

# MOSFET – Power, N-Channel, Shielded Gate

**60 V, 5.2 mΩ, 78 A**

**NTTFS5D1N06HL**

## General Description

This N-Channel MOSFET is produced using onsemi's advanced MOSFET process that incorporates Shielded Gate technology. This process has been optimized to minimize on-state resistance and yet maintain superior switching performance with best in class soft body diode.

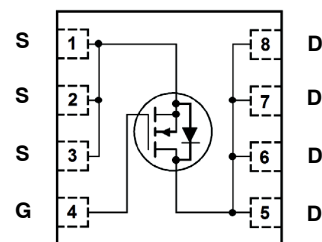
## Features

- Shielded Gate MOSFET Technology
- Max  $r_{DS(on)} = 5.2 \text{ m}\Omega$  at  $V_{GS} = 10 \text{ V}$ ,  $I_D = 16 \text{ A}$
- Max  $r_{DS(on)} = 7.1 \text{ m}\Omega$  at  $V_{GS} = 4.5 \text{ V}$ ,  $I_D = 13 \text{ A}$
- Lowers Switching Noise/EMI
- MSL1 Robust Package Design
- 100% UIL Tested
- RoHS Compliant

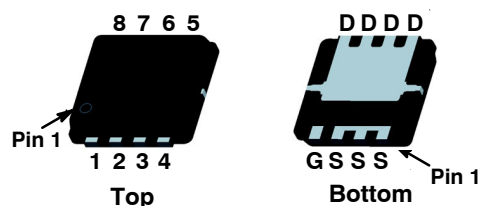
## Applications

- Primary DC-DC MOSFET
- Synchronous Rectifier in DC-DC and AC-DC
- Motor Drive

## ELECTRICAL CONNECTION

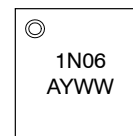


N-Channel MOSFET



WDFN8  
(3.3x3.3, 0.65 P)  
CASE 511DY

## MARKING DIAGRAM



|      |                     |
|------|---------------------|
| 1N06 | = Device Code       |
| A    | = Assembly Location |
| Y    | = Year Code         |
| WW   | = Work Week Code    |

## ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# NTTFS5D1N06HL

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

| Symbol         | Parameter                                                   | Ratings         | Unit             |
|----------------|-------------------------------------------------------------|-----------------|------------------|
| $V_{DS}$       | Drain to Source Voltage                                     | 60              | V                |
| $V_{GS}$       | Gate to Source Voltage                                      | $\pm 20$        | V                |
| $I_D$          | Drain Current –Continuous $T_C = 25^\circ\text{C}$ (Note 5) | 78              | A                |
|                | –Continuous $T_C = 100^\circ\text{C}$ (Note 5)              | 49              |                  |
|                | –Continuous $T_A = 25^\circ\text{C}$ (Note 1a)              | 18              |                  |
|                | –Pulsed (Note 4)                                            | 216             |                  |
| $E_{AS}$       | Single Pulse Avalanche Energy (Note 3)                      | 72              | mJ               |
| $P_D$          | Power Dissipation $T_C = 25^\circ\text{C}$                  | 63              | W                |
|                | Power Dissipation $T_A = 25^\circ\text{C}$ (Note 1a)        | 3.2             |                  |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range            | $-55$ to $+150$ | $^\circ\text{C}$ |

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.

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                         | Ratings | Unit               |
|-----------------|---------------------------------------------------|---------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case              | 2       | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient (Note 1a) | 39      |                    |

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

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

### OFF CHARACTERISTICS

|                                      |                                           |                                                             |    |    |     |                      |
|--------------------------------------|-------------------------------------------|-------------------------------------------------------------|----|----|-----|----------------------|
| $BV_{DSS}$                           | Drain to Source Breakdown Voltage         | $I_D = 250\ \mu\text{A}, V_{GS} = 0\ \text{V}$              | 60 |    |     | V                    |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\ \mu\text{A}$ , referenced to $25^\circ\text{C}$ |    | 37 |     | mV/ $^\circ\text{C}$ |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 48\ \text{V}, V_{GS} = 0\ \text{V}$               |    |    | 10  | $\mu\text{A}$        |
| $I_{GSS}$                            | Gate to Source Leakage Current            | $V_{GS} = +20\ \text{V}, V_{DS} = 0\ \text{V}$              |    |    | 100 | nA                   |

### ON CHARACTERISTICS

|                                        |                                                          |                                                            |     |      |     |                      |
|----------------------------------------|----------------------------------------------------------|------------------------------------------------------------|-----|------|-----|----------------------|
| $V_{GS(th)}$                           | Gate to Source Threshold Voltage                         | $V_{GS} = V_{DS}, I_D = 80\ \mu\text{A}$                   | 1.2 | 1.6  | 2.0 | V                    |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate to Source Threshold Voltage Temperature Coefficient | $I_D = 80\ \mu\text{A}$ , referenced to $25^\circ\text{C}$ |     | -5.2 |     | mV/ $^\circ\text{C}$ |
| $r_{DS(on)}$                           | Static Drain to Source On Resistance                     | $V_{GS} = 10\ \text{V}, I_D = 16\ \text{A}$                |     | 4.4  | 5.2 | m $\Omega$           |
|                                        |                                                          | $V_{GS} = 4.5\ \text{V}, I_D = 13\ \text{A}$               |     | 5.6  | 7.1 |                      |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                                  |  |      |  |          |
|-----------|------------------------------|------------------------------------------------------------------|--|------|--|----------|
| $C_{ISS}$ | Input Capacitance            | $V_{DS} = 30\ \text{V}, V_{GS} = 0\ \text{V}, f = 1\ \text{MHz}$ |  | 1610 |  | pF       |
| $C_{OSS}$ | Output Capacitance           |                                                                  |  | 313  |  |          |
| $C_{RSS}$ | Reverse Transfer Capacitance |                                                                  |  | 12.2 |  |          |
| $R_G$     | Gate Resistance              |                                                                  |  | 0.9  |  | $\Omega$ |

### SWITCHING CHARACTERISTICS

|              |                       |                                                                                            |  |      |  |    |
|--------------|-----------------------|--------------------------------------------------------------------------------------------|--|------|--|----|
| $t_{d(ON)}$  | Turn – On Delay Time  | $V_{DD} = 30\ \text{V}, I_D = 16\ \text{A}, V_{GS} = 4.5\ \text{V}, R_{GEN} = 2.5\ \Omega$ |  | 14   |  | ns |
| $t_{rd(ON)}$ | Rise Time             |                                                                                            |  | 24   |  |    |
| $t_{d(OFF)}$ | Turn – Off Delay Time |                                                                                            |  | 41.3 |  |    |
| $t_f$        | Fall Time             |                                                                                            |  | 12.2 |  |    |

# NTTFS5D1N06HL

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

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

### SWITCHING CHARACTERISTICS

|          |                               |                                               |  |      |  |    |
|----------|-------------------------------|-----------------------------------------------|--|------|--|----|
| $Q_g$    | Total Gate Charge             | $V_{GS} = 0\text{ V to } 10\text{ V}$         |  | 22.5 |  | nC |
| $Q_g$    | Total Gate Charge             | $V_{GS} = 0\text{ V to } 4.5\text{ V}$        |  | 10.3 |  |    |
| $Q_{gs}$ | Gate to Source Charge         | $V_{DD} = 30\text{ V}$<br>$I_D = 16\text{ A}$ |  | 5    |  |    |
| $Q_{gd}$ | Gate to Drain "Miller" Charge |                                               |  | 3    |  |    |

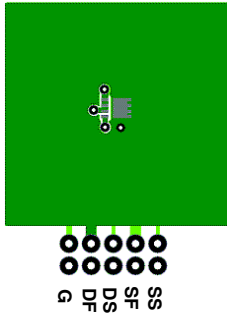
### DRAIN-SOURCE DIODE CHARACTERISTICS

|          |                                       |                                                       |  |      |     |    |
|----------|---------------------------------------|-------------------------------------------------------|--|------|-----|----|
| $V_{SD}$ | Source to Drain Diode Forward Voltage | $V_{GS} = 0\text{ V}, I_S = 16\text{ A (Note 2)}$     |  | 0.8  | 1.2 | V  |
|          |                                       | $V_{GS} = 0\text{ V}, I_S = 16\text{ A (Note 2)}$     |  | 0.66 |     |    |
| $t_{rr}$ | Reverse Recovery Time                 | $I_F = 16\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$ |  | 35.1 |     | ns |
| $Q_{rr}$ | Reverse Recovery Charge               |                                                       |  | 37   |     | nC |

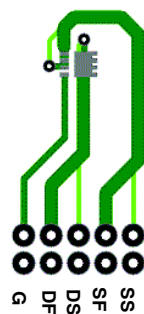
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

### NOTES:

- $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 × 1.5 in. board of FR-4 material.  $R_{\theta CA}$  is determined by the user's board design.



a)  $53^\circ\text{C/W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper.



b)  $125^\circ\text{C/W}$  when mounted on a minimum pad of 2 oz copper.

- Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0%.
- $E_{AS}$  of 72 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 12\text{ A}$ ,  $V_{DD} = 48\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 1\text{ mH}$ ,  $I_{AS} = 12\text{ A}$ .
- Pulsed  $I_D$  please refer to SOA graph for more details.
- Computed continuous current limited to Max Junction Temperature only, actual continuous current will be limited by thermal & electro-mechanical application board design.

TYPICAL CHARACTERISTICS

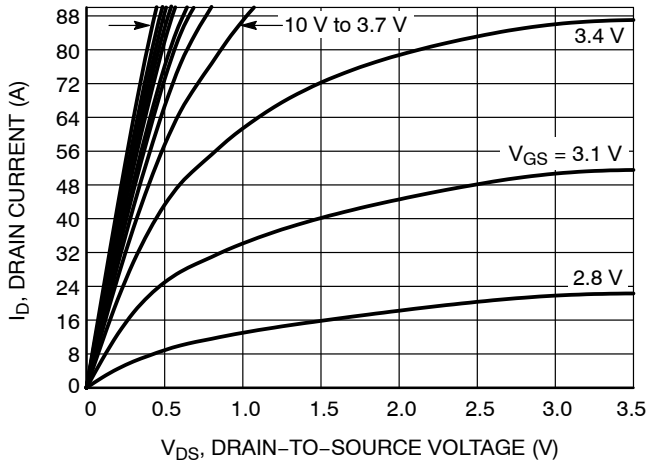


Figure 1. On-Region Characteristics

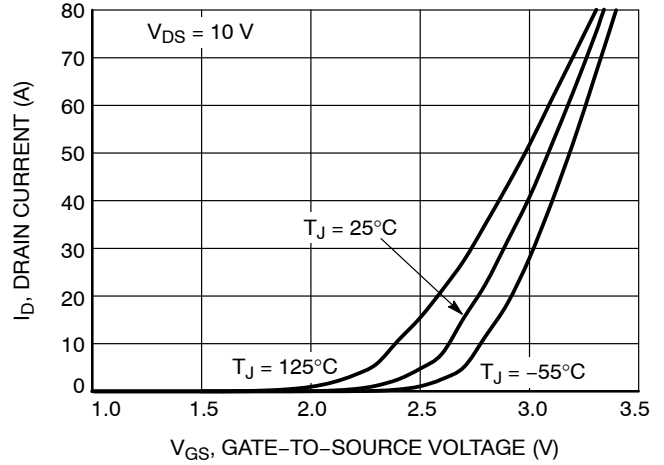


Figure 2. Transfer Characteristics

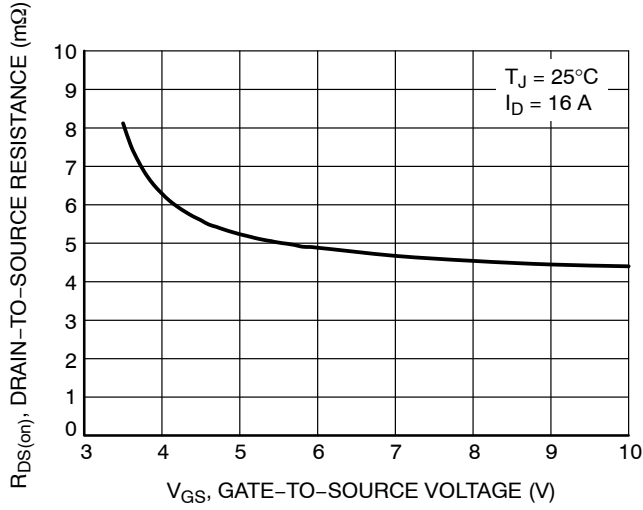


Figure 3. On-Resistance vs. Gate-to-Source Voltage

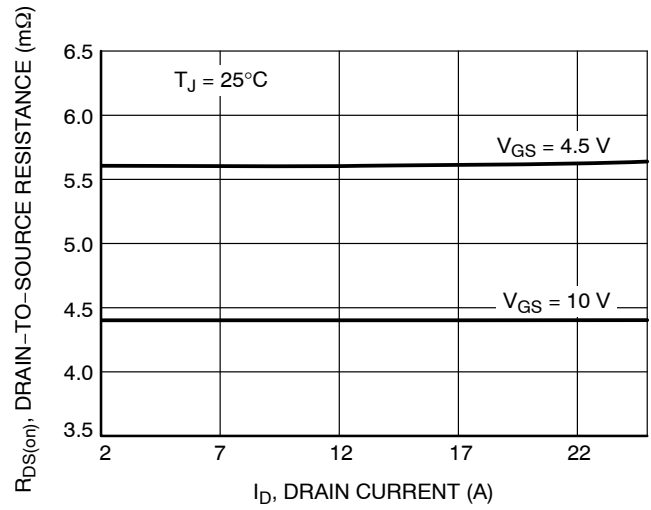


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

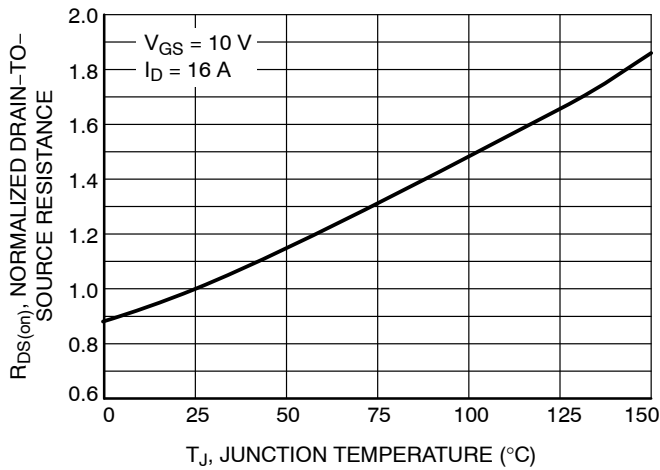


Figure 5. On-Resistance Variation with Temperature

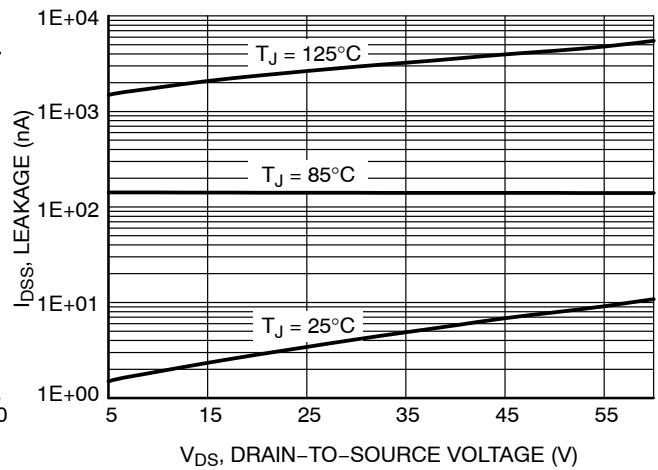


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS (continue)

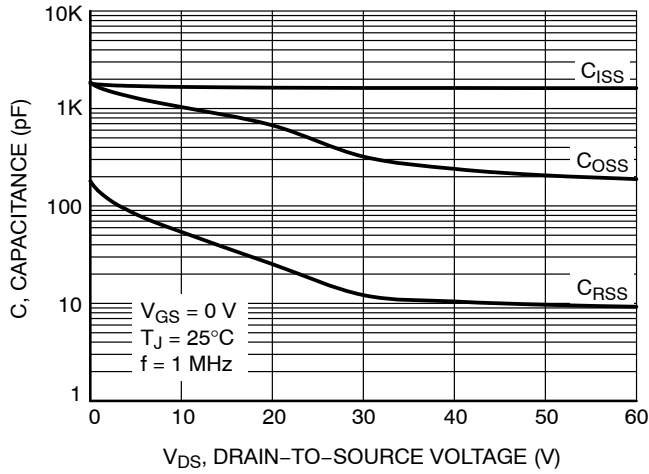


Figure 7. Capacitance Variation

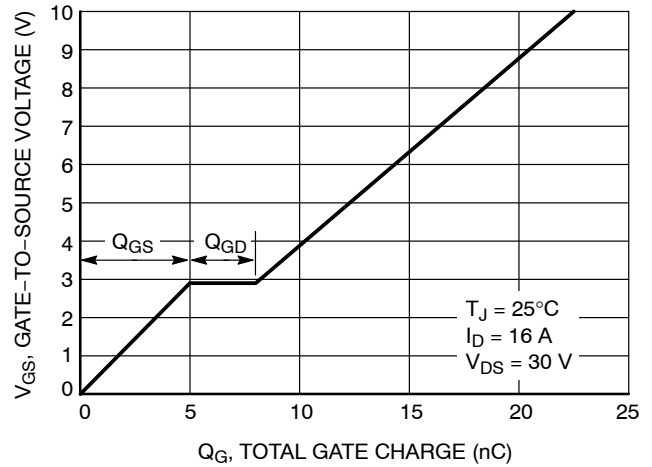


Figure 8. Gate-to-Source Voltage vs. Total Charge

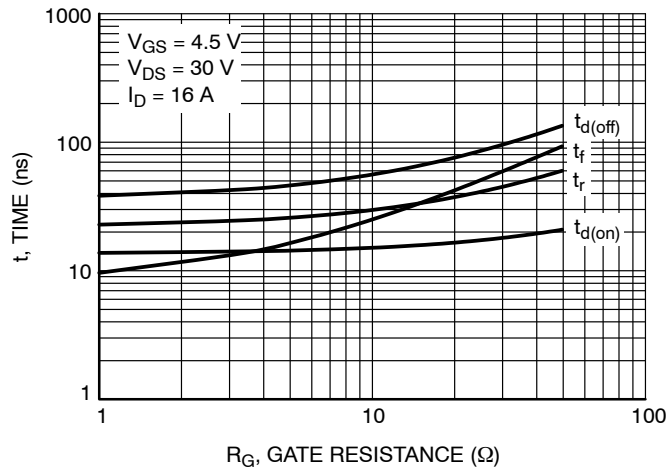


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

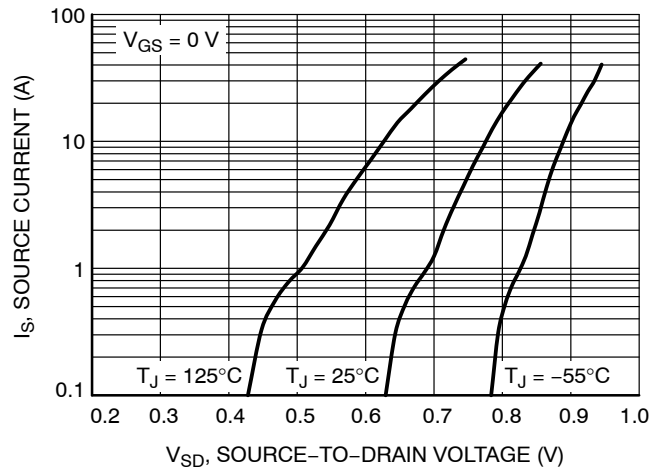


Figure 10. Diode Forward Voltage vs. Current

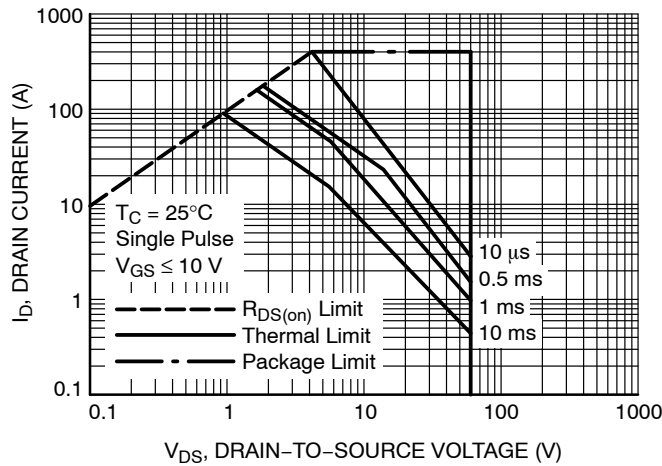


Figure 11. Maximum Rated Forward Biased Safe Operating Area

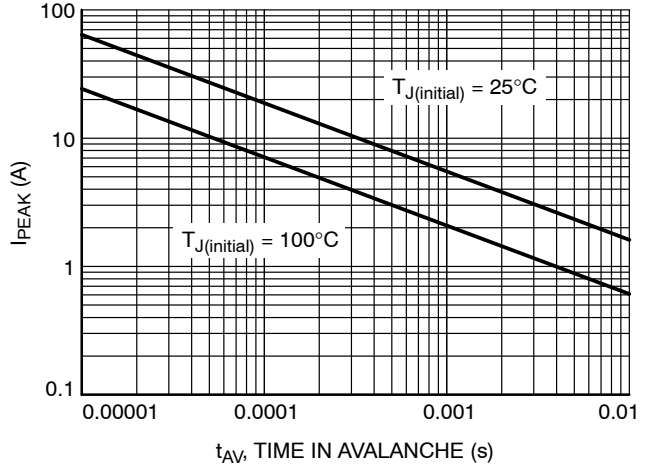


Figure 12. Maximum Drain Current vs. Time in Avalanche

# NTTFS5D1N06HL

## TYPICAL CHARACTERISTICS (continue)

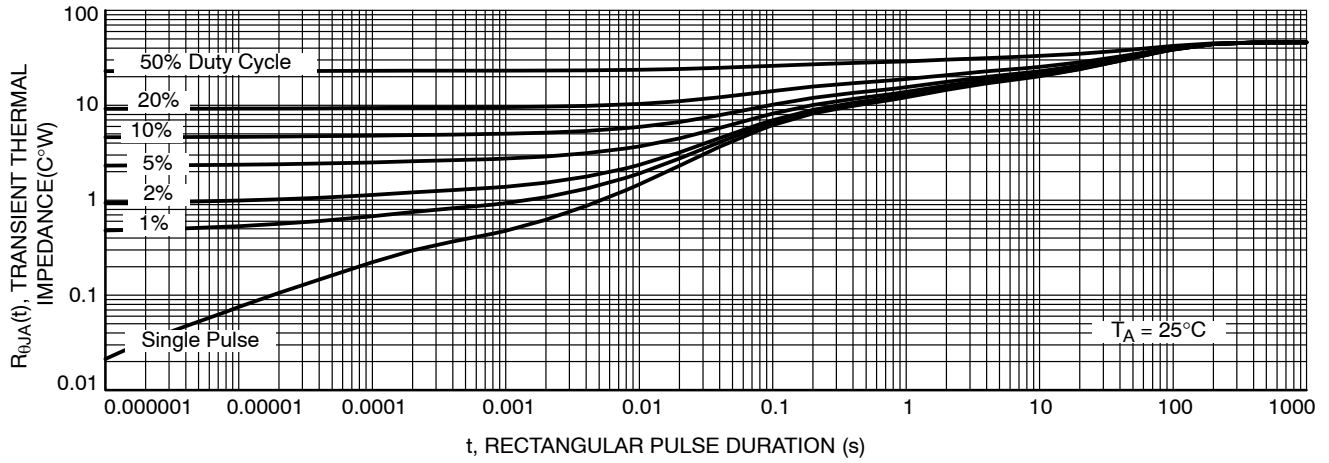


Figure 13. Thermal Response

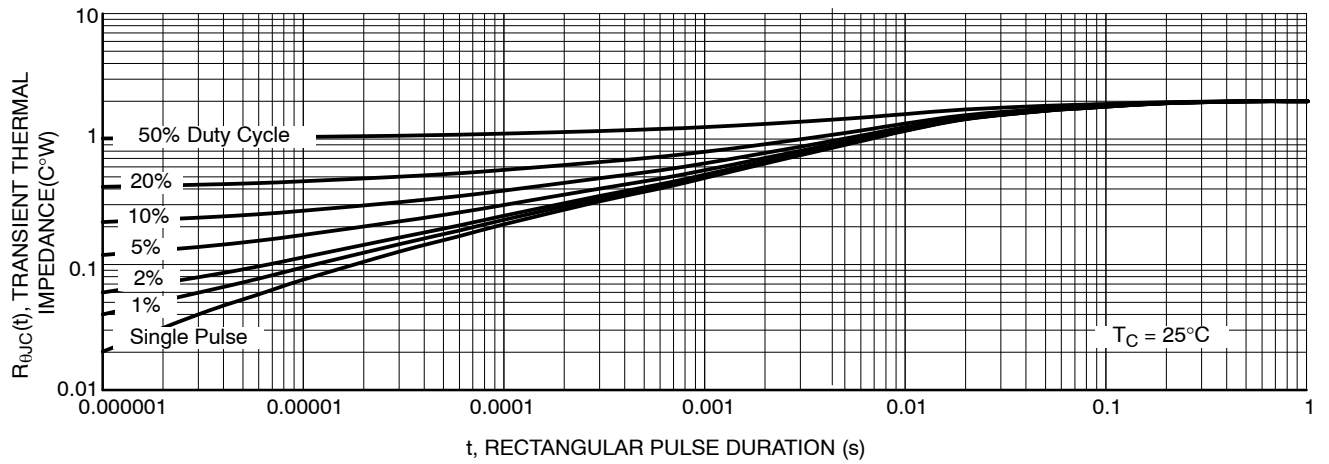


Figure 14. Thermal Response

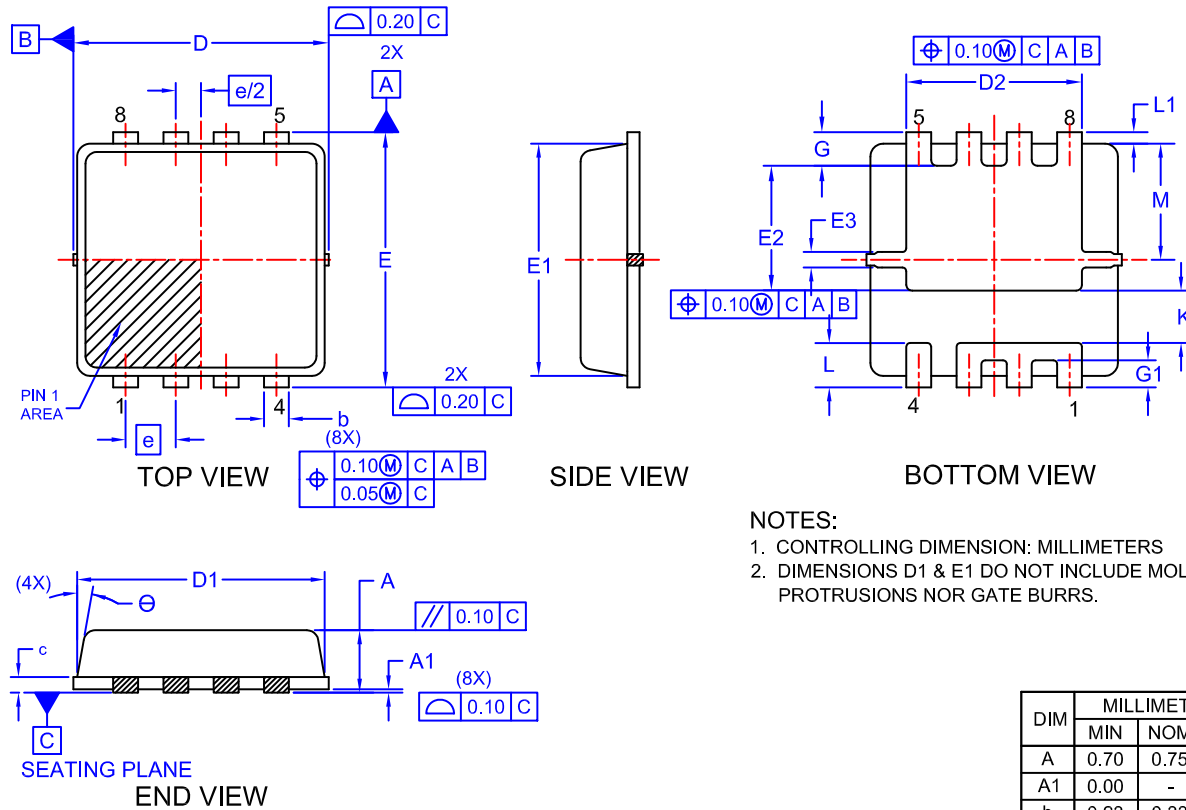
### PACKAGE MARKING AND ORDERING INFORMATION

| Device Marking | Device           | Package         | Reel Size | Tape Width | Quantity         |
|----------------|------------------|-----------------|-----------|------------|------------------|
| 1N06           | NTTFS5D1N06HLTAG | WDFN8 (3.3x3.3) | 7"        | 12 mm      | 1500 Tape & Reel |

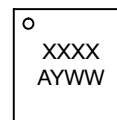
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, [BRD8011/D](#).

**WDFN8 3.3x3.3, 0.65P**  
CASE 511DY  
ISSUE A

DATE 21 AUG 2018


**NOTES:**

1. CONTROLLING DIMENSION: MILLIMETERS
2. DIMENSIONS D1 & E1 DO NOT INCLUDE MOLD FLASH PROTRUSIONS NOR GATE BURRS.

**GENERIC MARKING DIAGRAM\***


XXXX = Specific Device Code  
A = Assembly Location  
Y = Year Code  
WW = Work Week Code

\*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.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN         | NOM  | MAX  |
| A   | 0.70        | 0.75 | 0.80 |
| A1  | 0.00        | -    | 0.05 |
| b   | 0.23        | 0.33 | 0.43 |
| c   | 0.15        | 0.20 | 0.25 |
| D   | 3.20        | 3.30 | 3.40 |
| D1  | 2.95        | 3.13 | 3.30 |
| D2  | 1.98        | 2.20 | 2.40 |
| E   | 3.20        | 3.30 | 3.40 |
| E1  | 2.80        | 3.00 | 3.15 |
| E2  | 1.40        | 1.60 | 1.80 |
| E3  | 0.15        | 0.25 | 0.40 |
| e   | 0.65 BSC    |      |      |
| G   | 0.30        | 0.43 | 0.55 |
| G1  | 0.25        | 0.35 | 0.45 |
| K   | 0.55        | 0.75 | 0.95 |
| L   | 0.35        | 0.52 | 0.65 |
| L1  | 0.06        | 0.15 | 0.30 |
| M   | 1.35        | 1.50 | 1.60 |
| Θ   | 0           | -    | 12   |

|                         |                             |                                                                                                                                                                                     |
|-------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>WDFN8 3.3x3.3, 0.65P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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