# Silicon Carbide (SiC) MOSFET – 40 mohm, 1200 V, M1, TO-247-3L

# NVHL040N120SC1

| $V_{(BR)DSS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX |
|---|---|---|
| 1200 V | 56 mΩ @ 20 V | 60 A |

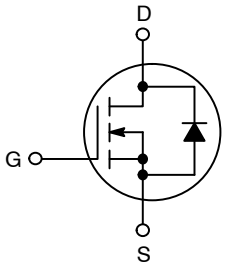
### Features

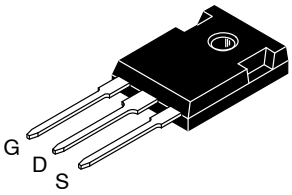
- Typ. $R_{DS(on)}$ = 40 mΩ
- Ultra Low Gate Charge (typ. $Q_{G(tot)}$ = 106 nC)
- Low Effective Output Capacitance (typ. $C_{oss}$ = 140 pF)
- 100% UIL Tested
- AEC−Q101 Qualified and PPAP Capable
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb−Free 2LI (on second level interconnection)

### Typical Applications

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

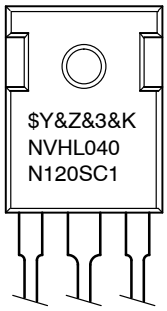
### N−CHANNEL MOSFET




**TO−247−3LD**
**CASE 340CX**

### MARKING DIAGRAM




$Y = **onsemi** Logo
&Z = Assembly Plant Code
&3 = Data Code (Year & Week)
&K = Lot
NVHL040N120SC1 = 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 $R_{\theta JC}$ | Steady State | $T_C$ = 25°C | $I_D$ | 60 | A |
| Power Dissipation $R_{\theta JC}$ | | | $P_D$ | 348 | W |
| Continuous Drain Current $R_{\theta JC}$ | Steady State | $T_C$ = 100°C | $I_D$ | 42 | A |
| Power Dissipation $R_{\theta JC}$ | | | $P_D$ | 174 | W |
| Pulsed Drain Current (Note 2) | $T_A$ = 25°C | | $I_{DM}$ | 240 | A |
| Single Pulse Surge Drain Current Capability | $T_A$ = 25°C, $t_p$ = 10 μs, $R_G$ = 4.7 Ω | | $I_{DSC}$ | 416 | A |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | −55 to +175 | °C |
| Source Current (Body Diode) | | | $I_S$ | 34 | A |
| Single Pulse Drain−to−Source Avalanche Energy ($I_{L(pk)}$ = 23 A, L = 1 mH) (Note 3) | | | $E_{AS}$ | 613 | mJ |

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.

### THERMAL RESISTANCE MAXIMUM RATINGS

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Junction−to−Case (Note 1) | $R_{\theta JC}$ | 0.43 | °C/W |
| Junction−to−Ambient (Note 1) | $R_{\theta JA}$ | 40 | °C/W |

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. $E_{AS}$ of 613 mJ is based on starting $T_J$ = 25°C; L = 1 mH, $I_{AS}$ = 35 A, $V_{DD}$ = 120 V, $V_{GS}$ = 20 V.

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| NVHL040N120SC1 | TO247−3L | 30 Units / Tube |

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## ELECTRICAL CHARACTERISTICS

| 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 | 1200 | – | – | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | $I_D$ = 1 mA, referenced to 25°C | – | 450 | – | mV/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 1200 V, $T_J$ = 25°C | – | – | 100 | μA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 1200 V, $T_J$ = 175°C | – | – | 250 | |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = +25/−15 V, $V_{DS}$ = 0 V | – | – | ±1 | μA |
| **ON CHARACTERISTICS** | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 10 mA | 1.8 | 2.97 | 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 | – | 39 | 56 | mΩ |
| | | $V_{GS}$ = 20 V, $I_D$ = 35 A, $T_J$ = 175°C | – | 67 | 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 | – | 1781 | – | pF |
| Output Capacitance | $C_{OSS}$ | | – | 140 | – | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | – | 12 | – | |
| 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 | – | 2.2 | – | Ω |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| 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 | – | 18 | – | ns |
| Rise Time | $t_r$ | | – | 41 | – | |
| Turn−Off Delay Time | $t_{d(off)}$ | | – | 33 | – | |
| Fall Time | $t_f$ | | – | 10.4 | – | |
| Turn-On Switching Loss | $E_{ON}$ | | – | 1003 | – | μJ |
| Turn-Off Switching Loss | $E_{OFF}$ | | – | 247 | – | |
| Total Switching Loss | $E_{TOT}$ | | – | 1248 | – | |
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | |
| Continuous Drain−to−Source Diode Forward Current | $I_{SD}$ | $V_{GS}$ = −5 V, $T_J$ = 25°C | – | – | 34 | A |
| Pulsed Drain−to−Source Diode Forward Current (Note 2) | $I_{SDM}$ | $V_{GS}$ = −5 V, $T_J$ = 25°C | – | – | 240 | A |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = −5 V, $I_{SD}$ = 17.5 A, $T_J$ = 25°C | – | 3.8 | – | 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 | $Q_{RR}$ | | – | 125 | – | nC |
| Reverse Recovery Energy | $E_{REC}$ | | – | 8.5 | – | μJ |
| Peak Reverse Recovery Current | $I_{RRM}$ | | – | 10.4 | – | A |
| Charge Time | $t_a$ | | – | 12.4 | – | ns |
| Discharge Time | $t_b$ | | – | 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

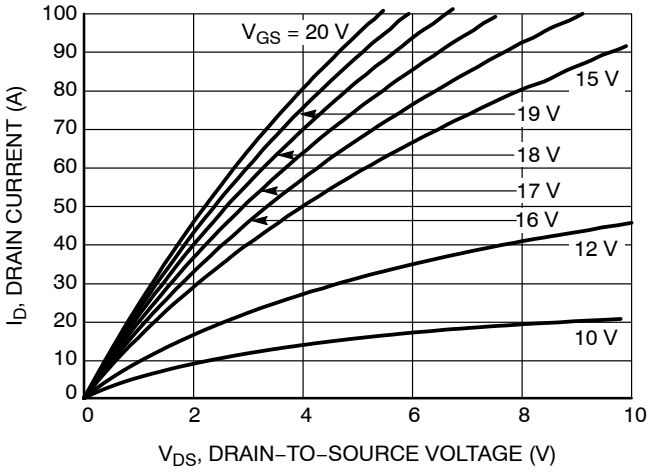



**Figure 1. On−Region Characteristics**

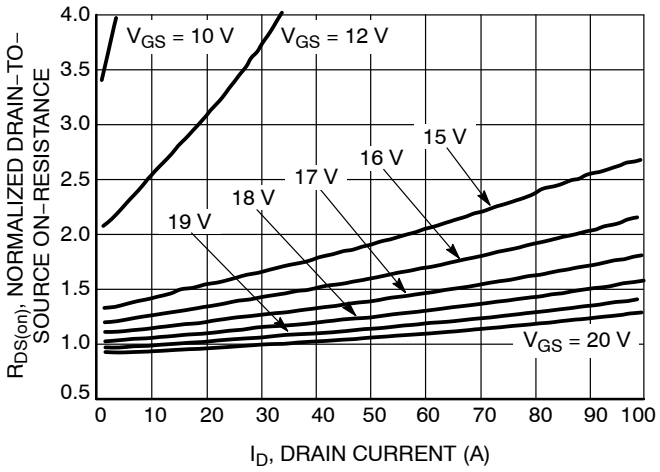



**Figure 2. Normalized On−Resistance vs. Drain Current and Gate Voltage**

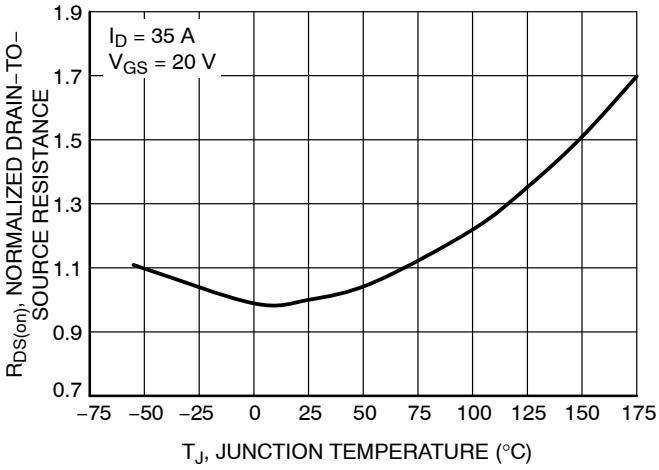



**Figure 3. On−Resistance Variation with Temperature**

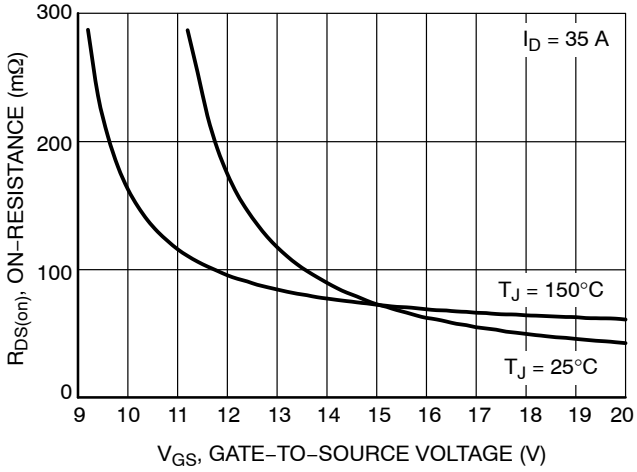



**Figure 4. On−Resistance vs. Gate−to−Source Voltage**

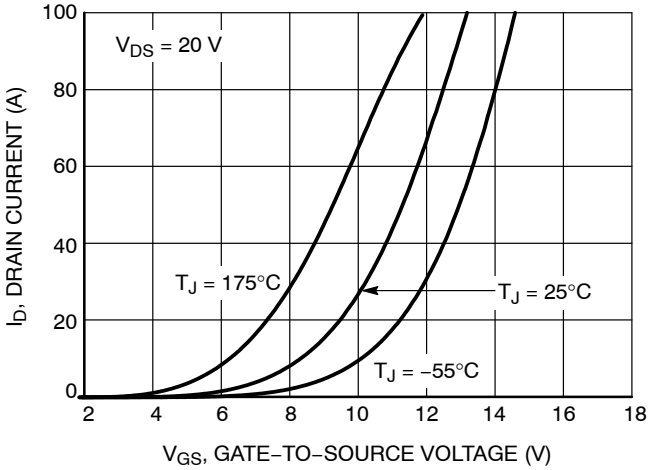



**Figure 5. Transfer Characteristics**

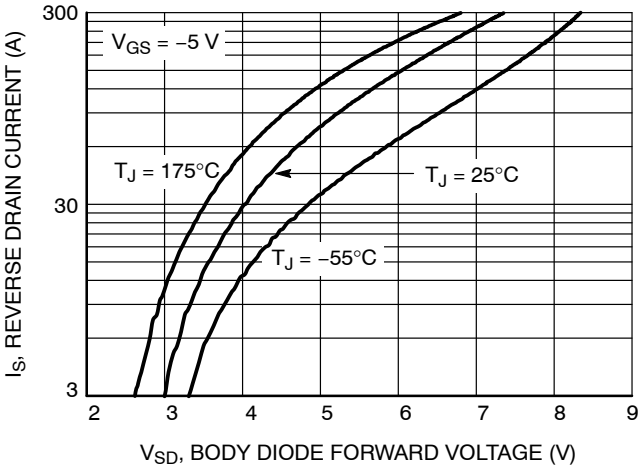



**Figure 6. Diode Forward Voltage vs. Current**

## TYPICAL CHARACTERISTICS (continued)

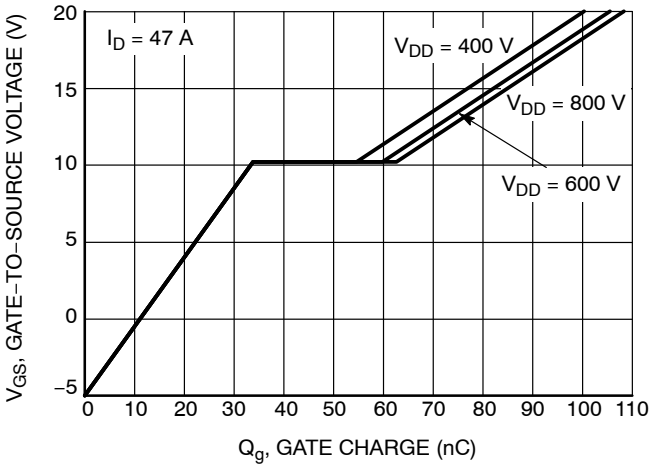



**Figure 7. Gate−to−Source Voltage vs. Total Charge**

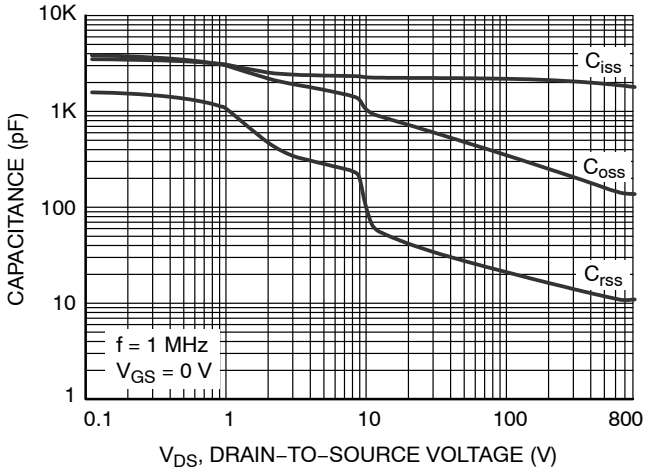



**Figure 8. Capacitance vs. Drain−to−Source Voltage**

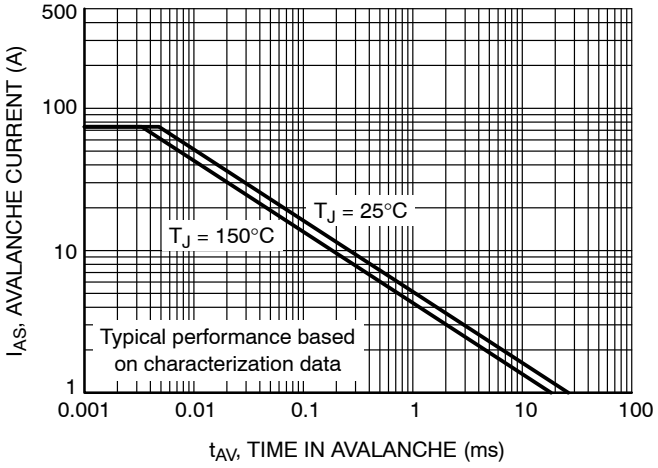



**Figure 9. Unclamped Inductive Switching Capability**

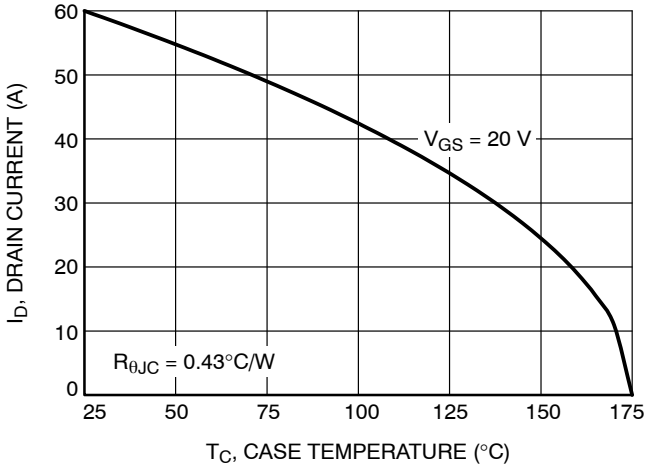



**Figure 10. Maximum Continuous Drain Current vs. Case Temperature**

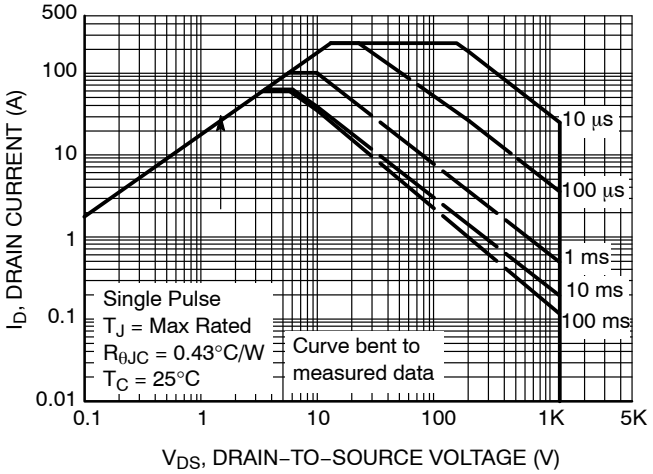



**Figure 11. Safe Operating Area**

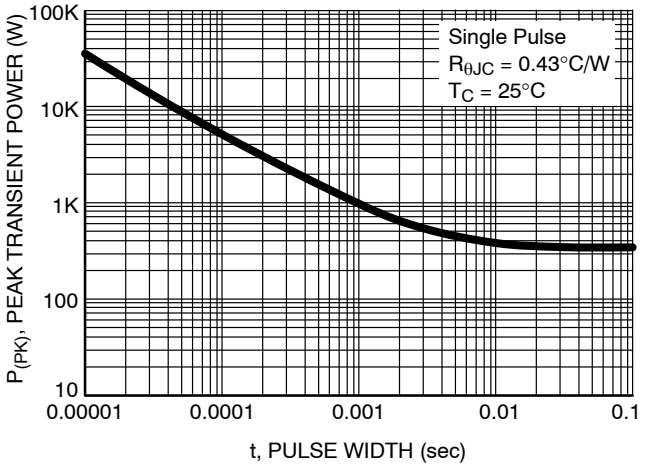



**Figure 12. Single Pulse Maximum Power Dissipation**

## TYPICAL CHARACTERISTICS (continued)

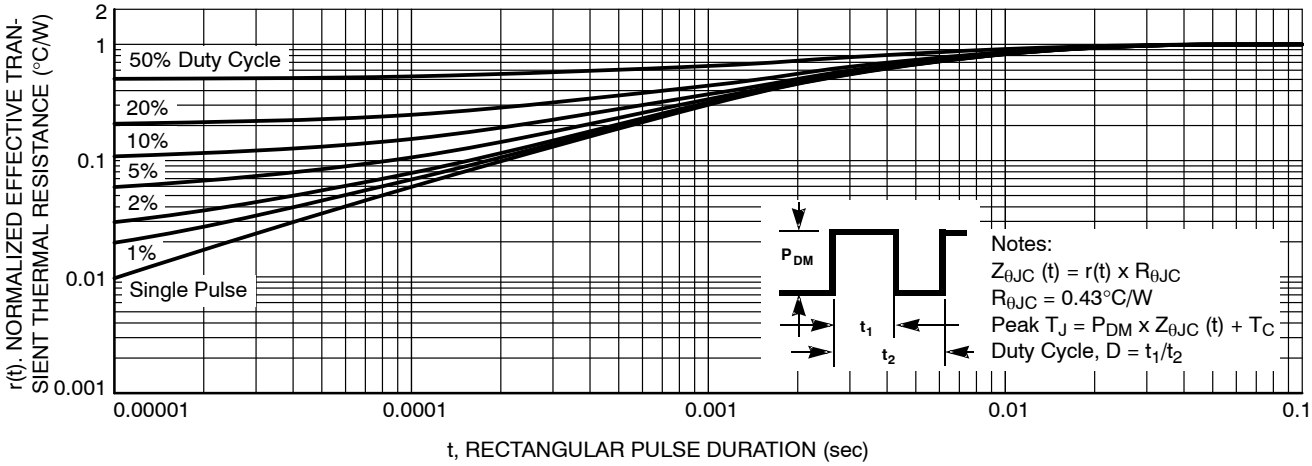
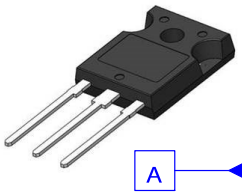
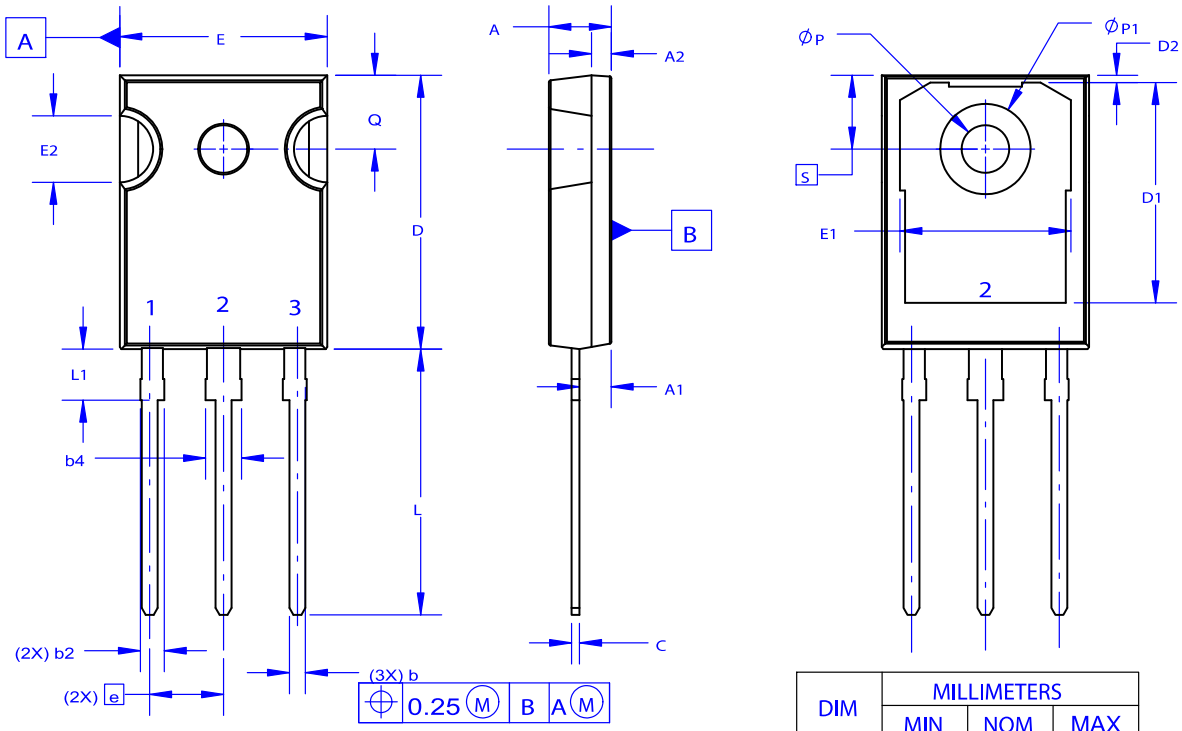



**Figure 13. Junction−to−Ambient Thermal Response**

**TO−247−3LD**
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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