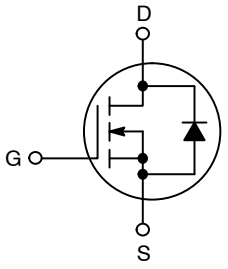
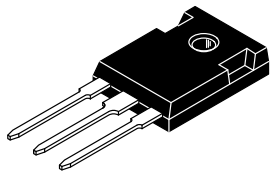
# Silicon Carbide (SiC) MOSFET – EliteSiC, 40 mohm, 1200 V, M3S, TO-247-3L

# NTHL040N120M3S

| $V_{(BR)DSS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|---|---|---|
| 1200 V | 54 mΩ @ 18 V | 54 A |

**N−CHANNEL MOSFET**



**TO−247−3LD**
**CASE 340CX**

### Features

- Typ. $R_{DS(on)}$ = 40 mΩ @ $V_{GS}$ = 18 V
- Ultra Low Gate Charge ($Q_{G(tot)}$ = 75 nC)
- High Speed Switching with Low Capacitance ($C_{oss}$ = 80 pF)
- 100% Avalanche Tested
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb−Free 2LI (on second level interconnection)

### Typical Applications

- Solar Inverters
- Electric Vehicle Charging Stations
- UPS (Uninterruptible Power Supplies)
- Energy Storage Systems
- SMPS (Switch Mode Power Supplies)

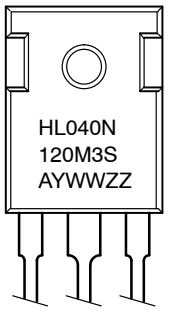
**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Parameter | | | Symbol | Value | Unit |
|---|---|---|---|---|---|
| Drain−to−Source Voltage | | | $V_{DSS}$ | 1200 | V |
| Gate−to−Source Voltage | | | $V_{GS}$ | −10/+22 | V |
| Continuous Drain Current (Notes 1, 3) | Steady State | $T_C$ = 25°C | $I_D$ | 54 | A |
| Power Dissipation (Note 1) | | | $P_D$ | 231 | W |
| Continuous Drain Current (Notes 1, 3) | Steady State | $T_C$ = 100°C | $I_D$ | 38 | A |
| Power Dissipation (Note 1) | | | $P_D$ | 115 | W |
| Pulsed Drain Current (Note 2) | $T_C$ = 25°C | | $I_{DM}$ | 134 | A |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | −55 to +175 | °C |
| Source Current (Body Diode) $T_C$ = 25°C, $V_{GS}$ = −3 V | | | $I_S$ | 45 | A |
| Single Pulse Drain−to−Source Avalanche Energy (Note 4) | | | $E_{AS}$ | 143 | mJ |
| Maximum Lead Temperature for Soldering (1/8″ from case for 5 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. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
2. Repetitive rating, limited by max junction temperature.
3. The maximum current rating is based on typical $R_{DS(on)}$ performance.
4. EAS of 143 mJ is based on starting $T_J$ = 25°C; L = 1 mH, $I_{AS}$ = 16.9 A, $V_{DD}$ = 100 V, $V_{GS}$ = 18 V.

**MARKING DIAGRAM**




HL040N120M3S = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
ZZ = Lot Traceability

**ORDERING INFORMATION**

| Device | Package | Shipping |
|---|---|---|
| NTHL040N120M3S | TO−247−3L | 30 Units / Tube |

**Table 1. THERMAL CHARACTERISTICS**

| Parameter | Symbol | Max | Unit |
|---|---|---|---|
| Junction−to−Case − Steady State (Note 1) | $R_{\theta JC}$ | 0.65 | °C/W |
| Junction−to−Ambient − Steady State (Note 1) | $R_{\theta JA}$ | 40 | |

**Table 2. 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.

**Table 3. ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF−STATE CHARACTERISTICS** | | | | | | |
| Drain−to−Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 1200 | – | – | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | $I_D$ = 1 mA, referenced to 25°C (Note 6) | – | 0.3 | – | V/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 1200 V, $T_J$ = 25°C | – | – | 100 | μA |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = +22/−10 V, $V_{DS}$ = 0 V | – | – | ±1 | μA |
| **ON−STATE CHARACTERISTICS** (Note 2) | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 10 mA | 2.04 | 2.9 | 4.4 | V |
| Drain−to−Source On Resistance | $R_{DS(on)}$ | $V_{GS}$ = 18 V, $I_D$ = 20 A, $T_J$ = 25°C | – | 40 | 54 | mΩ |
| | | $V_{GS}$ = 18 V, $I_D$ = 20 A, $T_J$ = 175°C (Note 6) | – | 80 | – | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 10 V, $I_D$ = 20 A (Note 6) | – | 16 | – | S |
| **CHARGES, CAPACITANCES & GATE RESISTANCE** | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$ = 0 V, f = 1 MHz, $V_{DS}$ = 800 V (Note 6) | – | 1700 | – | pF |
| Output Capacitance | $C_{OSS}$ | | – | 80 | – | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | – | 7 | – | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = −3/18 V, $V_{DS}$ = 800 V, $I_D$ = 20 A (Note 6) | – | 75 | – | nC |
| Threshold Gate Charge | $Q_{G(TH)}$ | | – | 4.4 | – | |
| Gate−to−Source Charge | $Q_{GS}$ | | – | 14 | – | |
| Gate−to−Drain Charge | $Q_{GD}$ | | – | 22 | – | |
| Gate−Resistance | $R_G$ | f = 1 MHz | – | 3.8 | – | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −3/18 V, $V_{DS}$ = 800 V, $I_D$ = 20 A, $R_G$ = 4.7 Ω Inductive load (Notes 5, 6) | – | 13 | – | ns |
| Rise Time | $t_r$ | | – | 32 | – | |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | – | 37 | – | |
| Fall Time | $t_f$ | | – | 11 | – | |
| Turn−On Switching Loss | $E_{ON}$ | | – | 412 | – | μJ |
| Turn−Off Switching Loss | $E_{OFF}$ | | – | 74 | – | |
| Total Switching Loss | $E_{tot}$ | | – | 486 | – | |

**Table 3. ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified) (continued)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SOURCE−DRAIN DIODE CHARACTERISTICS** | | | | | | |
| Continuous Source−Drain Diode Forward Current | $I_{SD}$ | $V_{GS}$ = −3 V, $T_C$ = 25°C (Note 6) | − | − | 45 | A |
| Pulsed Source−Drain Diode Forward Current (Note 2) | $I_{SDM}$ | | − | − | 134 | |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = −3 V, $I_{SD}$ = 20 A, $T_J$ = 25°C | − | 4.5 | − | V |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS}$ = −3/18 V, $I_{SD}$ = 20 A, $dI_S/dt$ = 1000 A/μs, $V_{DS}$ = 800 V (Note 6) | − | 17 | − | ns |
| Reverse Recovery Charge | $Q_{RR}$ | | − | 81 | − | nC |
| Reverse Recovery Energy | $E_{REC}$ | | − | 6.7 | − | μJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | − | 9.3 | − | A |
| Charge Time | $T_A$ | | − | 9.5 | − | ns |
| Discharge Time | $T_B$ | | − | 7.7 | − | 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.

5. $E_{ON}/E_{OFF}$ result is with body diode.
6. Defined by design, not subject to production test.

## TYPICAL CHARACTERISTICS

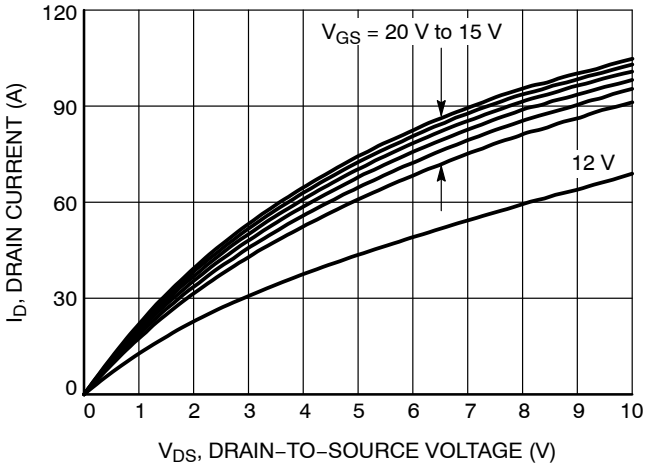



**Figure 1. On−Region Characteristics**

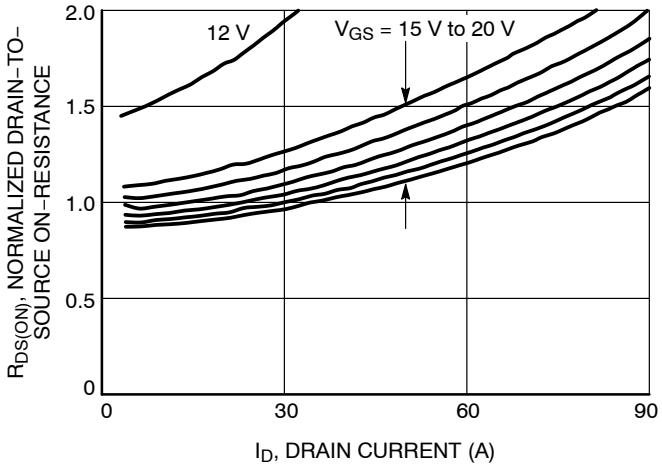



**Figure 2. Normalized On−Resistance vs. Drain Current and Gate Voltage**

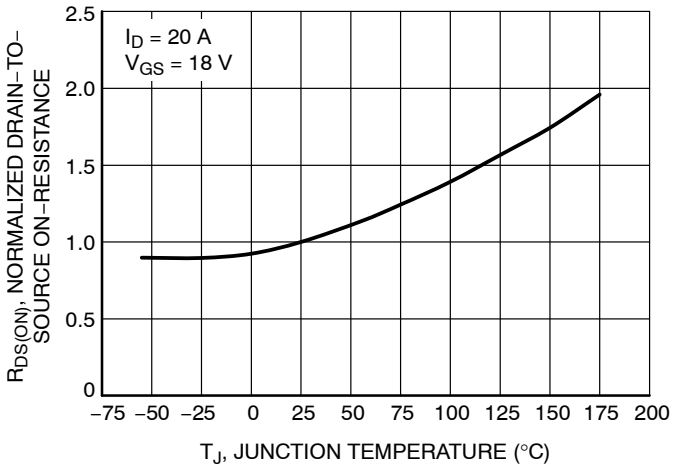



**Figure 3. On−Resistance Variation with Temperature**

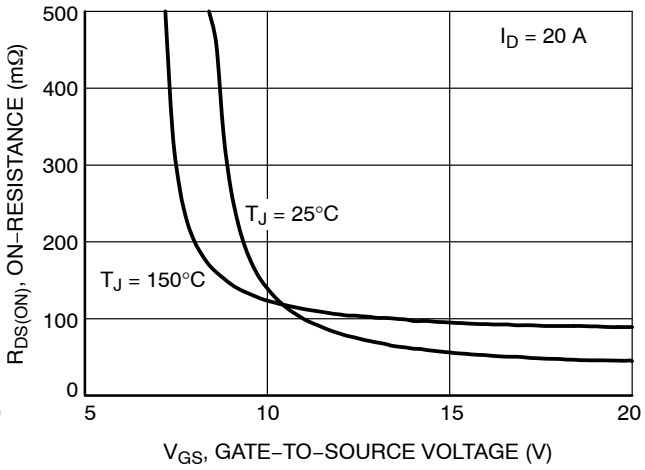



**Figure 4. On−Resistance vs. Gate−to−Source Voltage**

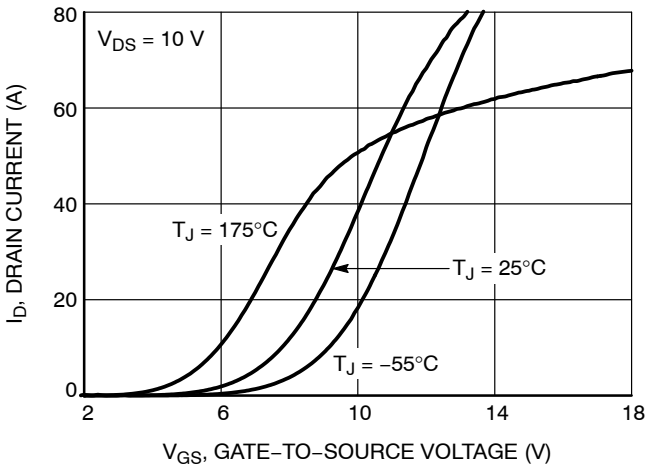



**Figure 5. Transfer Characteristics**

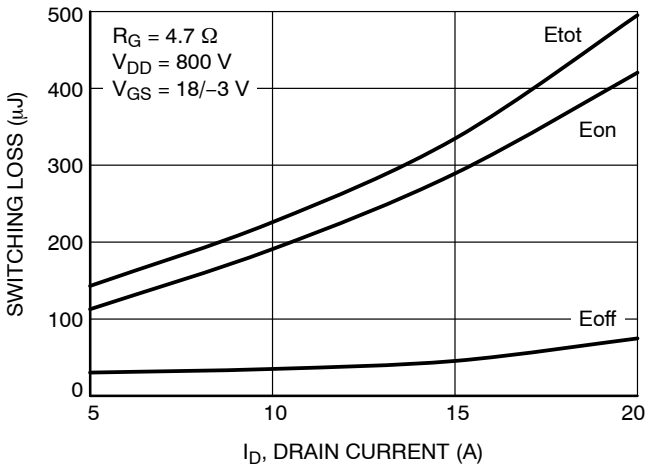



**Figure 6. Switching Loss vs. Drain Current**

## TYPICAL CHARACTERISTICS

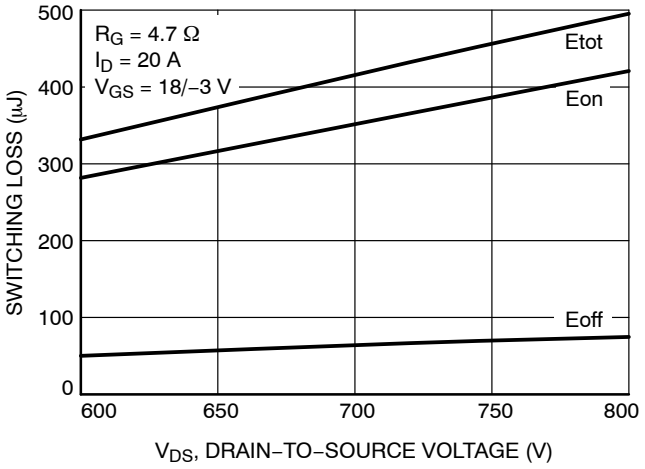



**Figure 7. Switching Loss vs. Drain−to−Source Voltage**

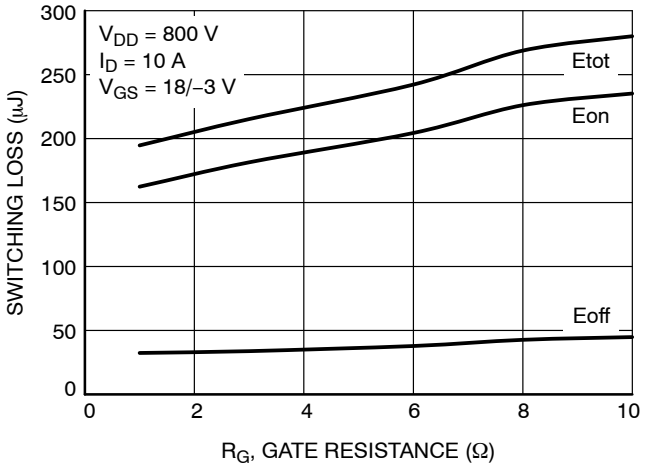



**Figure 8. Switching Loss vs. Gate Resistance**

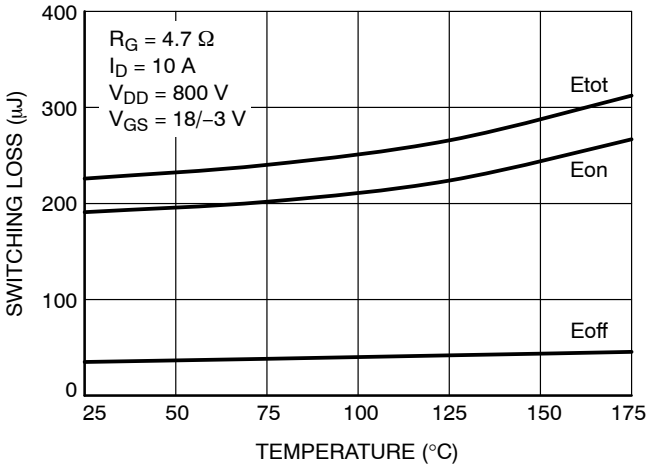



**Figure 9. Switching Loss vs. Temperature**

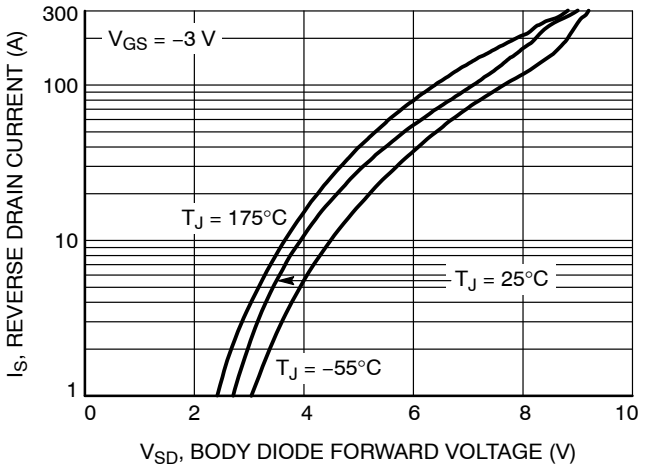



**Figure 10. Reverse Drain Current vs. Body Diode Forward Voltage**

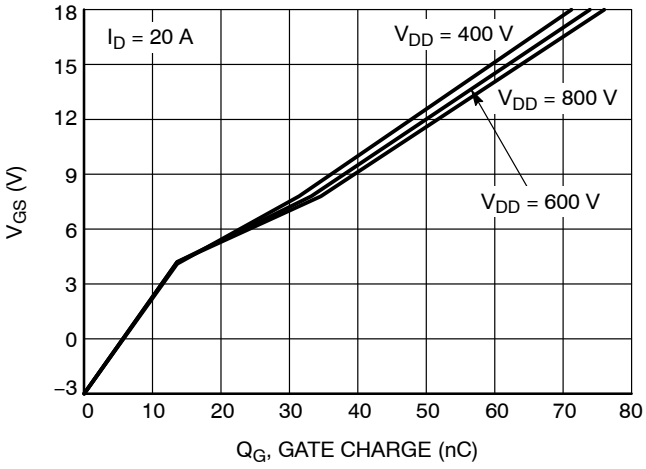



**Figure 11. Gate−to−Source Voltage vs. Total Charge**

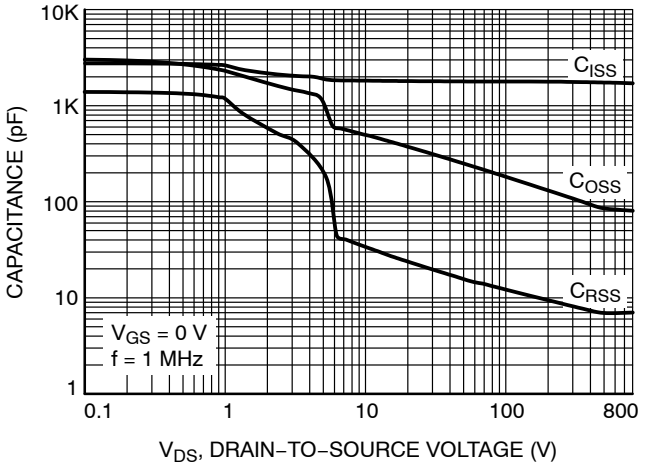



**Figure 12. Capacitance vs. Drain−to−Source Voltage**

## TYPICAL CHARACTERISTICS

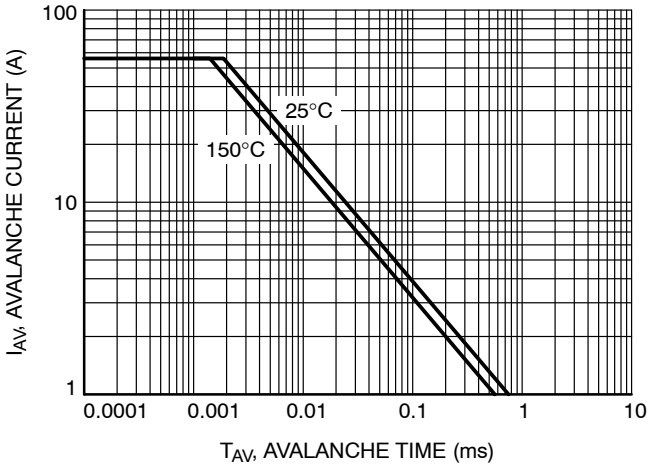



**Figure 13. Unclamped Inductive Switching Capability**

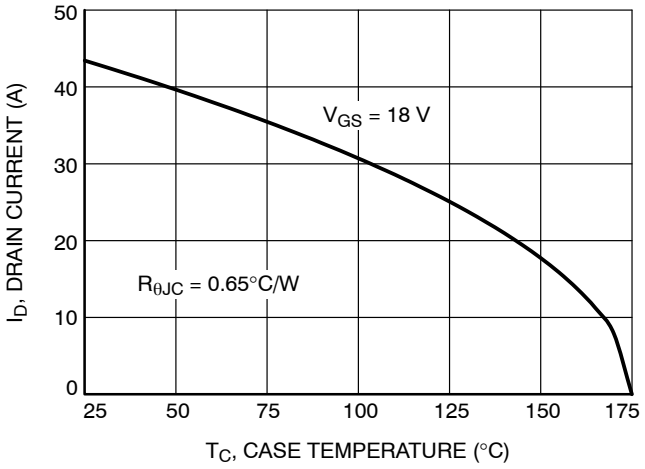



**Figure 14. Maximum Continuous Drain Current vs. Case Temperature**

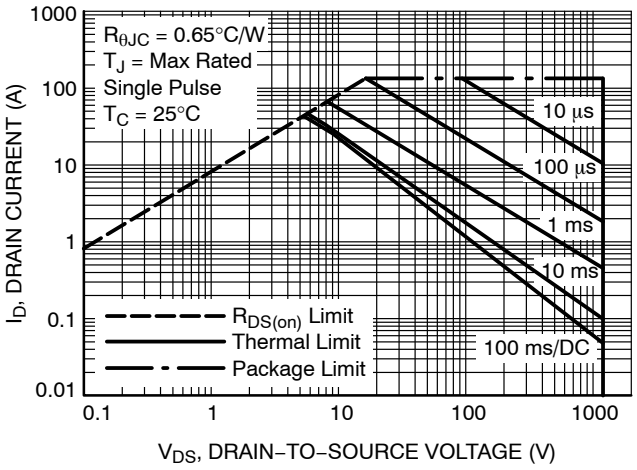



**Figure 15. Safe Operating Area**

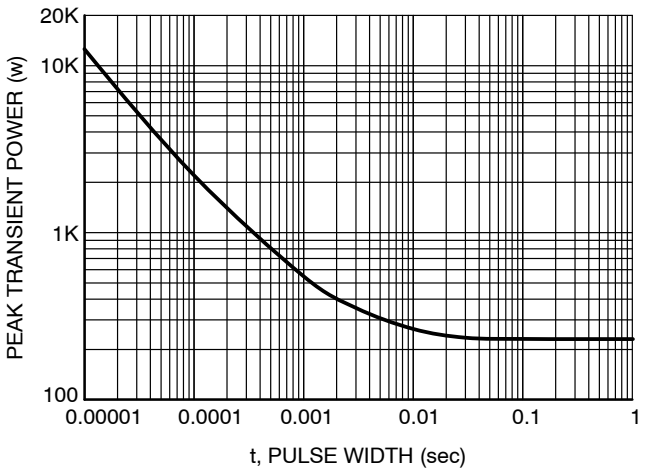



**Figure 16. Single Pulse Maximum Power Dissipation**

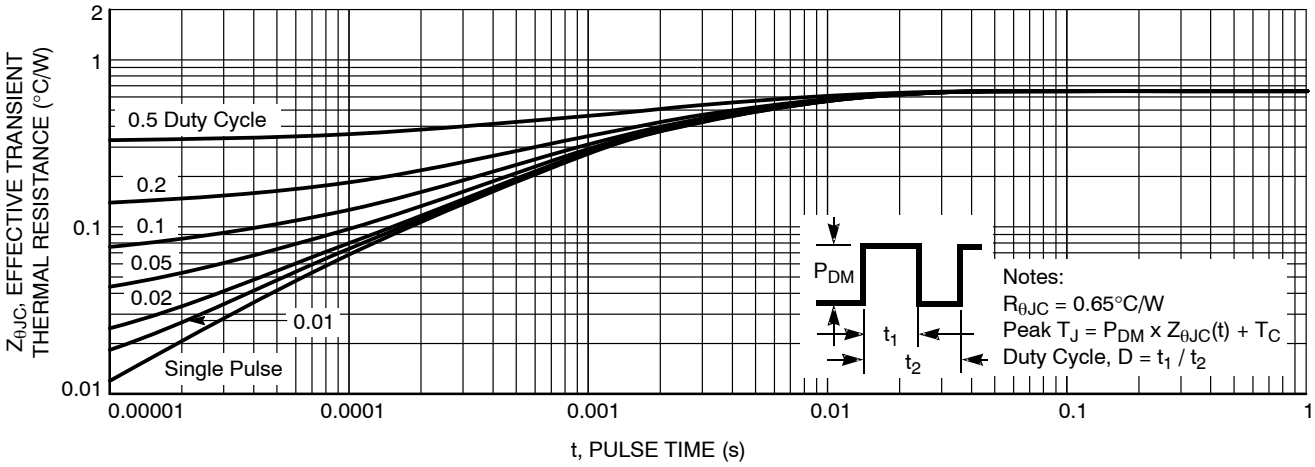
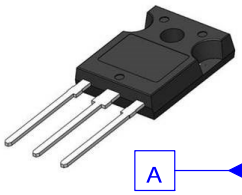
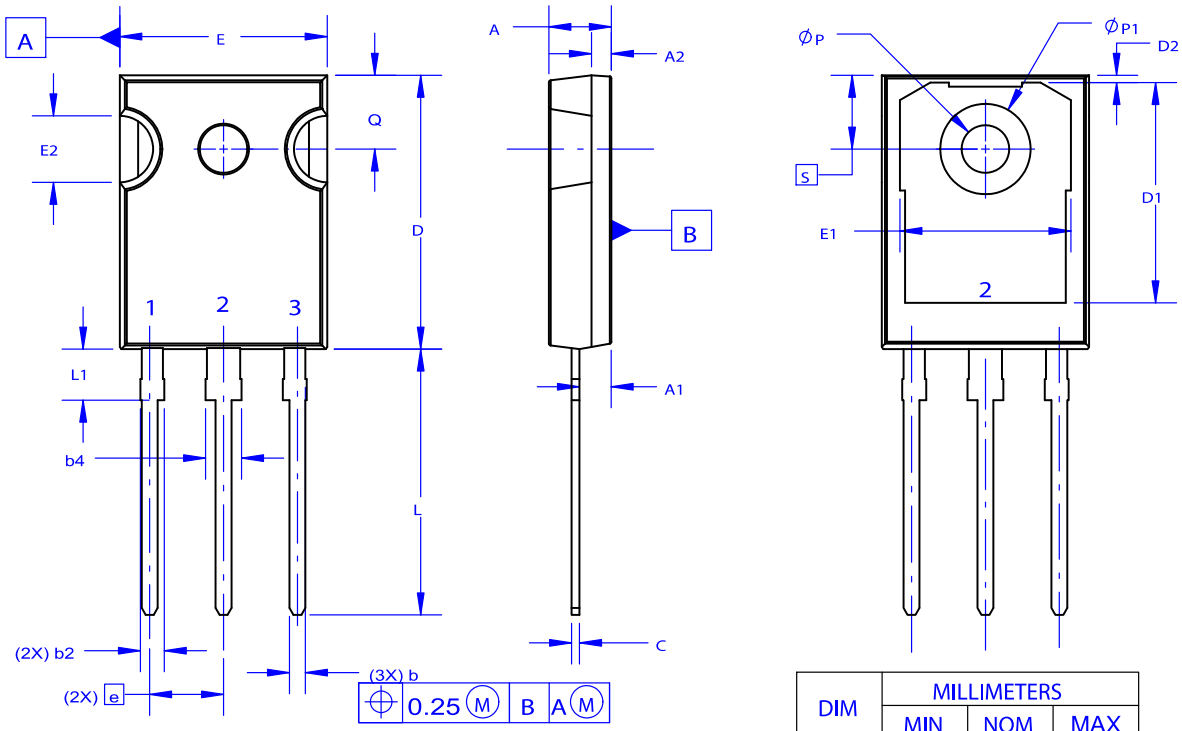



**Figure 17. Junction−to−Case Transient Thermal Response**

**TO−247−3LD**
CASE 340CX
ISSUE A

DATE 06 JUL 2020






NOTES: UNLESS OTHERWISE SPECIFIED.

A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.58 | 4.70 | 4.82 |
| A1 | 2.20 | 2.40 | 2.60 |
| A2 | 1.40 | 1.50 | 1.60 |
| D | 20.32 | 20.57 | 20.82 |
| E | 15.37 | 15.62 | 15.87 |
| E2 | 4.96 | 5.08 | 5.20 |
| e | ~ | 5.56 | ~ |
| L | 19.75 | 20.00 | 20.25 |
| L1 | 3.69 | 3.81 | 3.93 |
| ØP | 3.51 | 3.58 | 3.65 |
| Q | 5.34 | 5.46 | 5.58 |
| S | 5.34 | 5.46 | 5.58 |
| b | 1.17 | 1.26 | 1.35 |
| b2 | 1.53 | 1.65 | 1.77 |
| b4 | 2.42 | 2.54 | 2.66 |
| c | 0.51 | 0.61 | 0.71 |
| D1 | 13.08 | ~ | ~ |
| D2 | 0.51 | 0.93 | 1.35 |
| E1 | 12.81 | ~ | ~ |
| ØP1 | 6.60 | 6.80 | 7.00 |

## GENERIC MARKING DIAGRAM*


XXXXX = 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.

| | | |
|---|---|---|
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| **DESCRIPTION:** | **TO−247−3LD** | **PAGE 1 OF 1** |

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