

# NTD78N03

## Power MOSFET

25 V, 78 A, Single N-Channel, DPAK

### Features

- Low  $R_{DS(on)}$
- Optimized Gate Charge
- Pb-Free Packages are Available

### Applications

- Desktop VCORE
- DC-DC Converters
- Low Side Switch

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

| Parameter                                                                                                                                                    |                        |                       | Symbol                            | Value      | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------|-----------------------------------|------------|------|
| Drain-to-Source Voltage                                                                                                                                      |                        |                       | V <sub>BSS</sub>                  | 25         | V    |
| Gate-to-Source Voltage                                                                                                                                       |                        |                       | V <sub>GS</sub>                   | ± 20       | V    |
| Continuous Drain Current (Note 1)                                                                                                                            | Steady State           | T <sub>C</sub> = 25°C | I <sub>D</sub>                    | 14.8       | A    |
|                                                                                                                                                              |                        | T <sub>C</sub> = 85°C |                                   | 11.5       |      |
| Power Dissipation (Note 1)                                                                                                                                   |                        | T <sub>C</sub> = 25°C | P <sub>D</sub>                    | 2.3        | W    |
| Continuous Drain Current (Note 2)                                                                                                                            |                        | T <sub>C</sub> = 25°C | I <sub>D</sub>                    | 11.4       | A    |
|                                                                                                                                                              |                        | T <sub>C</sub> = 85°C |                                   | 8.8        |      |
| Power Dissipation (Note 2)                                                                                                                                   |                        | T <sub>C</sub> = 25°C | P <sub>D</sub>                    | 1.4        | W    |
| Continuous Drain Current (R <sub>θJC</sub> )                                                                                                                 |                        | T <sub>C</sub> = 25°C | I <sub>D</sub>                    | 78         | A    |
|                                                                                                                                                              |                        | T <sub>C</sub> = 85°C |                                   | 56         |      |
| Power Dissipation (R <sub>θJC</sub> )                                                                                                                        |                        | T <sub>C</sub> = 25°C | P <sub>D</sub>                    | 64         | W    |
| Pulsed Drain Current                                                                                                                                         | t <sub>p</sub> = 10 μs |                       | I <sub>DM</sub>                   | 210        | A    |
| Current Limited by Package                                                                                                                                   |                        | T <sub>A</sub> = 25°C | I <sub>DmaxPkg</sub>              | 45         | A    |
| Drain to Source dV/dt                                                                                                                                        |                        |                       | dV/dt                             | 8.0        | V/ns |
| Operating Junction and Storage Temperature                                                                                                                   |                        |                       | T <sub>J</sub> , T <sub>stg</sub> | -55 to 175 | °C   |
| Source Current (Body Diode)                                                                                                                                  |                        |                       | I <sub>S</sub>                    | 78         | A    |
| Single Pulse Drain-to-Source Avalanche Energy (V <sub>DD</sub> = 24 V, V <sub>GS</sub> = 10 V, L = 5.0 mH, I <sub>L(pk)</sub> = 17 A, R <sub>G</sub> = 25 Ω) |                        |                       | E <sub>AS</sub>                   | 722.5      | mJ   |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 seconds)                                                                                      |                        |                       | T <sub>L</sub>                    | 260        | °C   |

### THERMAL RESISTANCE

|                                             |                 |      |                    |
|---------------------------------------------|-----------------|------|--------------------|
| Junction-to-Case (Drain)                    | $R_{\theta JC}$ | 1.95 | $^\circ\text{C/W}$ |
| Junction-to-Ambient - Steady State (Note 1) | $R_{\theta JA}$ | 65   |                    |
| Junction-to-Ambient - Steady State (Note 2) | $R_{\theta JA}$ | 110  |                    |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

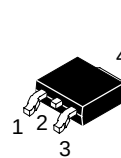
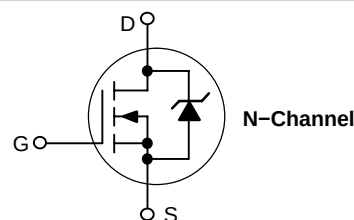
1. Surface-mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 in sq [1 oz] including traces).
2. Surface-mounted on FR4 board using the minimum recommended pad size.



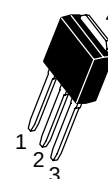
ON Semiconductor®

<http://onsemi.com>

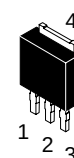
| $V_{(BR)DSS}$ | $R_{DS(on)}$ TYP | $I_D$ MAX |
|---------------|------------------|-----------|
| 25 V          | 4.6 @ 10 V       | 78 A      |
|               | 6.5 @ 4.5 V      |           |



CASE 369AA  
DPAK  
(Bend Lead)  
STYLE 2

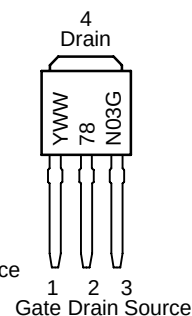
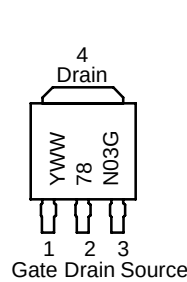
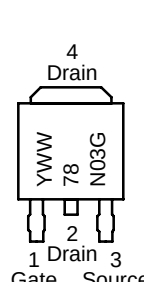


CASE 369D  
DPAK  
(Straight Lead)  
STYLE 2



CASE 369AD  
IPAK  
(Straight Lead)

### MARKING DIAGRAMS & PIN ASSIGNMENTS



Y = Year  
WW = Work Week  
78N03 = Device Code  
G = Pb-Free Package

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

# NTD78N03

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

| Parameter                                                 | Symbol                               | Test Condition                                   | Min | Typ | Max   | Unit  |
|-----------------------------------------------------------|--------------------------------------|--------------------------------------------------|-----|-----|-------|-------|
| <b>OFF CHARACTERISTICS</b>                                |                                      |                                                  |     |     |       |       |
| Drain-to-Source Breakdown Voltage                         | V <sub>(BR)DSS</sub>                 | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA   | 25  |     |       | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | V <sub>(BR)DSS</sub> /T <sub>J</sub> |                                                  |     | 24  |       | mV/°C |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                     | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 20 V |     |     | 1.5   | μA    |
|                                                           |                                      |                                                  |     |     | 10    |       |
| Gate-to-Source Leakage Current                            | I <sub>GSS</sub>                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V  |     |     | ± 100 | nA    |

## ON CHARACTERISTICS (Note 3)

|                                            |                                     |                                                             |     |      |     |       |
|--------------------------------------------|-------------------------------------|-------------------------------------------------------------|-----|------|-----|-------|
| Gate Threshold Voltage                     | V <sub>GS(TH)</sub>                 | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA | 1.0 | 1.6  | 3.0 | V     |
| Negative Threshold Temperature Coefficient | V <sub>GS(TH)</sub> /T <sub>J</sub> |                                                             |     | -5.0 |     | mV/°C |
| Drain-to-Source On Resistance              | R <sub>DS(on)</sub>                 | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 78 A               |     | 4.6  | 6.0 | mΩ    |
|                                            |                                     | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 36 A              |     | 6.5  | 7.8 |       |
| Forward Transconductance                   | g <sub>FS</sub>                     | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 15 A               |     | 22   |     | S     |

## CHARGES, CAPACITANCES AND GATE RESISTANCE

|                              |                     |                                                                           |  |      |      |    |
|------------------------------|---------------------|---------------------------------------------------------------------------|--|------|------|----|
| Input Capacitance            | C <sub>iss</sub>    | V <sub>GS</sub> = 0 V, f = 1.0 MHz,<br>V <sub>DS</sub> = 12 V             |  | 1920 | 2250 | pF |
| Output Capacitance           | C <sub>oss</sub>    |                                                                           |  | 960  |      |    |
| Reverse Transfer Capacitance | C <sub>rss</sub>    |                                                                           |  | 420  |      |    |
| Total Gate Charge            | Q <sub>G(TOT)</sub> | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 20 V,<br>I <sub>D</sub> = 20 A |  | 25.5 | 35   | nC |
| Threshold Gate Charge        | Q <sub>G(TH)</sub>  |                                                                           |  | 2.4  |      |    |
| Gate-to-Source Charge        | Q <sub>GS</sub>     |                                                                           |  | 5.3  |      |    |
| Gate-to-Drain Charge         | Q <sub>GD</sub>     |                                                                           |  | 18.2 |      |    |

## SWITCHING CHARACTERISTICS (Note 4)

|                     |                     |                                                                                                   |  |    |  |    |
|---------------------|---------------------|---------------------------------------------------------------------------------------------------|--|----|--|----|
| Turn-On Delay Time  | t <sub>d(on)</sub>  | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 20 V,<br>I <sub>D</sub> = 20 A, R <sub>G</sub> = 3.0 Ω |  | 11 |  | ns |
| Rise Time           | t <sub>r</sub>      |                                                                                                   |  | 68 |  |    |
| Turn-Off Delay Time | t <sub>d(off)</sub> |                                                                                                   |  | 23 |  |    |
| Fall Time           | t <sub>f</sub>      |                                                                                                   |  | 42 |  |    |

## DRAIN-SOURCE DIODE CHARACTERISTICS

|                       |                 |                                                                                              |                        |      |      |     |   |
|-----------------------|-----------------|----------------------------------------------------------------------------------------------|------------------------|------|------|-----|---|
| Forward Diode Voltage | V <sub>SD</sub> | V <sub>GS</sub> = 0 V,<br>I <sub>S</sub> = 20 A                                              | T <sub>J</sub> = 25°C  |      | 0.83 | 1.0 | V |
|                       |                 |                                                                                              | T <sub>J</sub> = 125°C |      | 0.7  |     |   |
| Reverse Recovery Time | t <sub>RR</sub> | V <sub>GS</sub> = 0 V, dI <sub>S</sub> /dI <sub>t</sub> = 100 A/μs,<br>I <sub>S</sub> = 20 A |                        | 39   |      | ns  |   |
| Charge Time           | t <sub>a</sub>  |                                                                                              |                        | 17.8 |      |     |   |
| Discharge Time        | t <sub>b</sub>  |                                                                                              |                        | 21   |      |     |   |
| Reverse Recovery Time | Q <sub>RR</sub> |                                                                                              |                        | 33   |      | nC  |   |

## PACKAGE PARASITIC VALUES

|                   |                |          |  |      |  |    |
|-------------------|----------------|----------|--|------|--|----|
| Source Inductance | L <sub>S</sub> | Ta = 25C |  | 2.49 |  | nH |
| Drain Inductance  | L <sub>D</sub> |          |  | 0.02 |  |    |
| Gate Inductance   | L <sub>G</sub> |          |  | 3.46 |  |    |
| Gate Resistance   | R <sub>G</sub> |          |  | 1.0  |  | Ω  |

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

4. Switching characteristics are independent of operating junction temperatures.

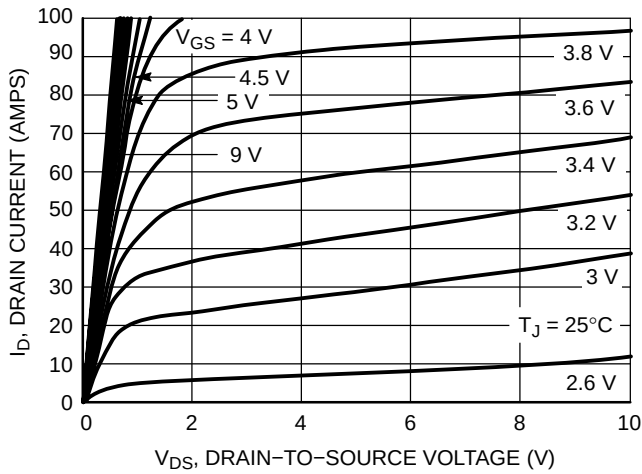


Figure 1. On-Region Characteristics

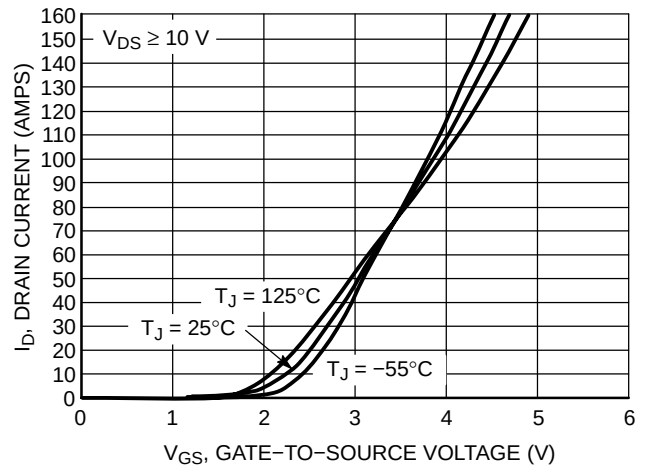


Figure 2. Transfer Characteristics

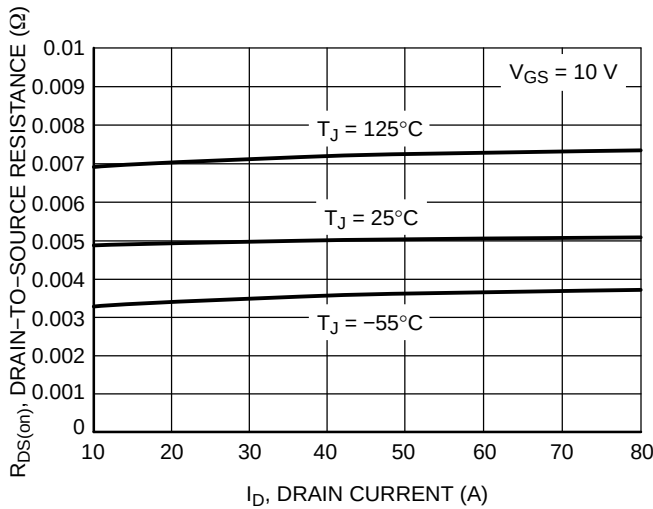


Figure 3. On-Resistance versus Drain Current and Temperature

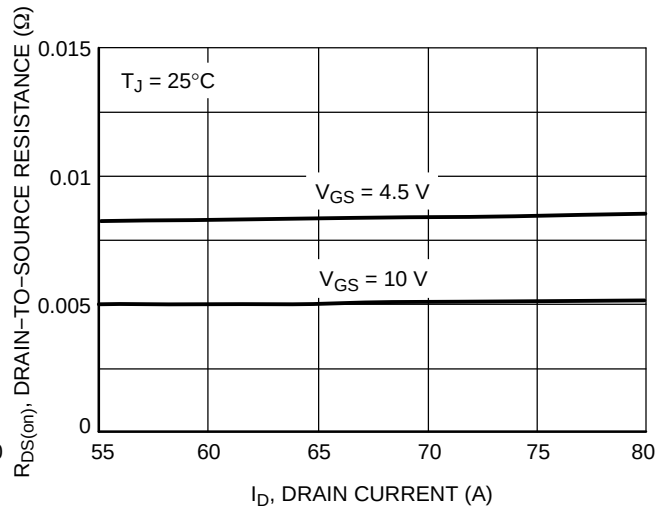


Figure 4. On-Resistance versus Drain Current and Gate Voltage

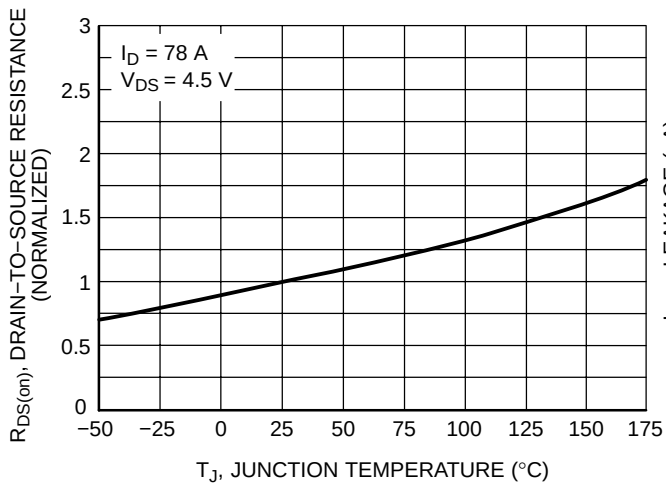


Figure 5. On-Resistance Variation with Temperature

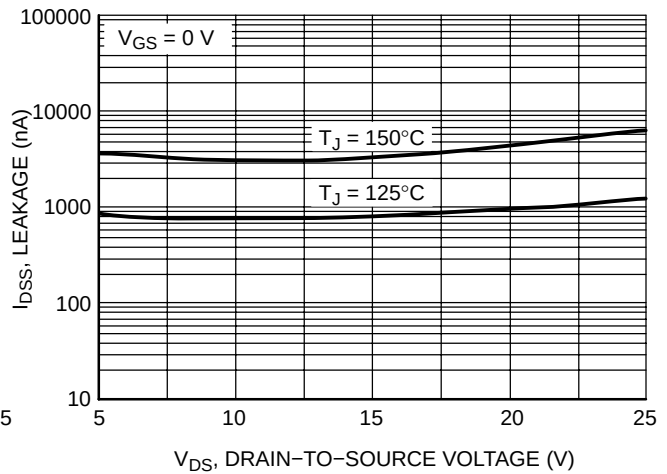
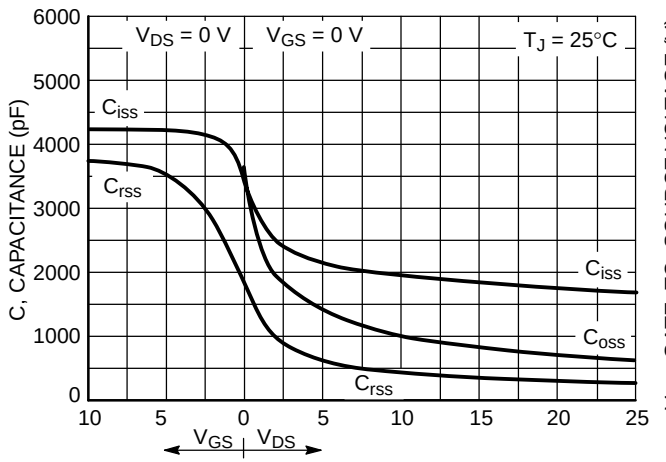
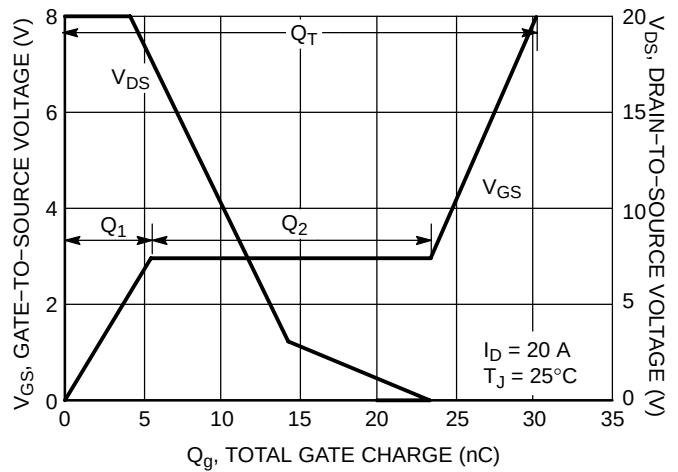


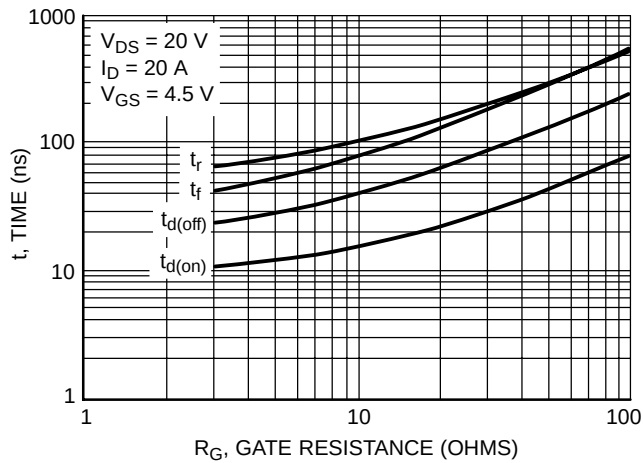
Figure 6. Drain-To-Source Leakage Current versus Voltage



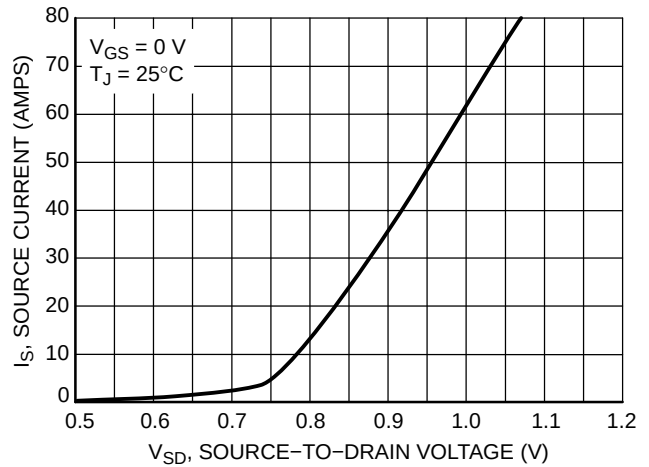
**Figure 7. Capacitance Variation**



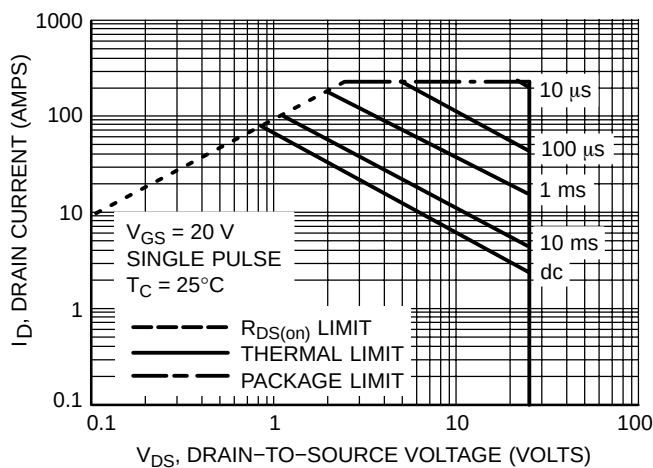
**Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Charge**



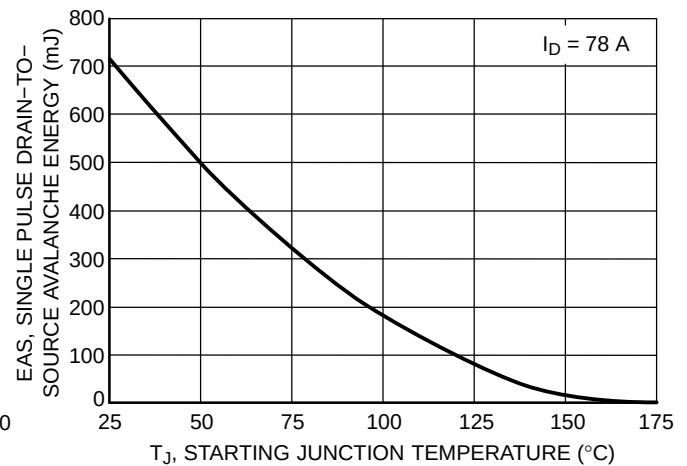
**Figure 9. Resistive Switching Time Variation versus Gate Resistance**



**Figure 10. Diode Forward Voltage versus Current**



**Figure 11. Maximum Rated Forward Biased Safe Operating Area**



**Figure 12. Maximum Avalanche Energy versus Starting Junction Temperature**

## NTD78N03

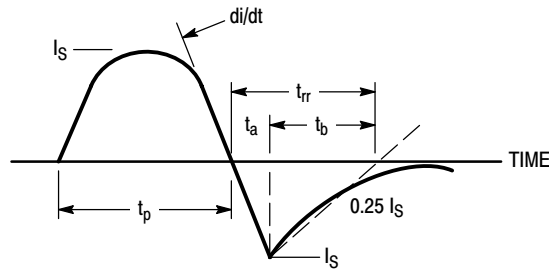


Figure 13. Diode Reverse Recovery Waveform

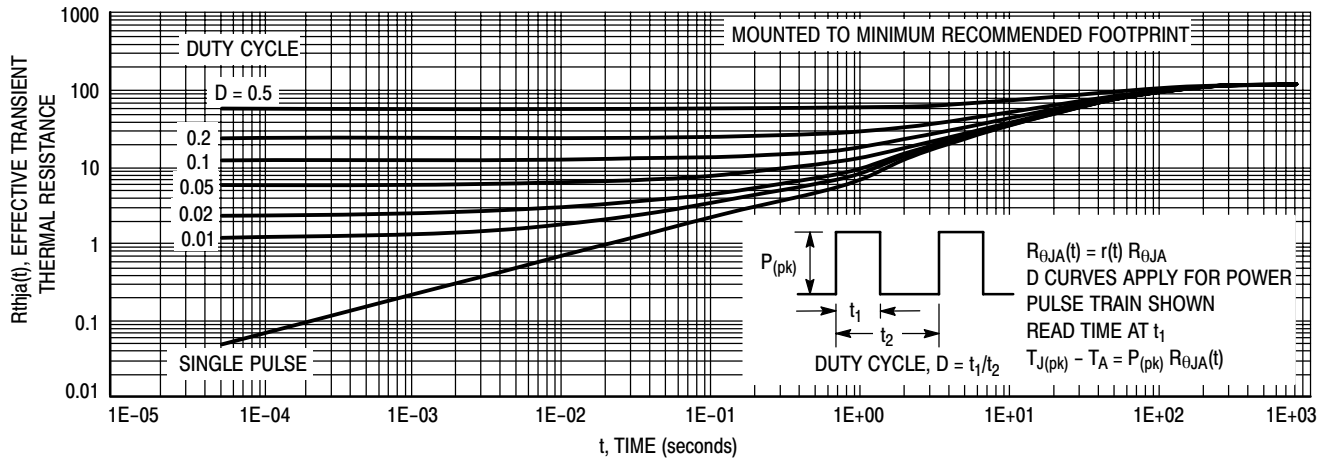
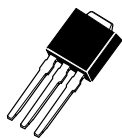


Figure 14. Thermal Response – Various Duty Cycles

### ORDERING INFORMATION

| Order Number | Package                                              | Shipping <sup>†</sup> |
|--------------|------------------------------------------------------|-----------------------|
| NTD78N03     | DPAK                                                 | 75 Units/Rail         |
| NTD78N03G    | DPAK<br>(Pb-Free)                                    | 75 Units/Rail         |
| NTD78N03T4   | DPAK                                                 | 2500 Tape & Reel      |
| NTD78N03T4G  | DPAK<br>(Pb-Free)                                    |                       |
| NTD78N03-1   | DPAK Straight Lead                                   | 75 Units/Rail         |
| NTD78N03-1G  | DPAK Straight Lead<br>(Pb-Free)                      |                       |
| NTD78N03-35  | DPAK-3 Straight Lead<br>(3.5 ± 0.15 mm)              | 75 Units/Rail         |
| NTD78N03-35G | DPAK-3 Straight Lead<br>(3.5 ± 0.15 mm)<br>(Pb-Free) |                       |

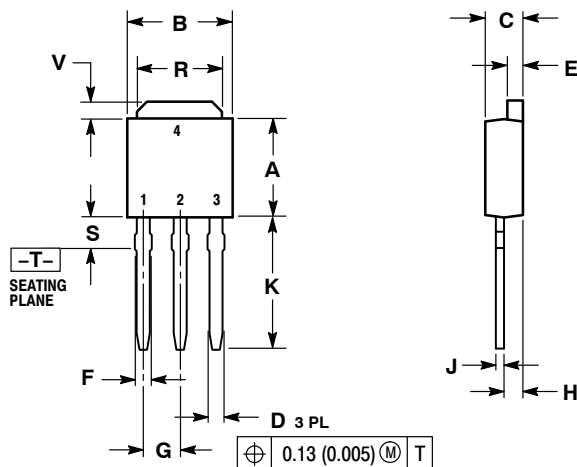
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



DPAK INSERTION MOUNT  
CASE 369  
ISSUE O

DATE 02 JAN 2000

SCALE 1:1



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.235     | 0.250 | 5.97        | 6.35 |
| B   | 0.250     | 0.265 | 6.35        | 6.73 |
| C   | 0.086     | 0.094 | 2.19        | 2.38 |
| D   | 0.027     | 0.035 | 0.69        | 0.88 |
| E   | 0.033     | 0.040 | 0.84        | 1.01 |
| F   | 0.037     | 0.047 | 0.94        | 1.19 |
| G   | 0.090 BSC |       | 2.29 BSC    |      |
| H   | 0.034     | 0.040 | 0.87        | 1.01 |
| J   | 0.018     | 0.023 | 0.46        | 0.58 |
| K   | 0.350     | 0.380 | 8.89        | 9.65 |
| R   | 0.175     | 0.215 | 4.45        | 5.46 |
| S   | 0.050     | 0.090 | 1.27        | 2.28 |
| V   | 0.030     | 0.050 | 0.77        | 1.27 |

STYLE 1:  
PIN 1. BASE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

STYLE 2:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

STYLE 3:  
PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. CATHODE

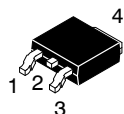
STYLE 4:  
PIN 1. CATHODE  
2. ANODE  
3. GATE  
4. ANODE

STYLE 5:  
PIN 1. GATE  
2. ANODE  
3. CATHODE  
4. ANODE

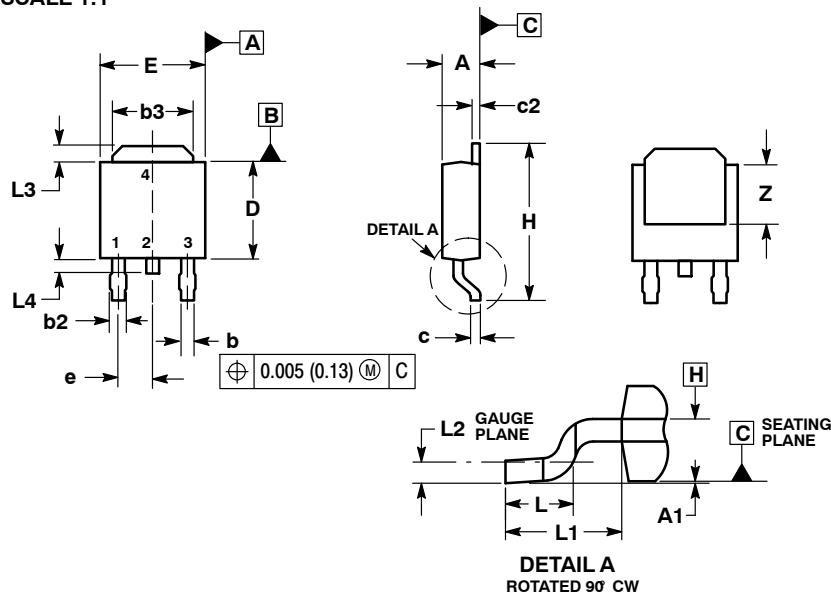
STYLE 6:  
PIN 1. MT1  
2. MT2  
3. GATE  
4. MT2

|                  |                      |                                                                                                                                                                                     |
|------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOCUMENT NUMBER: | 98ASB42319B          | Electronic versions are uncontrolled except when accessed directly from the Document Repository.<br>Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| DESCRIPTION:     | DPAK INSERTION MOUNT | PAGE 1 OF 1                                                                                                                                                                         |

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SCALE 1:1



STYLE 1:  
PIN 1. BASE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

STYLE 2:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

STYLE 3:  
PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. CATHODE

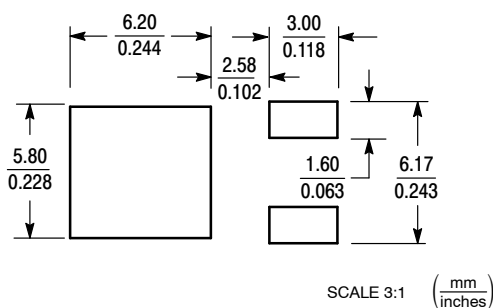
STYLE 4:  
PIN 1. CATHODE  
2. ANODE  
3. GATE  
4. ANODE

STYLE 5:  
PIN 1. GATE  
2. ANODE  
3. CATHODE  
4. ANODE

STYLE 6:  
PIN 1. MT1  
2. MT2  
3. GATE  
4. MT2

STYLE 7:  
PIN 1. GATE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

#### SOLDERING FOOTPRINT\*



SCALE 3:1 (mm/inches)

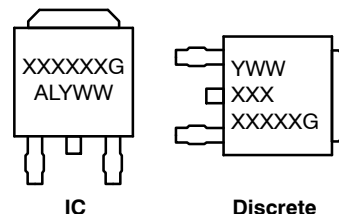
\*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

#### NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: INCHES.
- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
- DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
- DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.086     | 0.094 | 2.18        | 2.38  |
| A1  | 0.000     | 0.005 | 0.00        | 0.13  |
| b   | 0.025     | 0.035 | 0.63        | 0.89  |
| b2  | 0.030     | 0.045 | 0.76        | 1.14  |
| b3  | 0.180     | 0.215 | 4.57        | 5.46  |
| c   | 0.018     | 0.024 | 0.46        | 0.61  |
| c2  | 0.018     | 0.024 | 0.46        | 0.61  |
| D   | 0.235     | 0.245 | 5.97        | 6.22  |
| E   | 0.250     | 0.265 | 6.35        | 6.73  |
| e   | 0.090 BSC |       | 2.29 BSC    |       |
| H   | 0.370     | 0.410 | 9.40        | 10.41 |
| L   | 0.055     | 0.070 | 1.40        | 1.78  |
| L1  | 0.108 REF |       | 2.74 REF    |       |
| L2  | 0.020 BSC |       | 0.51 BSC    |       |
| L3  | 0.035     | 0.050 | 0.89        | 1.27  |
| L4  |           | 0.040 |             | 1.01  |
| Z   | 0.155     |       | 3.93        |       |

#### GENERIC MARKING DIAGRAM\*

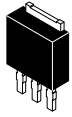


XXXXXX = Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking.

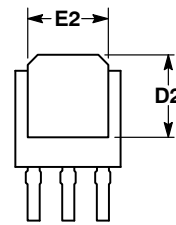
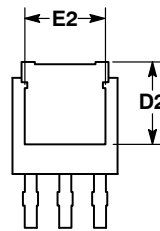
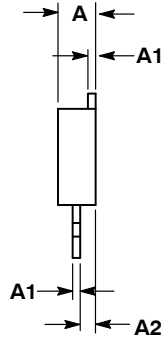
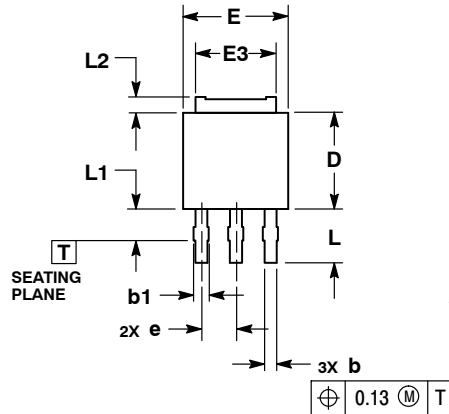
|                  |                     |                                                                                                                                                                                     |
|------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| DESCRIPTION:     | DPAK (SINGLE GAUGE) | PAGE 1 OF 1                                                                                                                                                                         |

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**3.5 MM IPAK, STRAIGHT LEAD**  
**CASE 369AD**  
**ISSUE B**

DATE 18 APR 2013

SCALE 1:1


OPTIONAL  
CONSTRUCTION

## NOTES:

- 1.. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- 2.. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM TERMINAL TIP.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD GATE OR MOLD FLASH.

| MILLIMETERS |          |      |
|-------------|----------|------|
| DIM         | MIN      | MAX  |
| A           | 2.19     | 2.38 |
| A1          | 0.46     | 0.60 |
| A2          | 0.87     | 1.10 |
| b           | 0.69     | 0.89 |
| b1          | 0.77     | 1.10 |
| D           | 5.97     | 6.22 |
| D2          | 4.80     | ---  |
| E           | 6.35     | 6.73 |
| E2          | 4.57     | 5.45 |
| E3          | 4.45     | 5.46 |
| e           | 2.28 BSC |      |
| L           | 3.40     | 3.60 |
| L1          | ---      | 2.10 |
| L2          | 0.89     | 1.27 |

**GENERIC MARKING  
DIAGRAMS\***

STYLE 1:  
PIN 1. BASE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

STYLE 2:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

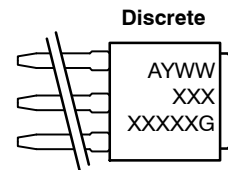
STYLE 3:  
PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. CATHODE

STYLE 4:  
PIN 1. CATHODE  
2. ANODE  
3. GATE  
4. ANODE

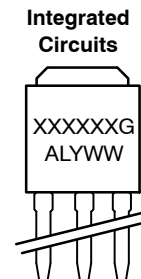
STYLE 5:  
PIN 1. GATE  
2. ANODE  
3. CATHODE  
4. ANODE

STYLE 6:  
PIN 1. MT1  
2. MT2  
3. GATE  
4. MT2

STYLE 7:  
PIN 1. GATE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR



Discrete


Integrated  
Circuits

XXXXXX = Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
WW = Work Week  
G = 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.

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DESCRIPTION: 3.5 MM IPAK, STRAIGHT LEAD

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