

# Silicon Carbide (SiC) MOSFET - EliteSiC, 12 mohm, 650 V, M3S, TO247-4L

## NTH4L012N065M3S

### Features

- Typical  $R_{DS(ON)} = 12 \text{ m}\Omega @ V_{GS} = 18 \text{ V}$
- Ultra Low Gate Charge ( $Q_{G(tot)} = 135 \text{ nC}$ )
- High Speed Switching with Low Capacitance ( $C_{OSS} = 281 \text{ pF}$ )
- 100% Avalanche Tested
- This Device is Halide Free and RoHS Compliant with Exemption 7a, Pb-Free 2LI (on second level interconnection)

### Applications

- SMPS, Solar Inverters, UPS, Energy Storage, EV Charging Infrastructure

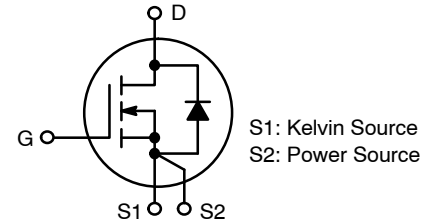
### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter                                                                                  | Symbol                                                                         | Value          | Unit             |
|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------|------------------|
| Drain-to-Source Voltage                                                                    | $V_{DSS}$                                                                      | 650            | V                |
| Dynamic Gate-to-Source Voltage                                                             | $V_{GS}$                                                                       | -10/<br>22.6   | V                |
| Continuous Drain Current                                                                   | $T_C = 25^\circ\text{C}$                                                       | $I_D$          | 102              |
| Power Dissipation                                                                          |                                                                                | $P_D$          | 375              |
| Continuous Drain Current                                                                   | $T_C = 100^\circ\text{C}$                                                      | $I_D$          | 81               |
| Power Dissipation                                                                          |                                                                                | $P_D$          | 187              |
| Pulsed Drain Current (Note 1)                                                              | $T_C = 25^\circ\text{C}$<br>$t_p = 100 \mu\text{s}$                            | $I_{DM}$       | 330              |
| Continuous Source-Drain Current (Body Diode)                                               | $T_C = 25^\circ\text{C}$<br>$V_{GS} = -3 \text{ V}$                            | $I_S$          | 62               |
|                                                                                            | $T_C = 100^\circ\text{C}$<br>$V_{GS} = -3 \text{ V}$                           |                | 35               |
| Pulsed Source-Drain Current (Body Diode) (Note 1)                                          | $T_C = 25^\circ\text{C}$<br>$V_{GS} = -3 \text{ V}$<br>$t_p = 100 \mu\text{s}$ | $I_{SM}$       | 250              |
| Single Pulse Avalanche Energy ( $I_{LPK} = 72 \text{ A}$ , $L = 0.1 \text{ mH}$ ) (Note 2) | $E_{AS}$                                                                       | 259            | mJ               |
| Operating Junction and Storage Temperature Range                                           | $T_J, T_{stg}$                                                                 | -55 to<br>+175 | $^\circ\text{C}$ |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 seconds)                    | $T_L$                                                                          | 270            | $^\circ\text{C}$ |

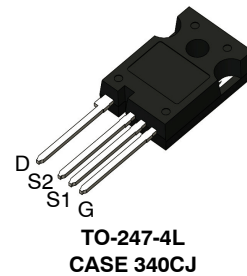
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Single pulse, limited by max junction temperature.
2. EAS of 259 mJ is based on starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.1 \text{ mH}$ ,  $I_{AS} = 72 \text{ A}$ ,  $V_{DD} = 100 \text{ V}$ ,  $V_{GS} = 18 \text{ V}$ .

| $V_{(BR)DSS}$ | $R_{DS(ON)} \text{ TYP}$     | $I_D \text{ MAX}$ |
|---------------|------------------------------|-------------------|
| 650 V         | 12 m $\Omega @ 18 \text{ V}$ | 102 A             |



N-CHANNEL MOSFET



### MARKING DIAGRAM



H4L012065M3S = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Lot Traceability

### ORDERING INFORMATION

| Device          | Package   | Shipping        |
|-----------------|-----------|-----------------|
| NTH4L012N065M3S | TO-247-4L | 30 Units / Tube |

**THERMAL CHARACTERISTICS**

| Parameter                                     | Symbol          | Value | Unit                 |
|-----------------------------------------------|-----------------|-------|----------------------|
| Thermal Resistance, Junction-to-Case (Note 3) | $R_{\theta JC}$ | 0.40  | $^{\circ}\text{C/W}$ |

3. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.

**RECOMMENDED OPERATING CONDITIONS**

| Parameter                                  | Symbol     | Value  | Unit |
|--------------------------------------------|------------|--------|------|
| Operation Values of Gate-to-Source Voltage | $V_{GSop}$ | -3/+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 Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                   |               |                                                                    |     |   |     |               |
|-----------------------------------|---------------|--------------------------------------------------------------------|-----|---|-----|---------------|
| Drain-to-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 25^{\circ}\text{C}$ | 650 | - | -   | V             |
| Zero Gate Voltage Drain Current   | $I_{DSS}$     | $V_{DS} = 650\text{ V}, T_J = 25^{\circ}\text{C}$                  | -   | - | 10  | $\mu\text{A}$ |
|                                   |               | $V_{DS} = 650\text{ V}, T_J = 175^{\circ}\text{C}$ (Note 5)        | -   | - | 500 | $\mu\text{A}$ |
| Gate-to-Source Leakage Current    | $I_{GSS}$     | $V_{GS} = -10\text{ V}, V_{DS} = 0\text{ V}$                       | -1  | - | -   | $\mu\text{A}$ |
|                                   |               | $V_{GS} = +22.6\text{ V}, V_{DS} = 0\text{ V}$                     | -   | - | 1   |               |

**ON CHARACTERISTICS**

|                               |              |                                                                               |     |     |     |                  |
|-------------------------------|--------------|-------------------------------------------------------------------------------|-----|-----|-----|------------------|
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 18\text{ V}, I_D = 40\text{ A}, T_J = 25^{\circ}\text{C}$           | -   | 12  | 17  | $\text{m}\Omega$ |
|                               |              | $V_{GS} = 18\text{ V}, I_D = 40\text{ A}, T_J = 175^{\circ}\text{C}$ (Note 5) | -   | 18  | -   |                  |
|                               |              | $V_{GS} = 15\text{ V}, I_D = 40\text{ A}, T_J = 25^{\circ}\text{C}$           | -   | 15  | -   |                  |
|                               |              | $V_{GS} = 15\text{ V}, I_D = 40\text{ A}, T_J = 175^{\circ}\text{C}$ (Note 5) | -   | 20  | -   |                  |
| Gate Threshold Voltage        | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 20\text{ mA}, T_J = 25^{\circ}\text{C}$               | 2.0 | 2.7 | 4.0 | V                |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 10\text{ V}, I_D = 40\text{ A}$ (Note 5)                            | -   | 45  | -   | S                |

**CHARGES, CAPACITANCES & GATE RESISTANCE**

|                              |              |                                                                              |   |      |   |             |
|------------------------------|--------------|------------------------------------------------------------------------------|---|------|---|-------------|
| Input Capacitance            | $C_{ISS}$    | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ (Note 5)      | - | 3610 | - | $\text{pF}$ |
| Output Capacitance           | $C_{OSS}$    |                                                                              | - | 281  | - |             |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                              | - | 24   | - |             |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{DD} = 400\text{ V}, I_D = 40\text{ A}, V_{GS} = -3/18\text{ V}$ (Note 5) | - | 135  | - | $\text{nC}$ |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                              | - | 35   | - |             |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                              | - | 29   | - |             |
| Gate Resistance              | $R_G$        | $f = 1\text{ MHz}$                                                           | - | 1.6  | - | $\Omega$    |

**SWITCHING CHARACTERISTICS**

|                         |              |                                                                                                                                     |   |     |   |               |
|-------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------|---|-----|---|---------------|
| Turn-On Delay Time      | $t_{d(ON)}$  | $V_{GS} = -3/18\text{ V}, I_D = 40\text{ A}, V_{DD} = 400\text{ V}, R_G = 4.7\text{ }\Omega, T_J = 25^{\circ}\text{C}$ (Notes 4, 5) | - | 5   | - | $\text{ns}$   |
| Turn-Off Delay Time     | $t_{d(OFF)}$ |                                                                                                                                     | - | 49  | - |               |
| Rise Time               | $t_r$        |                                                                                                                                     | - | 23  | - |               |
| Fall Time               | $t_f$        |                                                                                                                                     | - | 12  | - |               |
| Turn-On Switching Loss  | $E_{ON}$     |                                                                                                                                     | - | 143 | - | $\mu\text{J}$ |
| Turn-Off Switching Loss | $E_{OFF}$    |                                                                                                                                     | - | 145 | - |               |
| Total Switching Loss    | $E_{TOT}$    |                                                                                                                                     | - | 288 | - |               |

# NTH4L012N065M3S

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

| Parameter                        | Symbol       | Test Conditions                                                                                                                                                | Min | Typ | Max | Unit          |
|----------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| <b>SWITCHING CHARACTERISTICS</b> |              |                                                                                                                                                                |     |     |     |               |
| Turn-On Delay Time               | $t_{d(ON)}$  | $V_{GS} = -3/18\text{ V}$ , $I_D = 40\text{ A}$ ,<br>$V_{DD} = 400\text{ V}$ , $R_G = 4.7\text{ }\Omega$ ,<br>$T_J = 175\text{ }^{\circ}\text{C}$ (Notes 4, 5) | –   | 3.6 | –   | ns            |
| Turn-Off Delay Time              | $t_{d(OFF)}$ |                                                                                                                                                                | –   | 60  | –   |               |
| Rise Time                        | $t_r$        |                                                                                                                                                                | –   | 23  | –   |               |
| Fall Time                        | $t_f$        |                                                                                                                                                                | –   | 13  | –   |               |
| Turn-On Switching Loss           | $E_{ON}$     |                                                                                                                                                                | –   | 142 | –   | $\mu\text{J}$ |
| Turn-Off Switching Loss          | $E_{OFF}$    |                                                                                                                                                                | –   | 172 | –   |               |
| Total Switching Loss             | $E_{TOT}$    |                                                                                                                                                                | –   | 314 | –   |               |

## SOURCE-TO-DRAIN DIODE CHARACTERISTICS

|                               |           |                                                                                                                                                                  |   |     |     |               |
|-------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----|-----|---------------|
| Forward Diode Voltage         | $V_{SD}$  | $I_{SD} = 40\text{ A}$ , $V_{GS} = -3\text{ V}$ , $T_J = 25\text{ }^{\circ}\text{C}$                                                                             | – | 4.5 | 6.0 | V             |
|                               |           | $I_{SD} = 40\text{ A}$ , $V_{GS} = -3\text{ V}$ , $T_J = 175\text{ }^{\circ}\text{C}$<br>(Note 5)                                                                | – | 4.2 | –   |               |
| Reverse Recovery Time         | $t_{RR}$  | $V_{GS} = -3\text{ V}$ , $I_S = 40\text{ A}$ ,<br>$di/dt = 1000\text{ A}/\mu\text{s}$ , $V_{DS} = 400\text{ V}$ ,<br>$T_J = 25\text{ }^{\circ}\text{C}$ (Note 5) | – | 26  | –   | ns            |
| Charge Time                   | $t_a$     |                                                                                                                                                                  | – | 15  | –   |               |
| Discharge Time                | $t_b$     |                                                                                                                                                                  | – | 11  | –   |               |
| Reverse Recovery Charge       | $Q_{RR}$  |                                                                                                                                                                  | – | 195 | –   | nC            |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                                                                                  | – | 16  | –   | $\mu\text{J}$ |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                                                                                  | – | 13  | –   | A             |

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.

4.  $E_{ON}/E_{OFF}$  result is with body diode.

5. Defined by design, not subject to production test.

TYPICAL CHARACTERISTICS

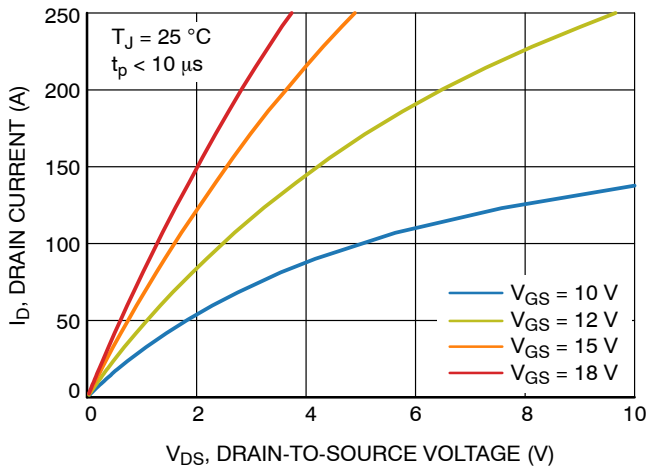


Figure 1. Output Characteristics

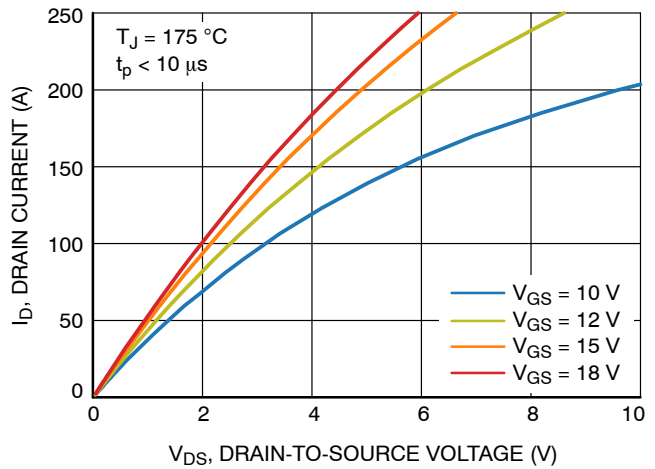


Figure 2. Output Characteristics

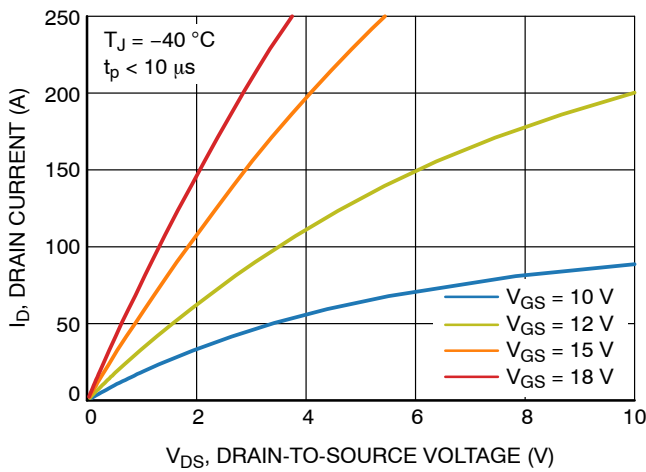


Figure 3. Output Characteristics

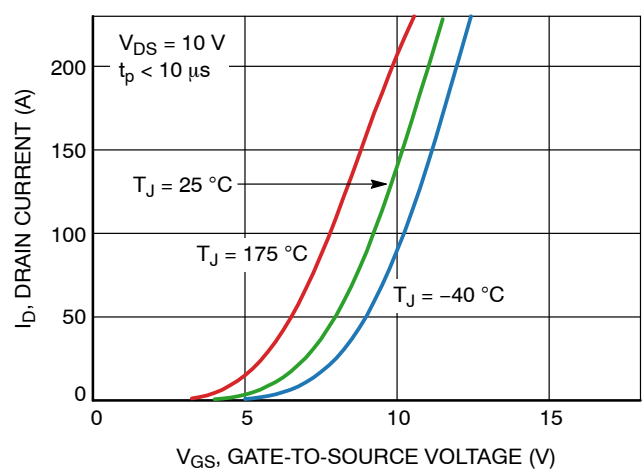


Figure 4.  $I_D$  vs.  $V_{GS}$

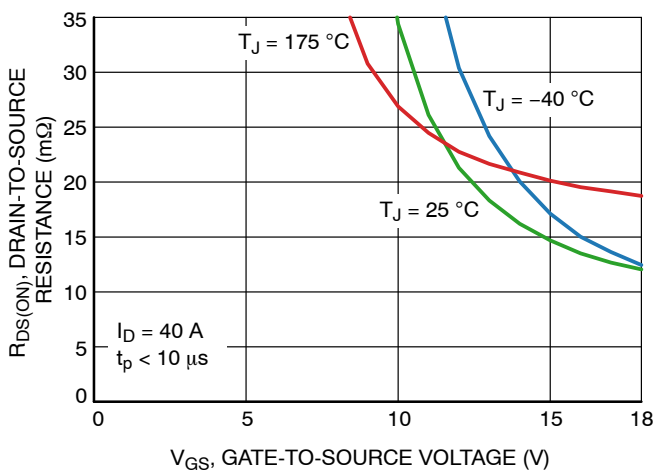


Figure 5.  $R_{DS(ON)}$  vs.  $V_{GS}$

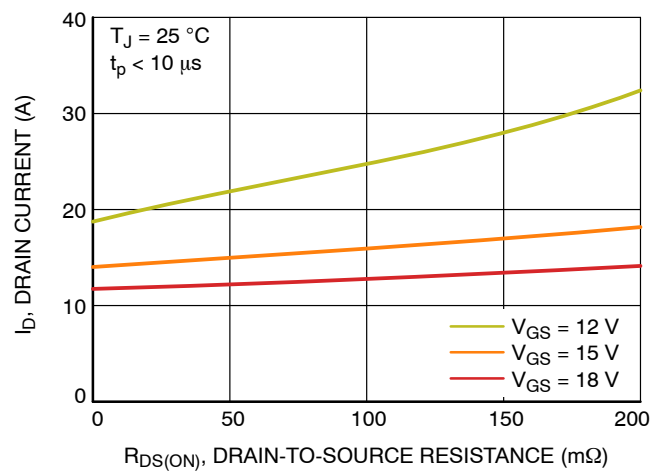


Figure 6.  $I_D$  vs.  $R_{DS(ON)}$

TYPICAL CHARACTERISTICS

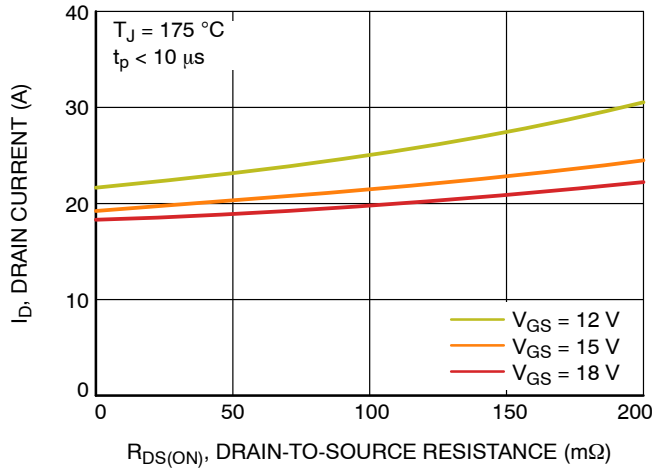


Figure 7.  $I_D$  vs.  $R_{DS(ON)}$

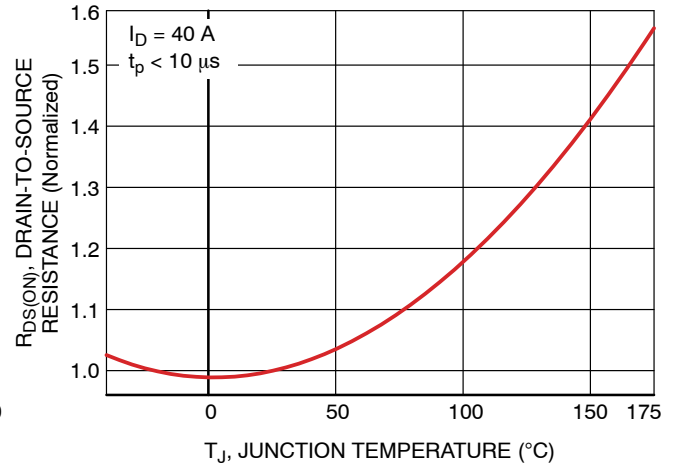


Figure 8.  $R_{DS(ON)}$  vs.  $T_J$

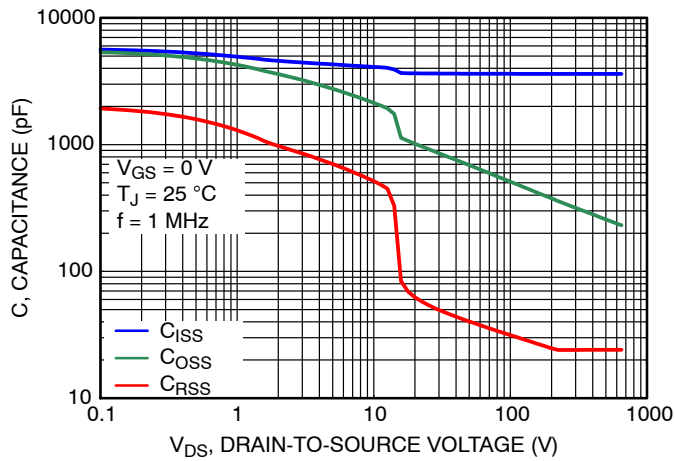


Figure 9. Capacitance Characteristics

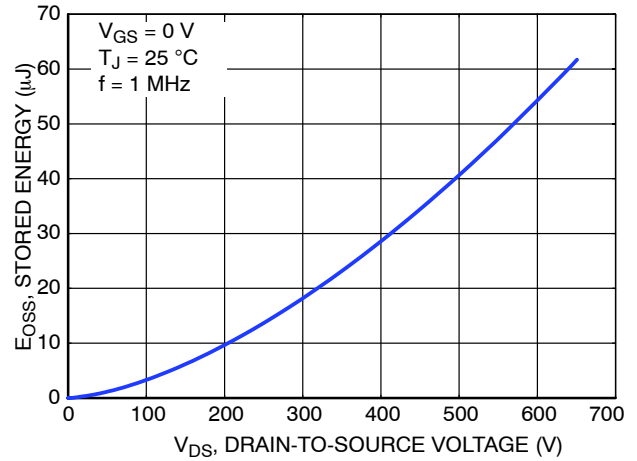


Figure 10. Stored Energy vs. Drain to Source Voltage

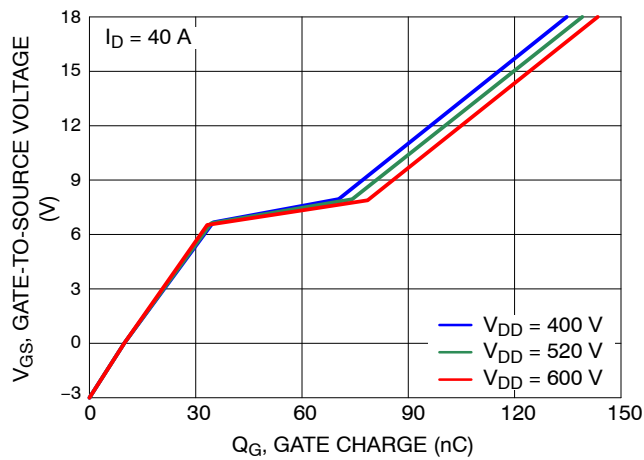


Figure 11. Gate Charge Characteristics

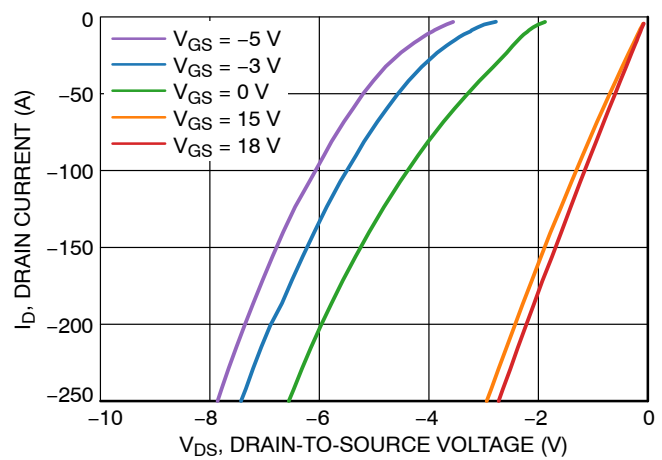


Figure 12. Reverse Conduction Characteristics

TYPICAL CHARACTERISTICS

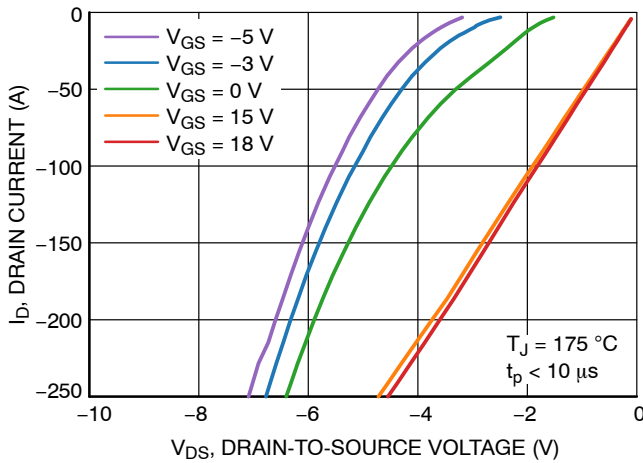


Figure 13. Reverse Conduction Characteristics

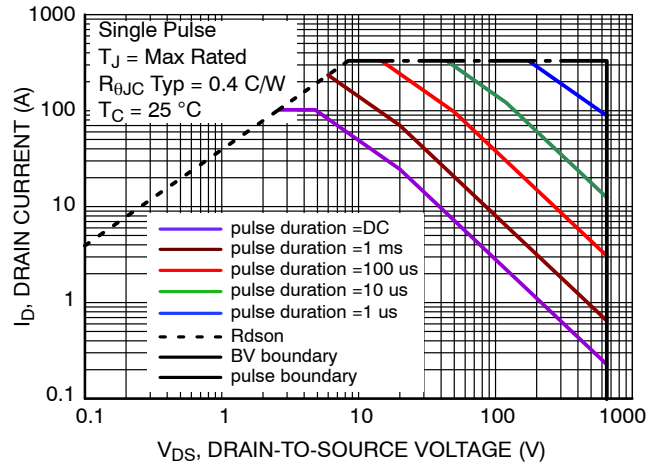


Figure 14. Safe Operating Area

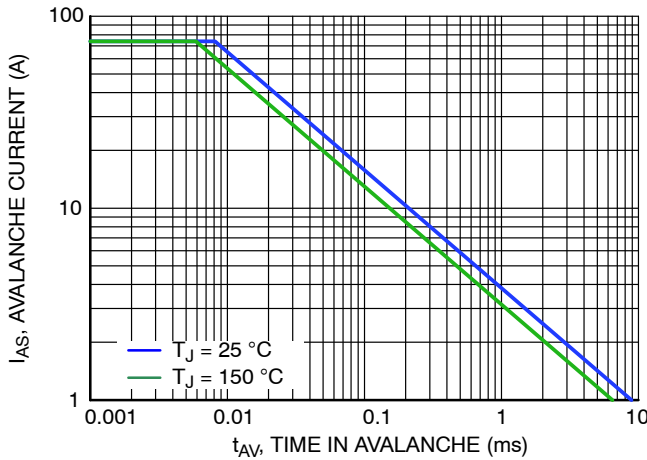


Figure 15. Avalanche Current vs. Pulse Time (UIS)

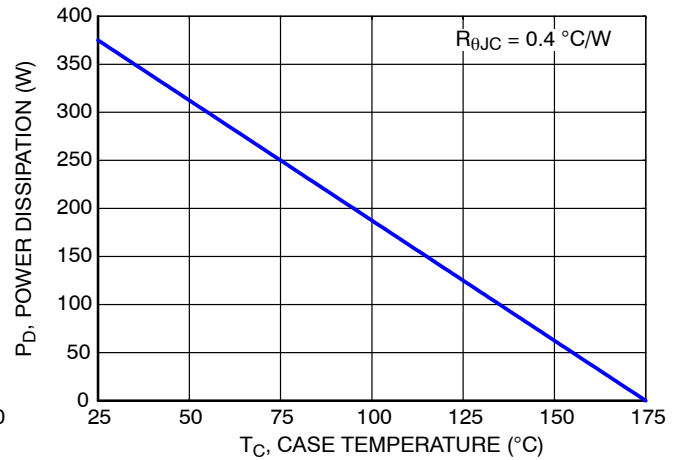


Figure 16. Maximum Power Dissipation vs. Case Temperature

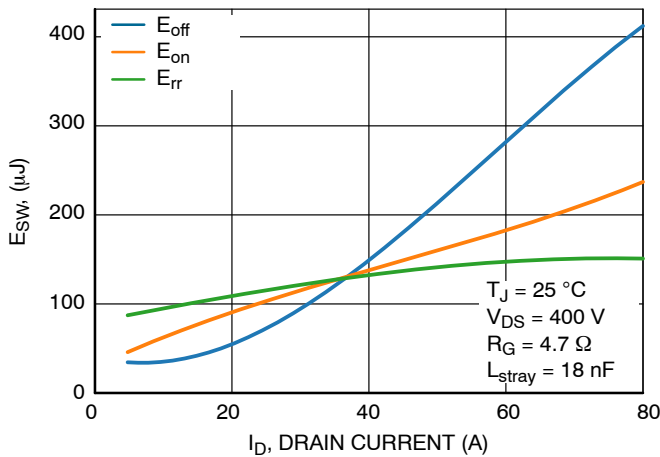


Figure 17. Inductive Switching Loss vs. Drain Current

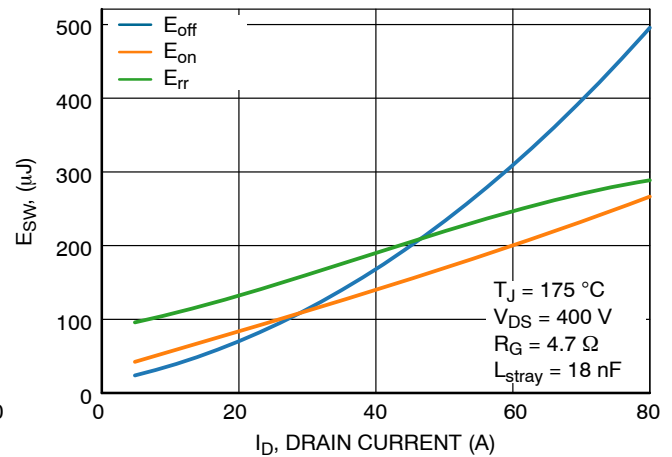


Figure 18. Inductive Switching Loss vs. Drain Current

TYPICAL CHARACTERISTICS

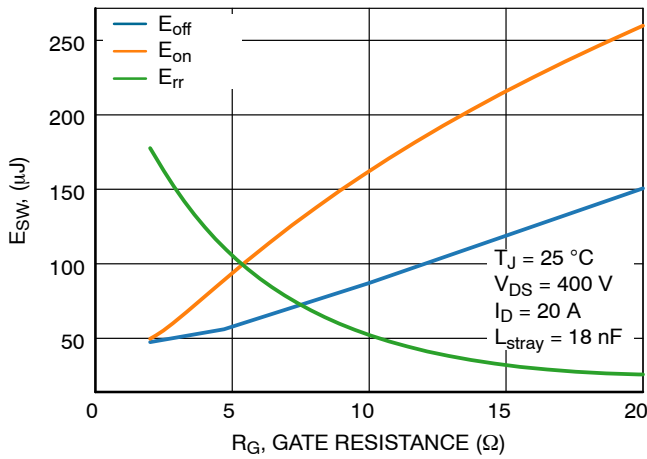


Figure 19. Inductive Switching Loss vs. Gate Resistance

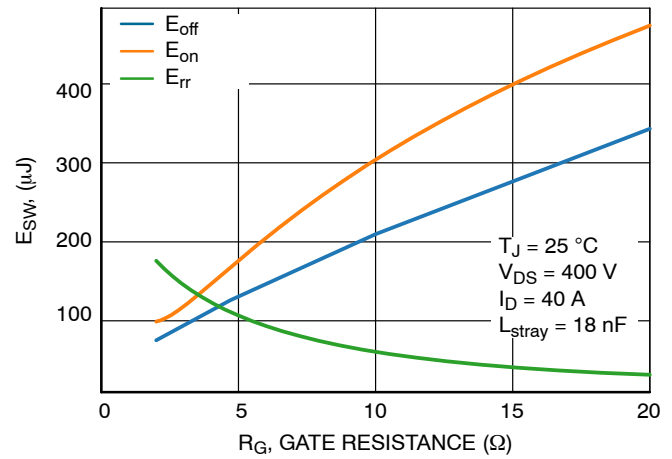


Figure 20. Inductive Switching Loss vs. Gate Resistance

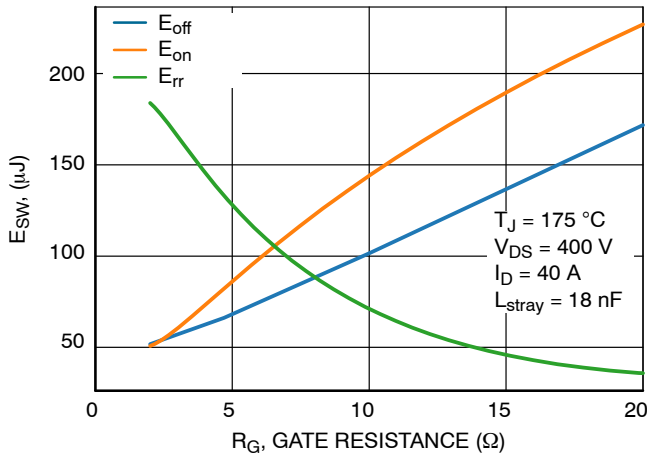


Figure 21. Inductive Switching Loss vs. Gate Resistance

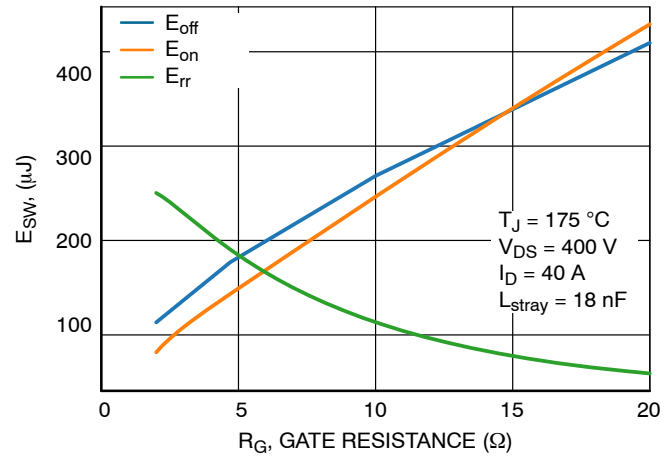


Figure 22. Inductive Switching Loss vs. Gate Resistance

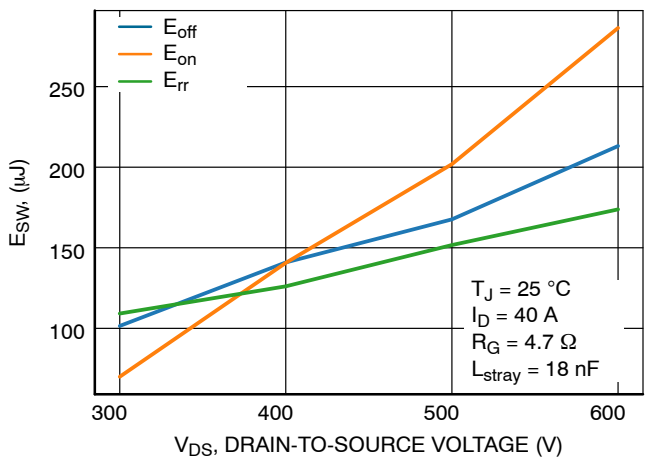


Figure 23. Inductive Switching Loss vs. Drain Voltage

TYPICAL CHARACTERISTICS

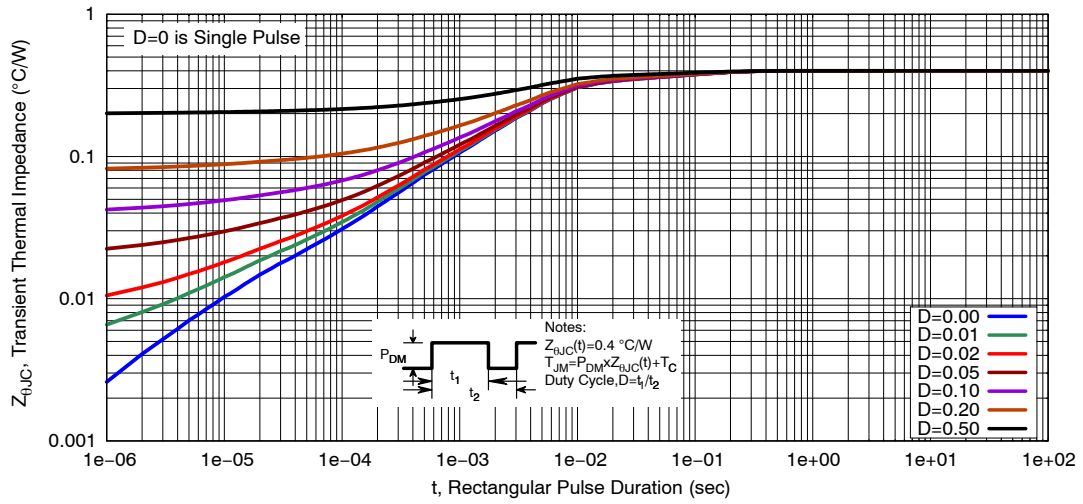


Figure 24. Thermal Response Characteristics



**REVISION HISTORY**

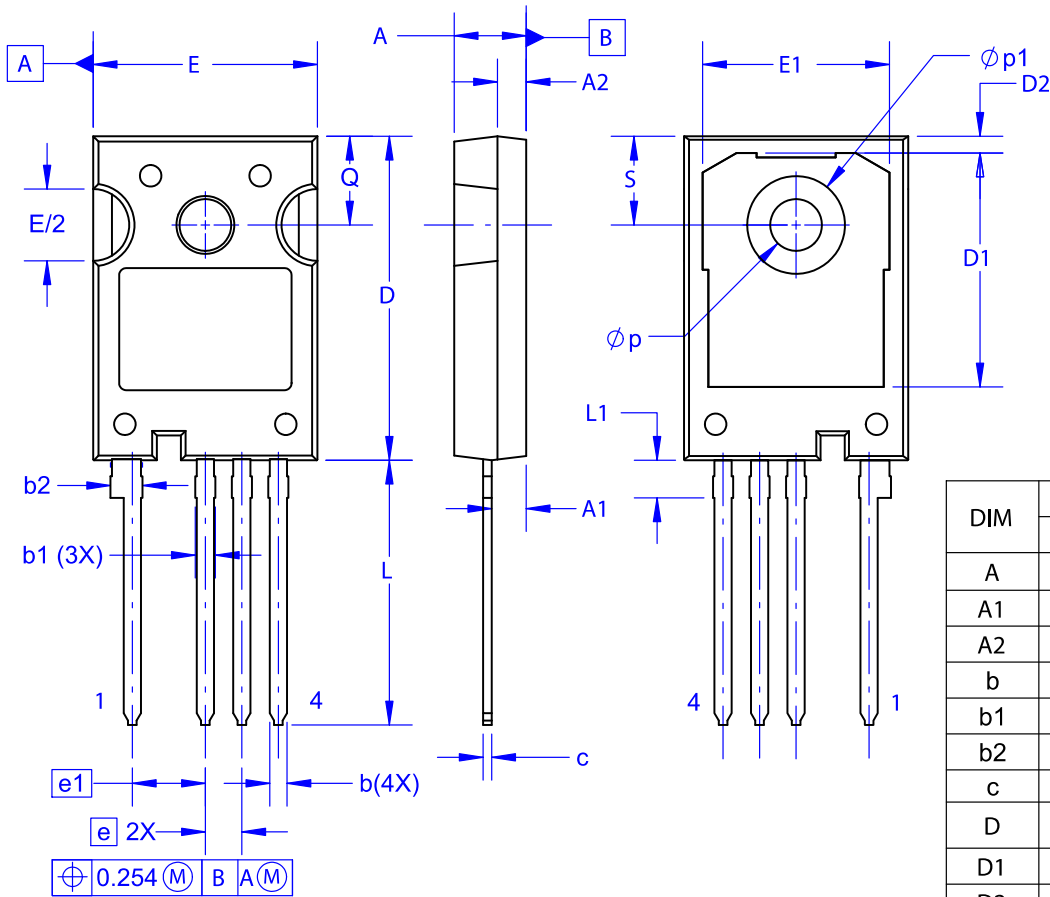
| <b>Revision</b> | <b>Description of Changes</b> | <b>Date</b> |
|-----------------|-------------------------------|-------------|
| 0               | Initial data sheet release.   | 10/30/2025  |

This document has undergone updates prior to the inclusion of this revision history table. The changes tracked here only reflect updates made on the noted approval dates.

# NTH4L012N065M3S

## PACKAGE DIMENSIONS

TO-247-4LD  
CASE 340CJ  
ISSUE A



### 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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