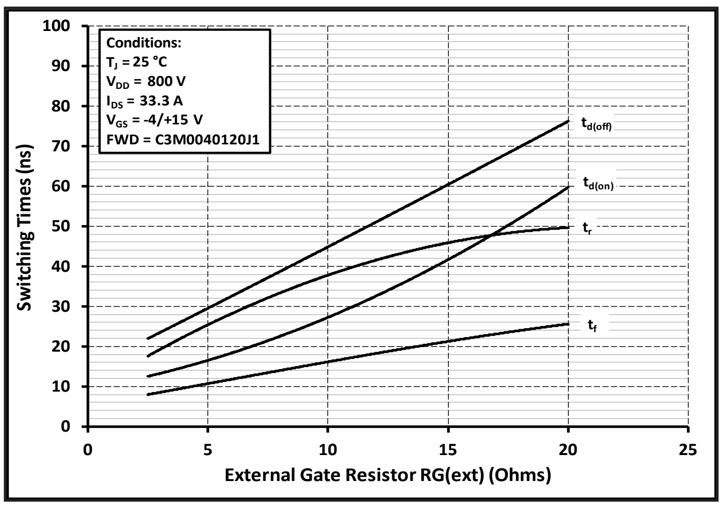



Figure 27. Switching Times vs. $R_{G(ext)}$

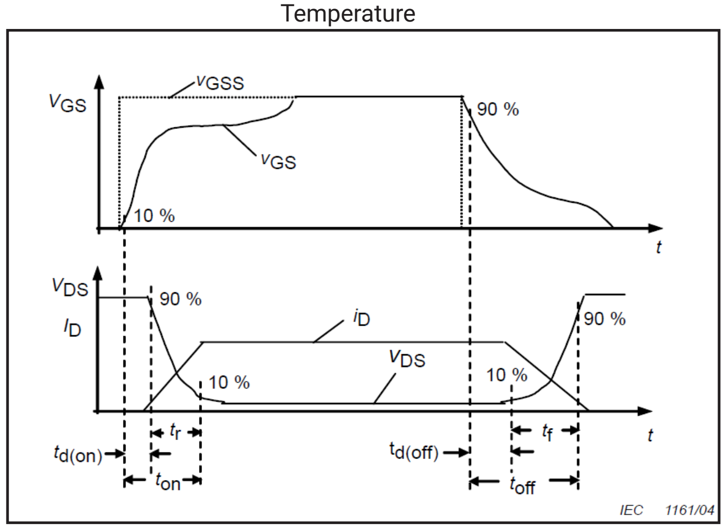



Figure 28. Switching Times Definition

## Test Circuit Schematic

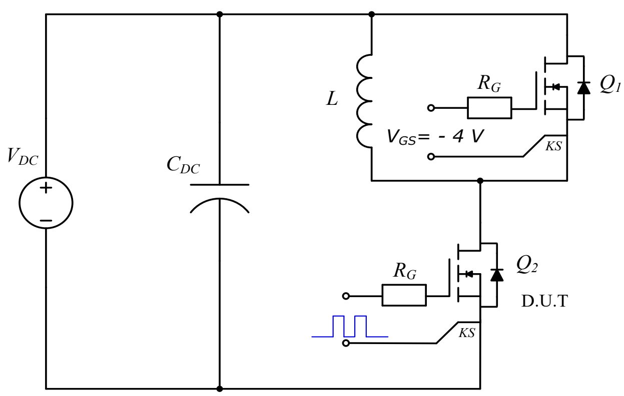
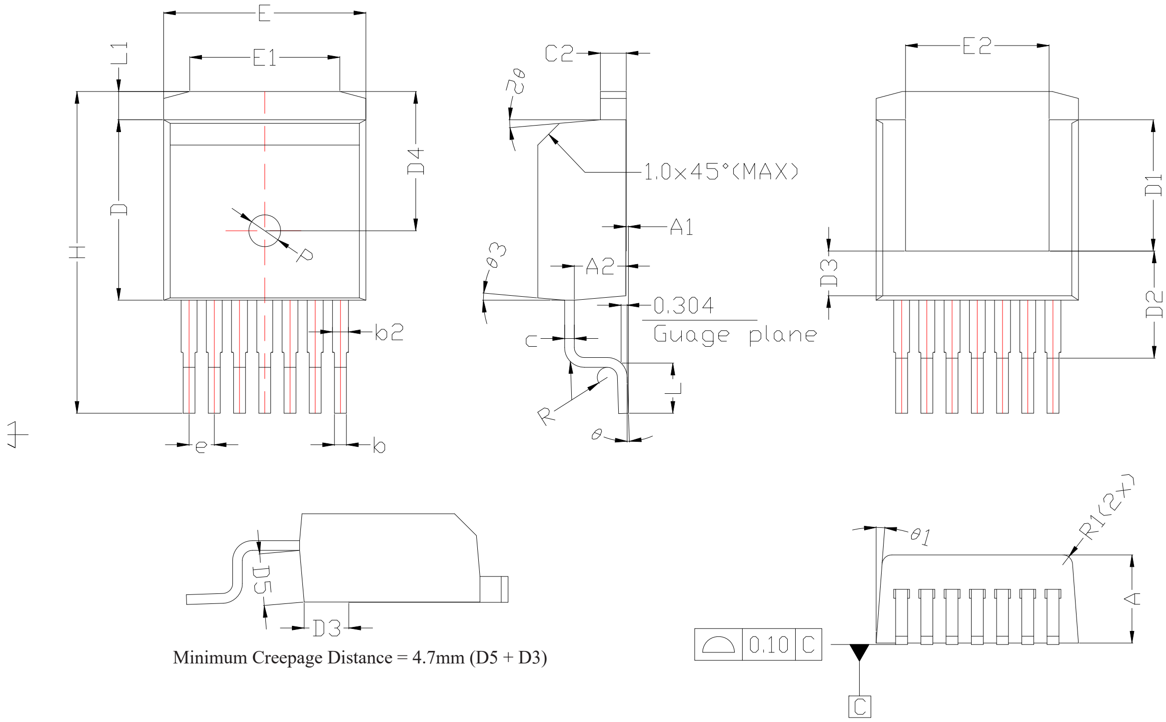



Figure 28. Clamped Inductive Switching Waveform Test Circuit

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

## Package Dimensions

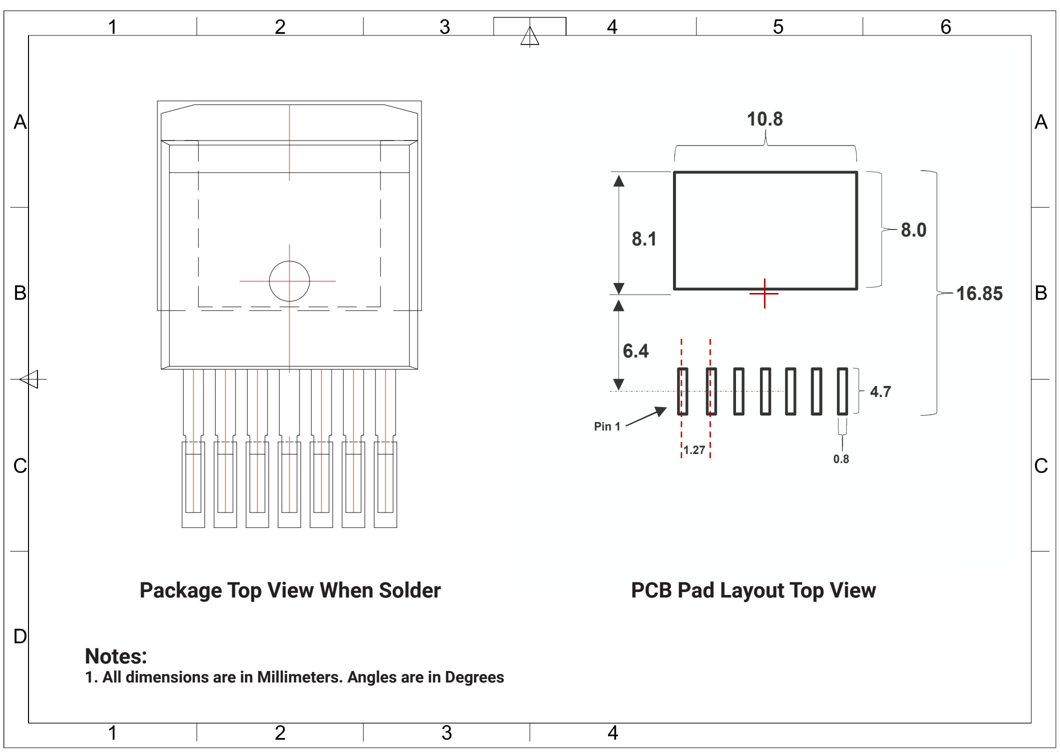
TO-263-7L XL




Minimum Creepage Distance = 4.7mm (D5 + D3)

| DIM | MIN | MAX | TYP |
|---|---|---|---|
| D | 9.025 | 9.125 | 9.075 |
| E | 10.13 | 10.23 | 10.18 |
| A | 4.30 | 4.57 | 4.435 |
| H | 15.043 | 17.313 | 16.178 |
| D1 | 6.50 | 6.70 | 6.60 |
| E1 | 6.50 | 8.60 | 7.55 |
| D2 | 5.39 REF. | | |
| E2 | 6.778 | 7.665 | 7.223 |
| D3 | 2.148 | —— | 2.248 |
| D4 | 7.00 REF. | | |
| D5 | 2.555 | —— | 2.605 |
| A1 | 0 | 0.25 | 0.125 |
| A2 | 2.595 REF. | | |
| e | 1.27 TYP. | | |
| L | 2.324 | 2.70 | 2.512 |
| b | 0.50 | 0.70 | 0.60 |
| L1 | 0.968 | 1.868 | 1.418 |
| b2 | 0.60 | 1.00 | 0.80 |
| C2 | 1.17 | 1.37 | 1.27 |
| c | 0.281 | 0.481 | 0.381 |
| R | 0.506 REF. | | |
| R1 | 0.50 REF. | | |
| P | Ø1.60 REF. | | |
| $\theta$ | 0° | 8° | 4° |
| $\theta 1$ | 4.5° | 5.5° | 5° |
| $\theta 2$ | 4° | 6° | 5° |
| $\theta 3$ | 4° | 6° | 5° |

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETER. ANGLES ARE IN DEGREE.
2. DIMENSION "D" DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH SHALL NOT EXCEED 0.50 MM PER SIDE. DIMENSION "E" DOES NOT INCLUDE MOLD FLASH, GATE BURRS,THE GATE BURRS SHALL NOT EXCEED 0.30MM .
3. THE PACKAGE TOP MAY BE SMALLER THAN THE PACKGE BOTOM. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTERMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, TIE BAR BURRS, GATE BURRS AND INTERLEAD FLASH,BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.
4. "b2" DIMENSION DON'T INCLUDE DAMBAR PROTRUSION.
5. THE VOID SHOULD BE CONTROL WITHIN 0.25MM.



## Notes

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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 your Cree representative to ensure you get the most up-to-date REACh SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

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