

# NTF5P03T3

Preferred Device

## Power MOSFET 5.2 Amps, 30 Volts P-Channel SOT-223

### Features

- Ultra Low  $R_{DS(on)}$
- Higher Efficiency Extending Battery Life
- Logic Level Gate Drive
- Miniature SOT-223 Surface Mount Package
- Avalanche Energy Specified

### Applications

- DC-DC Converters
- Power Management
- Motor Controls
- Inductive Loads
- Replaces MMFT5P03HD

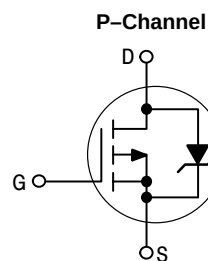


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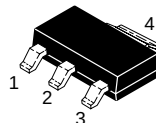
<http://onsemi.com>

**5.2 AMPERES  
30 VOLTS**

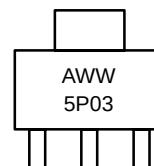
**$R_{DS(on)} = 100 \text{ m}\Omega$**



### MARKING DIAGRAM

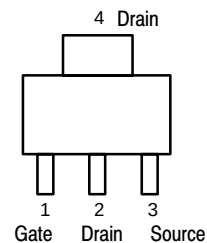


**SOT-223  
CASE 318E  
STYLE 3**



A = Assembly Location  
WW = Work Week  
5P03 = Device Code

### PIN ASSIGNMENT



### ORDERING INFORMATION

| Device    | Package | Shipping         |
|-----------|---------|------------------|
| NTF5P03T3 | SOT-223 | 1000 Tape & Reel |

# NTF5P03T3

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

Negative sign for P-Channel devices omitted for clarity

| Rating                                                                                                                                                                                                                        |                                                       | Symbol         | Max         | Unit                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------|-------------|----------------------------|
| Drain-to-Source Voltage                                                                                                                                                                                                       |                                                       | $V_{DSS}$      | -30         | V                          |
| Drain-to-Gate Voltage ( $R_{GS} = 1.0\text{ M}\Omega$ )                                                                                                                                                                       |                                                       | $V_{DGR}$      | -30         | V                          |
| Gate-to-Source Voltage – Continuous                                                                                                                                                                                           |                                                       | $V_{GS}$       | $\pm 20$    | V                          |
| 1" SQ.<br>FR-4 or G-10 PCB<br><br>10 seconds                                                                                                                                                                                  | Thermal Resistance – Junction to Ambient              | $R_{THJA}$     | 40          | $^\circ\text{C/W}$         |
|                                                                                                                                                                                                                               | Total Power Dissipation @ $T_A = 25^\circ\text{C}$    | $P_D$          | 3.13        | Watts                      |
|                                                                                                                                                                                                                               | Linear Derating Factor                                |                | 25          | $\text{mW}/^\circ\text{C}$ |
|                                                                                                                                                                                                                               | Drain Current – Continuous @ $T_A = 25^\circ\text{C}$ | $I_D$          | -5.2        | A                          |
|                                                                                                                                                                                                                               | Continuous @ $T_A = 70^\circ\text{C}$                 | $I_D$          | -4.1        | A                          |
| Pulsed Drain Current (Note 1)                                                                                                                                                                                                 |                                                       | $I_{DM}$       | -26         | A                          |
| Minimum<br>FR-4 or G-10 PCB<br><br>10 seconds                                                                                                                                                                                 | Thermal Resistance – Junction to Ambient              | $R_{THJA}$     | 80          | $^\circ\text{C/W}$         |
|                                                                                                                                                                                                                               | Total Power Dissipation @ $T_A = 25^\circ\text{C}$    | $P_D$          | 1.56        | Watts                      |
|                                                                                                                                                                                                                               | Linear Derating Factor                                |                | 12.5        | $\text{mW}/^\circ\text{C}$ |
|                                                                                                                                                                                                                               | Drain Current – Continuous @ $T_A = 25^\circ\text{C}$ | $I_D$          | -3.7        | A                          |
|                                                                                                                                                                                                                               | Continuous @ $T_A = 70^\circ\text{C}$                 | $I_D$          | -2.9        | A                          |
| Pulsed Drain Current (Note 1)                                                                                                                                                                                                 |                                                       | $I_{DM}$       | -19         | A                          |
| Operating and Storage Temperature Range                                                                                                                                                                                       |                                                       | $T_J, T_{stg}$ | - 55 to 150 | $^\circ\text{C}$           |
| Single Pulse Drain-to-Source Avalanche Energy – Starting $T_J = 25^\circ\text{C}$<br>( $V_{DD} = -30\text{ Vdc}$ , $V_{GS} = -10\text{ Vdc}$ , Peak $I_L = -12\text{ Apk}$ , $L = 3.5\text{ mH}$ , $R_G = 25\text{ }\Omega$ ) |                                                       | $E_{AS}$       | 250         | mJ                         |

1. Repetitive rating; pulse width limited by maximum junction temperature.

# NTF5P03T3

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                                                                                                                         |                      |          |          |             |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------|----------|-------------|--------------|
| Drain-to-Source Breakdown Voltage (Cpk ≥ 2.0) (Notes 2 and 4)<br>(V <sub>GS</sub> = 0 Vdc, I <sub>D</sub> = -0.25 μAdc)<br>Temperature Coefficient (Positive)           | V <sub>(BR)DSS</sub> | -30<br>- | -<br>-28 | -<br>-      | Vdc<br>mV/°C |
| Zero Gate Voltage Drain Current<br>(V <sub>DS</sub> = -24 Vdc, V <sub>GS</sub> = 0 Vdc)<br>(V <sub>DS</sub> = -24 Vdc, V <sub>GS</sub> = 0 Vdc, T <sub>J</sub> = 125°C) | I <sub>DSS</sub>     | -<br>-   | -<br>-   | -1.0<br>-25 | μAdc         |
| Gate-Body Leakage Current (V <sub>GS</sub> = ± 20 Vdc, V <sub>DS</sub> = 0 Vdc)                                                                                         | I <sub>GSS</sub>     | -        | -        | ± 100       | nAdc         |

### ON CHARACTERISTICS (Note 2)

|                                                                                                                                                                                       |                     |           |              |            |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------|--------------|------------|--------------|
| Gate Threshold Voltage (Cpk ≥ 2.0) (Notes 2 and 4)<br>(V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -0.25 μAdc)<br>Threshold Temperature Coefficient (Negative)               | V <sub>GS(th)</sub> | -1.0<br>- | -1.75<br>3.5 | -3.0<br>-  | Vdc<br>mV/°C |
| Static Drain-to-Source On-Resistance (Cpk ≥ 2.0) (Notes 2 and 4)<br>(V <sub>GS</sub> = -10 Vdc, I <sub>D</sub> = -5.2 Adc)<br>(V <sub>GS</sub> = -4.5 Vdc, I <sub>D</sub> = -2.6 Adc) | R <sub>DS(on)</sub> | -         | 76<br>107    | 100<br>150 | mΩ           |
| Forward Transconductance (Note 2) (V <sub>DS</sub> = -15 Vdc, I <sub>D</sub> = -2.0 Adc)                                                                                              | g <sub>fs</sub>     | 2.0       | 3.9          | -          | Mhos         |

### DYNAMIC CHARACTERISTICS

|                      |                                                                    |                  |   |     |     |    |
|----------------------|--------------------------------------------------------------------|------------------|---|-----|-----|----|
| Input Capacitance    | (V <sub>DS</sub> = -25 Vdc, V <sub>GS</sub> = 0 V,<br>f = 1.0 MHz) | C <sub>iss</sub> | - | 500 | 950 | pF |
| Output Capacitance   |                                                                    | C <sub>oss</sub> | - | 153 | 440 |    |
| Transfer Capacitance |                                                                    | C <sub>rss</sub> | - | 58  | 140 |    |

### SWITCHING CHARACTERISTICS (Note 3)

|                     |                                                                                                                          |                     |   |     |     |    |
|---------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------|---|-----|-----|----|
| Turn-On Delay Time  | (V <sub>DD</sub> = -15 Vdc, I <sub>D</sub> = -4.0 Adc,<br>V <sub>GS</sub> = -10 Vdc,<br>R <sub>G</sub> = 6.0 Ω) (Note 2) | t <sub>d(on)</sub>  | - | 10  | 24  | ns |
| Rise Time           |                                                                                                                          | t <sub>r</sub>      | - | 33  | 48  |    |
| Turn-Off Delay Time |                                                                                                                          | t <sub>d(off)</sub> | - | 38  | 94  |    |
| Fall Time           |                                                                                                                          | t <sub>f</sub>      | - | 20  | 92  |    |
| Turn-On Delay Time  | (V <sub>DD</sub> = -15 Vdc, I <sub>D</sub> = -2.0 Adc,<br>V <sub>GS</sub> = -10 Vdc,<br>R <sub>G</sub> = 6.0 Ω) (Note 2) | t <sub>d(on)</sub>  | - | 16  | 38  | ns |
| Rise Time           |                                                                                                                          | t <sub>r</sub>      | - | 45  | 110 |    |
| Turn-Off Delay Time |                                                                                                                          | t <sub>d(off)</sub> | - | 23  | 60  |    |
| Fall Time           |                                                                                                                          | t <sub>f</sub>      | - | 24  | 80  |    |
| Gate Charge         | (V <sub>DS</sub> = -24 Vdc, I <sub>D</sub> = -4.0 Adc,<br>V <sub>GS</sub> = -10 Vdc) (Note 2)                            | Q <sub>T</sub>      | - | 15  | 38  | nC |
|                     |                                                                                                                          | Q <sub>1</sub>      | - | 1.6 | -   |    |
|                     |                                                                                                                          | Q <sub>2</sub>      | - | 3.5 | -   |    |
|                     |                                                                                                                          | Q <sub>3</sub>      | - | 2.6 | -   |    |

### SOURCE-DRAIN DIODE CHARACTERISTICS

|                                |                                                                                                                                                  |                 |        |               |           |     |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------|---------------|-----------|-----|
| Forward On-Voltage             | (I <sub>S</sub> = -4.0 Adc, V <sub>GS</sub> = 0 Vdc)<br>(I <sub>S</sub> = -4.0 Adc, V <sub>GS</sub> = 0 Vdc,<br>T <sub>J</sub> = 125°C) (Note 2) | V <sub>SD</sub> | -<br>- | -1.1<br>-0.89 | -1.5<br>- | Vdc |
| Reverse Recovery Time          | (I <sub>S</sub> = -4.0 Adc, V <sub>GS</sub> = 0 Vdc,<br>dI <sub>S</sub> /dt = 100 A/μs) (Note 2)                                                 | t <sub>rr</sub> | -      | 34            | -         | ns  |
|                                |                                                                                                                                                  | t <sub>a</sub>  | -      | 20            | -         |     |
|                                |                                                                                                                                                  | t <sub>b</sub>  | -      | 14            | -         |     |
| Reverse Recovery Stored Charge |                                                                                                                                                  | Q <sub>RR</sub> | -      | 0.036         | -         | μC  |

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
3. Switching characteristics are independent of operating junction temperatures.
4. Reflects typical values.

$$C_{pk} = \left| \frac{\text{Max limit} - \text{Typ}}{3 \times \text{SIGMA}} \right|$$

TYPICAL ELECTRICAL CHARACTERISTICS

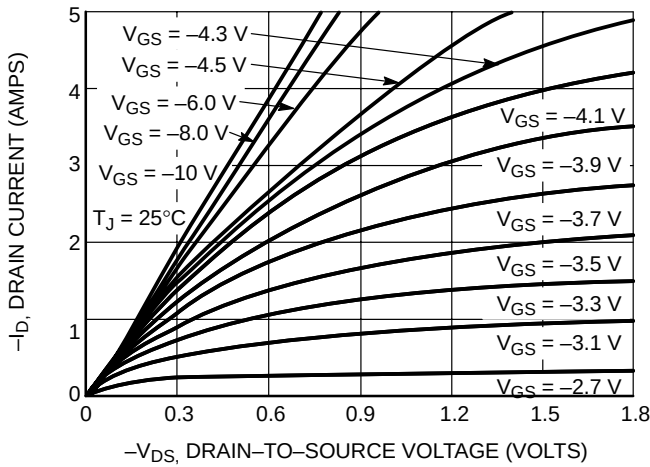


Figure 1. On-Region Characteristics

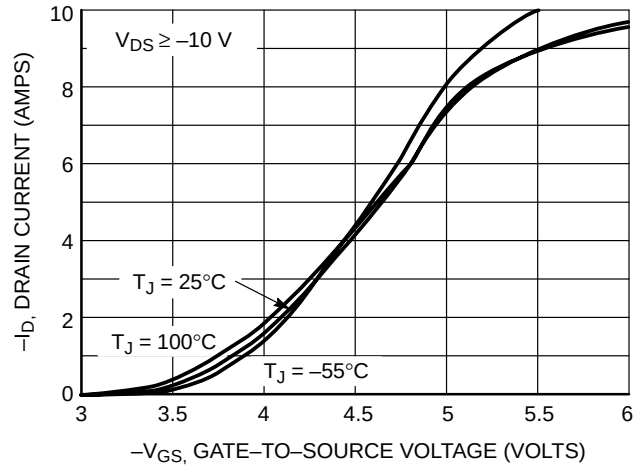


Figure 2. Transfer Characteristics

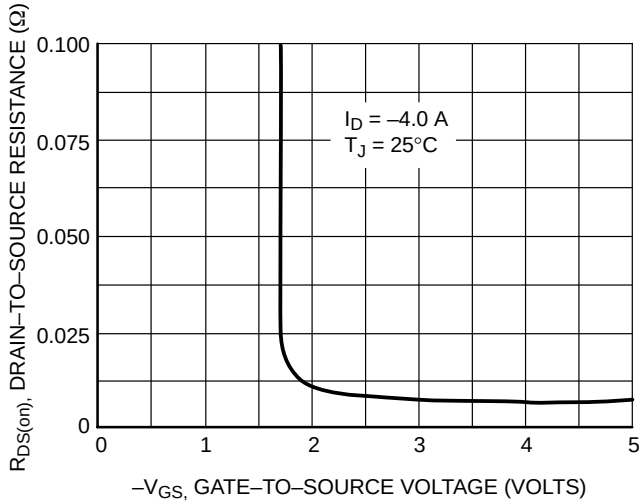


Figure 3. On-Resistance versus Gate-to-Source Voltage

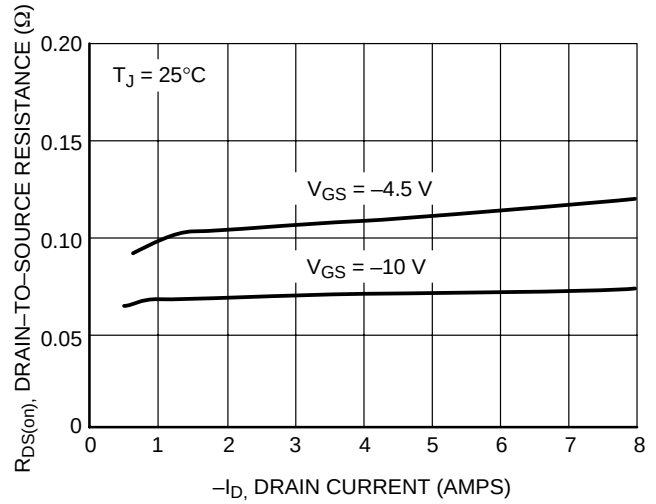


Figure 4. On-Resistance versus Drain Current and Gate Voltage

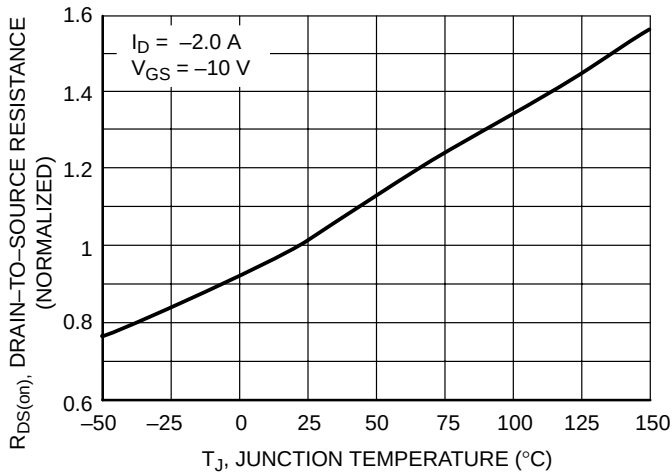


Figure 5. On-Resistance Variation with Temperature

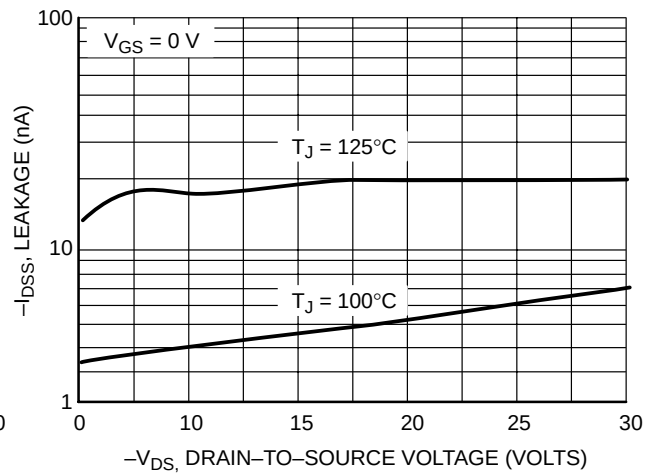


Figure 6. Drain-to-Source Leakage Current versus Voltage

TYPICAL ELECTRICAL CHARACTERISTICS

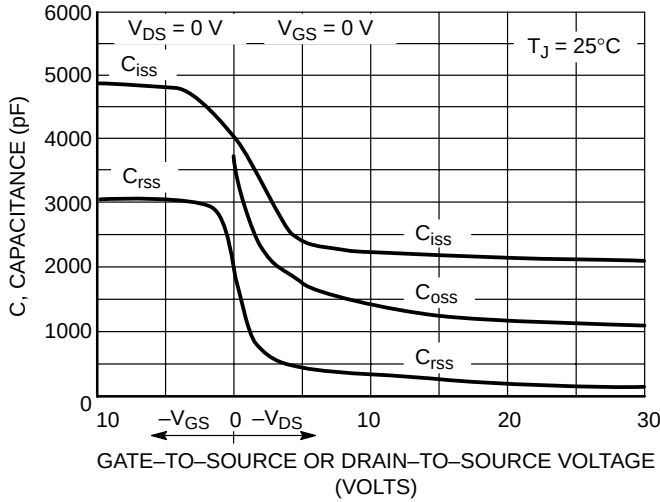


Figure 7. Capacitance Variation

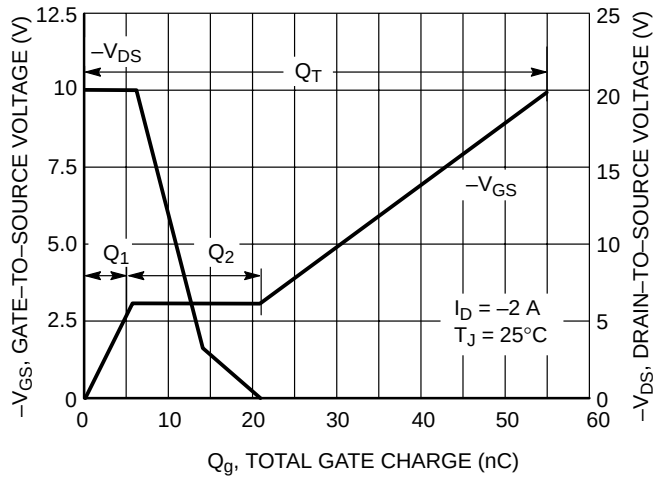


Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Charge

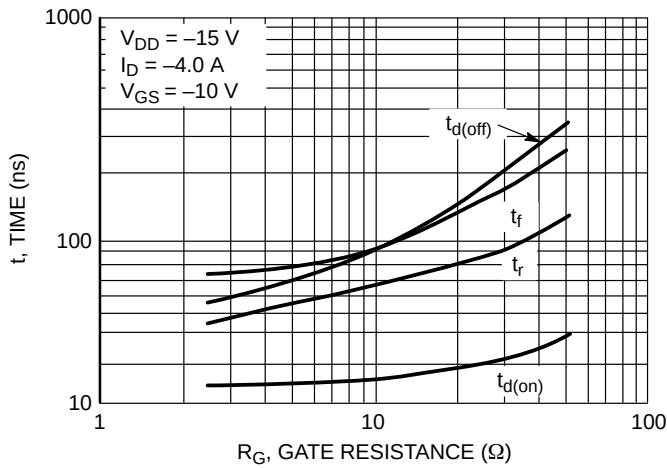


Figure 9. Resistive Switching Time Variation versus Gate Resistance

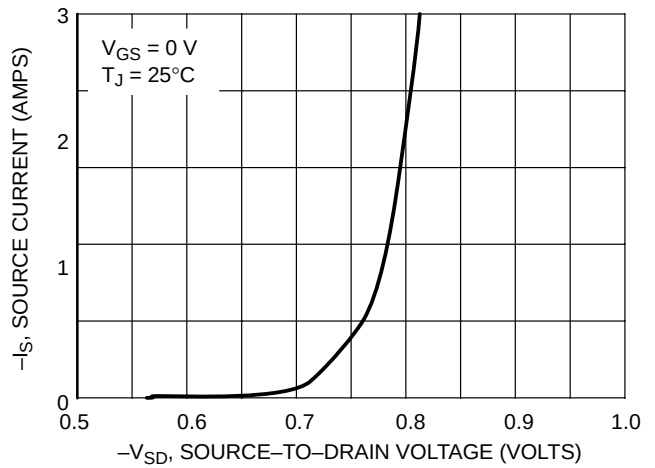


Figure 10. Diode Forward Voltage versus Current

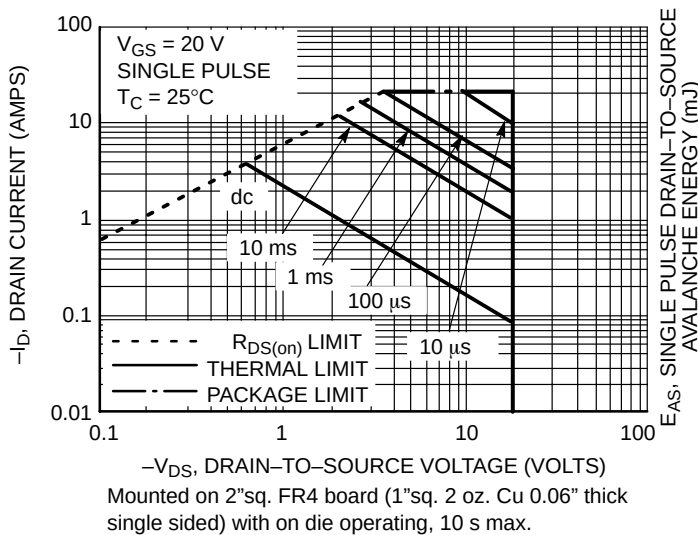


Figure 11. Maximum Rated Forward Biased Safe Operating Area

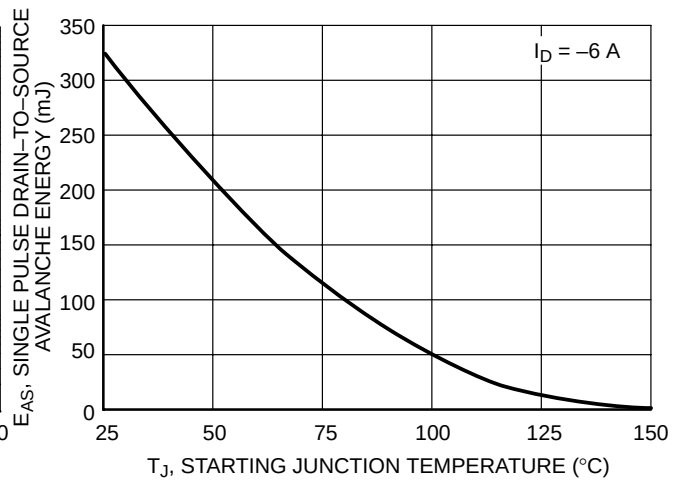


Figure 12. Maximum Avalanche Energy versus Starting Junction Temperature

TYPICAL ELECTRICAL CHARACTERISTICS

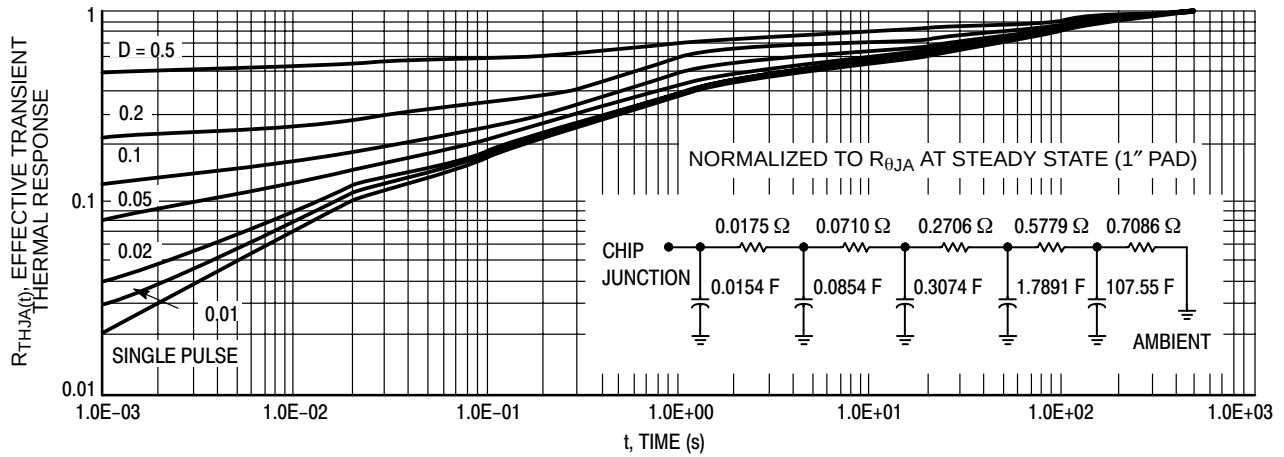


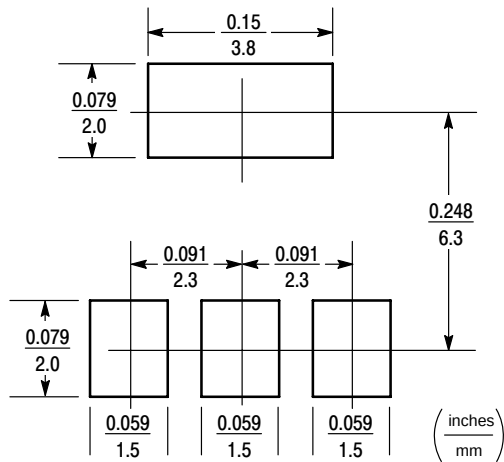
Figure 13. FET Thermal Response

INFORMATION FOR USING THE SOT-223 SURFACE MOUNT PACKAGE

MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection

interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



## TYPICAL SOLDER HEATING PROFILE

For any given circuit board, there will be a group of control settings that will give the desired heat pattern. The operator must set temperatures for several heating zones and a figure for belt speed. Taken together, these control settings make up a heating “profile” for that particular circuit board. On machines controlled by a computer, the computer remembers these profiles from one operating session to the next. Figure 14 shows a typical heating profile for use when soldering a surface mount device to a printed circuit board. This profile will vary among soldering systems, but it is a good starting point. Factors that can affect the profile include the type of soldering system in use, density and types of components on the board, type of solder used, and the type of board or substrate material being used. This profile shows

temperature versus time. The line on the graph shows the actual temperature that might be experienced on the surface of a test board at or near a central solder joint. The two profiles are based on a high density and a low density board. The Vitronics SMD310 convection/infrared reflow soldering system was used to generate this profile. The type of solder used was 62/36/2 Tin Lead Silver with a melting point between 177–189°C. When this type of furnace is used for solder reflow work, the circuit boards and solder joints tend to heat first. The components on the board are then heated by conduction. The circuit board, because it has a large surface area, absorbs the thermal energy more efficiently, then distributes this energy to the components. Because of this effect, the main body of a component may be up to 30 degrees cooler than the adjacent solder joints.

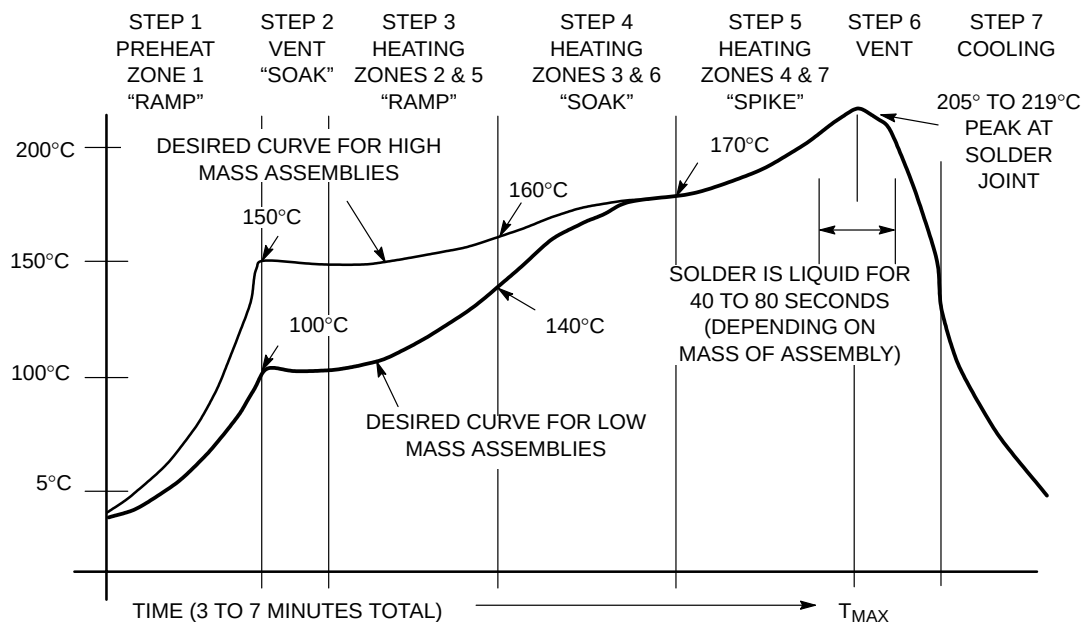
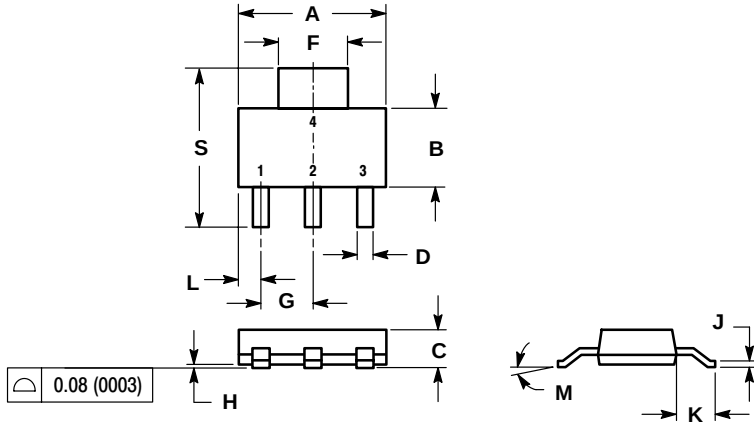


Figure 14. Typical Solder Heating Profile

# NTF5P03T3

## PACKAGE DIMENSIONS

SOT-223 (TO-261)  
CASE 318E-04  
ISSUE K



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

| DIM | INCHES |        | MILLIMETERS |       |
|-----|--------|--------|-------------|-------|
|     | MIN    | MAX    | MIN         | MAX   |
| A   | 0.249  | 0.263  | 6.30        | 6.70  |
| B   | 0.130  | 0.145  | 3.30        | 3.70  |
| C   | 0.060  | 0.068  | 1.50        | 1.75  |
| D   | 0.024  | 0.035  | 0.60        | 0.89  |
| F   | 0.115  | 0.126  | 2.90        | 3.20  |
| G   | 0.087  | 0.094  | 2.20        | 2.40  |
| H   | 0.0008 | 0.0040 | 0.020       | 0.100 |
| J   | 0.009  | 0.014  | 0.24        | 0.35  |
| K   | 0.060  | 0.078  | 1.50        | 2.00  |
| L   | 0.033  | 0.041  | 0.85        | 1.05  |
| M   | 0°     | 10°    | 0°          | 10°   |
| S   | 0.264  | 0.287  | 6.70        | 7.30  |

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

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