# Silicon Carbide (SiC) MOSFET - EliteSiC, 23 mohm, 650 V, M3S, D2PAK-7L
# NVBG023N065M3S

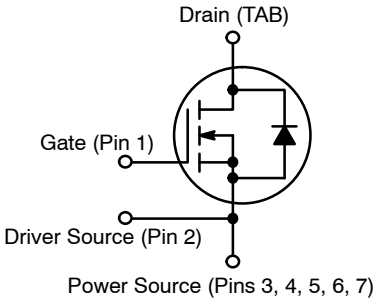
| $V_{(BR)DSS}$ | $R_{DS(ON)}$ TYP | $I_D$ MAX |
|---|---|---|
| 650 V | 23 mΩ @ 18 V | 40 A |

### Features

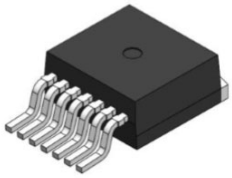
- Typical $R_{DS(ON)}$ = 23 mΩ @ $V_{GS}$ = 18 V
- Ultra Low Gate Charge ($Q_{G(tot)}$ = 69 nC)
- High Speed Switching with Low Capacitance (Coss = 153 pF)
- 100% Avalanche Tested
- AEC−Q101 Qualified and PPAP Capable
- This Device is Halide Free and RoHS Compliant with Exemption 7a, Pb−Free 2LI (on Second Level Interconnection)

### Applications

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




**N−CHANNEL MOSFET**



**D2PAK−7L**
**CASE 418BJ**

### MARKING DIAGRAM


BG023N065M3S = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
ZZ = Lot Traceability

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| NVBG023N065M3S | 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.

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

| Parameter | | Symbol | Value | Unit |
|---|---|---|---|---|
| Drain−to−Source Voltage | | $V_{DSS}$ | 650 | V |
| Gate−to−Source Voltage | | $V_{GS}$ | −8/+22 | |
| Continuous Drain Current (Note 1) | $T_C$ = 25°C | $I_D$ | 40 | A |
| Power Dissipation | | $P_D$ | 263 | W |
| Continuous Drain Current (Note 2) | $T_C$ = 100°C | $I_D$ | 40 | A |
| Power Dissipation | | $P_D$ | 131 | W |
| Pulsed Drain Current (Note 3) | $T_C$ = 25°C, $t_P$ = 100 μs | $I_{DM}$ | 216 | A |
| Continuous Source−Drain Current (Body Diode) | $T_C$ = 25°C, $V_{GS}$ = −3 V | $I_S$ | 40 | |
| | $T_C$ = 100°C, $V_{GS}$ = −3 V | | 25 | |
| Pulsed Source−Drain Current (Body Diode) (Note 3) | $T_C$ = 25°C, $V_{GS}$ = −3 V, $t_P$ = 100 μs | $I_{SM}$ | 159 | |
| Single Pulse Avalanche Energy (Note 4) | $I_{LPK}$ = 19.6 A, L = 1 mH | $E_{AS}$ | 192 | mJ |
| Operating Junction and Storage Temperature | | $T_j$, $T_{stg}$ | −55 to 175 | °C |
| Lead Temperature for Soldering Purposes (1/8" from Case for 10 s) | | $T_L$ | 270 | |

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. 40 A is limited by package. Power chip max drain current is 70 A if limited by max junction temperature.
2. 40 A is limited by package. Power chip max drain current is 50 A if limited by max junction temperature.
3. Repetitive rating, limited by max junction temperature.
4. $E_{AS}$ of 192 mJ is based on starting $T_J$ = 25°C, L = 1 mH, $I_{AS}$ = 19.6 A, $V_{DD}$ = 100 V, $V_{GS}$ = 18 V.

## THERMAL CHARACTERISTICS

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance, Junction−to−Case (Note 5) | $R_{\theta JC}$ | 0.57 | °C/W |
| Thermal Resistance, Junction−to−Ambient (Note 5) | $R_{\theta JA}$ | 40 | |

5. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.

## RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Operation Values of Gate−to−Source Voltage | $V_{GSop}$ | −5...−3<br>+18 | V |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

## ELECTRICAL CHARACTERISTICS ($T_J$ = 25°C unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Drain−to−Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA, $T_J$ = 25°C | 650 | – | – | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $\Delta V_{(BR)DSS}/\Delta T_J$ | $I_D$ = 1 mA, Referenced to 25°C | – | 89 | – | mV/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 650 V, $T_J$ = 25°C | – | – | 10 | μA |
| | | $V_{DS}$ = 650 V, $T_J$ = 175°C (Note 7) | – | – | 500 | μA |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = −8/+ 22 V, $V_{DS}$ = 0 V | – | – | ±1.0 | μA |
| **ON CHARACTERISTICS** | | | | | | |
| Drain−to−Source On Resistance | $R_{DS(ON)}$ | $V_{GS}$ = 18 V, $I_D$ = 20 A, $T_J$ = 25°C | – | 23 | 33 | mΩ |
| | | $V_{GS}$ = 18 V, $I_D$ = 20 A, $T_J$ = 175°C (Note 7) | – | 34 | – | |
| | | $V_{GS}$ = 15 V, $I_D$ = 20 A, $T_J$ = 25°C | – | 28 | – | |
| | | $V_{GS}$ = 15 V, $I_D$ = 20 A, $T_J$ = 175°C (Note 7) | – | 36 | – | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 10 mA, $T_J$ = 25°C | 2.0 | 2.8 | 4.0 | V |
| Forward Trans−conductance | $g_{FS}$ | $V_{DS}$ = 10 V, $I_D$ = 20 A (Note 7) | – | 14 | – | S |
| **CHARGES, CAPACITANCES & GATE RESISTANCE** | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, f = 1 MHz (Note 7) | – | 1951 | – | pF |
| Output Capacitance | $C_{OSS}$ | | – | 152 | – | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | – | 13 | – | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{DD}$ = 400 V, $I_D$ = 20 A, $V_{GS}$ = −3/18 V (Note 7) | – | 69 | – | nC |
| Gate−to−Source Charge | $Q_{GS}$ | | – | 19 | – | |
| Gate−to−Drain Charge | $Q_{GD}$ | | – | 18 | – | |
| Gate Resistance | $R_G$ | f = 1 MHz | – | 4.0 | – | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −3/18 V, $I_D$ = 20 A, $V_{DD}$ = 400 V, $R_G$ = 4.7 Ω, $T_J$ = 25°C (Note 6, 7) | – | 11 | – | ns |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | – | 35 | – | |
| Rise Time | $t_r$ | | – | 15 | – | |
| Fall Time | $t_f$ | | – | 9.6 | – | |
| Turn−On Switching Loss | $E_{ON}$ | | – | 51 | – | μJ |
| Turn−Off Switching Loss | $E_{OFF}$ | | – | 29 | – | |
| Total Switching Loss | $E_{TOT}$ | | – | 80 | – | |

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified) (continued)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −3/18 V, $I_D$ = 20 A, $V_{DD}$ = 400 V, $R_G$ = 4.7 Ω, $T_J$ = 175°C (Note 6, 7) | – | 9.6 | – | ns |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | – | 41 | – | |
| Rise Time | $t_r$ | | – | 14 | – | |
| Fall Time | $t_f$ | | – | 12 | – | |
| Turn−On Switching Loss | $E_{ON}$ | | – | 51 | – | μJ |
| Turn−Off Switching Loss | $E_{OFF}$ | | – | 45 | – | |
| Total Switching Loss | $E_{TOT}$ | | – | 96 | – | |
| **SOURCE−TO−DRAIN DIODE CHARACTERISTICS** | | | | | | |
| Forward Diode Voltage | $V_{SD}$ | $I_{SD}$ = 20 A, $V_{GS}$ = −3 V, $T_J$ = 25°C | – | 3.9 | 6.0 | V |
| | | $I_{SD}$ = 20 A, $V_{GS}$ = −3 V, $T_J$ = 175°C (Note 7) | – | 3.6 | – | |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS}$ = −3 V, $I_S$ = 20 A, dI/dt = 1000 A/μs, $V_{DS}$ = 400 V, $T_J$ = 25°C (Note 7) | – | 19 | – | ns |
| Charge time | $t_a$ | | – | 11 | – | |
| Discharge time | $t_b$ | | – | 8 | – | |
| Reverse Recovery Charge | $Q_{RR}$ | | – | 97 | – | nC |
| Reverse Recovery Energy | $E_{REC}$ | | – | 8.7 | – | μJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | – | 11 | – | A |

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.

6. EON/EOFF result is with body diode.
7. Defined by design, not subject to production test.

## TYPICAL CHARACTERISTICS

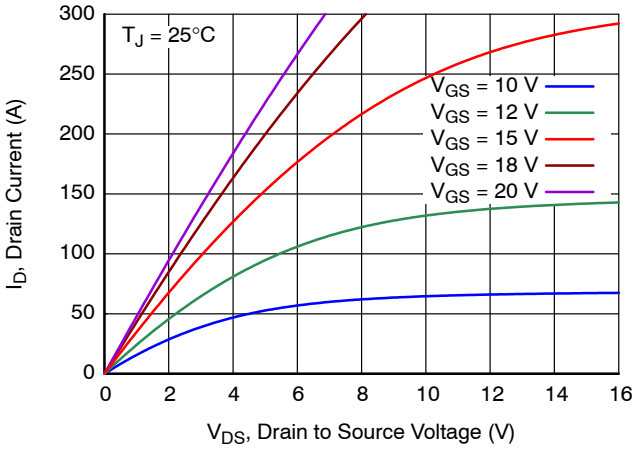



**Figure 1. Output Characteristics**

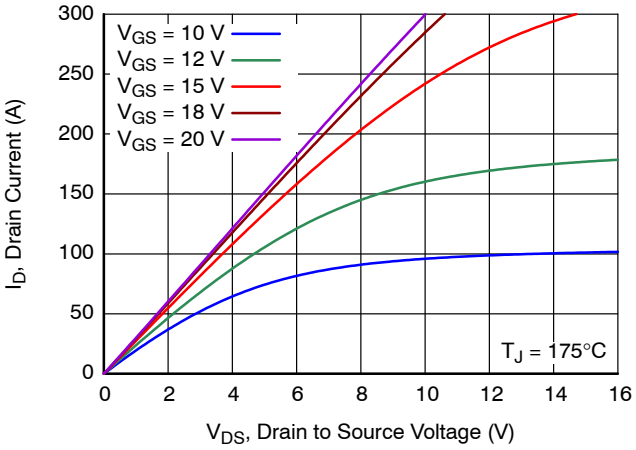



**Figure 2. Output Characteristics**

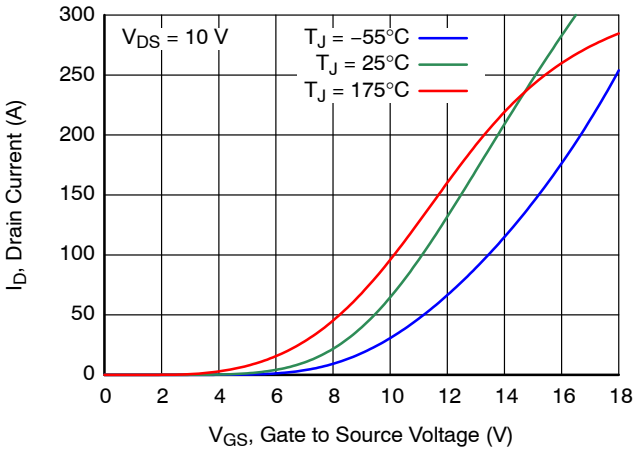



**Figure 3. Transfer Characteristics**

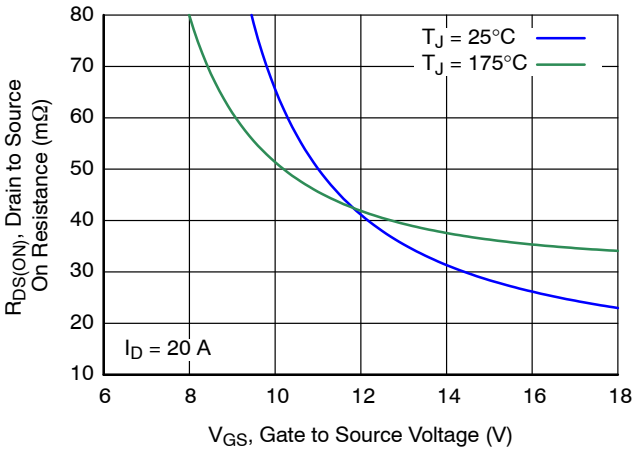



**Figure 4. On−Resistance vs. Gate Voltage**

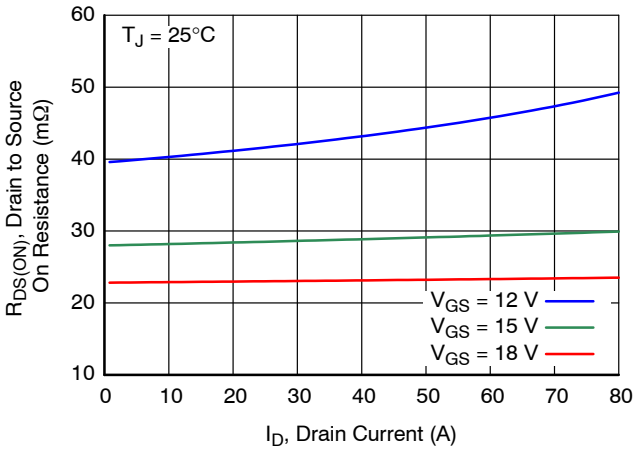



**Figure 5. On−Resistance vs. Drain Current**

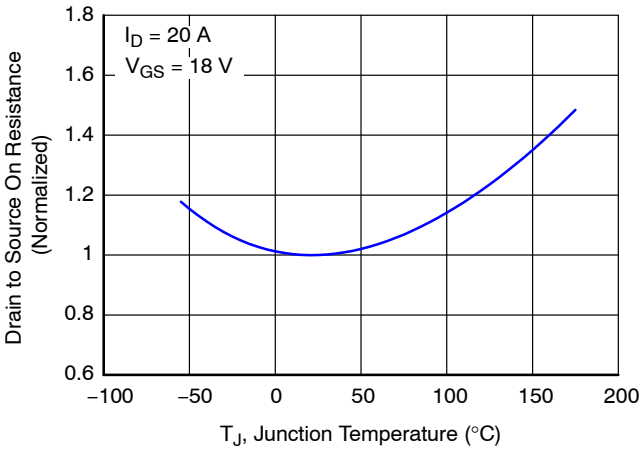



**Figure 6. On−Resistance vs. Junction Temperature**

## TYPICAL CHARACTERISTICS

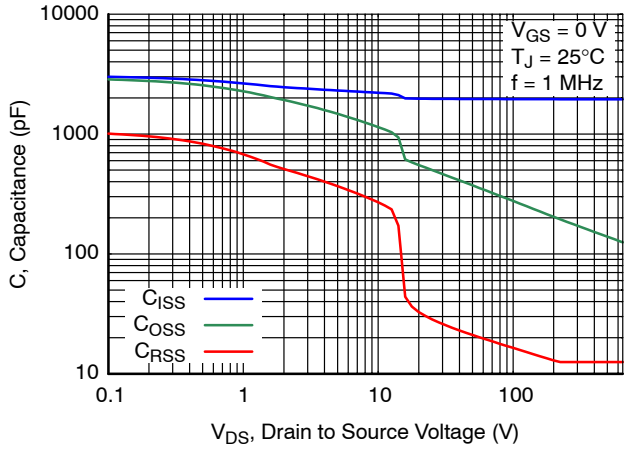



**Figure 7. Capacitance Characteristics**

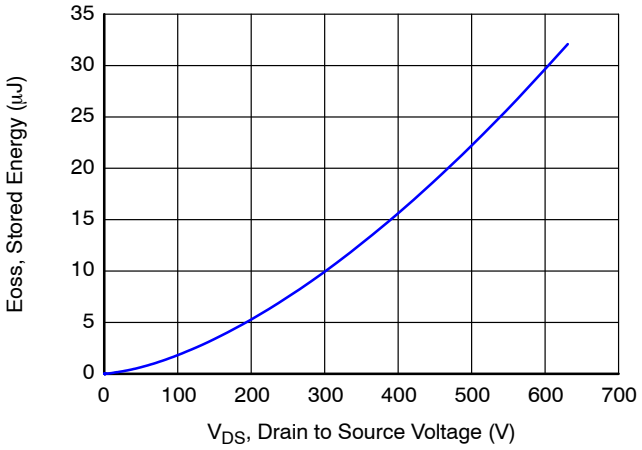



**Figure 8. Stored Energy vs. Drain to Source Voltage**

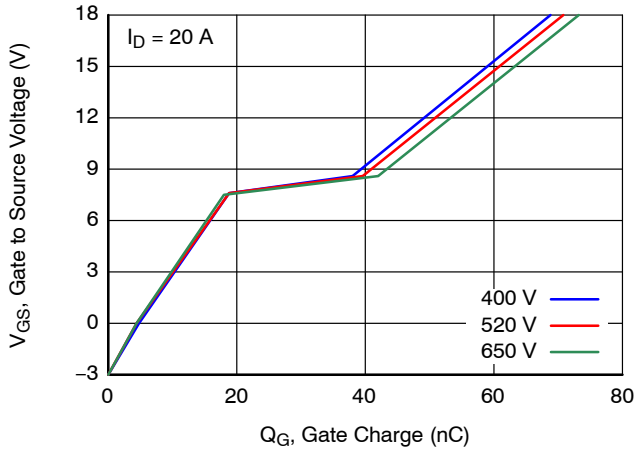



**Figure 9. Gate Charge Characteristics**

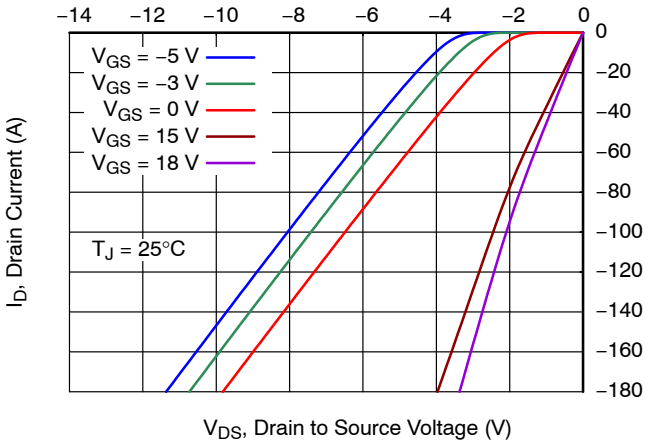



**Figure 10. Reverse Conduction Characteristics**

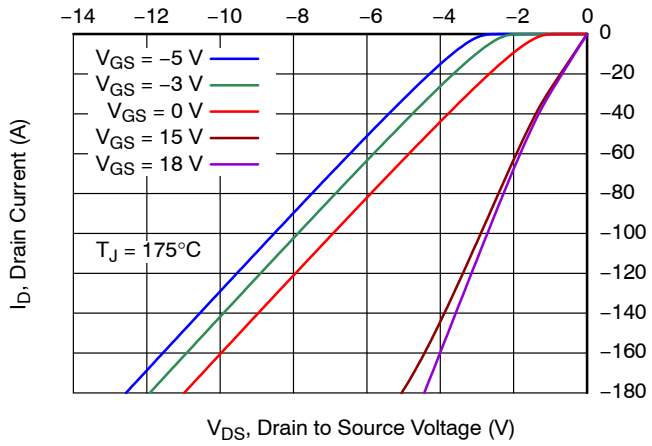



**Figure 11. Reverse Conduction Characteristics**

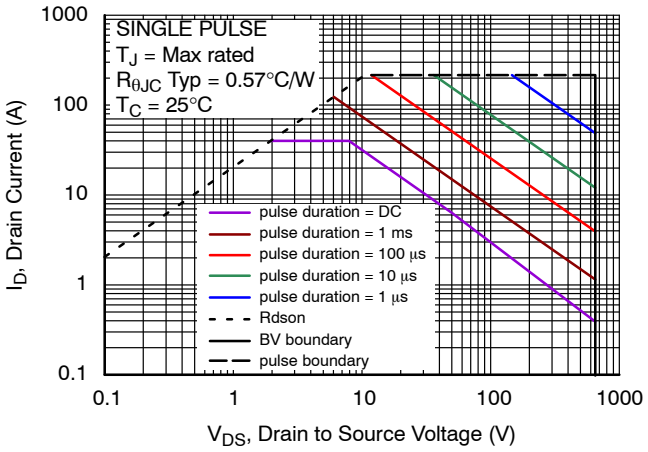



**Figure 12. Safe Operating Area**

## TYPICAL CHARACTERISTICS

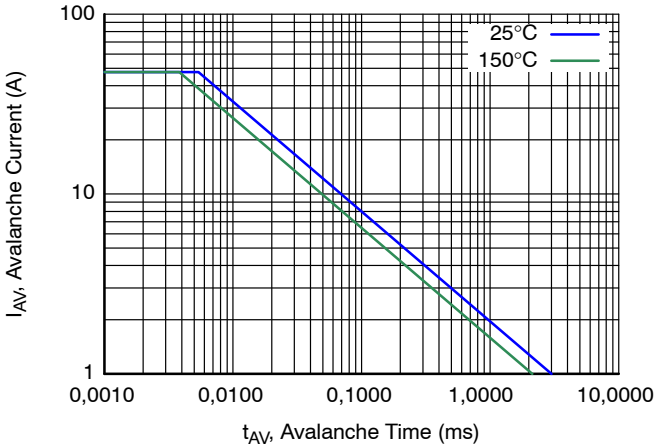



**Figure 13. Avalanche Current vs. Pulse Time (UIS)**

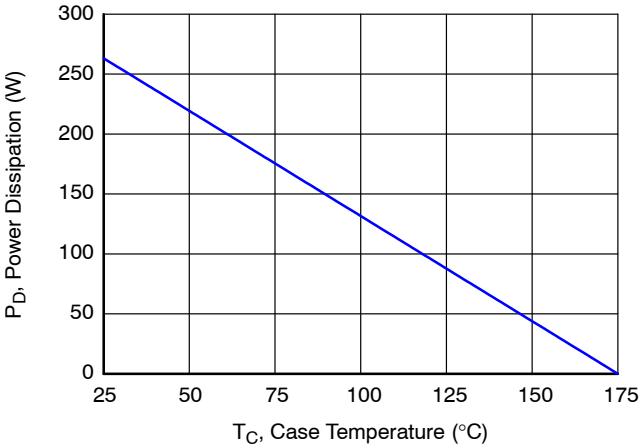



**Figure 14. Maximum Power Dissipation vs. Case Temperature**

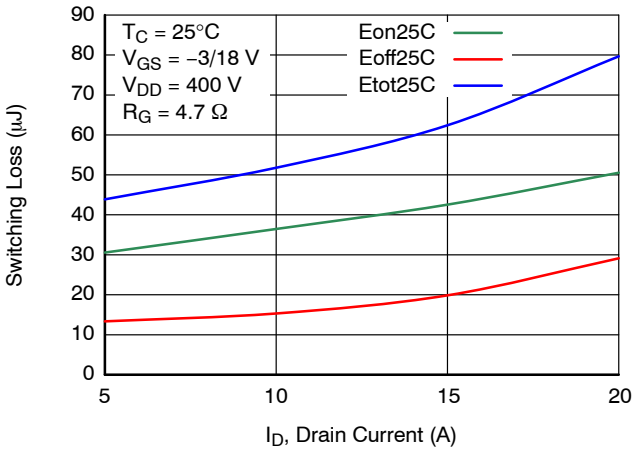



**Figure 15. Inductive Switching Loss vs. Drain Current**

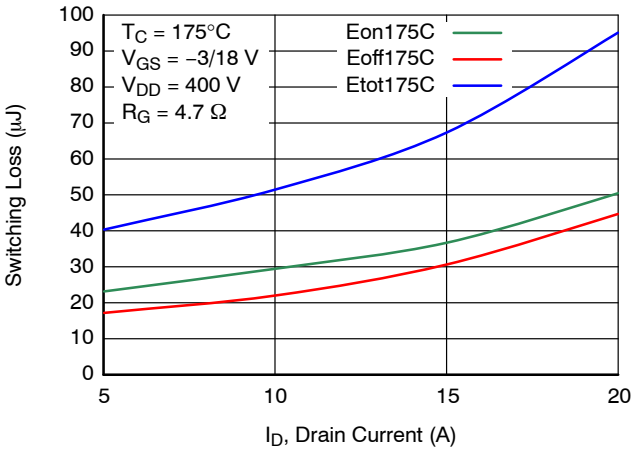



**Figure 16. Inductive Switching Loss vs. Drain Current**

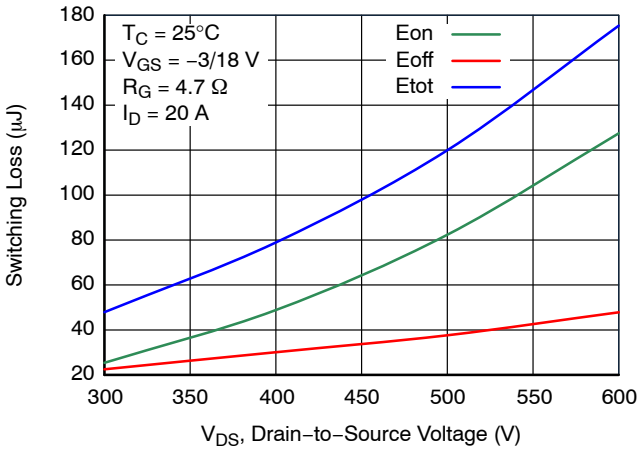



**Figure 17. Inductive Switching Loss vs. Drain Voltage**

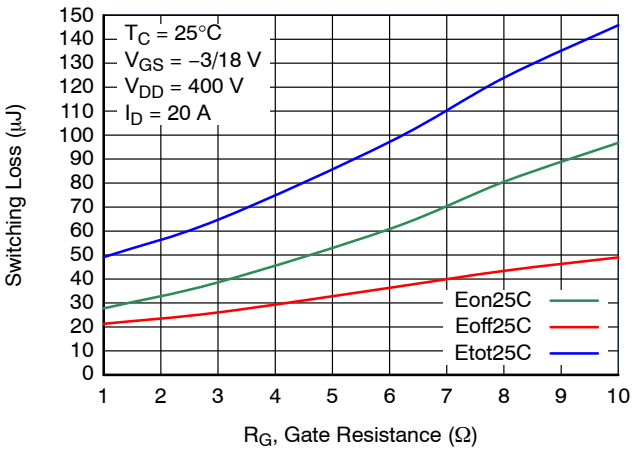



**Figure 18. Inductive Switching Loss vs. Gate Resistance**

## TYPICAL CHARACTERISTICS

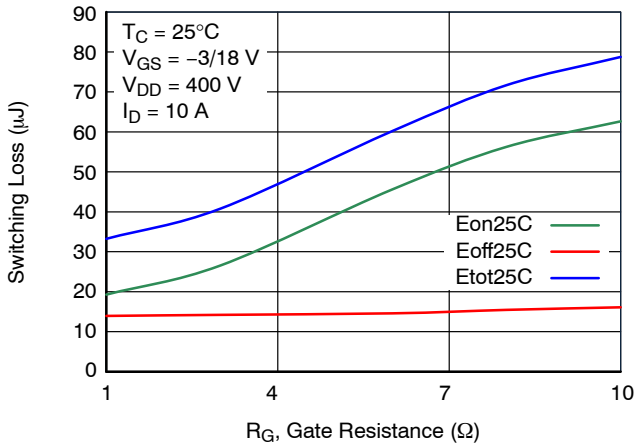



**Figure 19. Inductive Switching Loss vs. Gate Resistance**

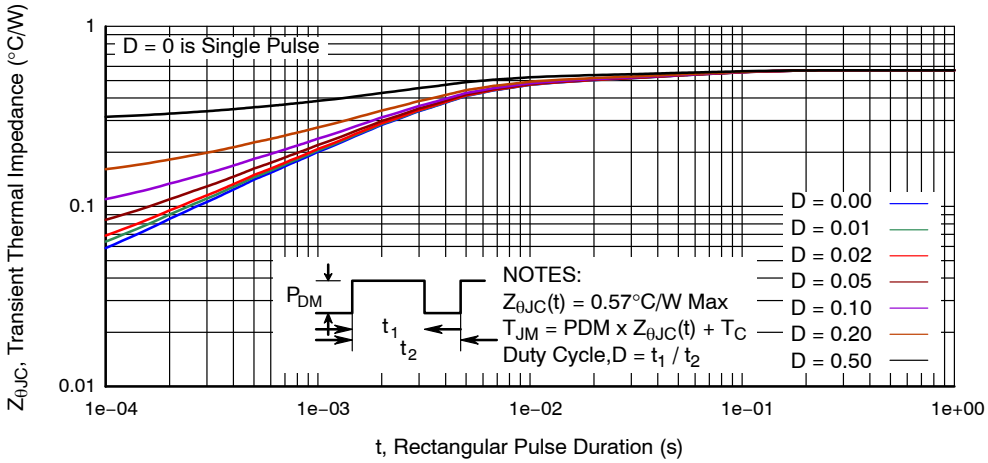
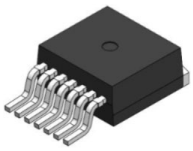


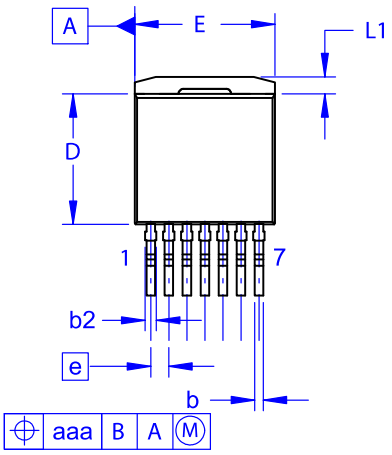

**Figure 20. Thermal Response Characteristics**

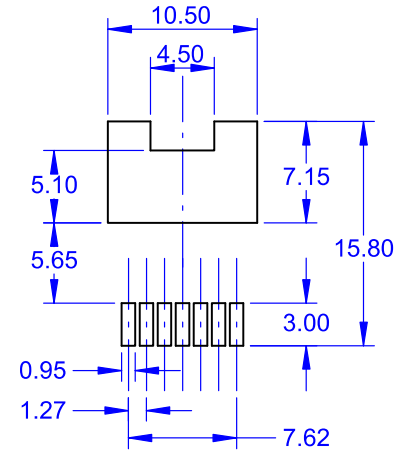
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

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

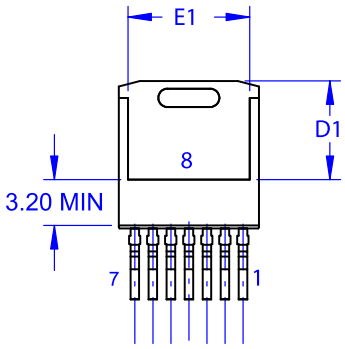
DATE 16 AUG 2019

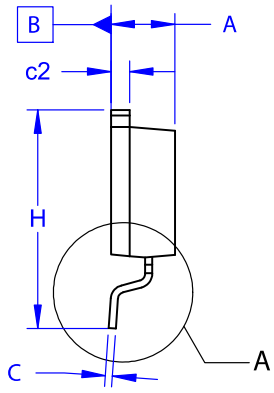





LAND PATTERN RECOMMENDATION




NOTES:

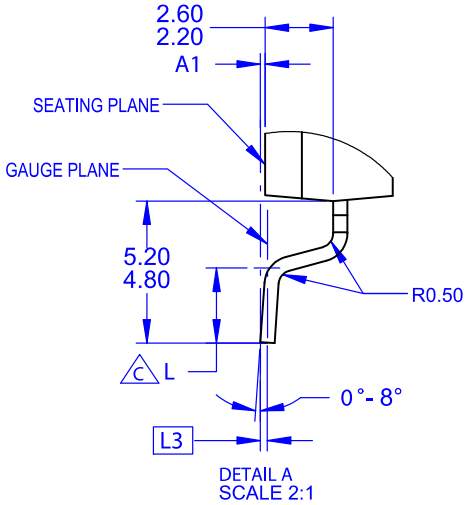
A. PACKAGE CONFORMS TO JEDEC TO-263 VARIATION CB EXCEPT WHERE NOTED.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. OUT OF JEDEC STANDARD VALUE.
D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.
E. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.

| 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** |

## ADDITIONAL INFORMATION

**TECHNICAL PUBLICATIONS**:
**Technical Library:** www.onsemi.com/design/resources/technical−documentation
**onsemi Website:** www.onsemi.com

**ONLINE SUPPORT**: www.onsemi.com/support
**For additional information, please contact your local Sales Representative at** www.onsemi.com/support/sales