

# Self-Protected FET with Temperature and Current Limit

HDPlus devices are an advanced series of power MOSFETs which utilize ON Semiconductor's latest MOSFET technology process to achieve the lowest possible on-resistance per silicon area while incorporating smart features. Integrated thermal and current limits work together to provide short circuit protection. The devices feature an integrated Drain-to-Gate Clamp that enables them to withstand high energy in the avalanche mode. The Clamp also provides additional safety margin against unexpected voltage transients. Electrostatic Discharge (ESD) protection is provided by an integrated Gate-to-Source Clamp.

## Features

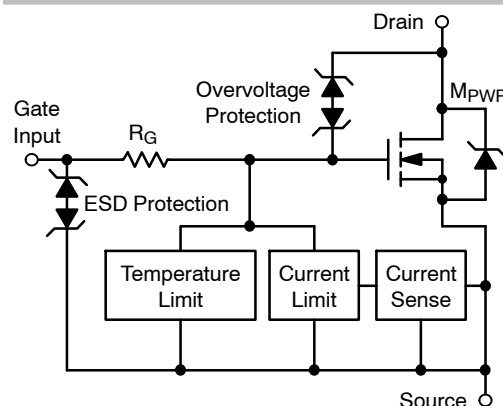
- Current Limitation
- Thermal Shutdown with Automatic Restart
- Short Circuit Protection
- Low  $R_{DS(on)}$
- $I_{DSS}$  Specified at Elevated Temperature
- Avalanche Energy Specified
- Slew Rate Control for Low Noise Switching
- Overvoltage Clamped Protection
- This is a Pb-Free Device



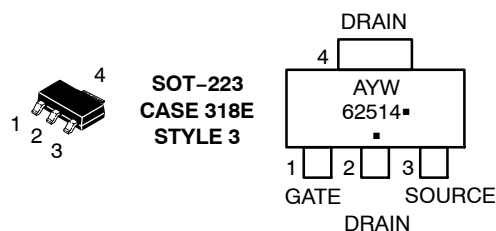
ON Semiconductor®

**<http://onsemi.com>**

**6.0 AMPERES\***  
**40 VOLTS CLAMPED**  
**R<sub>DS(on)</sub> = 90 mΩ**



### MARKING DIAGRAM



A = Assembly Location  
Y = Year  
W = Work Week  
62514 = Specific Device Code  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

## ORDERING INFORMATION

| Device      | Package              | Shipping <sup>†</sup> |
|-------------|----------------------|-----------------------|
| NIF62514T1G | SOT-223<br>(Pb-Free) | 1000/Tape & Reel      |
| NIF62514T3G | SOT-223<br>(Pb-Free) | 4000/Tape & Reel      |

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

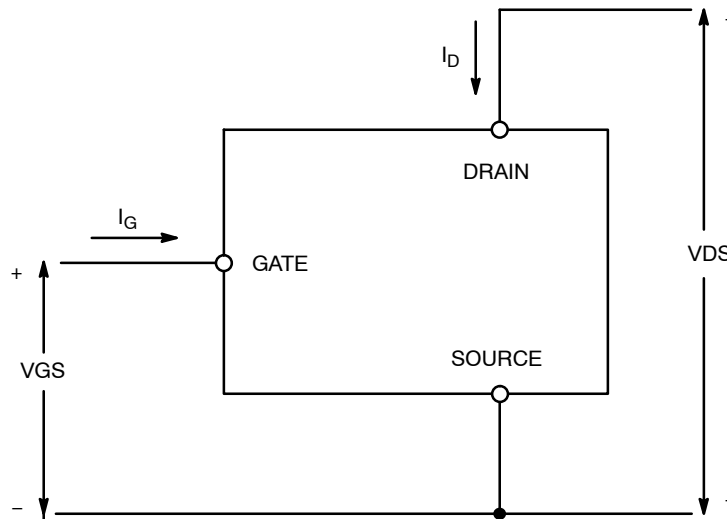
\*Limited by the current limit circuit.

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

| Rating                                                                                                                                                                                                        | Symbol                                                | Value               | Unit               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|---------------------|--------------------|
| Drain-to-Source Voltage Internally Clamped                                                                                                                                                                    | $V_{DSS}$                                             | 40                  | Vdc                |
| Drain-to-Gate Voltage Internally Clamped ( $R_{GS} = 1.0\text{ M}\Omega$ )                                                                                                                                    | $V_{DGR}$                                             | 40                  | Vdc                |
| Gate-to-Source Voltage                                                                                                                                                                                        | $V_{GS}$                                              | $\pm 16$            | Vdc                |
| Drain Current<br>- Continuous @ $T_A = 25^\circ\text{C}$<br>- Continuous @ $T_A = 100^\circ\text{C}$<br>- Pulsed ( $t_p \leq 10\text{ }\mu\text{s}$ )                                                         | $I_D$<br>$I_D$<br>$I_{DM}$                            | Internally Limited  |                    |
| Total Power Dissipation<br>@ $T_A = 25^\circ\text{C}$ (Note 1)<br>@ $T_A = 25^\circ\text{C}$ (Note 2)<br>@ $T_A = 25^\circ\text{C}$ (Note 3)                                                                  | $P_D$                                                 | 1.1<br>1.73<br>8.93 | W                  |
| Thermal Resistance,<br>Junction-to-Tab<br>Junction-to-Ambient (Note 1)<br>Junction-to-Ambient (Note 2)                                                                                                        | $R_{\theta JT}$<br>$R_{\theta JA}$<br>$R_{\theta JA}$ | 14<br>114<br>72.3   | $^\circ\text{C/W}$ |
| Single Pulse Drain-to-Source Avalanche Energy<br>( $V_{DD} = 25\text{ Vdc}$ , $V_{GS} = 5.0\text{ Vdc}$ , $V_{DS} = 40\text{ Vdc}$ , $I_L = 2.8\text{ Apk}$ , $L = 80\text{ mH}$ , $R_G = 25\text{ }\Omega$ ) | $E_{AS}$                                              | 300                 | mJ                 |
| Operating and Storage Temperature Range                                                                                                                                                                       | $T_J, T_{stg}$                                        | -55 to 150          | $^\circ\text{C}$   |

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. Mounted onto min pad board.
2. Mounted onto 1" pad board.
3. Mounted onto large heatsink.



**Figure 1. Voltage and Current Convention**

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

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

**OFF CHARACTERISTICS**

|                                                                                                                                                                                                                    |               |          |            |             |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------|------------|-------------|-----------------|
| Drain-to-Source Clamped Breakdown Voltage<br>( $V_{GS} = 0\text{ Vdc}$ , $I_D = 250\text{ }\mu\text{Adc}$ )<br>( $V_{GS} = 0\text{ Vdc}$ , $I_D = 250\text{ }\mu\text{Adc}$ , $T_J = 150^\circ\text{C}$ ) (Note 4) | $V_{(BR)DSS}$ | 42<br>42 | 46<br>45   | 50<br>50    | Vdc             |
| Zero Gate Voltage Drain Current<br>( $V_{DS} = 32\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )<br>( $V_{DS} = 32\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ , $T_J = 150^\circ\text{C}$ ) (Note 4)                           | $I_{DSS}$     | –<br>–   | 0.5<br>2.0 | 2.0<br>10   | $\mu\text{Adc}$ |
| Gate Input Current<br>( $V_{GS} = 5.0\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )<br>( $V_{GS} = -5.0\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )                                                                          | $I_{GSS}$     | –<br>–   | 50<br>550  | 100<br>1000 | $\mu\text{Adc}$ |

**ON CHARACTERISTICS**

|                                                                                                                                                                                                                                   |              |          |            |            |                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------|------------|------------|-----------------------------|
| Gate Threshold Voltage<br>( $V_{DS} = V_{GS}$ , $I_D = 150\text{ }\mu\text{Adc}$ )<br>Threshold Temperature Coefficient (Negative)                                                                                                | $V_{GS(th)}$ | 1.0<br>– | 1.7<br>4.0 | 2.0<br>–   | Vdc<br>mV/ $^\circ\text{C}$ |
| Static Drain-to-Source On-Resistance (Note 5)<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 1.4\text{ Adc}$ , $T_J @ 25^\circ\text{C}$ )<br>( $V_{GS} = 10\text{ Vdc}$ , $I_D = 1.4\text{ Adc}$ , $T_J @ 150^\circ\text{C}$ ) (Note 4)   | $R_{DS(on)}$ | –<br>–   | 90<br>165  | 100<br>190 | m $\Omega$                  |
| Static Drain-to-Source On-Resistance (Note 5)<br>( $V_{GS} = 5.0\text{ Vdc}$ , $I_D = 1.4\text{ Adc}$ , $T_J @ 25^\circ\text{C}$ )<br>( $V_{GS} = 5.0\text{ Vdc}$ , $I_D = 1.4\text{ Adc}$ , $T_J @ 150^\circ\text{C}$ ) (Note 4) | $R_{DS(on)}$ | –<br>–   | 105<br>185 | 120<br>210 | m $\Omega$                  |
| Source-Drain Forward On Voltage<br>( $I_S = 7\text{ A}$ , $V_{GS} = 0\text{ V}$ )                                                                                                                                                 | $V_{SD}$     | –        | 1.05       | –          | V                           |

**SWITCHING CHARACTERISTICS** (Note 4)

|                                                                                                           |                    |   |     |     |               |
|-----------------------------------------------------------------------------------------------------------|--------------------|---|-----|-----|---------------|
| Turn-on Delay Time<br>$R_L = 4.7\text{ }\Omega$ , $V_{in} = 0$ to $10\text{ V}$ , $V_{DD} = 12\text{ V}$  | $t_{d(on)}$        | – | 4.0 | 8.0 | $\mu\text{s}$ |
| Turn-on Rise Time<br>$R_L = 4.7\text{ }\Omega$ , $V_{in} = 0$ to $10\text{ V}$ , $V_{DD} = 12\text{ V}$   | $t_{rise}$         | – | 11  | 20  | $\mu\text{s}$ |
| Turn-off Delay Time<br>$R_L = 4.7\text{ }\Omega$ , $V_{in} = 10$ to $0\text{ V}$ , $V_{DD} = 12\text{ V}$ | $t_{d(off)}$       | – | 32  | 50  | $\mu\text{s}$ |
| Turn-off Fall Time<br>$R_L = 4.7\text{ }\Omega$ , $V_{in} = 10$ to $0\text{ V}$ , $V_{DD} = 12\text{ V}$  | $t_{fall}$         | – | 27  | 50  | $\mu\text{s}$ |
| Slew-Rate On<br>$R_L = 4.7\text{ }\Omega$ ,<br>$V_{in} = 0$ to $10\text{ V}$ , $V_{DD} = 12\text{ V}$     | $-dV_{DS}/dt_{on}$ | – | 1.5 | 2.5 | $\mu\text{s}$ |
| Slew-Rate Off<br>$R_L = 4.7\text{ }\Omega$ ,<br>$V_{in} = 10$ to $0\text{ V}$ , $V_{DD} = 12\text{ V}$    | $dV_{DS}/dt_{off}$ | – | 0.6 | 1.0 | $\mu\text{s}$ |

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

|                                                                                                                      |                      |            |             |           |                  |
|----------------------------------------------------------------------------------------------------------------------|----------------------|------------|-------------|-----------|------------------|
| Current Limit<br>( $V_{GS} = 5.0\text{ Vdc}$ )<br>( $V_{GS} = 5.0\text{ Vdc}$ , $T_J = 150^\circ\text{C}$ ) (Note 4) | $I_{LIM}$            | 6.0<br>3.0 | 9.0<br>5.0  | 11<br>8.0 | Adc              |
| Current Limit<br>( $V_{GS} = 10\text{ Vdc}$ )<br>( $V_{GS} = 10\text{ Vdc}$ , $T_J = 150^\circ\text{C}$ ) (Note 4)   | $I_{LIM}$            | 7.0<br>4.0 | 10.5<br>7.5 | 13<br>10  | Adc              |
| Temperature Limit (Turn-off) (Note 4)                                                                                | $T_{LIM(off)}$       | 150        | 175         | 200       | $^\circ\text{C}$ |
| Temperature Hysteresis (Note 4)                                                                                      | $\Delta T_{LIM(on)}$ | –          | 15          | –         | $^\circ\text{C}$ |
| Temperature Limit (Turn-off) (Note 4)                                                                                | $T_{LIM(off)}$       | 150        | 165         | 185       | $^\circ\text{C}$ |
| Temperature Hysteresis (Note 4)                                                                                      | $\Delta T_{LIM(on)}$ | –          | 15          | –         | $^\circ\text{C}$ |

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

|                                     |                        |     |      |   |   |   |
|-------------------------------------|------------------------|-----|------|---|---|---|
| Electro-Static Discharge Capability | Human Body Model (HBM) | ESD | 4000 | – | – | V |
| Electro-Static Discharge Capability | Machine Model (MM)     | ESD | 400  | – | – | V |

4. Not subject to production testing.

5. Pulse Test: Pulse Width = 300  $\mu\text{s}$ , Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

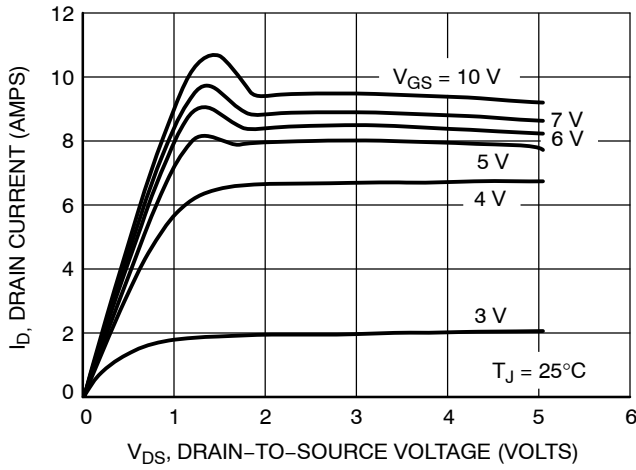


Figure 1. Output Characteristics

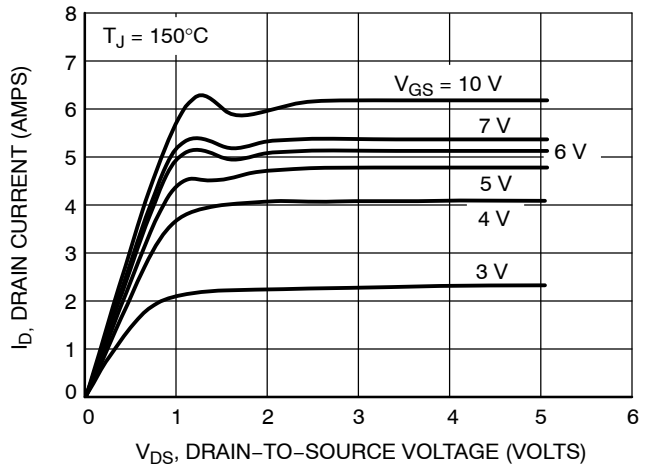


Figure 2. Output Characteristics

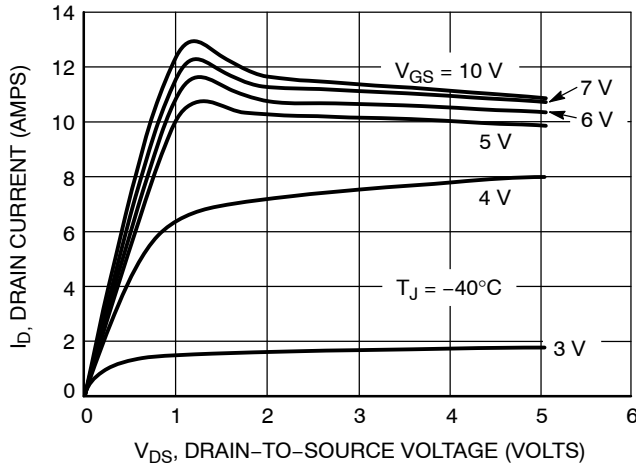


Figure 3. Output Characteristics

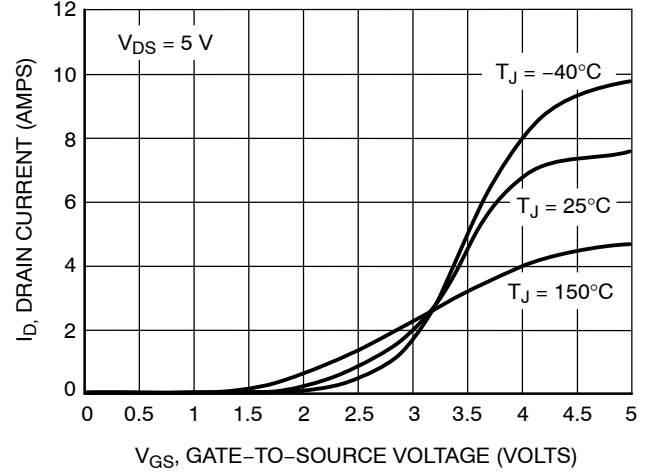


Figure 4. Transfer Characteristics

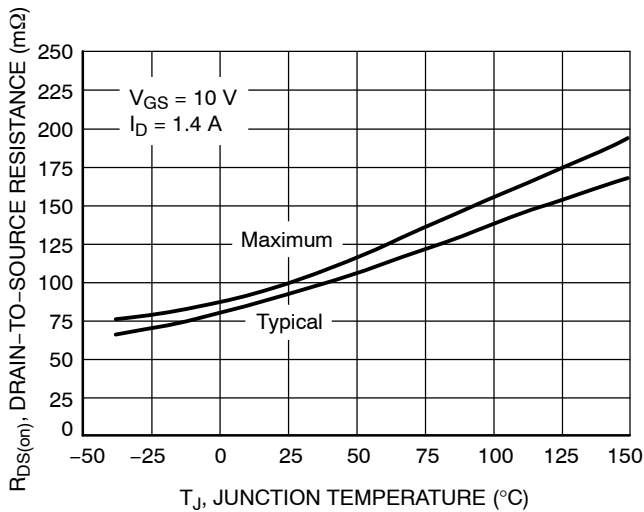


Figure 5. Drain-to-Source Resistance versus Junction Temperature

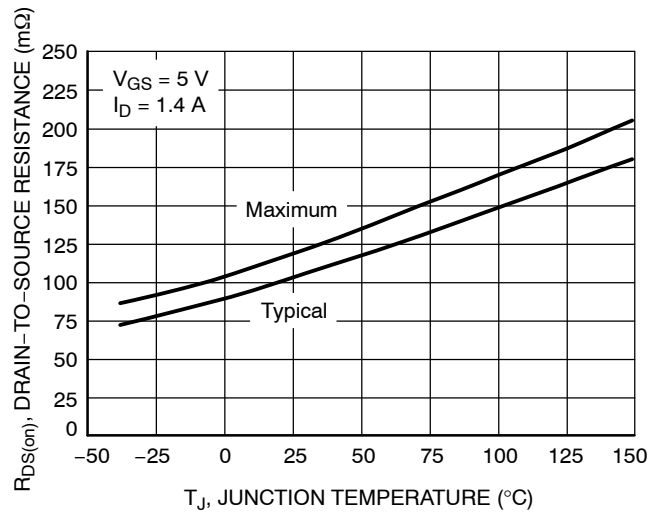


Figure 6. Drain-to-Source Resistance versus Junction Temperature

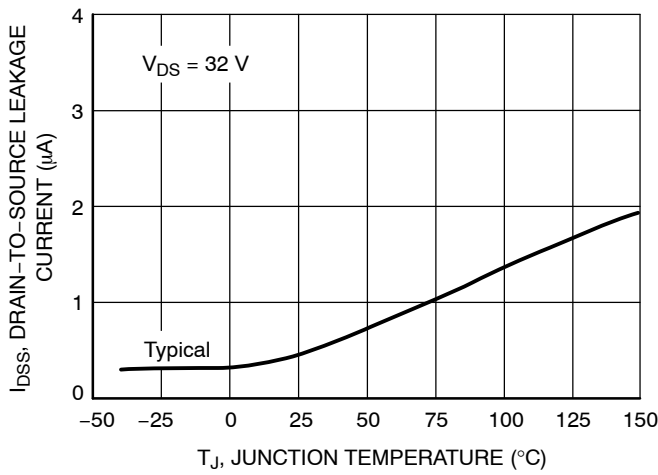


Figure 7. Drain-to-Source Resistance versus Junction Temperature

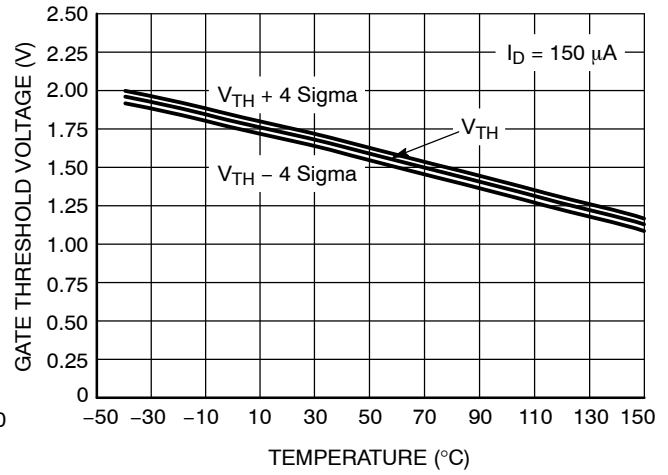


Figure 8. Gate Threshold Voltage versus Temperature

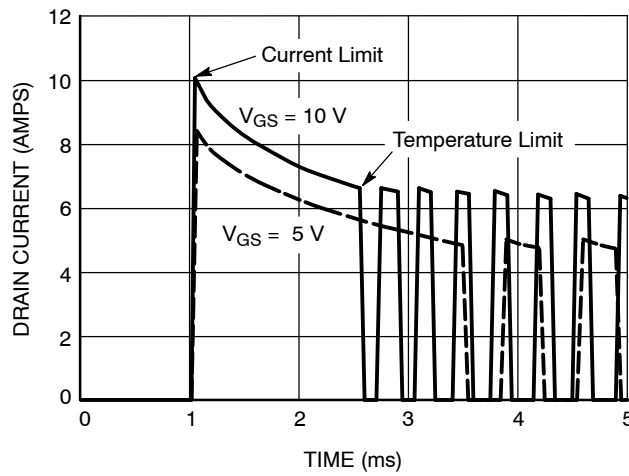


Figure 9. Short-circuit Response

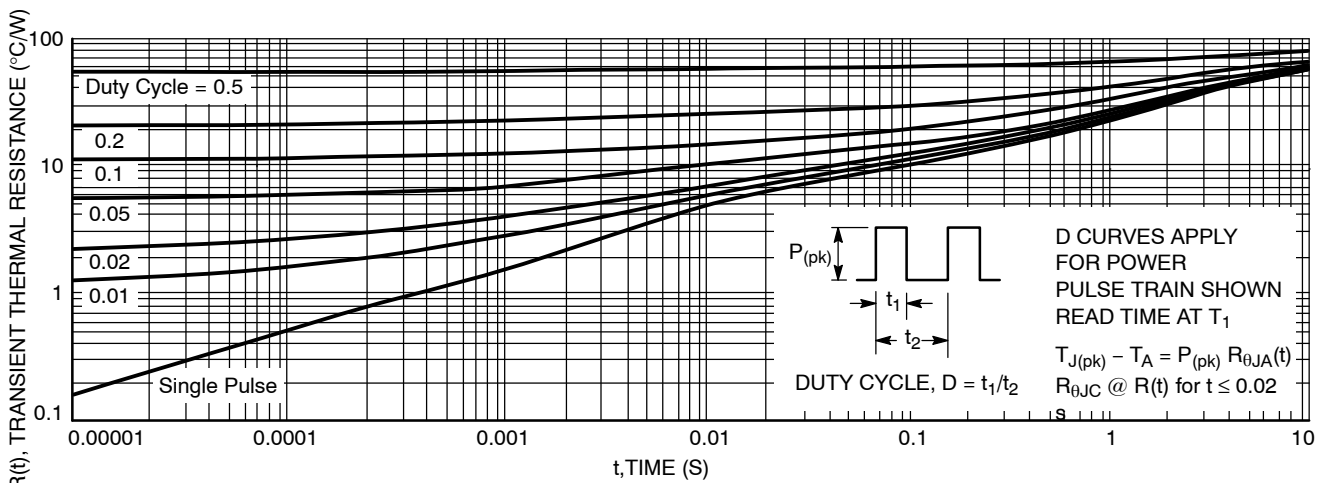
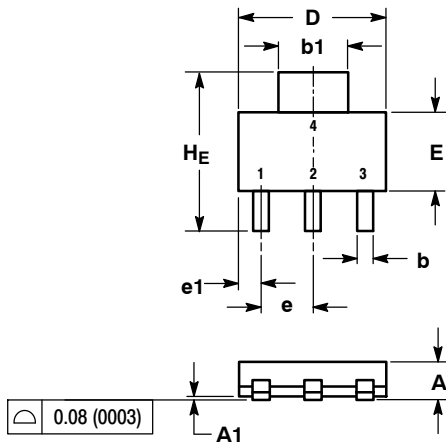


Figure 10. Transient Thermal Resistance  
(Non-normalized Junction-to-Ambient mounted on minimum pad area)

## PACKAGE DIMENSIONS

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

## NOTES:

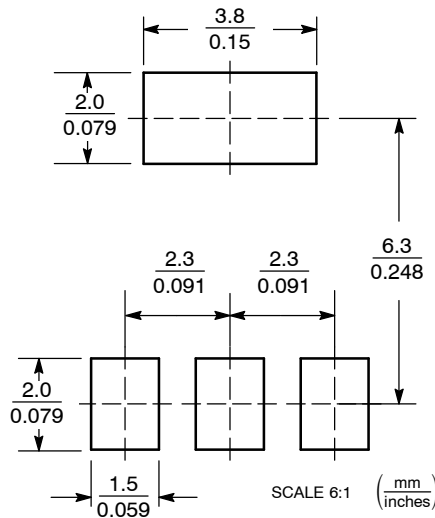
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| DIM | MILLIMETERS |      |      | INCHES |       |       |
|-----|-------------|------|------|--------|-------|-------|
|     | MIN         | NOM  | MAX  | MIN    | NOM   | MAX   |
| A   | 1.50        | 1.63 | 1.75 | 0.060  | 0.064 | 0.068 |
| A1  | 0.02        | 0.06 | 0.10 | 0.001  | 0.002 | 0.004 |
| b   | 0.60        | 0.75 | 0.89 | 0.024  | 0.030 | 0.035 |
| b1  | 2.90        | 3.06 | 3.20 | 0.115  | 0.121 | 0.126 |
| c   | 0.24        | 0.29 | 0.35 | 0.009  | 0.012 | 0.014 |
| D   | 6.30        | 6.50 | 6.70 | 0.249  | 0.256 | 0.263 |
| E   | 3.30        | 3.50 | 3.70 | 0.130  | 0.138 | 0.145 |
| e   | 2.20        | 2.30 | 2.40 | 0.087  | 0.091 | 0.094 |
| e1  | 0.85        | 0.94 | 1.05 | 0.033  | 0.037 | 0.041 |
| L1  | 1.50        | 1.75 | 2.00 | 0.060  | 0.069 | 0.078 |
| HE  | 6.70        | 7.00 | 7.30 | 0.264  | 0.276 | 0.287 |
| θ   | 0°          | —    | 10°  | 0°     | —     | 10°   |

## STYLE 3:

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

## SOLDERING FOOTPRINT



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

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