

# MOSFET - Single, N-Channel

**100 V, 25 mΩ, 24 A**

**NTTFD022N10C**

## General Description

This device includes two specialized N-Channel MOSFETs in a dual package. The switch node has been internally connected to enable easy placement and routing of synchronous buck converters. The control MOSFET (Q2) and synchronous (Q1) have been designed to provide optimal power efficiency.

## Features

Q1: N-Channel

- Max  $r_{DS(on)}$  = 25 mΩ at  $V_{GS} = 10$  V,  $I_D = 7.8$  A
- Max  $r_{DS(on)}$  = 61 mΩ at  $V_{GS} = 6$ ,  $I_D = 3.9$  A

Q2: N-Channel

- Max  $r_{DS(on)}$  = 25 mΩ at  $V_{GS} = 10$  V,  $I_D = 7.8$  A
- Max  $r_{DS(on)}$  = 61 mΩ at  $V_{GS} = 6$ ,  $I_D = 3.9$  A
- Low Inductance Packaging Shortens Rise/Fall Times, Resulting in Lower Switching Losses
- RoHS Compliant

## Applications

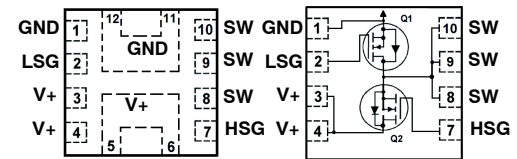
- Computing
- Communications
- General Purpose Point of Load

## PIN DESCRIPTION

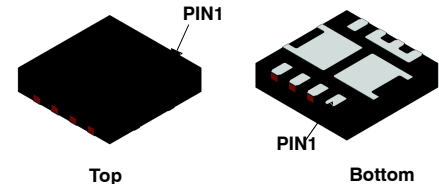
| Pin        | Name      | Description                    |
|------------|-----------|--------------------------------|
| 1, 11, 12  | GND (LSS) | Low Side Source                |
| 2          | LSG       | Low Side Gate                  |
| 3, 4, 5, 6 | V + (HSD) | High Side Drain                |
| 7          | HSG       | High Side Gate                 |
| 8, 9, 10   | SW        | Switching Node, Low Side Drain |

| $V_{(BR)DSS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX |
|---------------|------------------|-----------|
| 100 V         | 25 mΩ @ 10 V     | 24 A      |
|               | 61 mΩ @ 6 V      |           |

## ELECTRICAL CONNECTION

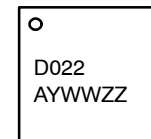


Dual N-Channel MOSFET



Power Clip 33 Symmetric  
(WQFN12)  
CASE 510CJ

## MARKING DIAGRAM



D022 = Specific Device Code  
A = Assembly Plant Code  
Y = Numeric Year Code  
WW = Work Week Code  
ZZ = Assembly Lot Code

## ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# NTTFD022N10C

## ORDERING INFORMATION AND PACKAGE MARKING

| Device       | Marking | Package             | Shipping <sup>†</sup>      |
|--------------|---------|---------------------|----------------------------|
| NTTFD022N10C | D022    | WQFN12<br>(Pb-Free) | 3000 Units/<br>Tape & Reel |

<sup>†</sup>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.

## MOSFET MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ , Unless otherwise specified)

| Symbol         | Parameter                                                                                    | Q1              | Q2            | Units            |
|----------------|----------------------------------------------------------------------------------------------|-----------------|---------------|------------------|
| $V_{DS}$       | Drain-to-Source Voltage                                                                      | 100             | 100           | V                |
| $V_{GS}$       | Gate-to-Source Voltage                                                                       | $\pm 20$        | $\pm 20$      | V                |
| $I_D$          | Drain Current – Continuous $T_C = 25^\circ\text{C}$<br>(Note 4)                              | 24              | 24            | A                |
|                | – Continuous $T_C = 100^\circ\text{C}$<br>(Note 4)                                           | 14              | 14            |                  |
|                | – Continuous $T_A = 25^\circ\text{C}$                                                        | 6 (Note 1a)     | 6 (Note 1b)   |                  |
|                | – Pulsed $T_A = 25^\circ\text{C}$                                                            | 349             | 349           |                  |
| $E_{AS}$       | Single Pulse Avalanche Energy ( $L = 3\text{ mH}$ , $I_{L(pk)} = 5.1\text{ A}$ )<br>(Note 3) | 39              | 39            | mJ               |
| $P_D$          | Power Dissipation for Single Operation $T_C = 25^\circ\text{C}$                              | 26              | 26            | W                |
|                | Power Dissipation for Single Operation $T_A = 25^\circ\text{C}$                              | 1.7 (Note 1a)   | 1.7 (Note 1b) |                  |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range                                             | $-55$ to $+150$ |               | $^\circ\text{C}$ |
| $T_L$          | Lead Temperature for Soldering Purposes ( $1/8''$ from case for 10 s)                        | 260             | 260           | $^\circ\text{C}$ |

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                               | Q1            | Q2            | Units              |
|-----------------|-----------------------------------------|---------------|---------------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case    | 4.8           | 4.8           | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 70 (Note 1a)  | 70 (Note 1b)  |                    |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 135 (Note 1c) | 135 (Note 1c) |                    |

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

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

### OFF CHARACTERISTICS

|                                      |                                           |                                                                   |    |     |    |           |                            |
|--------------------------------------|-------------------------------------------|-------------------------------------------------------------------|----|-----|----|-----------|----------------------------|
| $BV_{DSS}$                           | Drain-to-Source Breakdown Voltage         | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$            | Q1 | 100 |    |           | V                          |
|                                      |                                           | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0\text{ V}$            | Q2 | 100 |    |           |                            |
| $\frac{\Delta BV_{DSS}}{\Delta T_J}$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , referenced to $25^\circ\text{C}$ | Q1 |     | 80 |           | $\text{mV}/^\circ\text{C}$ |
|                                      |                                           | $I_D = 250\text{ }\mu\text{A}$ , referenced to $25^\circ\text{C}$ | Q2 |     | 80 |           |                            |
| $I_{DSS}$                            | Zero Gate Voltage Drain Current           | $V_{DS} = 80\text{ V}$ , $V_{GS} = 0\text{ V}$                    | Q1 |     |    | 1         | $\mu\text{A}$              |
|                                      |                                           | $V_{DS} = 80\text{ V}$ , $V_{GS} = 0\text{ V}$                    | Q2 |     |    | 1         |                            |
| $I_{GSS}$                            | Gate-to-Source Leakage Current, Forward   | $V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$                | Q1 |     |    | $\pm 100$ | nA                         |
|                                      |                                           | $V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$                | Q2 |     |    | $\pm 100$ |                            |

# NTTFD022N10C

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise noted)

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

### ON CHARACTERISTICS

|                                        |                                                          |                                                                        |    |   |      |    |       |
|----------------------------------------|----------------------------------------------------------|------------------------------------------------------------------------|----|---|------|----|-------|
| V <sub>GS(th)</sub>                    | Gate-to-Source Threshold Voltage                         | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 44 μA             | Q1 | 2 | 2.9  | 4  | V     |
|                                        |                                                          | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 44 μA             | Q2 | 2 | 2.9  | 4  |       |
| $\frac{\Delta V_{GS(th)}}{\Delta T_J}$ | Gate-to-Source Threshold Voltage Temperature Coefficient | I <sub>D</sub> = 44 μA, referenced to 25°C                             | Q1 |   | -9.2 |    | mV/°C |
|                                        |                                                          | I <sub>D</sub> = 44 μA, referenced to 25°C                             | Q2 |   | -9.2 |    |       |
| r <sub>DS(on)</sub>                    | Drain-to-Source On Resistance                            | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 7.8 A                         | Q1 |   | 18.7 | 25 | mΩ    |
|                                        |                                                          | V <sub>GS</sub> = 6 V, I <sub>D</sub> = 3.9 A                          |    |   | 28   | 61 |       |
|                                        |                                                          | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 7.8 A, T <sub>J</sub> = 125°C |    |   | 32.6 |    |       |
| r <sub>DS(on)</sub>                    | Drain-to-Source On Resistance                            | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 7.8 A                         | Q2 |   | 18.7 | 25 | mΩ    |
|                                        |                                                          | V <sub>GS</sub> = 6 V, I <sub>D</sub> = 3.9 A                          |    |   | 28   | 61 |       |
|                                        |                                                          | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 7.8 A, T <sub>J</sub> = 125°C |    |   | 32.6 |    |       |
| g <sub>FS</sub>                        | Forward Transconductance                                 | V <sub>DS</sub> = 5 V, I <sub>D</sub> = 7.8 A                          | Q1 |   | 191  |    | S     |
|                                        |                                                          | V <sub>DS</sub> = 5 V, I <sub>D</sub> = 7.8 A                          | Q2 |   | 191  |    |       |

### DYNAMIC CHARACTERISTICS

|                  |                              |                                                                                                                                        |    |  |     |  |    |
|------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|----|--|-----|--|----|
| C <sub>ISS</sub> | Input Capacitance            | Q1:<br>V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0 V, f = 1 Mhz<br><br>Q2:<br>V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0 V, f = 1 MHz | Q1 |  | 585 |  | pF |
|                  |                              |                                                                                                                                        | Q2 |  | 585 |  |    |
| C <sub>OSS</sub> | Output Capacitance           |                                                                                                                                        | Q1 |  | 354 |  | pF |
|                  |                              |                                                                                                                                        | Q2 |  | 354 |  |    |
| C <sub>RSS</sub> | Reverse Transfer Capacitance |                                                                                                                                        | Q1 |  | 8   |  | pF |
|                  |                              |                                                                                                                                        | Q2 |  | 8   |  |    |
| R <sub>G</sub>   | Gate Resistance              | T <sub>A</sub> = 25°C                                                                                                                  | Q1 |  | 1.5 |  | Ω  |
|                  |                              |                                                                                                                                        | Q2 |  | 1.5 |  |    |

### SWITCHING CHARACTERISTICS

|         |                               |                                                                                                                       |    |  |      |  |    |
|---------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------|----|--|------|--|----|
| td(ON)  | Turn-On Delay Time            | Q1:<br>VDD = 50 V, ID = 7.8 A,<br>RGEN = 6 Ω<br><br>Q2:<br>VDD = 50 V, ID = 7.8 A,<br>RGEN = 6 Ω                      | Q1 |  | 8.5  |  | ns |
|         |                               |                                                                                                                       | Q2 |  | 8.5  |  |    |
| tr      | Rise Time                     |                                                                                                                       | Q1 |  | 3.2  |  | ns |
|         |                               |                                                                                                                       | Q2 |  | 3.2  |  |    |
| tD(OFF) | Turn-Off Delay Time           |                                                                                                                       | Q1 |  | 13.3 |  | ns |
|         |                               |                                                                                                                       | Q2 |  | 13.3 |  |    |
| tf      | Fall Time                     |                                                                                                                       | Q1 |  | 4.1  |  | ns |
|         |                               |                                                                                                                       | Q2 |  | 4.1  |  |    |
| Qg      | Total Gate Charge             | VGS = 0 V to 10 V<br><br><br><br><br><br><br><br>Q1:<br>VDD = 50 V,<br>ID = 7.8 A<br>Q2:<br>VDD = 50 V,<br>ID = 7.8 A | Q1 |  | 9.0  |  | nC |
|         |                               |                                                                                                                       | Q2 |  | 9.0  |  |    |
| Qg      | Total Gate Charge             |                                                                                                                       | Q1 |  | 5.89 |  | nC |
|         |                               |                                                                                                                       | Q2 |  | 5.89 |  |    |
| Qgs     | Gate-to-Source Gate Charge    |                                                                                                                       | Q1 |  | 2.67 |  | nC |
|         |                               |                                                                                                                       | Q2 |  | 2.67 |  |    |
| Qgd     | Gate-to-Drain “Miller” Charge |                                                                                                                       | Q1 |  | 2.0  |  | nC |
|         |                               |                                                                                                                       | Q2 |  | 2.0  |  |    |

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

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

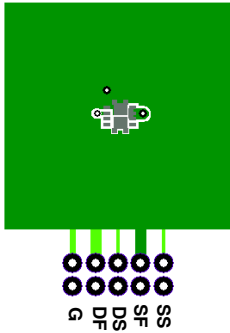
**DRAIN-SOURCE DIODE CHARACTERISTICS**

|          |                                       |                                                                                                                                        |    |  |      |     |    |
|----------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|----|--|------|-----|----|
| $V_{SD}$ | Source-to-Drain Diode Forward Voltage | $V_{GS} = 0\text{ V}$ , $I_S = 7.8\text{ A}$ (Note 2)                                                                                  | Q1 |  | 0.82 | 1.5 | V  |
|          |                                       | $V_{GS} = 0\text{ V}$ , $I_S = 7.8\text{ A}$ (Note 2)                                                                                  | Q2 |  | 0.82 | 1.5 |    |
| $t_{rr}$ | Reverse Recovery Time                 | Q1:<br>$I_F = 7.8\text{ A}$ , $di/dt = 300\text{ A}/\mu\text{s}$<br>Q2:<br>$I_F = 7.8\text{ A}$ , $di/dt = 300\text{ A}/\mu\text{s}$   | Q1 |  | 33   |     | ns |
|          |                                       |                                                                                                                                        | Q2 |  | 33   |     |    |
| $Q_{rr}$ | Reverse Recovery Charge               | $I_F = 7.8\text{ A}$ , $di/dt = 300\text{ A}/\mu\text{s}$                                                                              | Q1 |  | 35   |     | nC |
|          |                                       |                                                                                                                                        | Q2 |  | 35   |     |    |
| $t_{rr}$ | Reverse Recovery Time                 | Q1:<br>$I_F = 7.8\text{ A}$ , $di/dt = 1000\text{ A}/\mu\text{s}$<br>Q2:<br>$I_F = 7.8\text{ A}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ | Q1 |  | 14   |     | ns |
|          |                                       |                                                                                                                                        | Q2 |  | 14   |     |    |
| $Q_{rr}$ | Reverse Recovery Charge               | $I_F = 7.8\text{ A}$ , $di/dt = 1000\text{ A}/\mu\text{s}$                                                                             | Q1 |  | 91   |     | nC |
|          |                                       |                                                                                                                                        | Q2 |  | 91   |     |    |

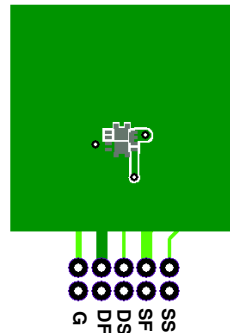
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

**NOTES:**

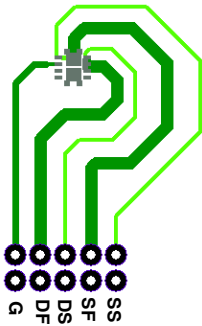
1.  $R_{\theta JA}$  is determined with the device mounted on a 1 in<sup>2</sup> pad 2 oz copper pad on a 1.5 × 1.5 in. board of FR-4 material.  $R_{\theta CA}$  is determined by the user's board design.



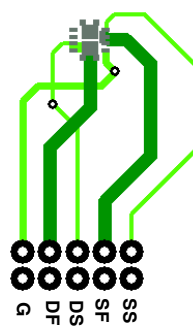
a)  $70^\circ\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper.



b)  $70^\circ\text{C}/\text{W}$  when mounted on a 1 in<sup>2</sup> pad of 2 oz copper.



c)  $135^\circ\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper.



d)  $135^\circ\text{C}/\text{W}$  when mounted on a minimum pad of 2 oz copper.

2. Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty cycle < 2.0%.
3. Q1:  $E_{AS}$  of 39 mJ is based on starting  $T_J = 25^\circ\text{C}$ ; N-ch:  $L = 3\text{ mH}$ ,  $I_{AS} = 5.1\text{ A}$ ,  $V_{DD} = 80\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 3\text{ mH}$ ,  $I_{AS} = 5.3\text{ A}$ .  
Q2:  $E_{AS}$  of 39 mJ is based on starting  $T_J = 25^\circ\text{C}$ ; N-ch:  $L = 3\text{ mH}$ ,  $I_{AS} = 5.1\text{ A}$ ,  $V_{DD} = 80\text{ V}$ ,  $V_{GS} = 10\text{ V}$ . 100% test at  $L = 3\text{ mH}$ ,  $I_{AS} = 5.3\text{ A}$ .
4. Computed continuous current limited to Max Junction Temperature only, actual continuous current will be limited by thermal & electro-mechanical application board design.

TYPICAL CHARACTERISTICS

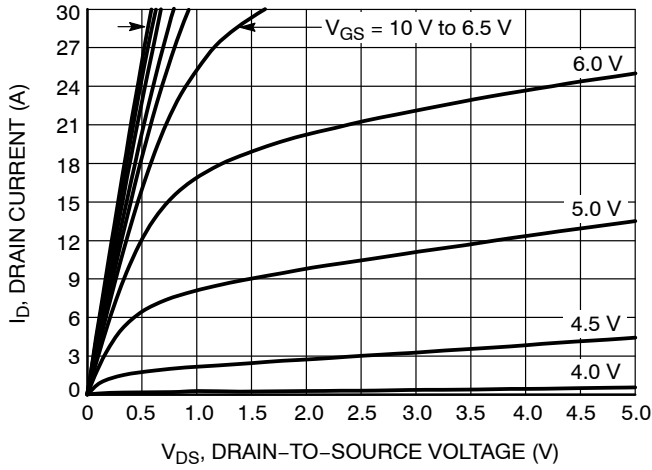


Figure 1. On-Region Characteristics

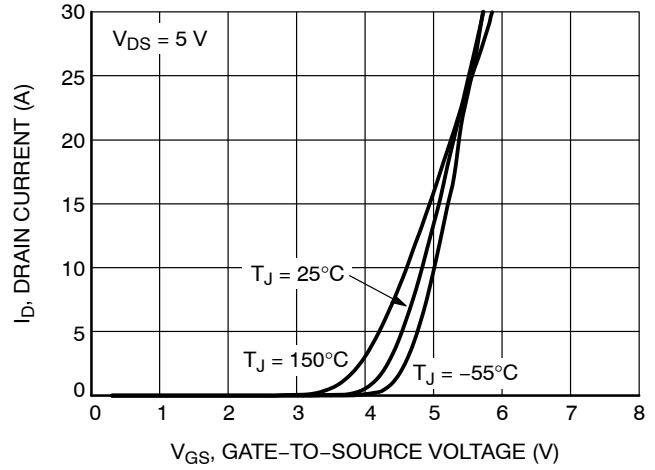


Figure 2. Transfer Characteristics

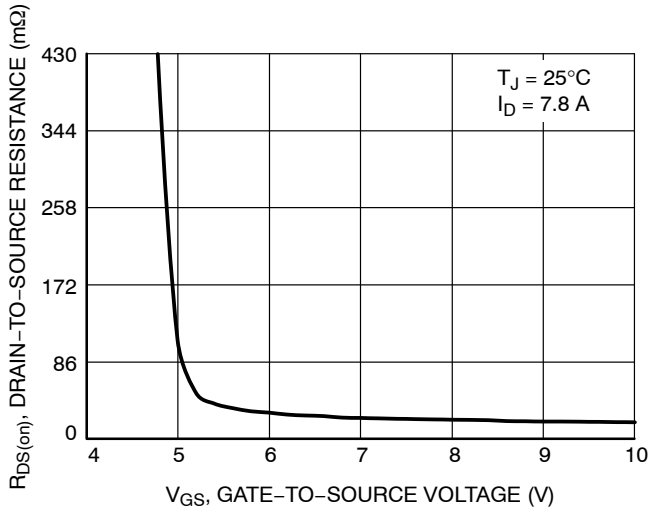


Figure 3. On-Resistance vs. Gate-to-Source Voltage

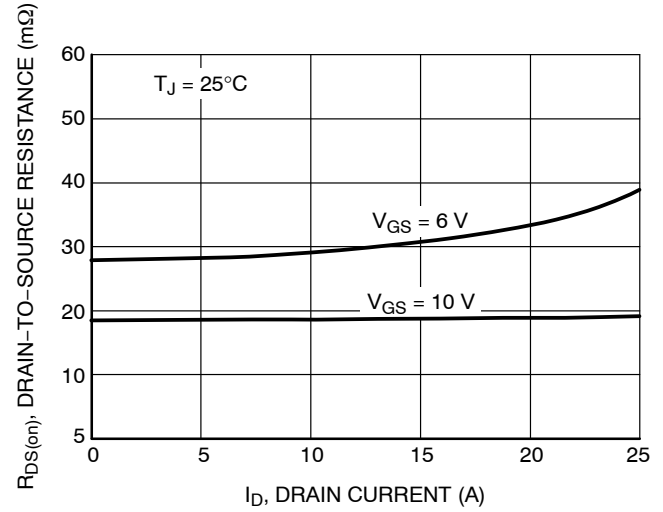


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

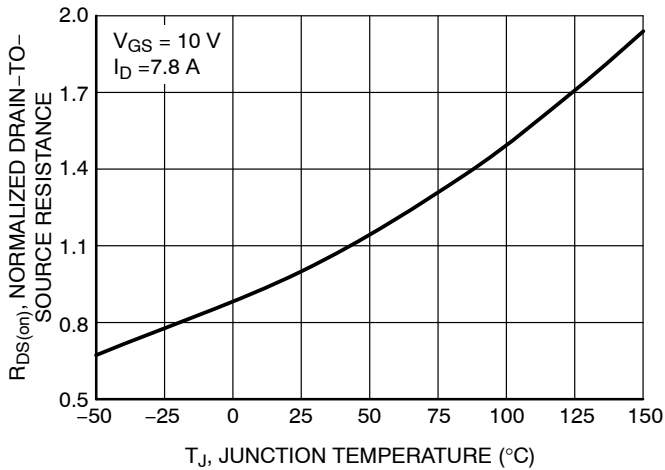


Figure 5. On-Resistance Variation with Temperature

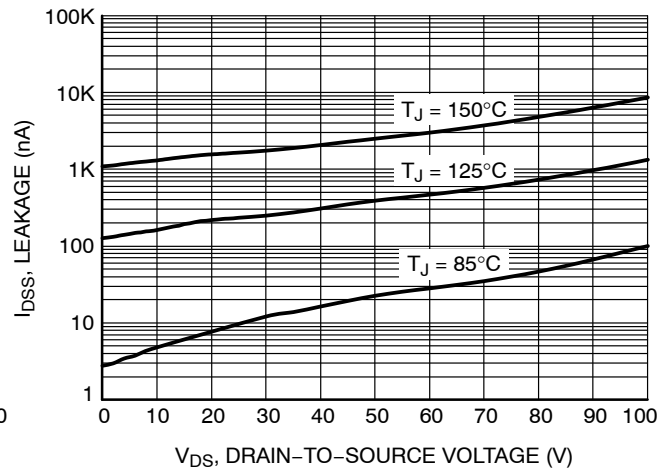


Figure 6. Drain-to-Source Leakage Current vs. Voltage

TYPICAL CHARACTERISTICS

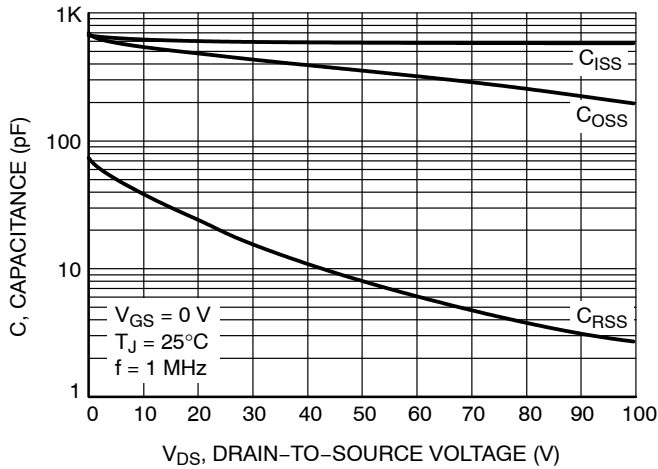


Figure 7. Capacitance Variation

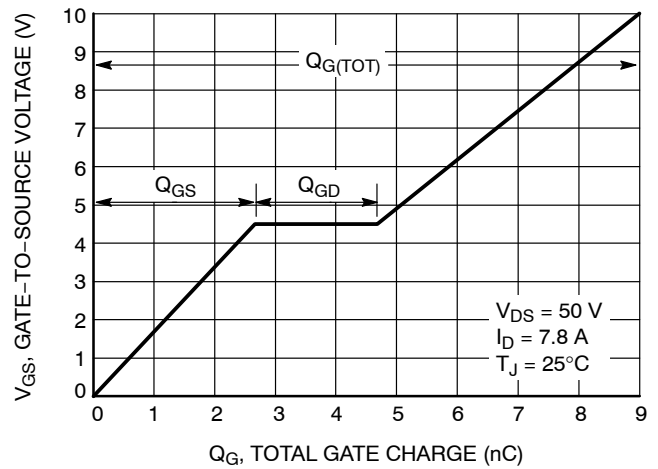


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Charge

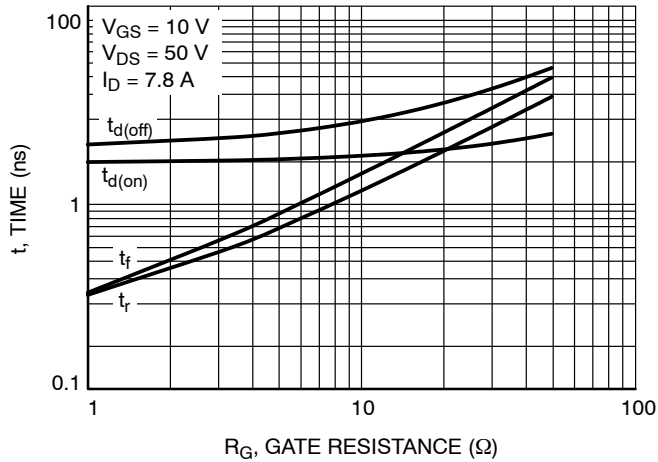


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

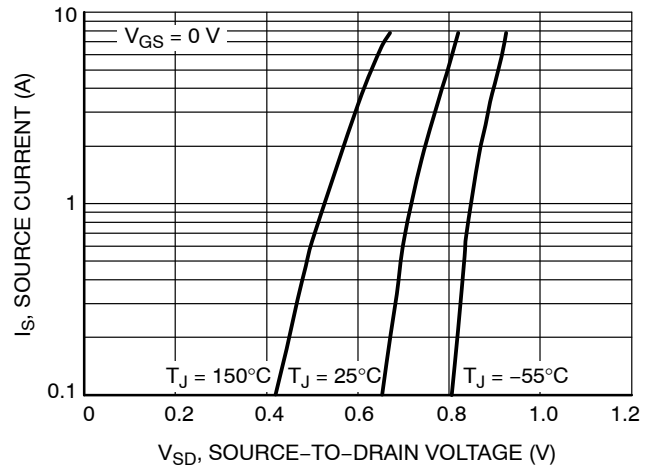


Figure 10. Diode Forward Voltage vs. Current

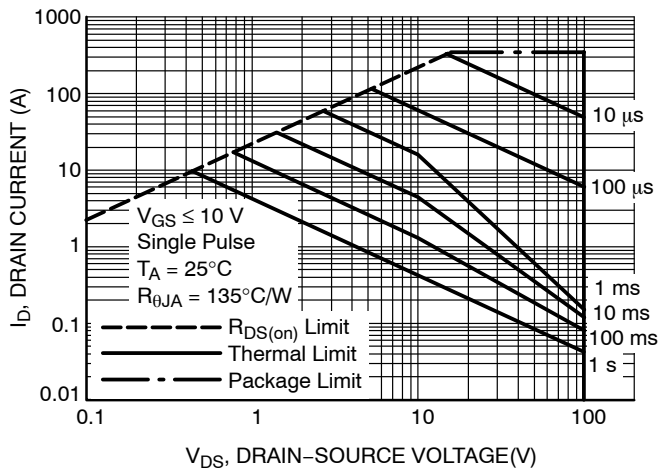


Figure 11. Safe Operating Area

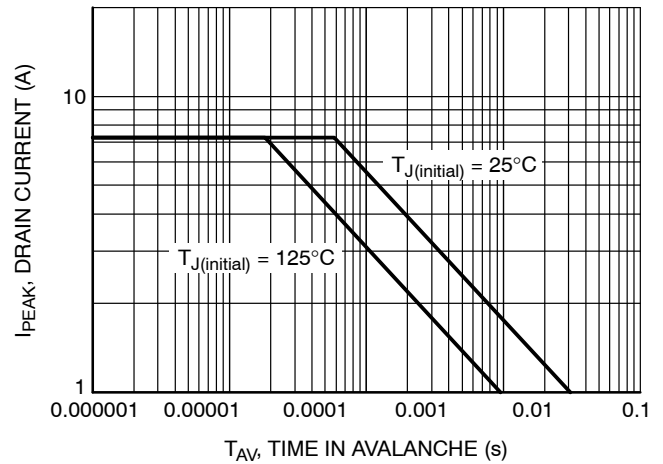


Figure 12.  $I_{PEAK}$  vs. Time in Avalanche

# NTTFD022N10C

## TYPICAL CHARACTERISTICS

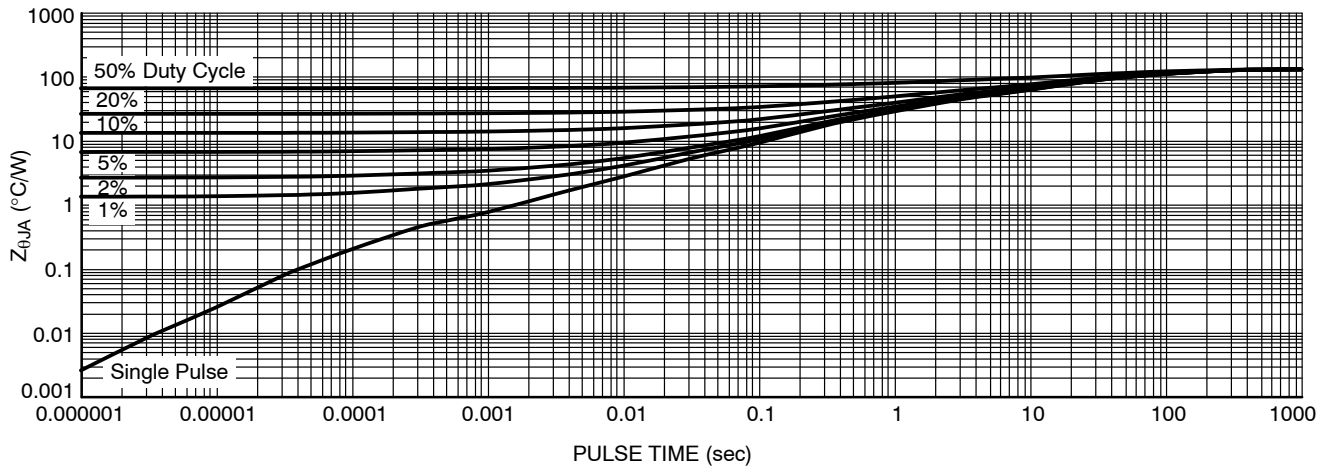
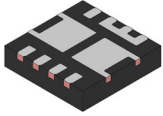
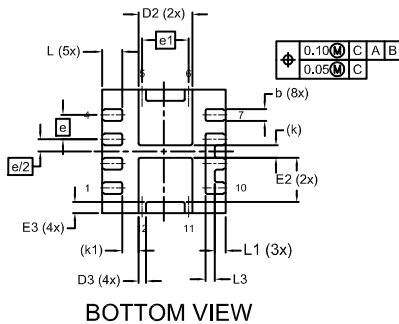
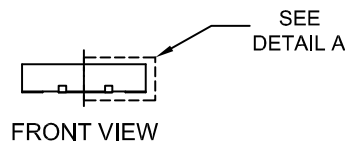
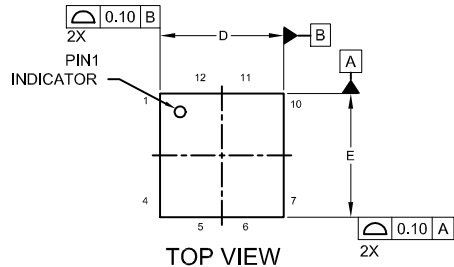
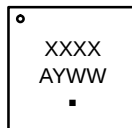


Figure 13. Thermal Characteristics


**WQFN12 3.3X3.3, 0.65P**  
**CASE 510CJ**  
**ISSUE A**

DATE 08 AUG 2022

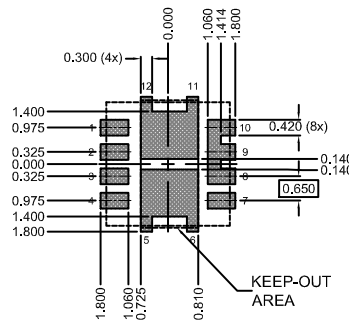
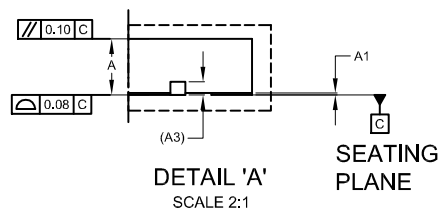

**GENERIC**  
**MARKING DIAGRAM\***


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

**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE EXPOSED
4. SEATING PLANE IS DEFINED BY THE TERMINALS. "A1" IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.
5. IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.



\*FOR ADDITIONAL INFORMATION ON OUR PB-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERM/D.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN         | NOM  | MAX  |
| A   | 0.70        | 0.75 | 0.80 |
| A1  | 0.00        | --   | 0.05 |
| A3  | 0.20 REF    |      |      |
| b   | 0.27        | 0.32 | 0.37 |
| D   | 3.20        | 3.30 | 3.40 |
| D2  | 1.34        | 1.44 | 1.54 |
| D3  | 0.10        | 0.20 | 0.30 |
| E   | 3.20        | 3.30 | 3.40 |
| E2  | 1.09        | 1.19 | 1.29 |
| E3  | 0.20        | 0.30 | 0.40 |
| e   | 0.65 BSC    |      |      |
| e/2 | 0.325 BSC   |      |      |
| e1  | 1.24 BSC    |      |      |
| k   | 0.33 REF    |      |      |
| k1  | 0.43 REF    |      |      |
| L   | 0.44        | 0.54 | 0.64 |
| L1  | 0.19        | 0.29 | 0.39 |
| L3  | 0.15        | 0.25 | 0.35 |

|                         |                              |                                                                                                                                                                                     |
|-------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>WQFN12 3.3X3.3, 0.65P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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