

# Silicon Carbide (SiC) MOSFET – EliteSiC, 60 mohm, 900 V, M2, TO-247-4L

## NTH4L060N090SC1

### Features

- Typ.  $R_{DS(on)}$  = 60 m $\Omega$  @  $V_{GS}$  = 15 V  
Typ.  $R_{DS(on)}$  = 43 m $\Omega$  @  $V_{GS}$  = 18 V
- Ultra Low Gate Charge (typ.  $Q_{G(tot)}$  = 87 nC)
- Low Effective Output Capacitance (typ.  $C_{oss}$  = 113 pF)
- 100% UIL Tested
- 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

### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter   | Symbol                                    | Value       | Unit             |
|---|---|-------------|------------------|
| Drain-to-Source Voltage   | $V_{DSS}$                                 | 900         | V                |
| Gate-to-Source Voltage  | $V_{GS}$                                  | +22/-8      | V                |
| Recommended Operation Values of Gate-to-Source Voltage  | $T_C < 175^\circ\text{C}$<br>$V_{GSop}$   | -5/+15      | V                |
| Continuous Drain Current $R_{\theta JC}$  | Steady State<br>$T_C = 25^\circ\text{C}$  | $I_D$       | 46 A             |
| Power Dissipation $R_{\theta JC}$   |   | $P_D$       | 221 W            |
| Continuous Drain Current $R_{\theta JC}$  | Steady State<br>$T_C = 100^\circ\text{C}$ | $I_D$       | 32 A             |
| Power Dissipation $R_{\theta JC}$   |   | $P_D$       | 110 W            |
| Pulsed Drain Current (Note 2)   | $T_A = 25^\circ\text{C}$                  | $I_{DM}$    | 211 A            |
| Operating Junction and Storage Temperature Range  | $T_J, T_{stg}$                            | -55 to +175 | $^\circ\text{C}$ |
| Source Current (Body Diode)   | $I_S$                                     | 22          | A                |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 18\text{ A}, L = 1\text{ mH}$ ) (Note 3) | $E_{AS}$                                  | 162         | mJ               |

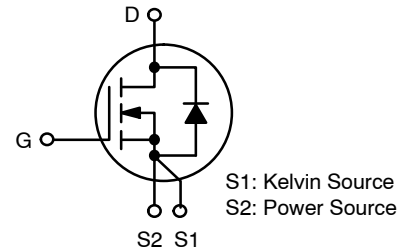
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL RESISTANCE MAXIMUM RATINGS

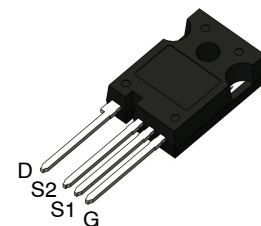
| Parameter                    | Symbol          | Value | Unit               |
|------------------------------|-----------------|-------|--------------------|
| Junction-to-Case (Note 1)    | $R_{\theta JC}$ | 0.68  | $^\circ\text{C/W}$ |
| Junction-to-Ambient (Note 1) | $R_{\theta JA}$ | 40    | $^\circ\text{C/W}$ |

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 162 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 18\text{ A}$ ,  $V_{DD} = 100\text{ V}$ ,  $V_{GS} = 15\text{ V}$ .

| $V_{(BR)DSS}$ | $R_{DS(on)}$ MAX     | $I_D$ MAX |
|---------------|----------------------|-----------|
| 900 V         | 84 m $\Omega$ @ 15 V | 46 A      |



N-CHANNEL MOSFET



TO-247-4L  
CASE 340CJ

### MARKING DIAGRAM



|              |                        |
|--------------|------------------------|
| H4L060090SC1 | = Specific Device Code |
| A            | = Assembly Site        |
| Y            | = Year of Production   |
| WW           | = Work Week Number     |
| ZZ           | = Assembly Lot Number  |

### ORDERING INFORMATION

| Device          | Package   | Shipping        |
|-----------------|-----------|-----------------|
| NTH4L060N090SC1 | TO-247-4L | 30 Units / Tube |

# NTH4L060N090SC1

## ELECTRICAL CHARACTERISTICS

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|   |                   |   |     |     |         |                      |
|---|-------------------|---|-----|-----|---------|----------------------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$                              | 900 |     |         | V                    |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | $I_D = 1\text{ mA}$ , referenced to $25^\circ\text{C}$                |     | 574 |         | mV/ $^\circ\text{C}$ |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}, V_{DS} = 900\text{ V}, T_J = 25^\circ\text{C}$  |     |     | 100     | $\mu\text{A}$        |
|   |                   | $V_{GS} = 0\text{ V}, V_{DS} = 900\text{ V}, T_J = 175^\circ\text{C}$ |     |     | 250     |                      |
| Gate-to-Source Leakage Current                            | $I_{GSS}$         | $V_{GS} = +22/-8\text{ V}, V_{DS} = 0\text{ V}$                       |     |     | $\pm 1$ | $\mu\text{A}$        |

### ON CHARACTERISTICS

|                               |              |  |     |     |     |            |
|-------------------------------|--------------|--|-----|-----|-----|------------|
| Gate Threshold Voltage        | $V_{GS(th)}$ | $V_{GS} = V_{DS}, I_D = 5\text{ mA}$                               | 1.8 | 2.7 | 4.3 | V          |
| Recommended Gate Voltage      | $V_{GOP}$    |  | -5  |     | +15 | V          |
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 15\text{ V}, I_D = 20\text{ A}, T_J = 25^\circ\text{C}$  |     | 60  | 84  | m $\Omega$ |
|                               |              | $V_{GS} = 18\text{ V}, I_D = 20\text{ A}, T_J = 25^\circ\text{C}$  |     | 43  |     |            |
|                               |              | $V_{GS} = 15\text{ V}, I_D = 20\text{ A}, T_J = 175^\circ\text{C}$ |     | 76  |     |            |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 20\text{ V}, I_D = 20\text{ A}$                          |     | 17  |     | S          |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                              |              |   |                    |      |     |    |
|------------------------------|--------------|---|--------------------|------|-----|----|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 450\text{ V}$      |                    | 1770 |     | pF |
| Output Capacitance           | $C_{OSS}$    |   |                    | 113  |     |    |
| Reverse Transfer Capacitance | $C_{RSS}$    |   |                    | 11   |     |    |
| Total Gate Charge            | $Q_{G(tot)}$ | $V_{GS} = -5/15\text{ V}, V_{DS} = 720\text{ V}, I_D = 10\text{ A}$ |                    | 87   |     | nC |
| Threshold Gate Charge        | $Q_{G(th)}$  |   |                    | 17   |     |    |
| Gate-to-Source Charge        | $Q_{GS}$     |   |                    | 27   |     |    |
| Gate-to-Drain Charge         | $Q_{GD}$     |   |                    | 26   |     |    |
| Gate Resistance              | $R_G$        |   | $f = 1\text{ MHz}$ |      | 3.0 |    |

### SWITCHING CHARACTERISTICS

|                         |              |   |  |    |     |    |               |
|-------------------------|--------------|---|--|----|-----|----|---------------|
| Turn-On Delay Time      | $t_{d(on)}$  | $V_{GS} = -5/15\text{ V}, V_{DS} = 720\text{ V}, I_D = 20\text{ A}, R_G = 2.5\text{ }\Omega,$<br>Inductive Load |  | 17 | 31  | ns |               |
| Rise Time               | $t_r$        |   |  | 15 | 27  |    |               |
| Turn-Off Delay Time     | $t_{d(off)}$ |   |  | 29 | 47  |    |               |
| Fall Time               | $t_f$        |   |  | 11 | 20  |    |               |
| Turn-On Switching Loss  | $E_{ON}$     |   |  |    | 183 |    | $\mu\text{J}$ |
| Turn-Off Switching Loss | $E_{OFF}$    |   |  |    | 52  |    |               |
| Total Switching Loss    | $E_{TOT}$    |   |  |    | 235 |    |               |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|   |           |  |  |     |     |               |
|---|-----------|--|--|-----|-----|---------------|
| Continuous Drain-to-Source Diode Forward Current      | $I_{SD}$  | $V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$   |  |     | 22  | A             |
| Pulsed Drain-to-Source Diode Forward Current (Note 2) | $I_{SDM}$ | $V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$   |  |     | 184 | A             |
| Forward Diode Voltage                                 | $V_{SD}$  | $V_{GS} = -5\text{ V}, I_{SD} = 10\text{ A}, T_J = 25^\circ\text{C}$   |  | 3.9 |     | V             |
| Reverse Recovery Time                                 | $t_{RR}$  | $V_{GS} = -5/15\text{ V}, I_{SD} = 30\text{ A},$<br>$di/dt = 1000\text{ A}/\mu\text{s}, V_{DS} = 720\text{ V}$ |  | 18  |     | ns            |
| Reverse Recovery Charge                               | $Q_{RR}$  |  |  | 84  |     | nC            |
| Reverse Recovery Energy                               | $E_{REC}$ |  |  | 1.0 |     | $\mu\text{J}$ |
| Peak Reverse Recovery Current                         | $I_{RRM}$ |  |  | 9.0 |     | A             |
| Charge Time   | $t_a$     |  |  | 10  |     | ns            |
| Discharge Time  | $t_b$     |  |  | 8.0 |     | 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

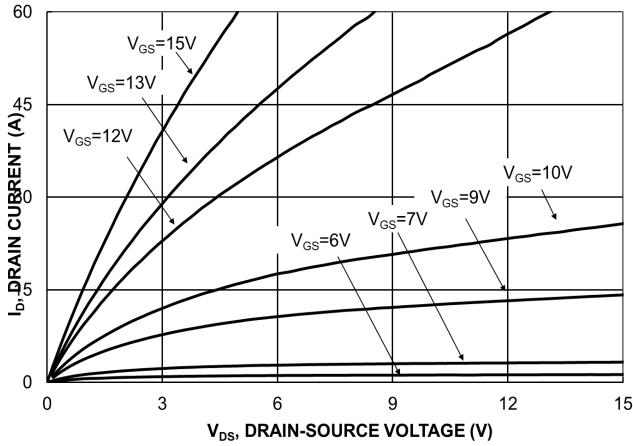


Figure 1. On-Region Characteristics

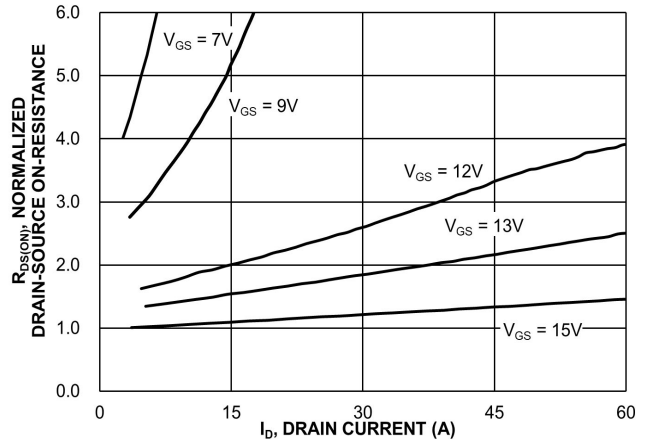


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

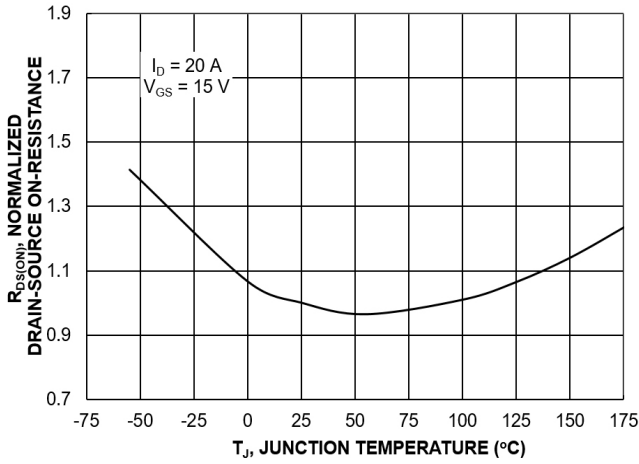


Figure 3. On-Resistance Variation with Temperature

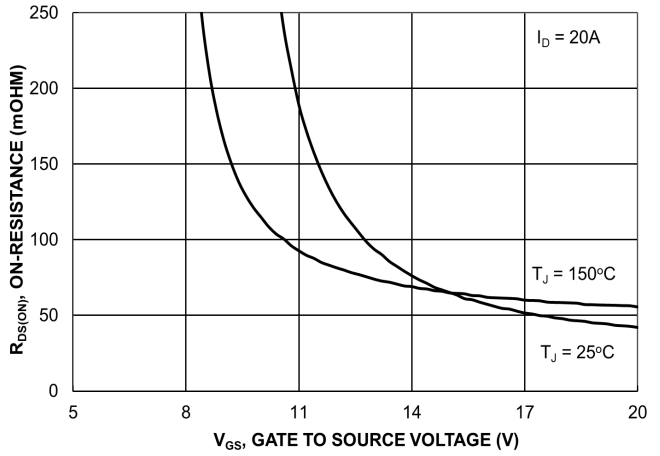


Figure 4. On-Resistance vs. Gate-to-Source Voltage

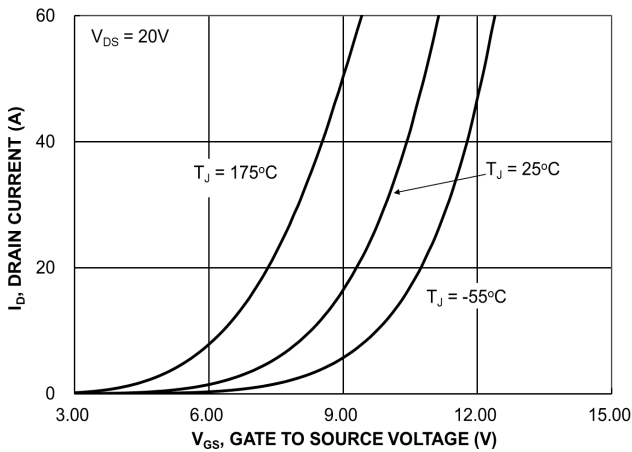


Figure 5. Transfer Characteristics

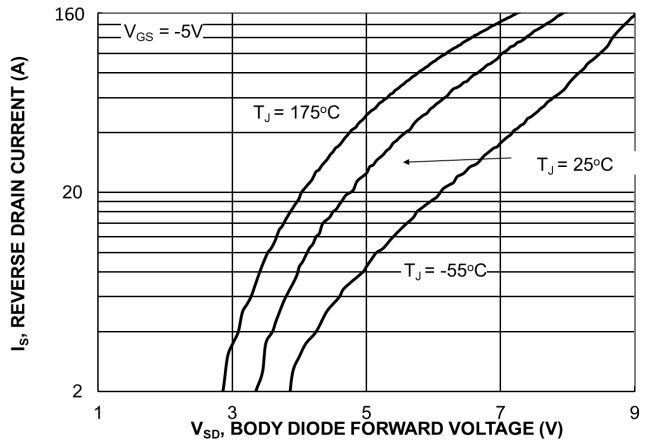


Figure 6. Diode Forward Voltage vs. Current

TYPICAL CHARACTERISTICS (continued)

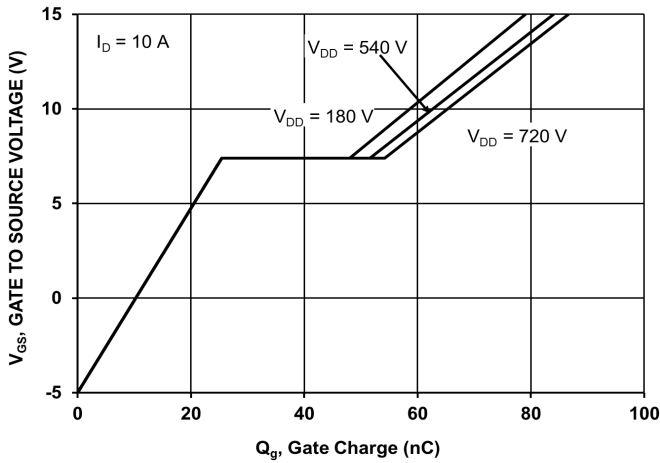


Figure 7. Gate-to-Source Voltage vs. Total Charge

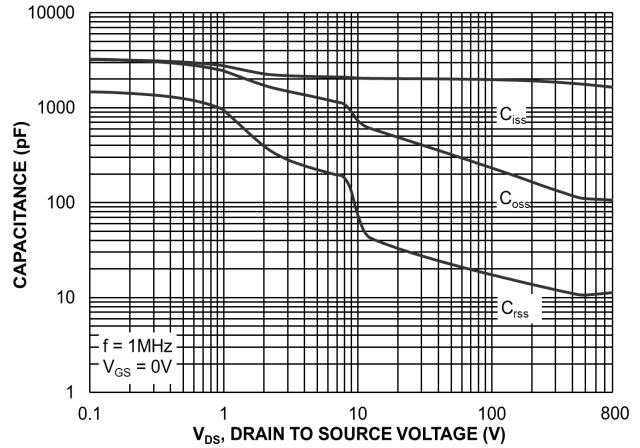


Figure 8. Capacitance vs. Drain-to-Source Voltage

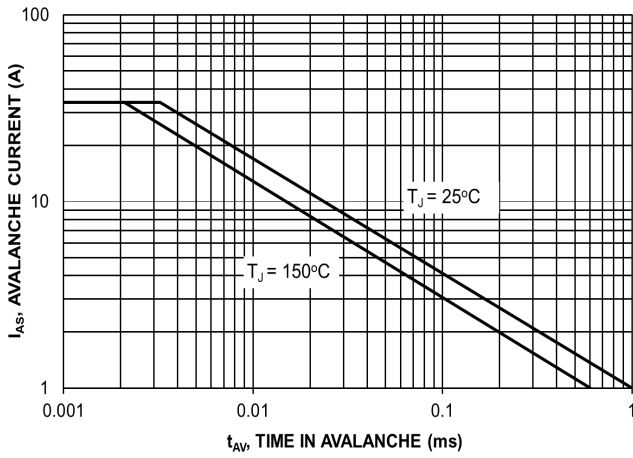


Figure 9. Unclamped Inductive Switching Capability

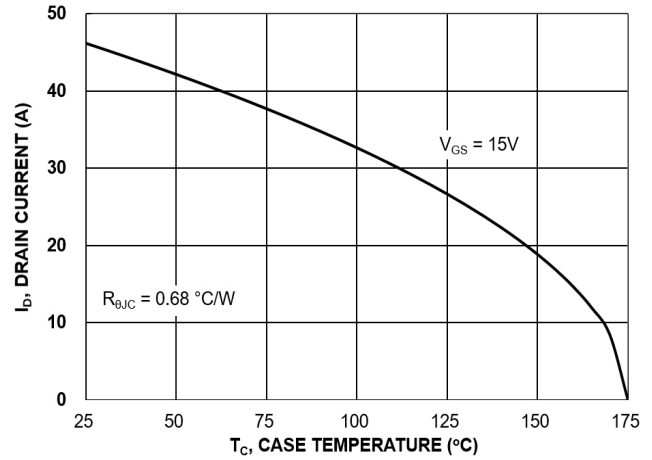


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

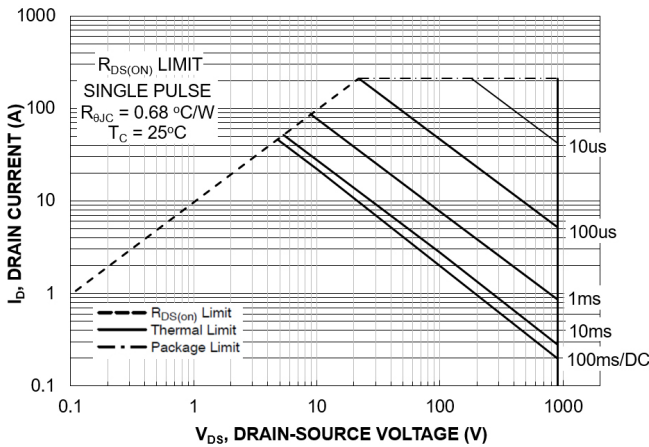


Figure 11. Safe Operating Area

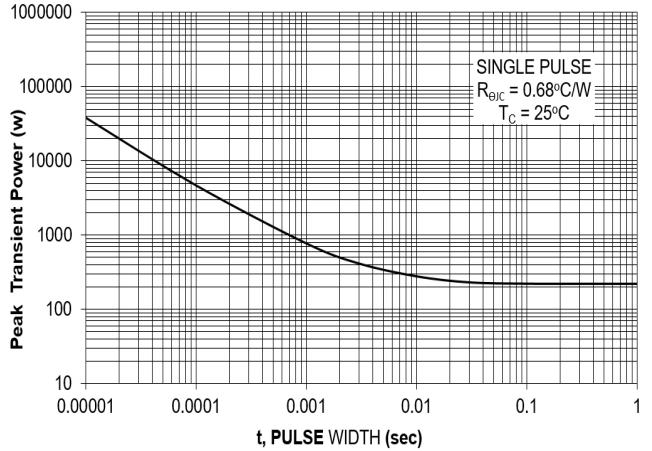


Figure 12. Single Pulse Maximum Power Dissipation

TYPICAL CHARACTERISTICS (continued)

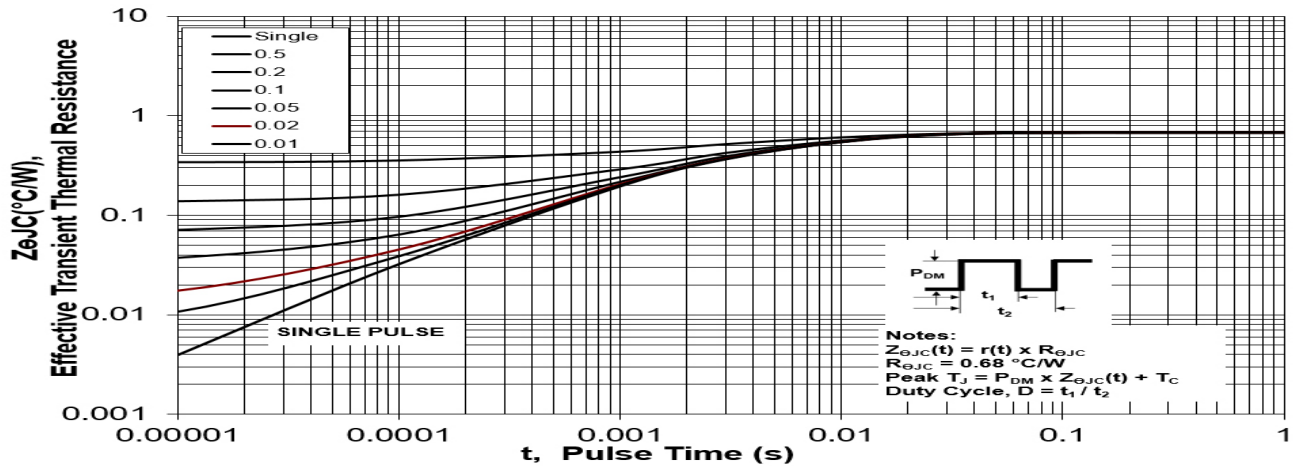


Figure 13. Junction-to-Ambient Thermal Response

# MECHANICAL CASE OUTLINE

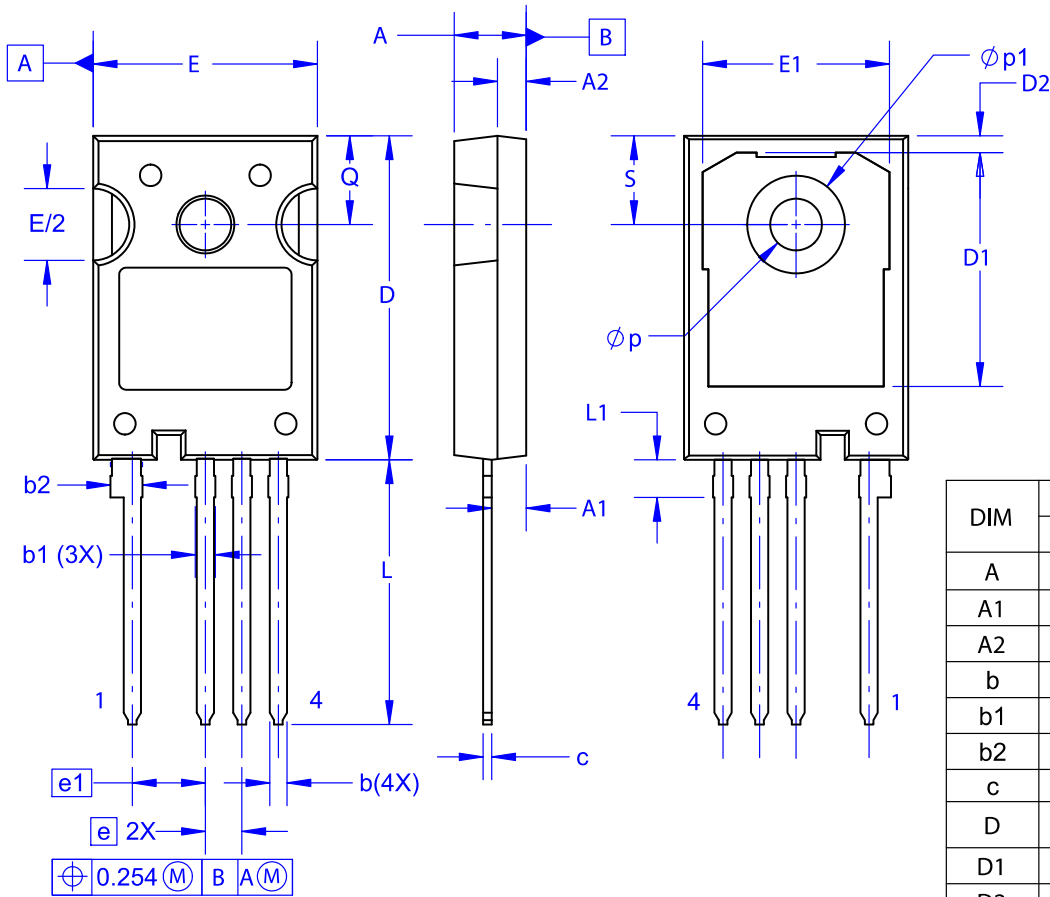
## PACKAGE DIMENSIONS

ON Semiconductor®



TO-247-4LD  
CASE 340CJ  
ISSUE A

DATE 16 SEP 2019



| 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  |

NOTES:

- A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
- B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- C. ALL DIMENSIONS ARE IN MILLIMETERS.
- D. DRAWING CONFORMS TO ASME Y14.5-2009.

|                         |                    |  |
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