

# Silicon Carbide (SiC) MOSFET – EliteSiC, 14 mohm, 1200 V, M3P, TO-247-4L

## NTH4L014N120M3P

### Features

- Typ.  $R_{DS(on)}$  = 14 m $\Omega$  @  $V_{GS}$  = 18 V
- Low Switching Losses (Typ. EON 1308  $\mu$ J at 74 A, 800 V)
- 100% Avalanche Tested
- These Devices are RoHS Compliant

### Typical Applications

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

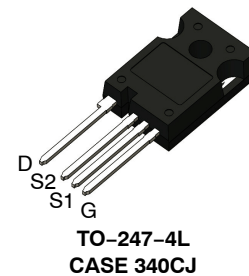
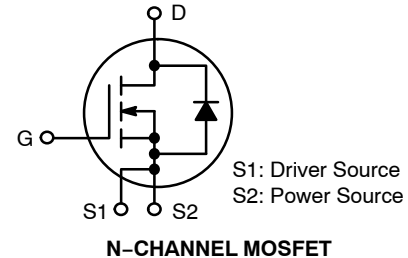
### MAXIMUM RATINGS ( $T_J$ = 25°C unless otherwise noted)

| 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, 2)                                                                   | Steady State | $T_C = 25^\circ\text{C}$  | $I_D$          | 152         | A    |
| Power Dissipation (Note 1)                                                                              |              |                           | $P_D$          | 686         | W    |
| Continuous Drain Current (Notes 1, 2)                                                                   | Steady State | $T_C = 100^\circ\text{C}$ | $I_D$          | 107         | A    |
| Power Dissipation (Note 1)                                                                              |              |                           | $P_D$          | 343         | W    |
| Pulsed Drain Current (Note 2)                                                                           |              | $T_C = 25^\circ\text{C}$  | $I_{DM}$       | 407         | A    |
| Operating Junction and Storage Temperature Range                                                        |              |                           | $T_J, T_{stg}$ | -55 to +175 | °C   |
| Source Current (Body Diode)<br>$T_C = 25^\circ\text{C}, V_{GS} = -3\text{ V}$                           |              |                           | $I_S$          | 129         | A    |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 28.9\text{ A}, L = 1\text{ mH}$ ) (Note 4) |              |                           | $E_{AS}$       | 418         | mJ   |
| Maximum Lead Temperature for Soldering<br>(1/25" from case for 10 s)                                    |              |                           | $T_L$          | 270         | °C   |

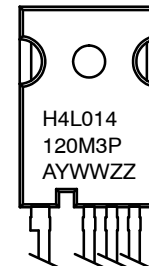
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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. The maximum current rating is based on typical  $R_{DS(on)}$  performance.
3. Repetitive rating, limited by max junction temperature.
4. EAS of 418 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 28.9\text{ A}$ ,  $V_{DD} = 100\text{ V}$ ,  $V_{GS} = 18\text{ V}$ .

| $V_{(BR)DSS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|---------------|--------------------------|-------------------|
| 1200 V        | 20 m $\Omega$ @ 18 V     | 152 A             |



### MARKING DIAGRAM



H4L014120M3P = Specific Device Code

A = Assembly Location

Y = Year

WW = Work Week

ZZ = Lot Traceability

### ORDERING INFORMATION

| Device          | Package   | Shipping        |
|-----------------|-----------|-----------------|
| NTH4L014N120M3P | TO-247-4L | 30 Units / Tube |

## THERMAL CHARACTERISTICS

| Parameter                                   | Symbol          | Typ  | Max  | Unit |
|---------------------------------------------|-----------------|------|------|------|
| Junction-to-Case – Steady State (Note 1)    | $R_{\theta JC}$ | 0.17 | 0.22 | °C/W |
| Junction-to-Ambient – Steady State (Note 1) | $R_{\theta JA}$ |      | 40   |      |

## 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.

ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$  unless otherwise specified)

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

## OFF-STATE CHARACTERISTICS

|                                                           |                   |                                                                       |      |     |         |               |
|-----------------------------------------------------------|-------------------|-----------------------------------------------------------------------|------|-----|---------|---------------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$                              | 1200 | –   | –       | V             |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | $I_D = 1\text{ mA}$ , referenced to $25^\circ\text{C}$ (Note 6)       | –    | 0.3 | –       | V/°C          |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 25^\circ\text{C}$ | –    | –   | 100     | $\mu\text{A}$ |
| Gate-to-Source Leakage Current                            | $I_{GSS}$         | $V_{GS} = +22/-10\text{ V}, V_{DS} = 0\text{ V}$                      | –    | –   | $\pm 1$ | $\mu\text{A}$ |

## ON-STATE CHARACTERISTICS (Note 2)

|                               |              |                                                                             |      |     |      |                  |
|-------------------------------|--------------|-----------------------------------------------------------------------------|------|-----|------|------------------|
| Gate Threshold Voltage        | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 37\text{ mA}$                                       | 2.08 | 3.0 | 4.63 | V                |
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 18\text{ V}, I_D = 74\text{ A}, T_J = 25^\circ\text{C}$           | –    | 14  | 20   | $\text{m}\Omega$ |
|                               |              | $V_{GS} = 18\text{ V}, I_D = 74\text{ A}, T_J = 175^\circ\text{C}$ (Note 6) | –    | 29  | –    |                  |
|                               |              | $V_{GS} = 15\text{ V}, I_D = 74\text{ A}, T_J = 25^\circ\text{C}$           | –    | 16  | 27   |                  |
|                               |              | $V_{GS} = 15\text{ V}, I_D = 74\text{ A}, T_J = 150^\circ\text{C}$ (Note 6) | –    | 27  | –    |                  |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 10\text{ V}, I_D = 74\text{ A}$ (Note 6)                          | –    | 29  | –    | S                |

## CHARGES, CAPACITANCES &amp; GATE RESISTANCE

|                              |              |                                                                              |   |      |   |             |
|------------------------------|--------------|------------------------------------------------------------------------------|---|------|---|-------------|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$ (Note 6)      | – | 6230 | – | $\text{pF}$ |
| Output Capacitance           | $C_{OSS}$    |                                                                              | – | 262  | – |             |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                              | – | 29   | – |             |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 74\text{ A}$ (Note 6) | – | 322  | – | $\text{nC}$ |
| Threshold Gate Charge        | $Q_{G(TH)}$  |                                                                              | – | 45   | – |             |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                              | – | 51   | – |             |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                              | – | 81   | – |             |
| Gate-Resistance              | $R_G$        | $f = 1\text{ MHz}$                                                           | – | 1.4  | – | $\Omega$    |

## SWITCHING CHARACTERISTICS

|                         |              |                                                                                                                           |   |      |   |               |
|-------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------|---|------|---|---------------|
| Turn-On Delay Time      | $t_{d(ON)}$  | $V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 74\text{ A}, R_G = 2\text{ }\Omega$<br>inductive load (Notes 5, 6) | – | 26   | – | $\text{ns}$   |
| Rise Time               | $t_r$        |                                                                                                                           | – | 40   | – |               |
| Turn-Off Delay Time     | $t_{d(OFF)}$ |                                                                                                                           | – | 68   | – |               |
| Fall Time               | $t_f$        |                                                                                                                           | – | 13   | – |               |
| Turn-On Switching Loss  | $E_{ON}$     |                                                                                                                           | – | 1308 | – | $\mu\text{J}$ |
| Turn-Off Switching Loss | $E_{OFF}$    |                                                                                                                           | – | 601  | – |               |
| Total Switching Loss    | $E_{tot}$    |                                                                                                                           | – | 1909 | – |               |



# NTH4L014N120M3P

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise specified) (continued)

| Parameter                                              | Symbol    | Test Condition                                                                                                               | Min | Typ | Max | Unit          |
|--------------------------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| <b>SOURCE-DRAIN DIODE CHARACTERISTICS</b>              |           |                                                                                                                              |     |     |     |               |
| Continuous Source-Drain Diode Forward Current (Note 1) | $I_{SD}$  | $V_{GS} = -3\text{ V}, T_C = 25^\circ\text{C}$<br>(Note 6)                                                                   | –   | –   | 127 | A             |
| Pulsed Source-Drain Diode Forward Current (Note 2)     | $I_{SDM}$ |                                                                                                                              | –   | –   | 407 |               |
| Forward Diode Voltage                                  | $V_{SD}$  | $V_{GS} = -3\text{ V}, I_{SD} = 74\text{ A}, T_J = 25^\circ\text{C}$                                                         | –   | 5.2 | –   | V             |
| Reverse Recovery Time                                  | $t_{RR}$  | $V_{GS} = -3/18\text{ V}, I_{SD} = 74\text{ A},$<br>$dI_S/dt = 1000\text{ A}/\mu\text{s}, V_{DS} = 800\text{ V}$<br>(Note 6) | –   | 36  | –   | ns            |
| Reverse Recovery Charge                                | $Q_{RR}$  |                                                                                                                              | –   | 332 | –   | nC            |
| Reverse Recovery Energy                                | $E_{REC}$ |                                                                                                                              | –   | 14  | –   | $\mu\text{J}$ |
| Peak Reverse Recovery Current                          | $I_{RRM}$ |                                                                                                                              | –   | 19  | –   | A             |
| Charge time                                            | $T_A$     |                                                                                                                              | –   | 20  | –   | ns            |
| Discharge time                                         | $T_B$     |                                                                                                                              | –   | 16  | –   | 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

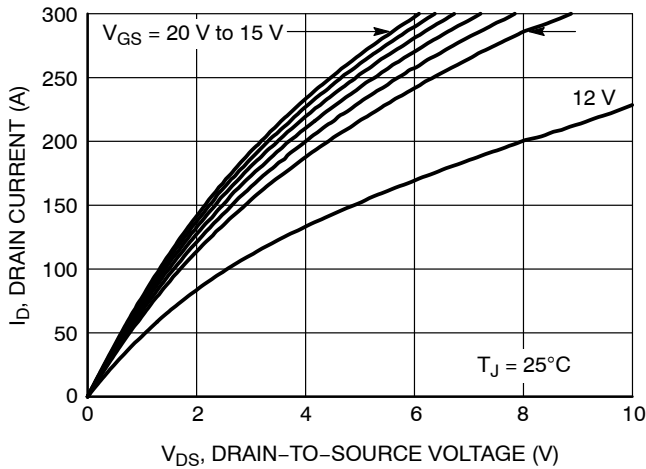


Figure 1. On-Region Characteristics

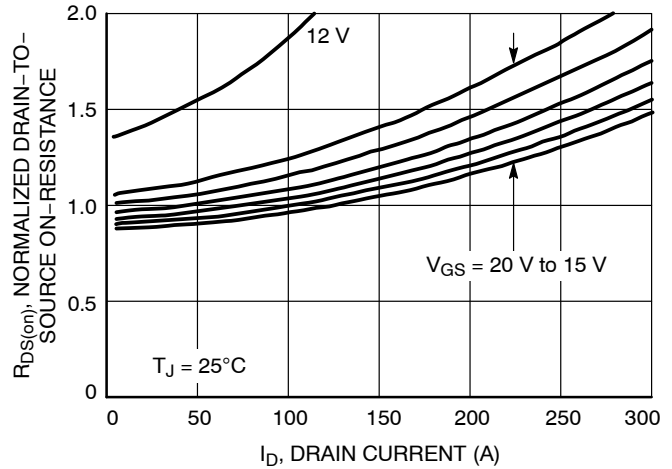


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

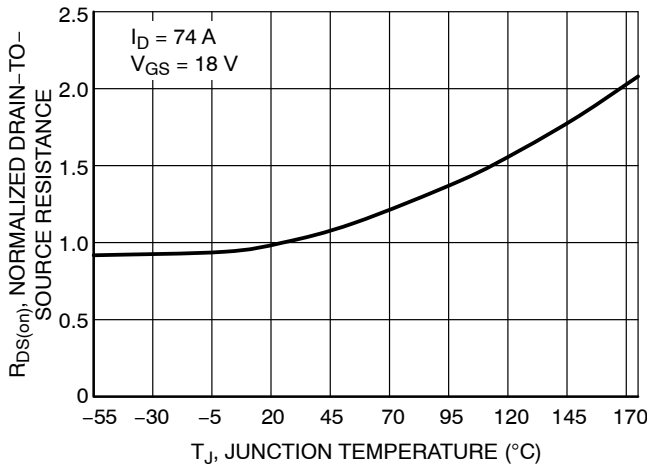


Figure 3. On-Resistance Variation with Temperature

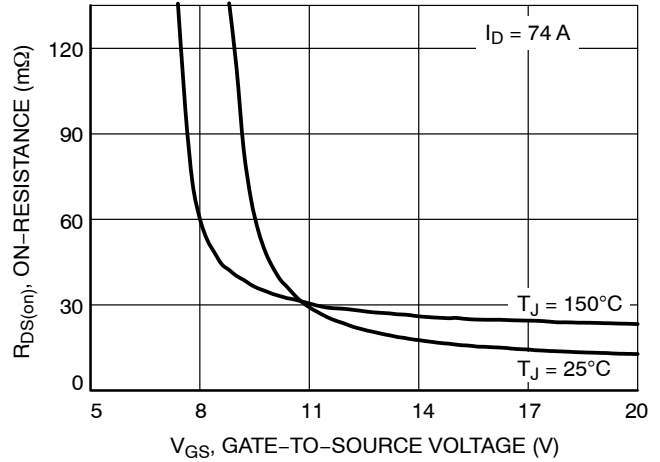


Figure 4. On-Resistance vs. Gate-to-Source Voltage

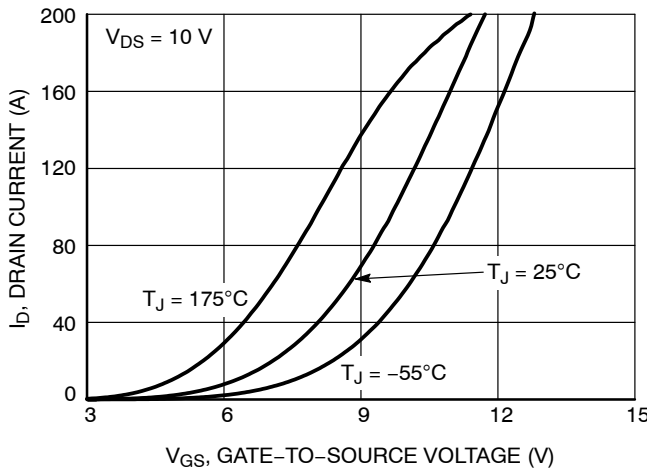


Figure 5. Transfer Characteristics

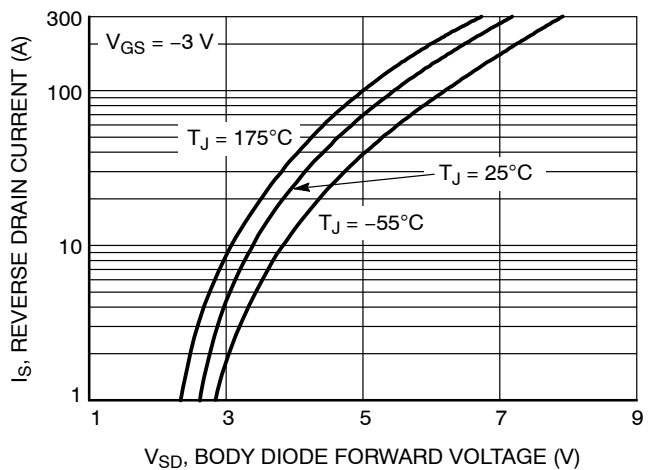


Figure 6. Diode Forward Voltage vs. Current

TYPICAL CHARACTERISTICS

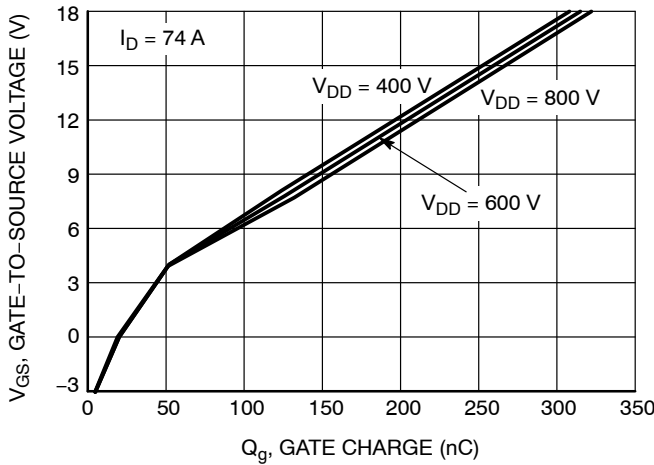


Figure 7. Gate-to-Source Voltage vs. Total Charge

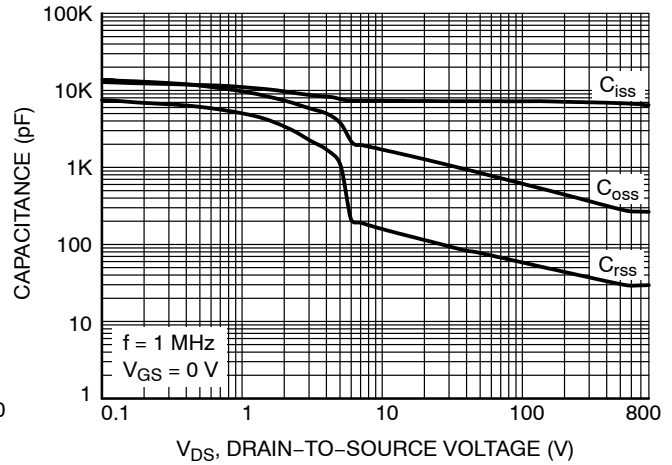


Figure 8. Capacitance vs. Drain-to-Source Voltage

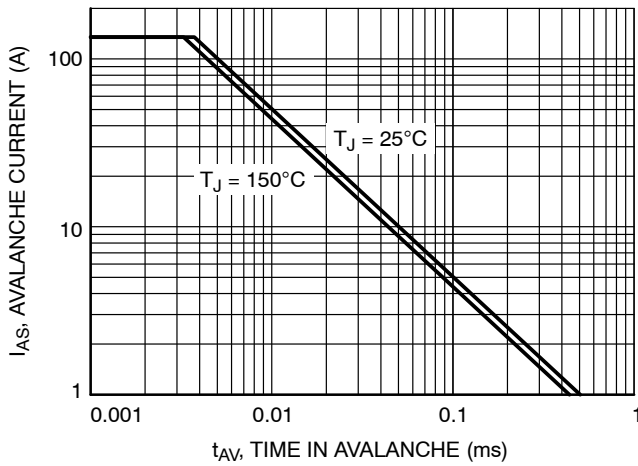


Figure 9. Unclamped Inductive Switching Capability

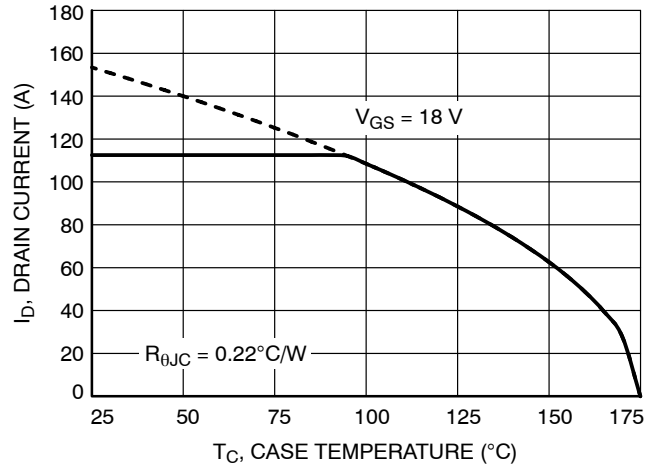


Figure 10. Maximum Continuous Drain Current vs. Case Temperature

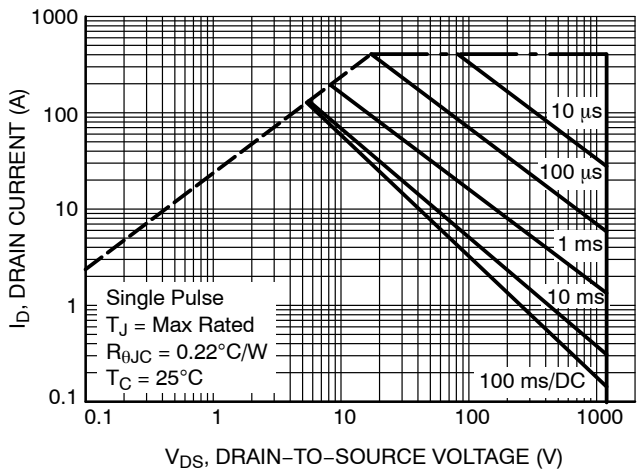


Figure 11. Safe Operating Area

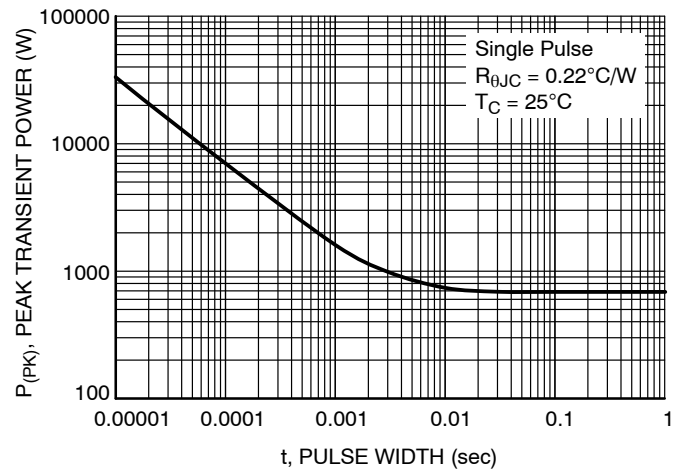


Figure 12. Single Pulse Maximum Power Dissipation

TYPICAL CHARACTERISTICS

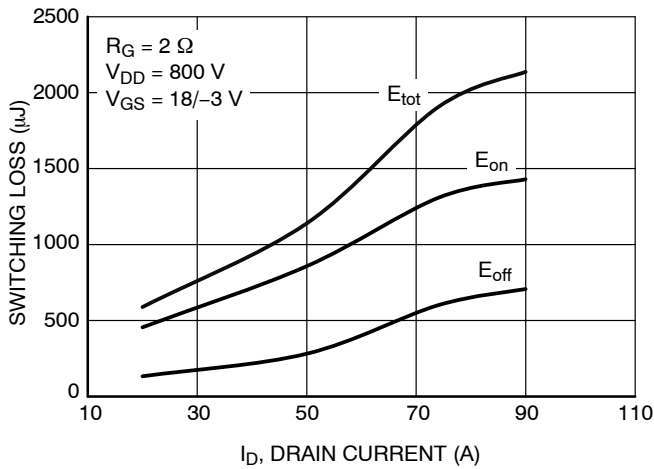


Figure 13. Switching Loss vs. Drain Current

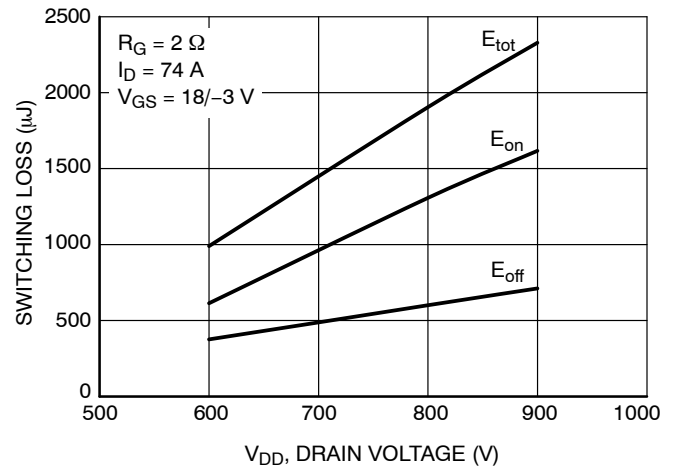


Figure 14. Switching Loss vs. Drain Voltage

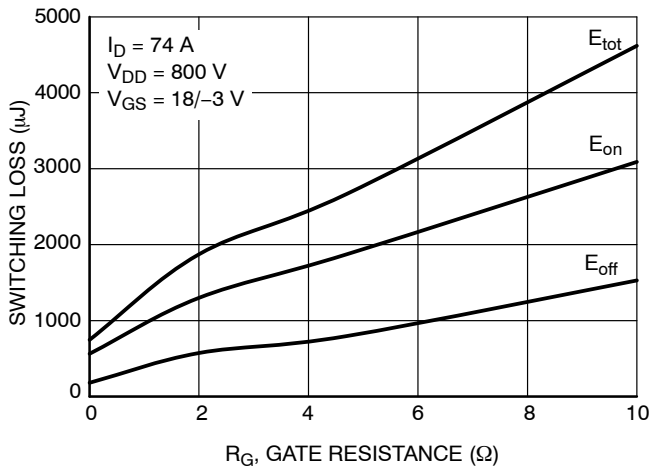


Figure 15. Switching Loss vs. Gate Resistance

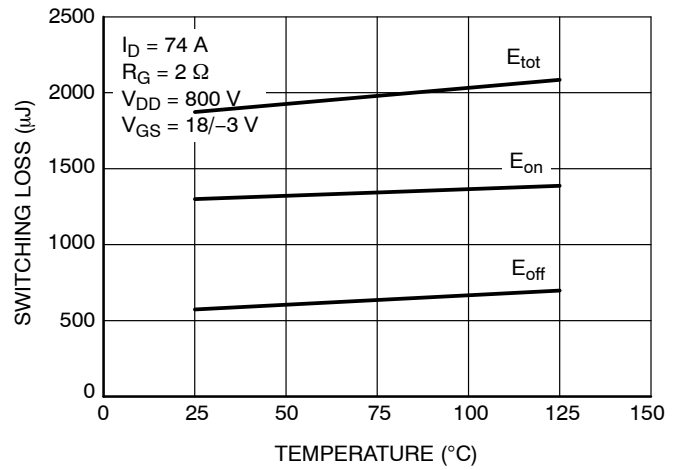


Figure 16. Switching Loss vs. Temperature

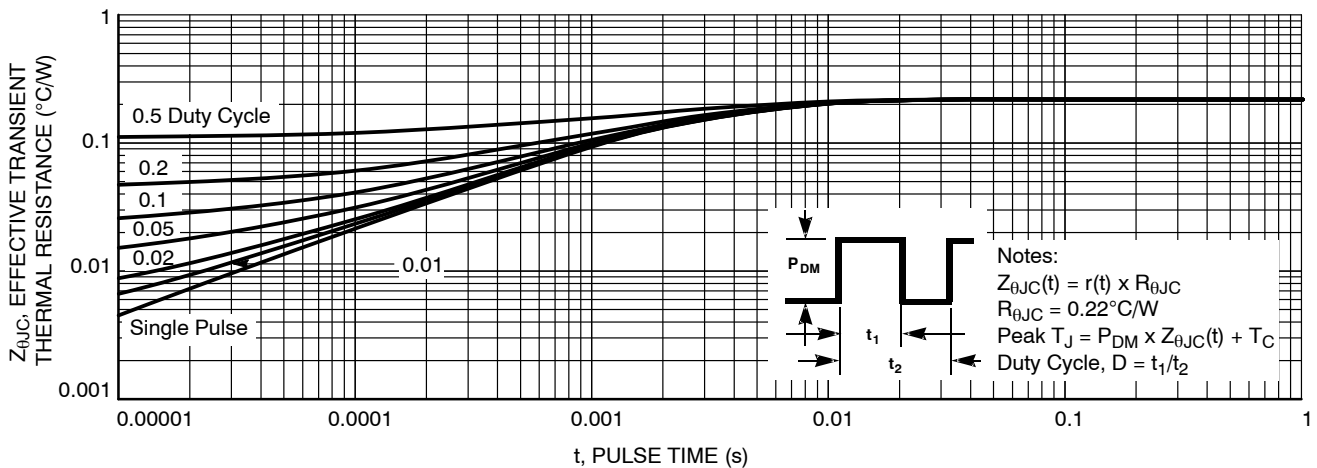
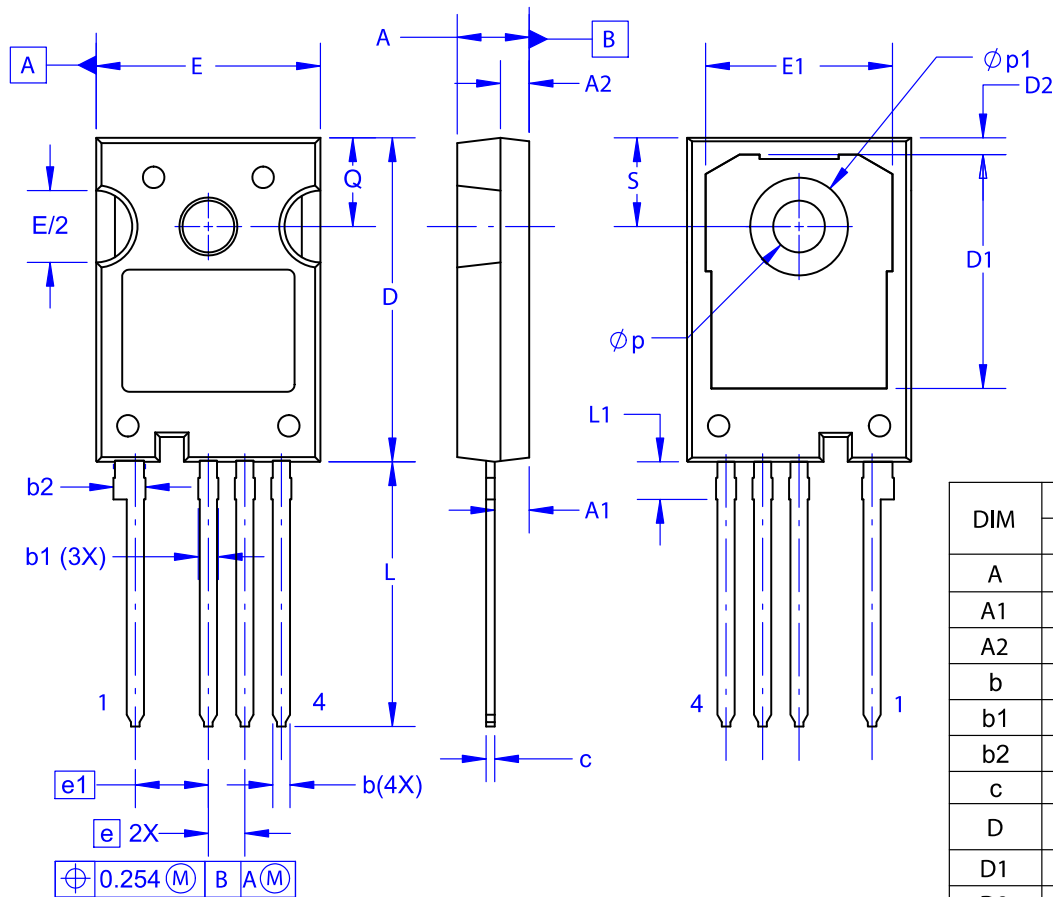


Figure 17. Junction-to-Case Transient Thermal Response

**TO-247-4LD**  
**CASE 340CJ**  
**ISSUE A**

DATE 16 SEP 2019


**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.

| 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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