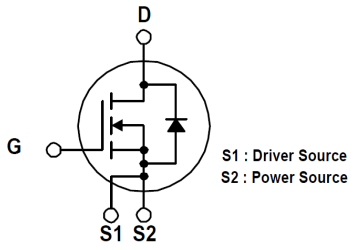
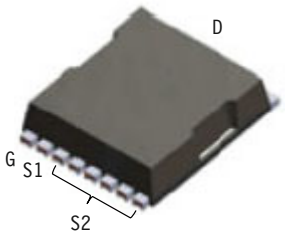
# Silicon Carbide (SiC) MOSFET – EliteSiC, 32 mohm, 650 V, M3S, TOLL

# NTBL032N065M3S

| $V_{(BR)DSS}$ | $R_{DS(ON)}$ TYP | $I_D$ MAX |
|---|---|---|
| 650 V | 32 mΩ @ 18 V | 55 A |




**N−Channel MOSFET**




**H−PSOF8L**
**CASE 100DC**

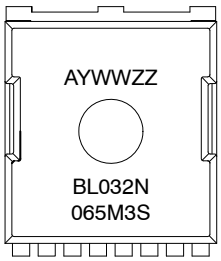
### Features

- Typical $R_{DS(on)}$ = 32 mΩ @ $V_{GS}$ = 18 V
- Ultra Low Gate Charge ($Q_{G(tot)}$ = 55 nC)
- High Speed Switching with Low Capacitance (Coss = 113 pF)
- 100% Avalanche Tested
- This Device is Halide Free and RoHS Compliant with Exemption 7a, Pb−Free 2LI (on second level interconnection)

### Applications

- SMPS (Switching Mode Power Supplies)
- Solar Inverters
- UPS (Uninterruptable Power Supplies)
- Energy Storage
- EV Charging Infrastructure

### MARKING DIAGRAM




| | |
|---|---|
| A | = Assembly Location |
| Y | = Year |
| WW | = Work Week |
| ZZ | = Assembly Lot Code |
| BL032N065M3S | = Specific Device Code |

### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

**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 | V |
| Continuous Drain Current | $T_C$ = 25°C | $I_D$ | 55 | A |
| Power Dissipation | | $P_D$ | 227 | W |
| Continuous Drain Current | $T_C$ = 100°C | $I_D$ | 39 | A |
| Power Dissipation | | $P_D$ | 113 | W |
| Pulsed Drain Current (Note 1) | $T_C$ = 25°C, $t_p$ = 100 μs | $I_{DM}$ | 192 | A |
| Continuous Source−Drain Current (Body Diode) | $T_C$ = 25°C, $V_{GS}$ = −3 V | $I_S$ | 33 | A |
| | $T_C$ = 100°C, $V_{GS}$ = −3 V | | 19 | |
| Pulsed Source−Drain Current (Body Diode) (Note 1) | $T_C$ = 25°C, $V_{GS}$ = −3 V, $t_p$ = 100 μs | $I_{SM}$ | 173 | A |
| Single Pulse Avalanche Energy ($I_{LPK}$ = 16.7 A, L = 1 mH) (Note 2) | | $E_{AS}$ | 139 | mJ |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | −55 to +175 | °C |
| Lead Temperature for Soldering Purposes (1/8″ from Case for 10 s) | | $T_L$ | 260 | °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. Repetitive rating, limited by max junction temperature.
2. $E_{AS}$ of 139 mJ is based on starting $T_J$ = 25°C, L = 1 mH, $I_{AS}$ = 16.7 A, $V_{DD}$ = 100 V, $V_{GS}$ = 18 V.

**THERMAL CHARACTERISTICS**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance, Junction−to−Case (Note 3) | $R_{\theta JC}$ | 0.66 | °C/W |
| Thermal Resistance, Junction−to−Ambient (Note 3) | $R_{\theta JA}$ | 43 | °C/W |

3. 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/+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 stated)

| 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 | 650 | | | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $\Delta V_{(BR)DSS}/\Delta T_J$ | $I_D$ = 1 mA, Referenced to 25°C | | 90 | | 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 5) | | | 500 | μA |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = −8/+22 V, $V_{DS}$ = 0 V | | | ±1 | μA |
| **ON CHARACTERISTICS** | | | | | | |
| Drain−to−Source On Resistance | $R_{DS(on)}$ | $V_{GS}$ = 18 V, $I_D$ = 15 A, $T_J$ = 25°C | | 32 | 44 | mΩ |
| | | $V_{GS}$ = 18 V, $I_D$ = 15 A, $T_J$ = 175°C (Note 5) | | 47 | | |
| | | $V_{GS}$ = 15 V, $I_D$ = 15 A, $T_J$ = 25°C | | 41 | | |
| | | $V_{GS}$ = 15 V, $I_D$ = 15 A, $T_J$ = 175°C (Note 5) | | 52 | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 7.5 mA | 2.0 | 2.9 | 4.0 | V |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 10 V, $I_D$ = 15 A | | 9.9 | | S |
| **CHARGES, CAPACITANCES & GATE RESISTANCE** | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$ = 0 V, f = 1 MHz, $V_{DS}$ = 400 V (Note 5) | | 1396 | | pF |
| Output Capacitance | $C_{OSS}$ | | | 113 | | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | 8.9 | | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = −3/18 V, $V_{DD}$ = 400 V, $I_D$ = 15 A (Note 5) | | 55 | | nC |
| Gate−to−Source Charge | $Q_{GS}$ | | | 15 | | |
| Gate−to−Drain Charge | $Q_{GD}$ | | | 14 | | |
| Gate−Resistance | $R_G$ | f = 1 MHz | | 5.0 | | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −3/18 V, $V_{DD}$ = 400 V, $I_D$ = 15 A, $R_G$ = 4.7 Ω, $T_J$ = 25°C (Notes 4, 5) | | 8.8 | | ns |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | | 31 | | |
| Rise Time | $t_r$ | | | 12 | | |
| Fall Time | $t_f$ | | | 9 | | |
| Turn−On Switching Loss | $E_{ON}$ | | | 33 | | μJ |
| Turn−Off Switching Loss | $E_{OFF}$ | | | 16 | | |
| Total Switching Loss | $E_{TOT}$ | | | 49 | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −3/18 V, $V_{DD}$ = 400 V, $I_D$ = 15 A, $R_G$ = 4.7 Ω, $T_J$ = 175°C (Notes 4, 5) | | 7.8 | | ns |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | | 37 | | |
| Rise Time | $t_r$ | | | 12 | | |
| Fall Time | $t_f$ | | | 11 | | |
| Turn−On Switching Loss | $E_{ON}$ | | | 31 | | μJ |
| Turn−Off Switching Loss | $E_{OFF}$ | | | 25 | | |
| Total Switching Loss | $E_{TOT}$ | | | 56 | | |
| **SOURCE−TO−DRAIN DIODE CHARACTERISTICS** | | | | | | |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = −3 V, $I_{SD}$ = 15 A, $T_J$ = 25°C | | 4.5 | 6.0 | V |
| | | $V_{GS}$ = −3 V, $I_{SD}$ = 15 A, $T_J$ = 175°C | | 4.2 | | |

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

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SOURCE−TO−DRAIN DIODE CHARACTERISTICS** | | | | | | |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS}$ = −3 V, $I_S$ = 15 A, dI/dt = 1000 A/μs, $V_{DS}$ = 400 V (Note 5) | | 15.5 | | ns |
| Charge Time | $t_a$ | | | 8.9 | | |
| Discharge Time | $t_b$ | | | 6.6 | | |
| Reverse Recovery Charge | $Q_{RR}$ | | | 72 | | nC |
| Reverse Recovery Energy | $E_{REC}$ | | | 4.6 | | μJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | | 9.3 | | A |

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

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

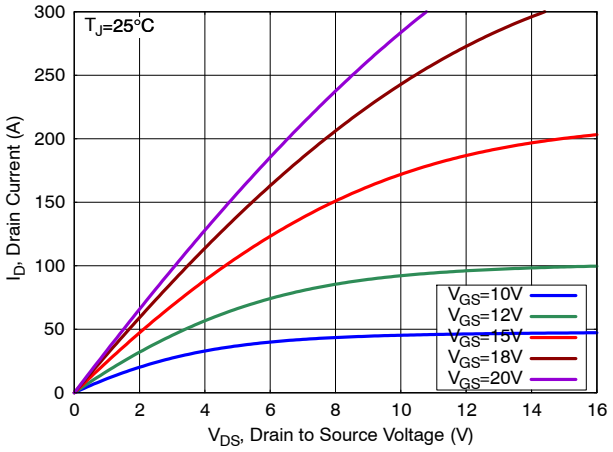



**Figure 1. Output Characteristics**

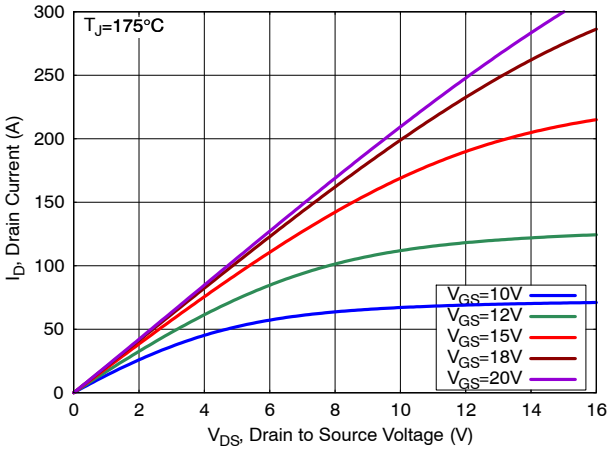



**Figure 2. Output Characteristics**

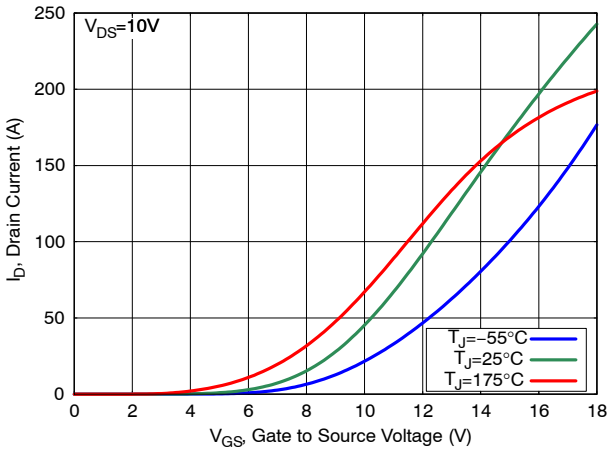



**Figure 3. Transfer Characteristics**

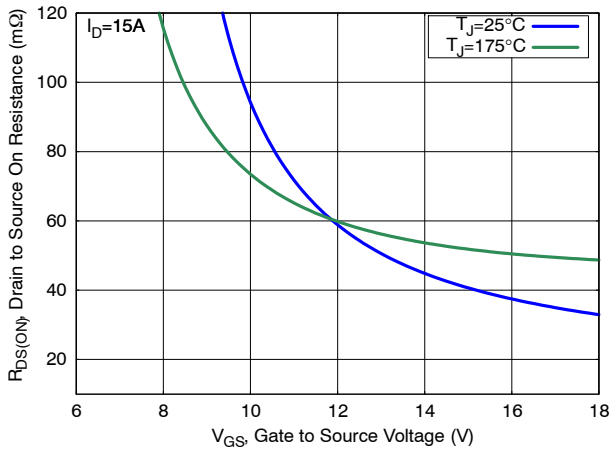



**Figure 4. On−Resistance vs. Gate Voltage**

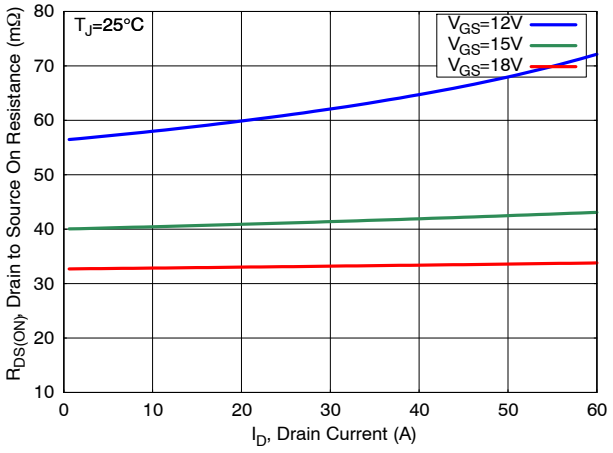



**Figure 5. On−Resistance vs. Drain Current**

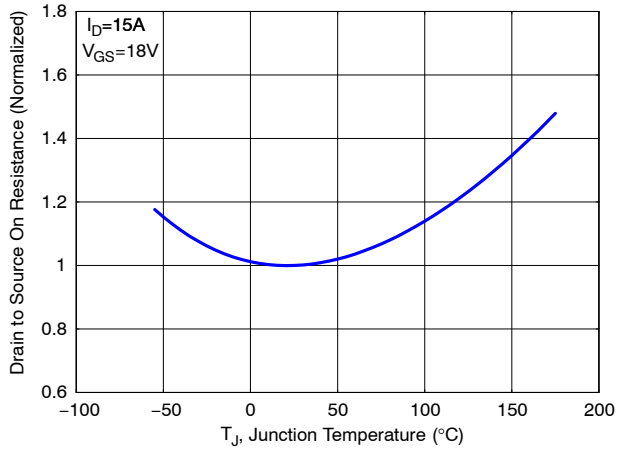



**Figure 6. On−Resistance vs. Junction Temperature**

## TYPICAL CHARACTERISTICS

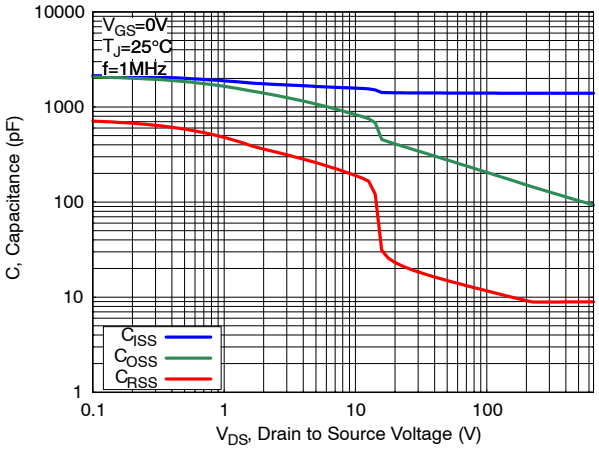



**Figure 7. Capacitance Characteristics**

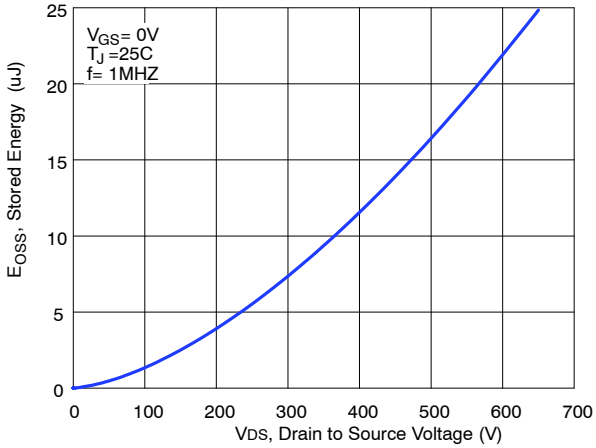



**Figure 8. Stored Energy vs. Drain−to−Source Voltage**

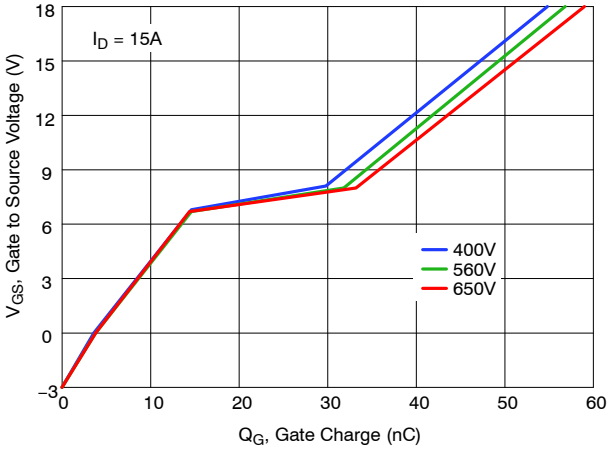



**Figure 9. Gate Charge Characteristics**

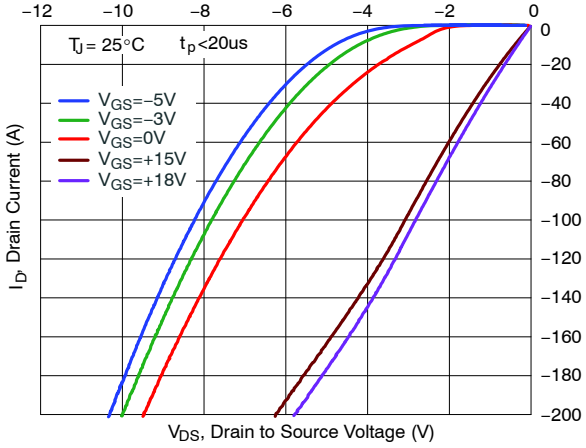



**Figure 10. Reverse Conduction Characteristics**

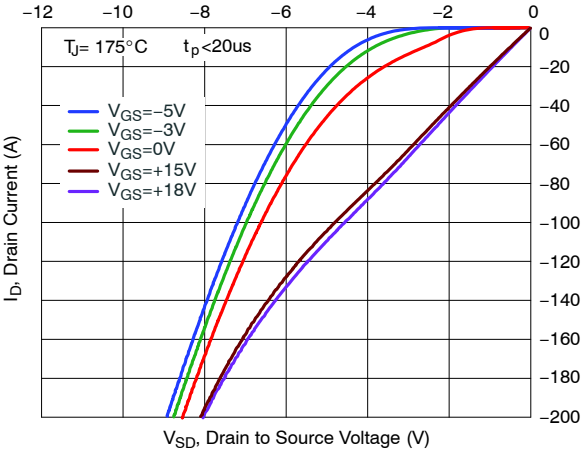



**Figure 11. Reverse Conduction Characteristics**

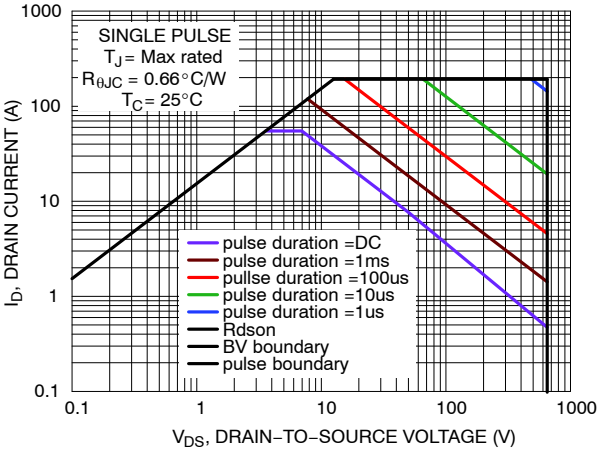



**Figure 12. Safe Operating Area**

## TYPICAL CHARACTERISTICS

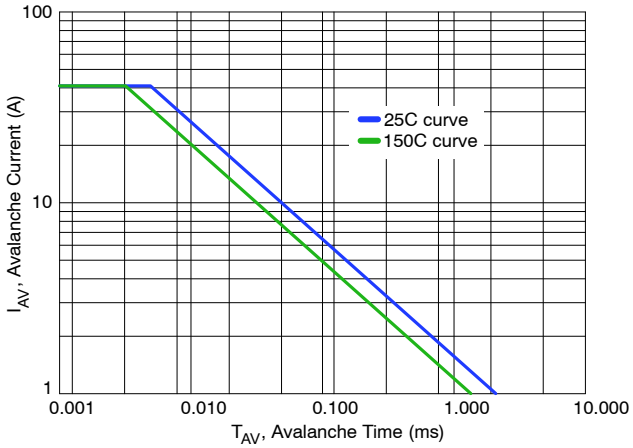



**Figure 13. Avalanche Current vs. Pulse Time (UIS)**

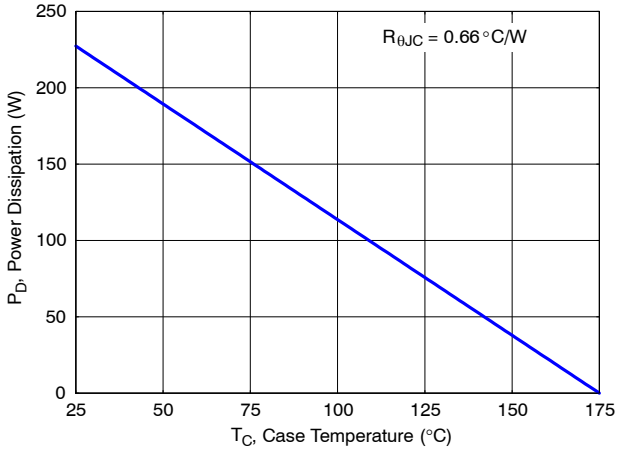



**Figure 14. Maximum Power Dissipation vs. Case Temperature**

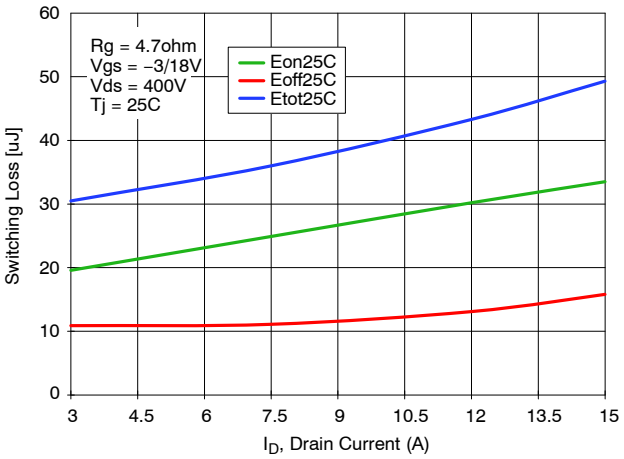



**Figure 15. Inductive Switching Loss vs. Drain Current**

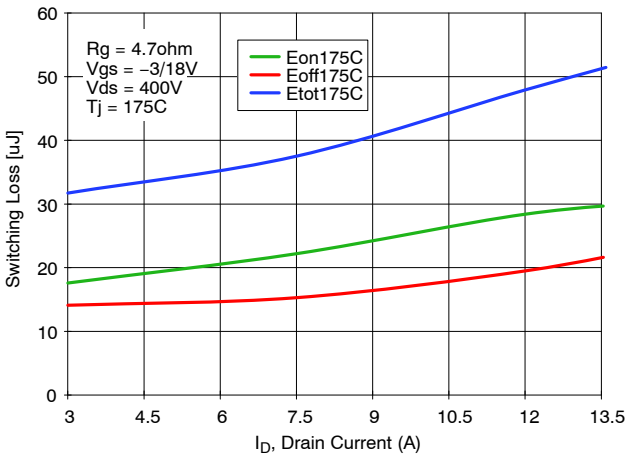



**Figure 16. Inductive Switching Loss vs. Drain Current**

## TYPICAL CHARACTERISTICS

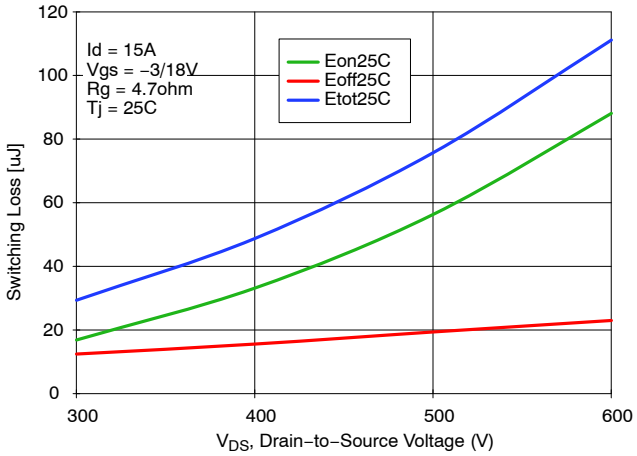



**Figure 17. Inductive Switching Loss vs. Drain Voltage**

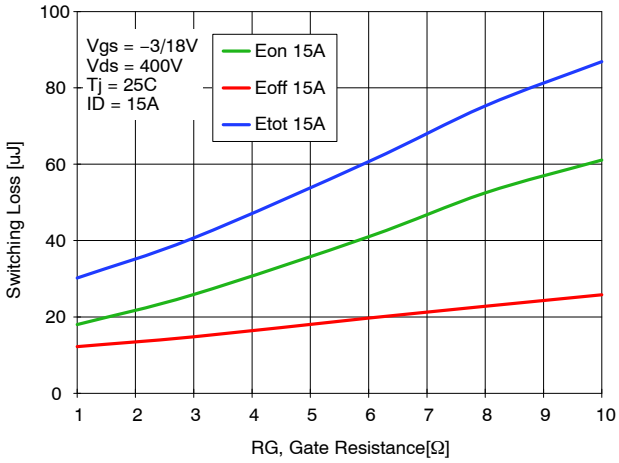



**Figure 18. Inductive Switching Loss vs. Gate Resistance**

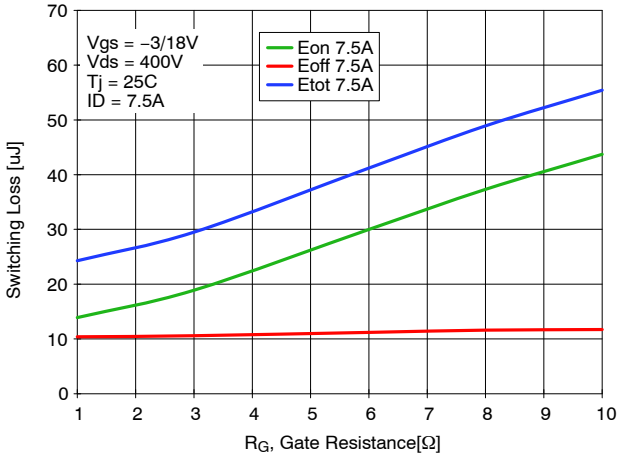



**Figure 19. Inductive Switching Loss vs. Gate Resistance**

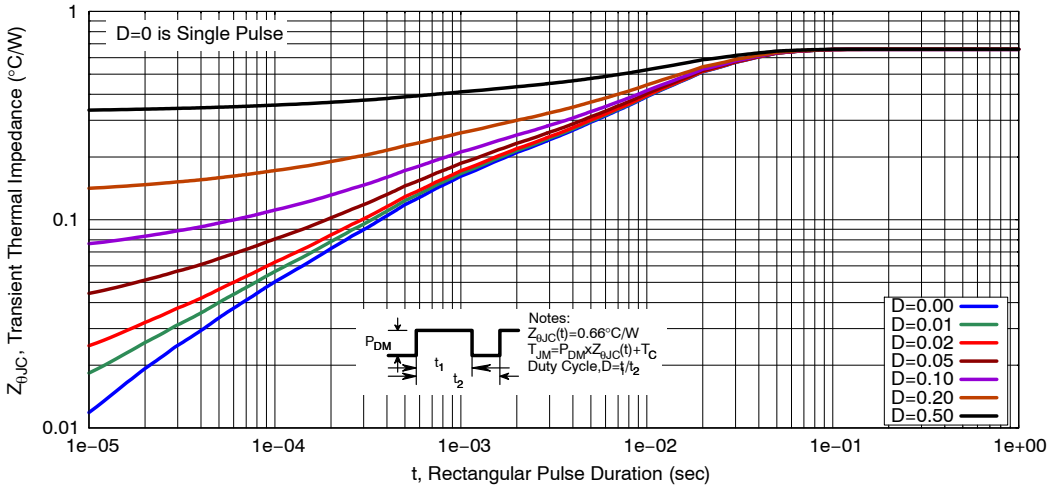
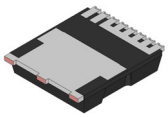



**Figure 20. Thermal Response Characteristics**

## DEVICE ORDERING INFORMATION

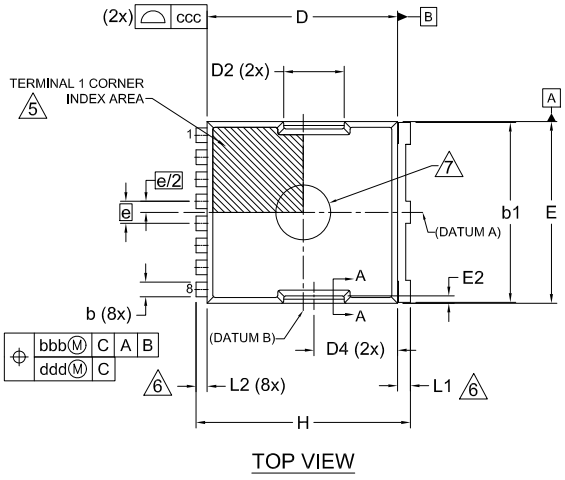
| Device | Package | Shipping† |
|---|---|---|
| NTBL032N065M3S | H−PSOF8L | 2000 / Tape & Reel |

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

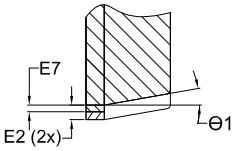


# H−PSOF8L 9.90x10.38x2.30, 1.20P
CASE 100DC
ISSUE D

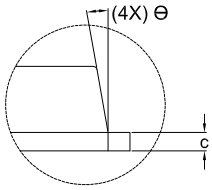
DATE 30 JUL 2024



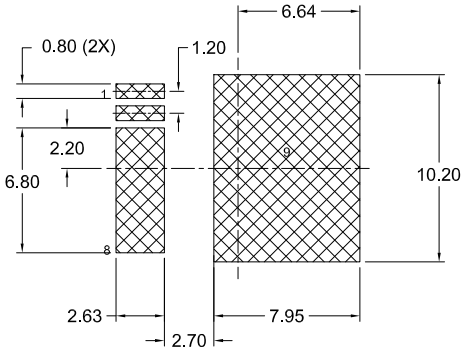

TOP VIEW




SECTION "A-A"
SCALE: 2X

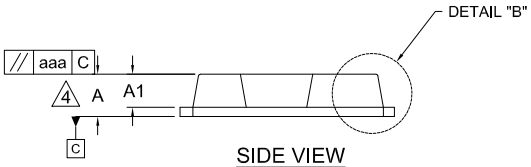



DETAIL "B"
SCALE: 2X

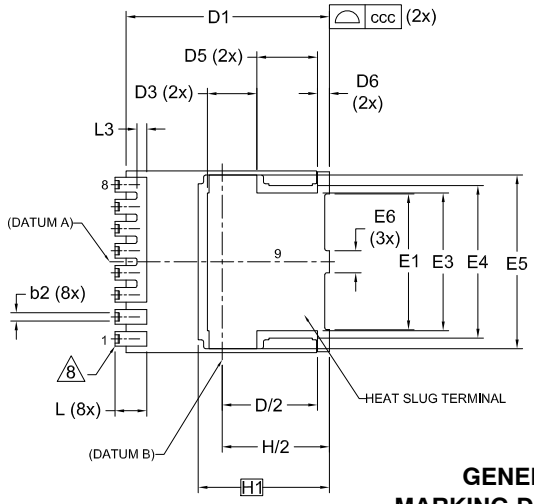



LAND PATTERN
RECOMMENDATION

*FOR ADDITIONAL INFORMATION ON OUR PB-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ONSEMI SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.




SIDE VIEW



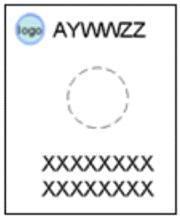

BOTTOM VIEW

NOTES:
1. PACKAGE STANDARD REFERENCE: JEDEC MO-299, ISSUE B.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
3. "e" REPRESENTS THE TERMINAL PITCH.
4. THIS DIMENSION INCLUDES ENCAPSULATION THICKNESS "A1", AND PACKAGE BODY THICKNESS, BUT DOES NOT INCLUDE ATTACHED FEATURES, e.g.,EXTERNAL OR CHIP CAPACITORS. AN INTEGRAL HEATSLUG IS NOT CONSIDERED AS ATTACHED FEATURE.
5. A VISUAL INDEX FEATURE MUST BE LOCATED WITHIN THE HATCHED AREA.
6. DIMENSIONS b1,L1,L2 APPLY TO PLATED TERMINALS.
7. THE LOCATION AND SIZE OF EJECTOR MARKS ARE OPTIONAL.
8. THE LOCATION AND NUMBER OF FUSED LEADS ARE OPTIONAL.

| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN. | NOM. | MAX. |
| A | 2.20 | 2.30 | 2.40 |
| A1 | 1.70 | 1.80 | 1.90 |
| b | 0.70 | 0.80 | 0.90 |
| b1 | 9.70 | 9.80 | 9.90 |
| b2 | 0.35 | 0.45 | 0.55 |
| c | 0.40 | 0.50 | 0.60 |
| D | 10.28 | 10.38 | 10.48 |
| D/2 | 5.09 | 5.19 | 5.29 |
| D1 | 10.98 | 11.08 | 11.18 |
| D2 | 3.20 | 3.30 | 3.40 |
| D3 | 2.60 | 2.70 | 2.80 |
| D4 | 4.45 | 4.55 | 4.65 |
| D5 | 3.20 | 3.30 | 3.40 |
| D6 | 0.55 | 0.65 | 0.75 |
| E | 9.80 | 9.90 | 10.00 |
| E1 | 7.30 | 7.40 | 7.50 |
| E2 | 0.30 | 0.40 | 0.50 |
| E3 | 7.40 | 7.50 | 7.60 |
| E4 | 8.20 | 8.30 | 8.40 |

| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN. | NOM. | MAX. |
| E5 | 9.36 | 9.46 | 9.56 |
| E6 | 1.10 | 1.20 | 1.30 |
| E7 | 0.15 | 0.18 | 0.21 |
| e | 1.20 BSC | | |
| e/2 | 0.60 BSC | | |
| H | 11.58 | 11.68 | 11.78 |
| H/2 | 5.74 | 5.84 | 5.94 |
| H1 | 7.15 BSC | | |
| L | 1.63 | 1.73 | 1.83 |
| L1 | 0.60 | 0.70 | 0.80 |
| L2 | 0.50 | 0.60 | 0.70 |
| L3 | 0.43 | 0.53 | 0.63 |
| Θ | 10° REF | | |
| Θ1 | 10° REF | | |
| aaa | 0.20 | | |
| bbb | 0.25 | | |
| ccc | 0.20 | | |
| ddd | 0.20 | | |
| eee | 0.10 | | |

## GENERIC MARKING DIAGRAM*




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

*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.

| | | |
|---|---|---|
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| **DESCRIPTION:** | **H−PSOF8L 9.90x10.38x2.30, 1.20P** | **PAGE 1 OF 1** |

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