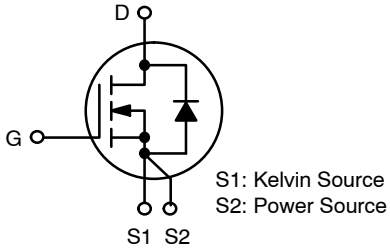
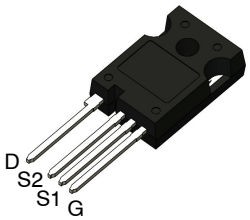
# Silicon Carbide (SiC) MOSFET – EliteSiC, 40 mohm, 1200 V, M1, TO-247-4L

# NTH4L040N120SC1

| $V_{(BR)DSS}$ | $R_{DS(ON)}$ MAX | $I_D$ MAX |
|---|---|---|
| 1200 V | 56 mΩ @ 20 V | 58 A |




**N−CHANNEL MOSFET**




**TO−247−4LD**
**CASE 340CJ**

### Features

- Typ. $R_{DS(on)}$ = 40 mΩ
- Ultra Low Gate Charge ($Q_{G(tot)}$ = 106 nC)
- High Speed Switching with Low Capacitance ($C_{oss}$ = 137 pF)
- 100% Avalanche Tested
- $T_J$ = 175°C
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb−Free 2LI (on second level interconnection)

### Typical Applications

- UPS
- DC-DC Converter
- Boost Inverter

### MARKING DIAGRAM

A = Assembly Location
Y = Year
WW = Work Week
ZZ = Lot Traceability
NTH4L040N120SC1 = Specific Device Code

### 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 | | | $V_{GS}$ | −15/+25 | V |
| Recommended Operation Values of Gate−to−Source Voltage | | $T_C$ < 175°C | $V_{GSop}$ | −5/+20 | V |
| Continuous Drain Current (Note 2) | Steady State | $T_C$ = 25°C | $I_D$ | 58 | A |
| Power Dissipation (Note 2) | | | $P_D$ | 319 | W |
| Continuous Drain Current (Notes 1, 2) | Steady State | $T_C$ = 100°C | $I_D$ | 41 | A |
| Power Dissipation (Notes 1, 2) | | | $P_D$ | 160 | W |
| Pulsed Drain Current (Note 3) | $T_A$ = 25°C | | $I_{DM}$ | 232 | A |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | −55 to +175 | °C |
| Source Current (Body Diode) | | | $I_S$ | 32 | A |
| Single Pulse Drain−to−Source Avalanche Energy ($I_{L(pk)}$ = 34 A, L = 1 mH) (Note 4) | | | $E_{AS}$ | 578 | mJ |
| Maximum Lead Temperature for Soldering (1/8″ from case for 5 s) | | | $T_L$ | 300 | °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. JA is constant value to follow guide table of LV/HV discrete final datasheet generation.
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. EAS of 578 mJ is based on starting $T_J$ = 25°C; L = 1 mH, $I_{AS}$ = 34 A, $V_{DD}$ = 120 V, $V_{GS}$ = 20 V.

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| NTH4L040N120SC1 | TO−247−4LD | 30 Units / Tube |

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**Table 1. THERMAL RESISTANCE MAXIMUM RATINGS**

| Parameter | Symbol | Max | Unit |
|---|---|---|---|
| Junction−to−Case − Steady State (Note 2) | $R_{\theta JC}$ | 0.47 | °C/W |
| Junction−to−Ambient − Steady State (Notes 1, 2) | $R_{\theta JA}$ | 40 | |

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

| 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 | | 1200 | − | − | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | $I_D$ = 1 mA, referenced to 25°C | | − | 0.45 | − | V/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 1200 V | $T_J$ = 25°C | − | − | 100 | μA |
| | | | $T_J$ = 175°C | − | − | 1 | mA |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = +25/−15 V, $V_{DS}$ = 0 V | | − | − | ±1 | μA |
| **ON CHARACTERISTICS** (Note 3) | | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 10 mA | | 1.8 | 3 | 4.3 | V |
| Recommended Gate Voltage | $V_{GOP}$ | | | −5 | − | +20 | V |
| Drain−to−Source On Resistance | $R_{DS(on)}$ | $V_{GS}$ = 20 V, $I_D$ = 35 A, $T_J$ = 25°C | | − | 40 | 56 | mΩ |
| | | $V_{GS}$ = 20 V, $I_D$ = 35 A, $T_J$ = 175°C | | − | 70 | 100 | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 20 V, $I_D$ = 35 A | | − | 20 | − | S |
| **CHARGES, CAPACITANCES & GATE RESISTANCE** | | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$ = 0 V, f = 1 MHz, $V_{DS}$ = 800 V | | − | 1762 | − | pF |
| Output Capacitance | $C_{OSS}$ | | | − | 137 | − | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | − | 11 | − | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = −5/20 V, $V_{DS}$ = 600 V, $I_D$ = 47 A | | − | 106 | − | nC |
| Threshold Gate Charge | $Q_{G(TH)}$ | | | − | 16 | − | |
| Gate−to−Source Charge | $Q_{GS}$ | | | − | 34 | − | |
| Gate−to−Drain Charge | $Q_{GD}$ | | | − | 26 | − | |
| Gate−Resistance | $R_G$ | f = 1 MHz | | − | 2.4 | − | Ω |
| **SWITCHING CHARACTERISTICS, VGS = 10 V** | | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −5/20 V, $V_{DS}$ = 800 V, $I_D$ = 47 A, $R_G$ = 4.7 Ω Inductive load | | − | 17 | 30 | ns |
| Rise Time | $t_r$ | | | − | 20 | 36 | |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | | − | 32 | 51 | |
| Fall Time | $t_f$ | | | − | 10 | 20 | |
| Turn−On Switching Loss | $E_{ON}$ | | | − | 411 | − | μJ |
| Turn−Off Switching Loss | $E_{OFF}$ | | | − | 205 | − | |
| Total Switching Loss | $E_{tot}$ | | | − | 616 | − | |
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | | |
| Continuous Drain−Source Diode Forward Current | $I_{SD}$ | $V_{GS}$ = −5 V, $T_J$ = 25°C | | − | − | 32 | A |
| Pulsed Drain−Source Diode Forward Current (Note 3) | $I_{SDM}$ | | | − | − | 232 | |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = −5 V, $I_{SD}$ = 17.5 A, $T_J$ = 25°C | | − | 3.7 | − | V |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS}$ = −5/20 V, $I_{SD}$ = 47 A, $dI_S/dt$ = 1000 A/μs | | − | 24 | − | ns |
| Reverse Recovery Charge | $Q_{RR}$ | | | − | 124.8 | − | nC |

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

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | |
| Reverse Recovery Energy | $E_{REC}$ | $V_{GS}$ = −5/20 V, $I_{SD}$ = 47 A, $dI_S/dt$ = 1000 A/μs | – | 8.4 | – | μJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | – | 10.4 | – | A |
| Charge Time | Ta | | – | 12.4 | – | ns |
| Discharge Time | Tb | | – | 11.6 | – | 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

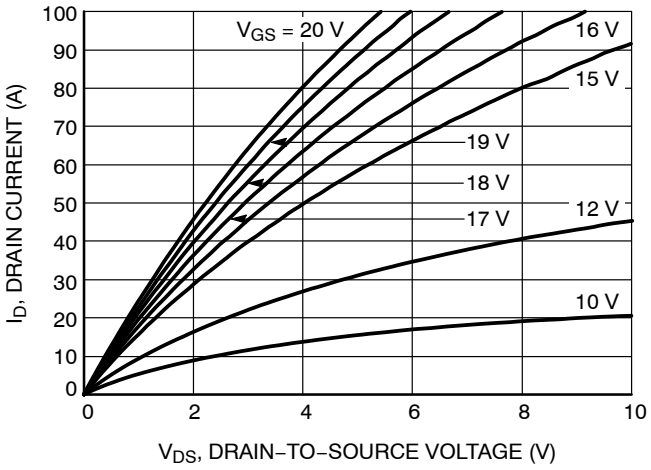



**Figure 1. On−Region Characteristics**

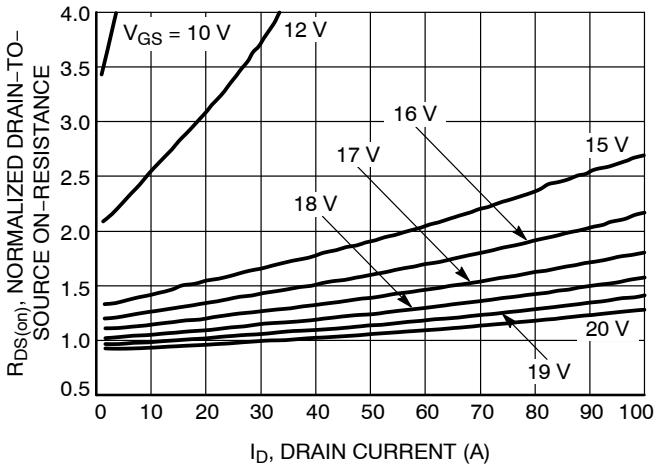



**Figure 2. Normalized On−Resistance vs. Drain Current and Gate Voltage**

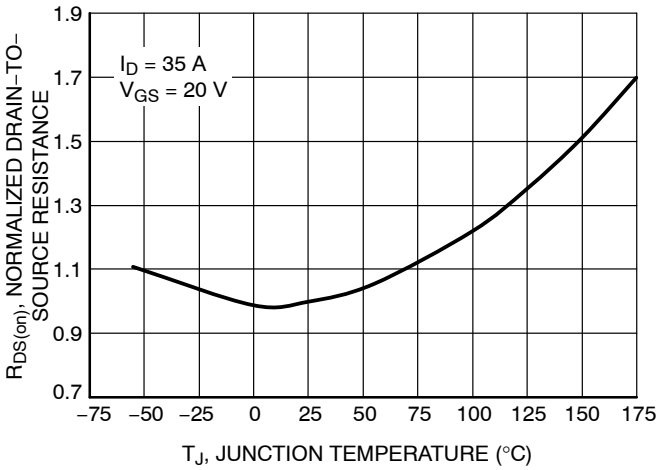



**Figure 3. On−Resistance Variation with Temperature**

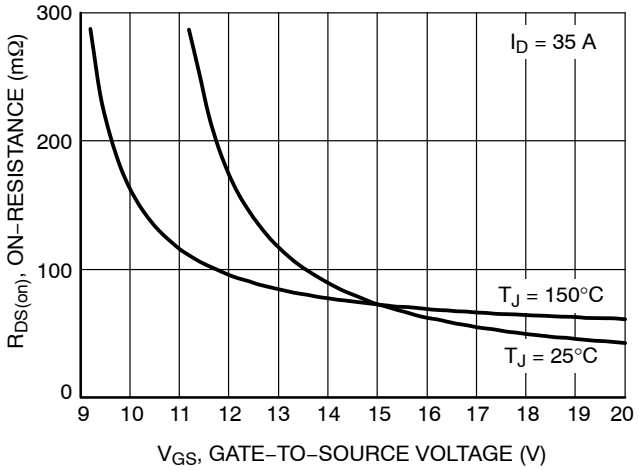



**Figure 4. On−Resistance vs. Gate−to−Source Voltage**

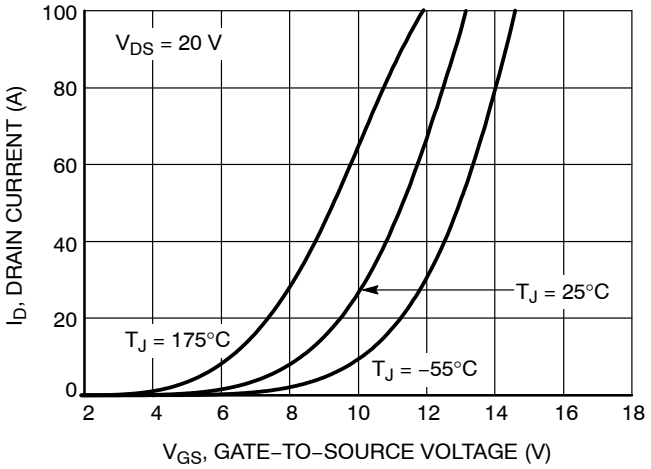



**Figure 5. Transfer Characteristics**

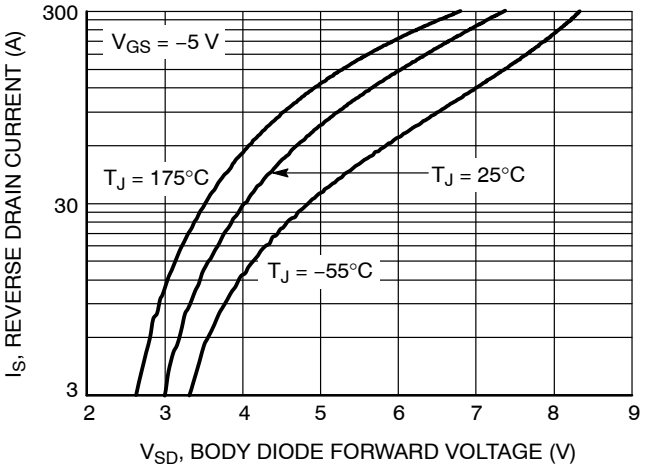



**Figure 6. Diode Forward Voltage vs. Current**

## TYPICAL CHARACTERISTICS (CONTINUED)

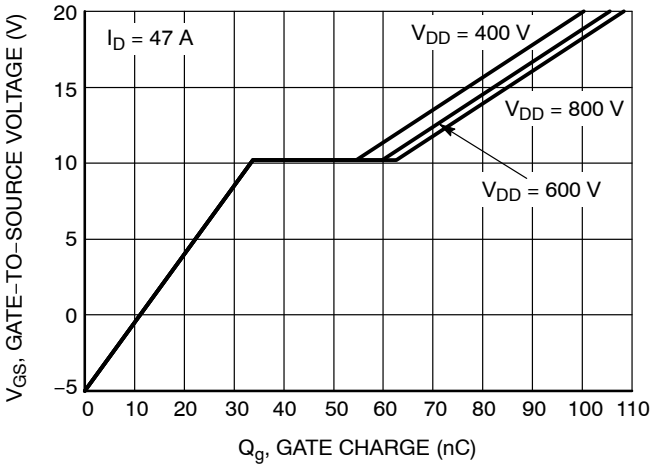



**Figure 7. Gate−to−Source Voltage vs. Total Charge**

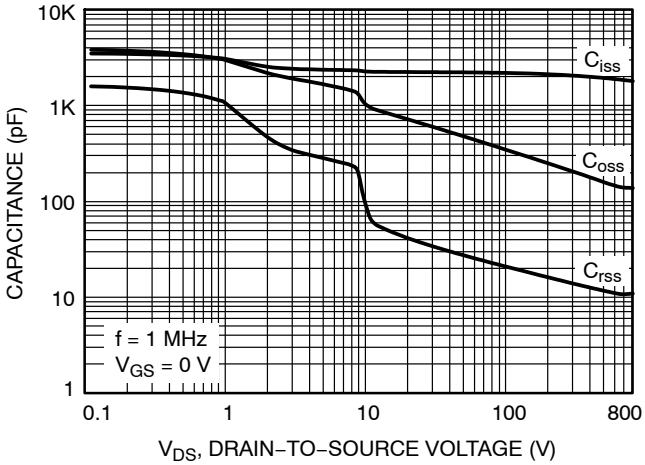



**Figure 8. Capacitance vs. Drain−to−Source Voltage**

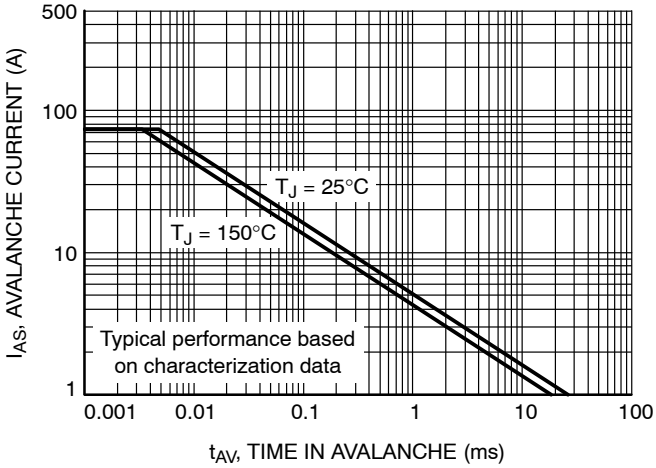



**Figure 9. Unclamped Inductive Switching Capability**

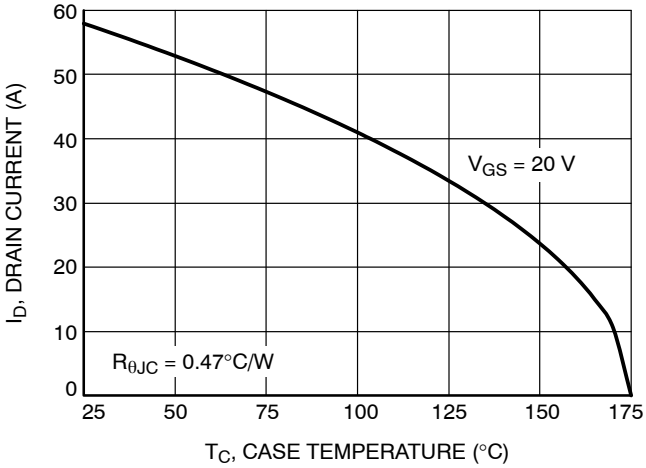



**Figure 10. Maximum Continuous Drain Current vs. Case Temperature**

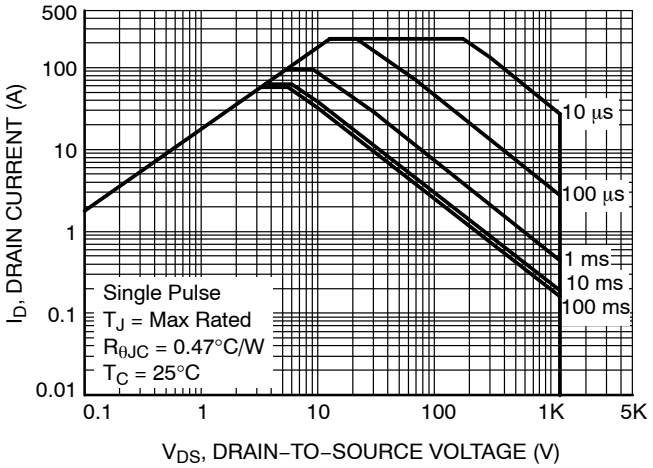



**Figure 11. Safe Operating Area**

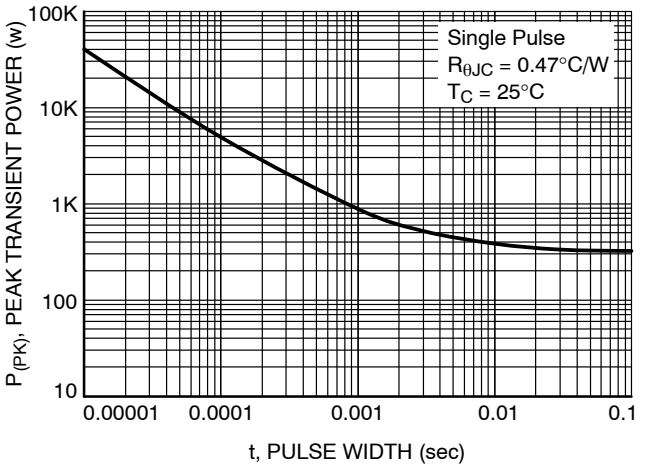



**Figure 12. Single Pulse Maximum Power Dissipation**

## TYPICAL CHARACTERISTICS (CONTINUED)

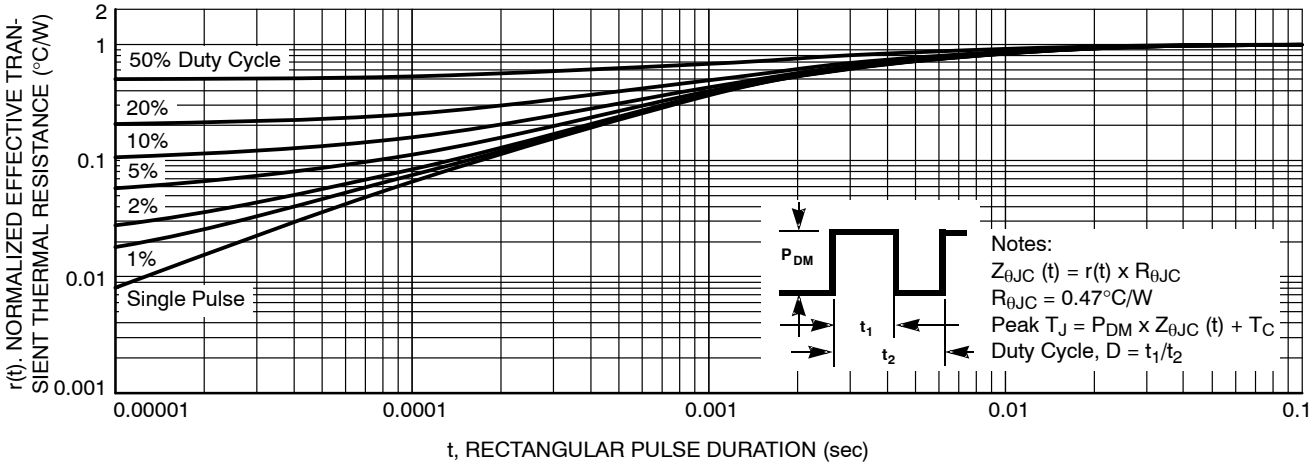
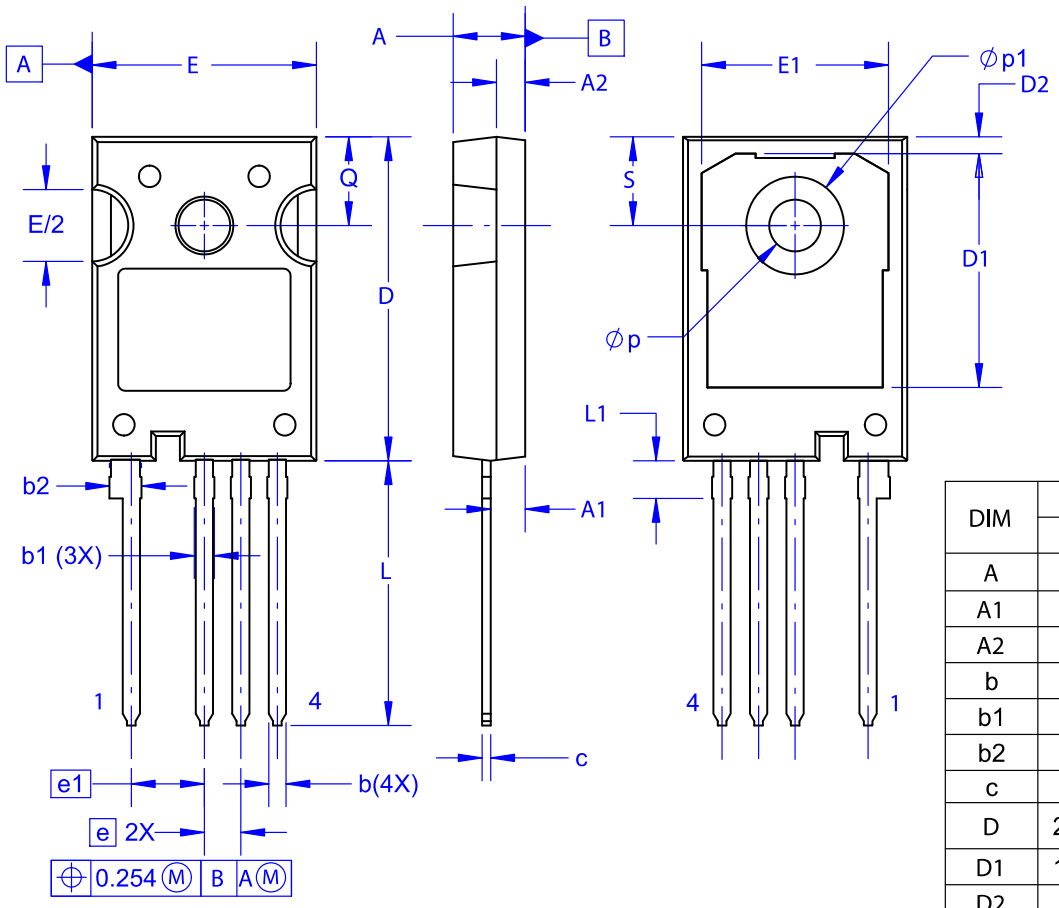



**Figure 13. Junction−to−Ambient Thermal Response**

**TO−247−4LD**
CASE 340CJ
ISSUE A

DATE 16 SEP 2019




NOTES:

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C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DRAWING CONFORMS TO ASME Y14.5-2009.

| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.10 | 2.40 | 2.70 |
| A2 | 1.80 | 2.00 | 2.20 |
| b | 1.07 | 1.20 | 1.33 |
| b1 | 1.20 | 1.40 | 1.60 |
| b2 | 2.02 | 2.22 | 2.42 |
| c | 0.50 | 0.60 | 0.70 |
| D | 22.34 | 22.54 | 22.74 |
| D1 | 16.00 | 16.25 | 16.50 |
| D2 | 0.97 | 1.17 | 1.37 |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 12.80 | 13.00 | 13.20 |
| E/2 | 4.80 | 5.00 | 5.20 |
| L | 18.22 | 18.42 | 18.62 |
| L1 | 2.42 | 2.62 | 2.82 |
| p | 3.40 | 3.60 | 3.80 |
| p1 | 6.60 | 6.80 | 7.00 |
| Q | 5.97 | 6.17 | 6.37 |
| S | 5.97 | 6.17 | 6.37 |

| | | |
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