# Silicon Carbide (SiC) MOSFET – 20 mohm, 900 V, M2, D2PAK-7L

# NVBG020N090SC1

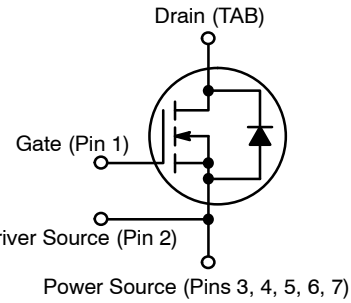
| $V_{(BR)DSS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|---|---|---|
| 900 V | 28 mΩ @ 15 V | 112 A |

### Features

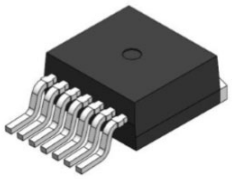
- Typ. $R_{DS(on)}$ = 20 mΩ @ $V_{GS}$ = 15 V
- Typ. $R_{DS(on)}$ = 16 mΩ @ $V_{GS}$ = 18 V
- Ultra Low Gate Charge (typ. $Q_{G(tot)}$ = 200 nC)
- Low Effective Output Capacitance (typ. $C_{oss}$ = 295 pF)
- 100% Avalanche Tested
- AEC−Q101 Qualified and PPAP Capable
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb−Free 2LI (on second level interconnection)

### Typical Applications

- Automotive On Board Charger
- Automotive DC-DC Converter for EV/HEV




**N−CHANNEL MOSFET**



**D2PAK−7L**
**CASE 418BJ**

### MARKING DIAGRAM


A = Assembly Location
Y = Year
WW = Work Week
ZZ = Lot Traceability
NVBG020N090SC1 = Specific Device Code

### MAXIMUM RATINGS ($T_J$ = 25°C unless otherwise noted)

| Parameter | | | Symbol | Value | Unit |
|---|---|---|---|---|---|
| Drain−to−Source Voltage | | | $V_{DSS}$ | 900 | V |
| Gate−to−Source Voltage | | | $V_{GS}$ | +22/−8 | V |
| Recommended Operation Values of Gate−Source Voltage | | $T_C$ < 175°C | $V_{GSop}$ | +15/−5 | V |
| Continuous Drain Current $R_{\theta JC}$ (Note 2) | Steady State | $T_C$ = 25°C | $I_D$ | 112 | A |
| Power Dissipation $R_{\theta JC}$ (Note 2) | Steady State | $T_C$ = 25°C | $P_D$ | 477 | W |
| Continuous Drain Current $R_{\theta JA}$ (Notes 1, 2) | Steady State | $T_A$ = 25°C | $I_D$ | 9.8 | A |
| Power Dissipation $R_{\theta JA}$ (Notes 1, 2) | Steady State | $T_A$ = 25°C | $P_D$ | 3.7 | W |
| Pulsed Drain Current (Note 3) | | $T_A$ = 25°C | $I_{DM}$ | 448 | A |
| Single Pulse Surge Drain Current Capability (Note 4) | $T_A$ = 25°C, $t_p$ = 10 μs, $R_G$ = 4.7 Ω | | $I_{DSC}$ | 854 | A |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | −55 to +175 | °C |
| Source Current (Body Diode) | | | $I_S$ | 148 | A |
| Single Pulse Drain−to−Source Avalanche Energy ($I_L$ = 23 $A_{pk}$, L = 1 mH) (Note 5) | | | $E_{AS}$ | 264 | mJ |
| Maximum Lead Temperature for Soldering, 1/8″ from Case for 10 Seconds | | | $T_L$ | 245 | °C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Surface mounted on a FR−4 board using1 $in^2$ pad of 2 oz copper.
2. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
3. Repetitive rating, limited by max junction temperature.
4. Peak current might be limited by transconductance.
5. $E_{AS}$ of 264 mJ is based on starting $T_J$ = 25°C; L = 1 mH, $I_{AS}$ = 23 A, $V_{DD}$ = 100 V, $V_{GS}$ = 15 V.

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| NVBG020N090SC1 | D2PAK−7L | 800 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

**Table 1. THERMAL CHARACTERISTICS**

| Parameter | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance Junction−to−Case (Note 2) | $R_{\theta JC}$ | 0.31 | °C/W |
| Thermal Resistance Junction−to−Ambient (Notes 1, 2) | $R_{\theta JA}$ | 41 | °C/W |

**Table 2. ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise stated)

| Parameter | Symbol | Test Condition | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Drain−to−Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA | | 900 | | | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | $I_D$ = 1 mA, refer to 25°C | | | 440 | | mV/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 900 V | $T_J$ = 25°C | | | 100 | μA |
| | | | $T_J$ = 175°C | | | 250 | μA |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = +22/−8 V, $V_{DS}$ = 0 V | | | | ±1 | μA |
| **ON CHARACTERISTICS** | | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$ , $I_D$ = 20 mA | | 1.8 | 2.6 | 4.3 | V |
| Recommended Gate Voltage | $V_{GOP}$ | | | −5 | | +15 | V |
| Drain−to−Source On Resistance | $R_{DS(on)}$ | $V_{GS}$ = 15 V, $I_D$ = 60 A, $T_J$ = 25°C | | | 20 | 28 | mΩ |
| | | $V_{GS}$ = 18 V, $I_D$ = 60 A, $T_J$ = 25°C | | | 16 | | |
| | | $V_{GS}$ = 15 V, $I_D$ = 60 A, $T_J$ = 175°C | | | 27 | | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 20 V, $I_D$ = 60 A | | | 49 | | S |
| **CHARGES, CAPACITANCES & GATE RESISTANCE** | | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$ = 0 V, f = 1 MHz, $V_{DS}$ = 450 V | | | 4415 | | pF |
| Output Capacitance | $C_{OSS}$ | | | | 295 | | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | | 25 | | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = −5/15 V, $V_{DS}$ = 720 V, $I_D$ = 60 A | | | 200 | | nC |
| Threshold Gate Charge | $Q_{G(TH)}$ | | | | 42 | | |
| Gate−to−Source Charge | $Q_{GS}$ | | | | 76 | | |
| Gate−to−Drain Charge | $Q_{GD}$ | | | | 56 | | |
| Gate−Resistance | $R_G$ | f = 1 MHz | | | 1.5 | | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −5/15 V, $V_{DS}$ = 720 V, $I_D$ = 60 A, $R_G$ = 2.5 Ω, Inductive Load | | | 39 | | ns |
| Rise Time | $t_r$ | | | | 52 | | |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | | | 58 | | |
| Fall Time | $t_f$ | | | | 13 | | |
| Turn−On Switching Loss | $E_{ON}$ | | | | 1551 | | μJ |
| Turn−Off Switching Loss | $E_{OFF}$ | | | | 179 | | |
| Total Switching Loss | $E_{TOT}$ | | | | 1730 | | |
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | | |
| Continuous Drain−Source Diode Forward Current | $I_{SD}$ | $V_{GS}$ = −5 V, $T_J$ = 25°C | | | | 148 | A |
| Pulsed Drain−Source Diode Forward Current (Note 3) | $I_{SDM}$ | $V_{GS}$ = −5 V, $T_J$ = 25°C | | | | 448 | A |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = −5 V, $I_{SD}$ = 30 A, $T_J$ = 25°C | | | 3.7 | | V |

**Table 2. ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise stated) (continued)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS}$ = −5/15 V, $I_{SD}$ = 60 A, $dI_S/dt$ = 1000 A/μs, $V_{DS}$ = 720 V | | 28 | | ns |
| Reverse Recovery Charge | $Q_{RR}$ | | | 186 | | nC |
| Reverse Recovery Energy | $E_{REC}$ | | | 4 | | μJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | | 14 | | A |
| Charge Time | Ta | | | 17 | | ns |
| Discharge Time | Tb | | | 11 | | ns |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## TYPICAL CHARACTERISTICS

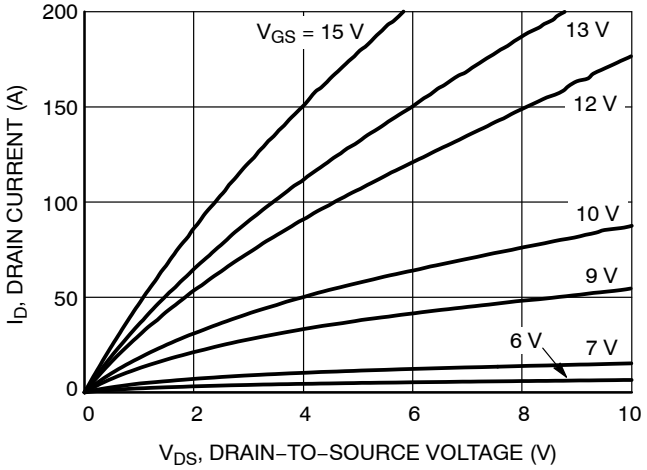



**Figure 1. On−Region Characteristics**

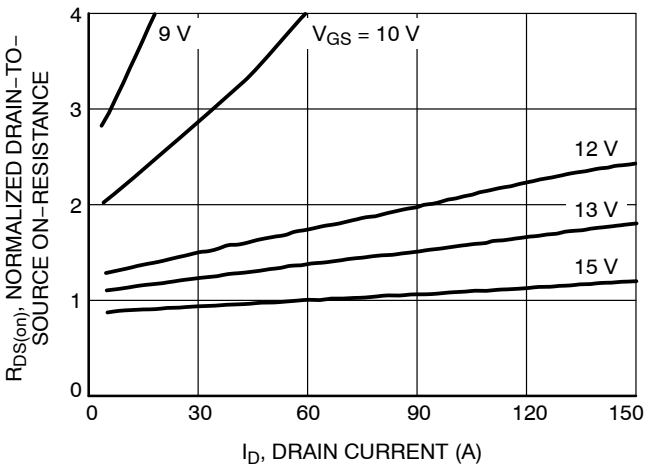



**Figure 2. Normalized On−Resistance vs. Drain Current and Gate Voltage**

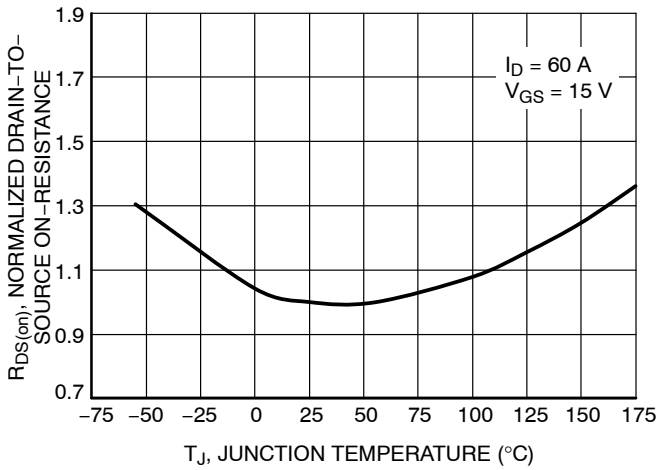



**Figure 3. On−Resistance Variation with Temperature**

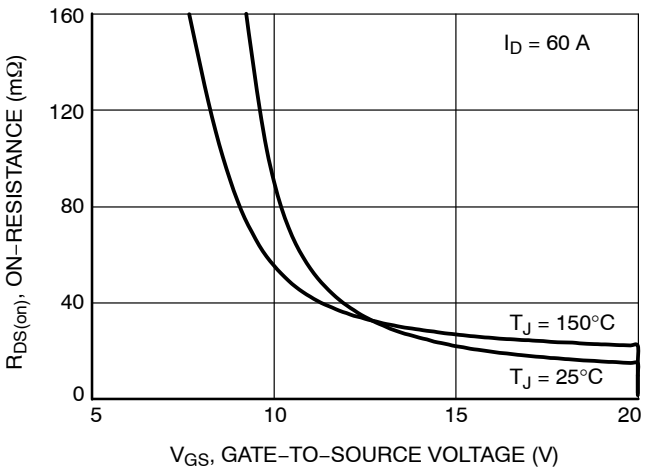



**Figure 4. On−Resistance vs. Gate−to−Source Voltage**

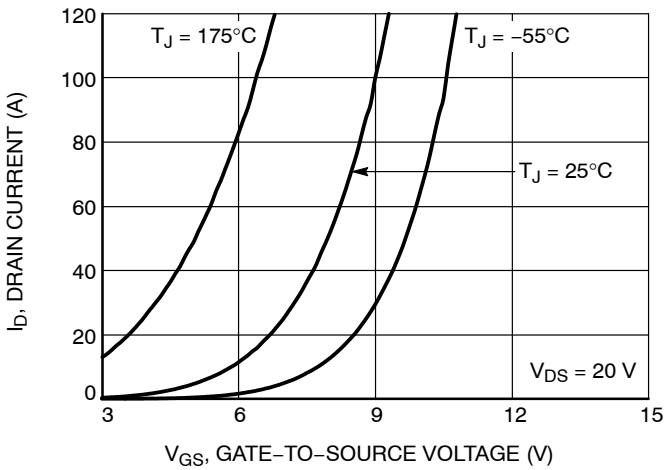



**Figure 5. Transfer Characteristics**

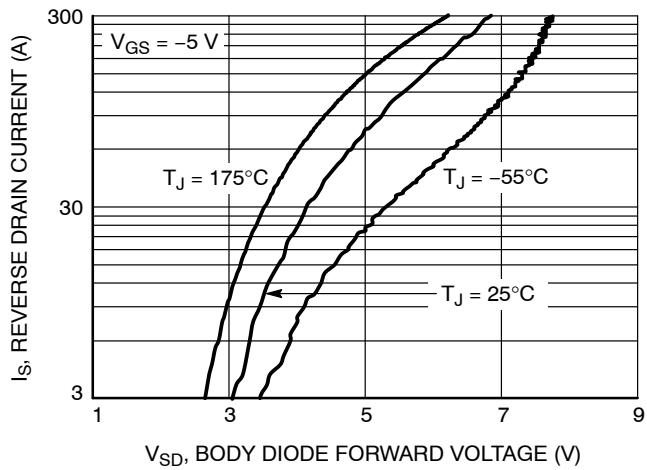



**Figure 6. Diode Forward Voltage vs. Current**

## TYPICAL CHARACTERISTICS (continued)

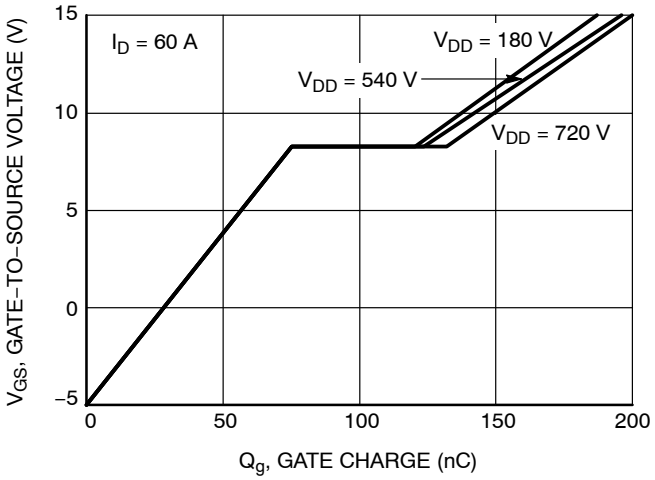



**Figure 7. Gate−to−Source Voltage vs. Total Charge**

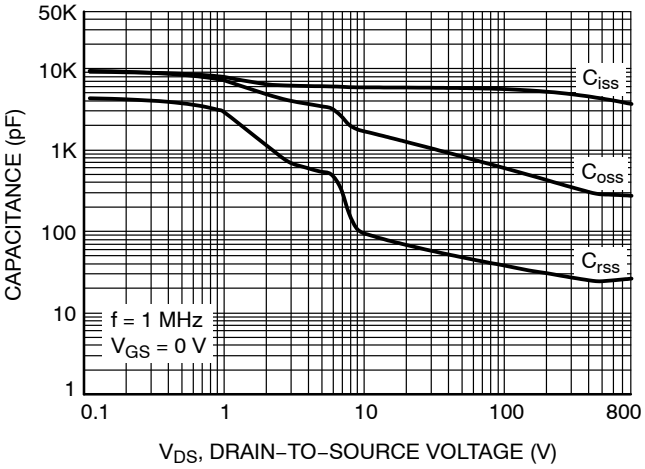



**Figure 8. Capacitance vs. Drain−to−Source Voltage**

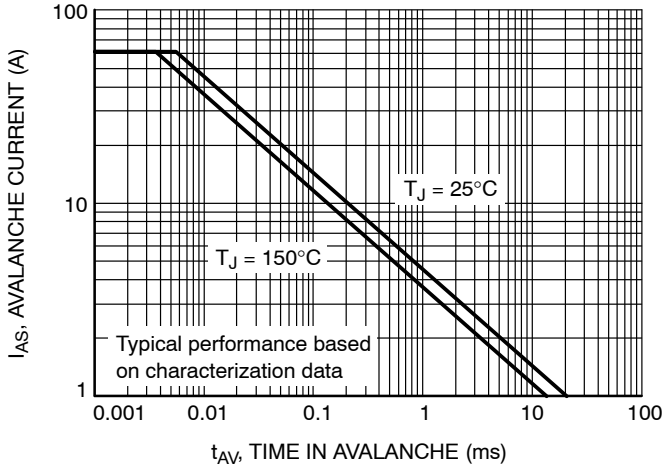



**Figure 9. Unclamped Inductive Switching Capability**

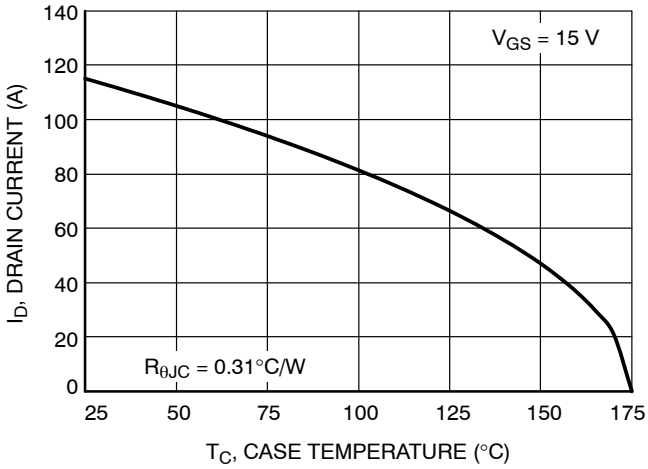



**Figure 10. Maximum Continuous Drain Current vs. Case Temperature**

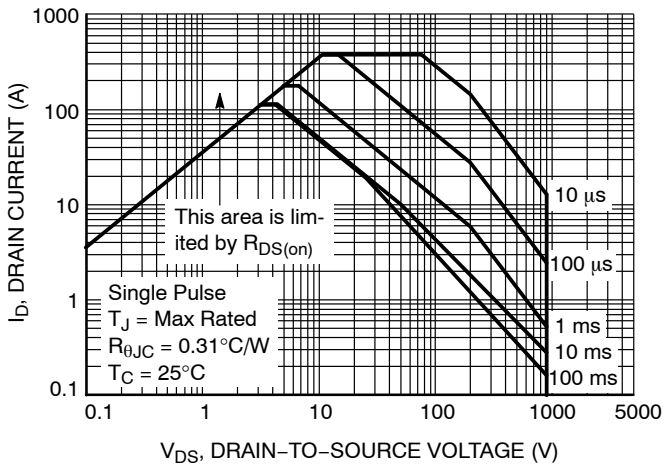



**Figure 11. Safe Operating Area**

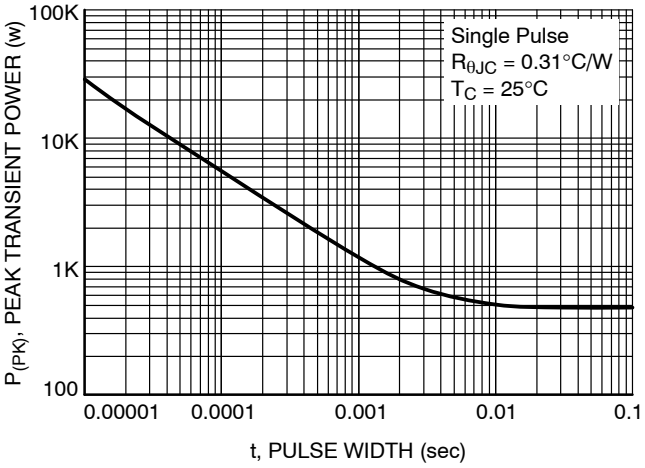



**Figure 12. Single Pulse Maximum Power Dissipation**

## TYPICAL CHARACTERISTICS (continued)

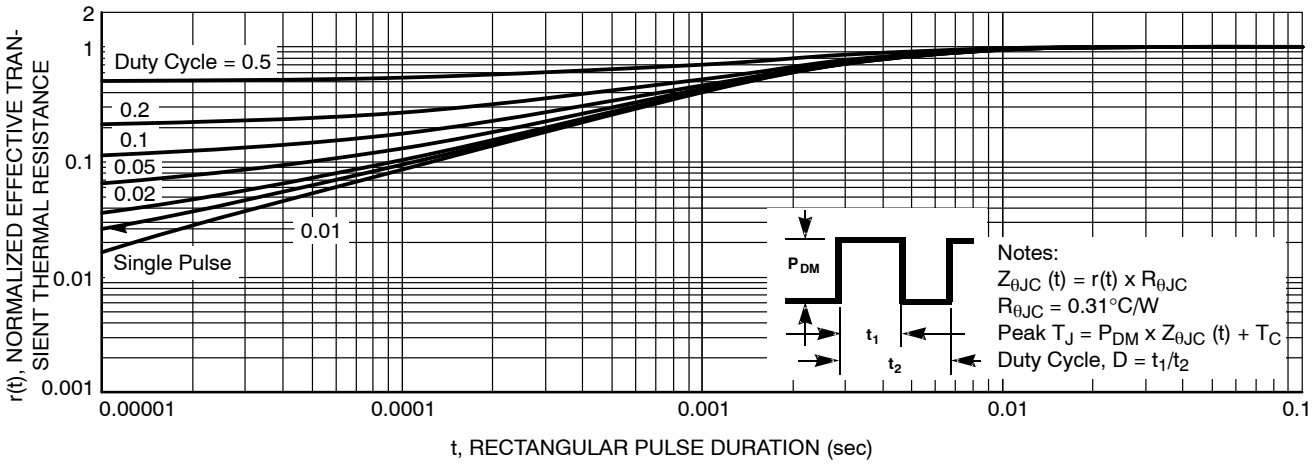


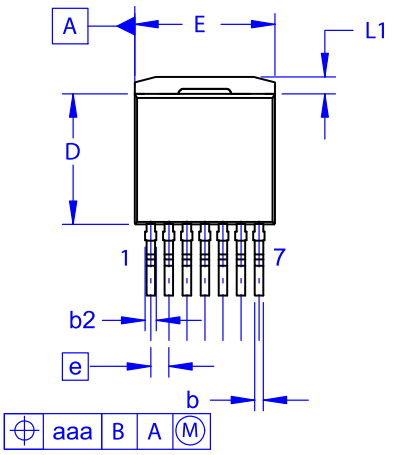

**Figure 13. Junction−to−Ambient Transient Thermal Response Curve**

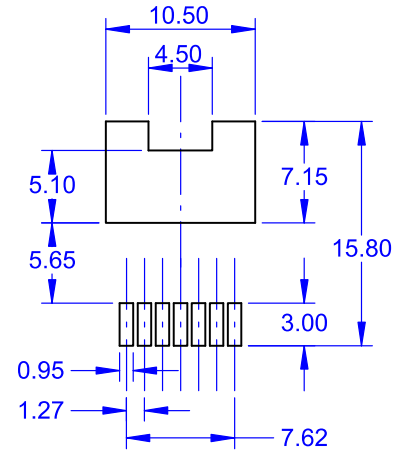
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

ON Semiconductor®

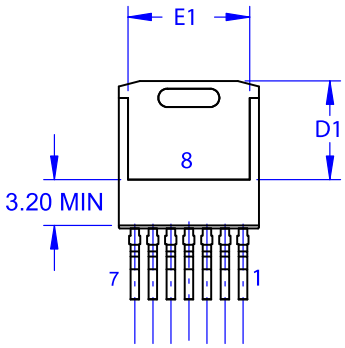
**D²PAK7 (TO−263−7L HV)**
CASE 418BJ
ISSUE B

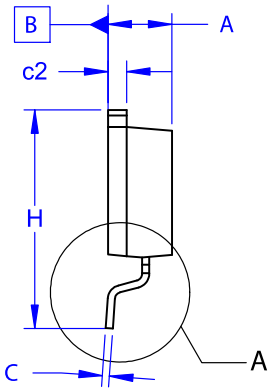
DATE 16 AUG 2019




LAND PATTERN RECOMMENDATION




NOTES:

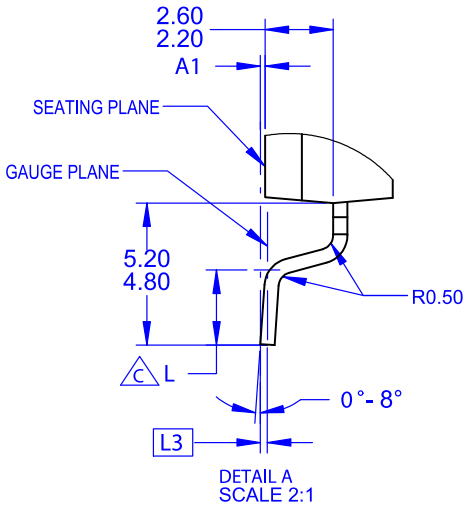
A. PACKAGE CONFORMS TO JEDEC TO-263 VARIATION CB EXCEPT WHERE NOTED.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. OUT OF JEDEC STANDARD VALUE.
D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.
E. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.

| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.30 | 4.50 | 4.70 |
| A1 | 0.00 | 0.10 | 0.20 |
| b2 | 0.60 | 0.70 | 0.80 |
| b | 0.51 | 0.60 | 0.70 |
| c | 0.40 | 0.50 | 0.60 |
| c2 | 1.20 | 1.30 | 1.40 |
| D | 9.00 | 9.20 | 9.40 |
| D1 | 6.15 | 6.80 | 7.15 |
| E | 9.70 | 9.90 | 10.20 |
| E1 | 7.15 | 7.65 | 8.15 |
| e | ~ | 1.27 | ~ |
| H | 15.10 | 15.40 | 15.70 |
| L | 2.44 | 2.64 | 2.84 |
| L1 | 1.00 | 1.20 | 1.40 |
| L3 | ~ | 0.25 | ~ |
| aaa | ~ | ~ | 0.25 |

### GENERIC MARKING DIAGRAM*


XXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.




DETAIL A
SCALE 2:1

| | | |
|---|---|---|
| **DOCUMENT NUMBER:** | **98AON84234G** | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red. |
| **DESCRIPTION:** | **D²PAK7 (TO−263−7L HV)** | **PAGE 1 OF 1** |

## PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT**:
**Email Requests to:** orderlit@onsemi.com

**onsemi Website:** www.onsemi.com

**TECHNICAL SUPPORT**
**North American Technical Support:**
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

**Europe, Middle East and Africa Technical Support:**
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative

◊