

# N-Channel Logic Level Enhancement Mode Field Effect Transistor

## NDT014L

### General Description

These N-Channel logic level enhancement mode power field effect transistors are produced using onsemi's proprietary, high cell density, DMOS technology. This very high density process is especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulses in the avalanche and commutation modes. These devices are particularly suited for low voltage applications such as DC motor control and DC-DC conversion where fast switching, low in-line power loss, and resistance to transients are needed.

### Features

- 2.8 A, 60 V.  $R_{DS(ON)} = 0.2 \Omega$  @  $V_{GS} = 4.5$  V  
 $R_{DS(ON)} = 0.16 \Omega$  @  $V_{GS} = 10$  V
- High Density Cell Design For Extremely Low  $R_{DS(ON)}$
- High Power and Current Handling Capability in a Widely Used Surface Mount Package
- This Device is Pb-Free

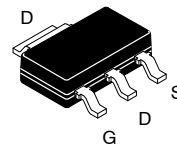
### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)

| Symbol         | Parameter                               | Value      | Unit             |
|----------------|-----------------------------------------|------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage                    | 60         | V                |
| $V_{GSS}$      | Gate-Source Voltage                     | $\pm 20$   | V                |
| $I_D$          | Drain Current                           |            | A                |
|                | – Continuous (Note 1a)                  | $\pm 2.8$  |                  |
|                | – Pulsed                                | $\pm 10$   |                  |
| $P_D$          | Maximum Power Dissipation (Note 1a)     | 3          | W                |
|                | (Note 1b)                               | 1.3        |                  |
|                | (Note 1c)                               | 1.1        |                  |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range | -65 to 150 | $^\circ\text{C}$ |

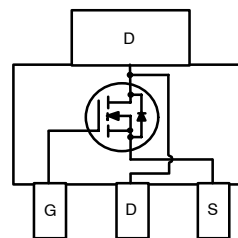
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL CHARACTERISTICS Values are at $T_A = 25^\circ\text{C}$ unless otherwise noted.

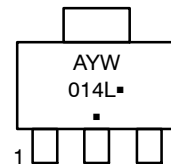
| Symbol          | Parameter                                         | Ratings | Unit               |
|-----------------|---------------------------------------------------|---------|--------------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (Note 1a) | 42      | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case (Note 1)     | 12      | $^\circ\text{C/W}$ |



SOT-223  
CASE 318H



### MARKING DIAGRAM



A = Assembly Location  
Y = Year  
W = Work Week  
014L = Specific Device Code  
▪ = Pb-Free Package

### ORDERING INFORMATION

| Device  | Package | Shipping <sup>†</sup> |
|---------|---------|-----------------------|
| NDT014L | SOT-223 | 4000 / 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](http://BRD8011/D).

# NDT014L

**ELECTRICAL CHARACTERISTICS** Values are at  $T_A = 25^\circ\text{C}$  unless otherwise noted.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|-----------|------------|-----|-----|-----|------|
|--------|-----------|------------|-----|-----|-----|------|

## OFF CHARACTERISTICS

|            |                                 |                                                                         |    |   |           |               |
|------------|---------------------------------|-------------------------------------------------------------------------|----|---|-----------|---------------|
| $BV_{DSS}$ | Drain–Source Breakdown Voltage  | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                     | 60 | – | –         | V             |
| $I_{DSS}$  | Zero Gate Voltage Drain Current | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$<br>$T_J = 55^\circ\text{C}$ | –  | – | 25<br>250 | $\mu\text{A}$ |
| $I_{GSSF}$ | Gate–Body Leakage, Forward      | $V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$                             | –  | – | 100       | nA            |
| $I_{GSSR}$ | Gate–Body Leakage, Reverse      | $V_{GS} = -20\text{ V}, V_{DS} = 0\text{ V}$                            | –  | – | -100      | nA            |

## ON CHARACTERISTICS (Note 2)

|              |                                   |                                                                              |          |              |             |          |
|--------------|-----------------------------------|------------------------------------------------------------------------------|----------|--------------|-------------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$<br>$T_J = 125^\circ\text{C}$ | 1<br>0.8 | 1.5<br>1.1   | 3<br>2      | V        |
| $R_{DS(on)}$ | Static Drain–Source On–Resistance | $V_{GS} = 4.5\text{ V}, I_D = 2.8\text{ A}$<br>$T_J = 125^\circ\text{C}$     | –        | 0.17<br>0.22 | 0.2<br>0.36 | $\Omega$ |
|              |                                   | $V_{GS} = 10\text{ V}, I_D = 3.4\text{ A}$                                   | –        | 0.12         | 0.16        |          |
| $I_{D(on)}$  | On–State Drain Current            | $V_{GS} = 4.5\text{ V}, V_{DS} = 5\text{ V}$                                 | 5        | –            | –           | A        |
|              |                                   | $V_{DS} = 10\text{ V}, V_{DS} = 5\text{ V}$                                  | 10       | –            | –           |          |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = 5\text{ V}, I_D = 2.8\text{ A}$                                    | –        | 4.2          | –           | S        |

## DYNAMIC CHARACTERISTICS

|           |                              |                                                                      |   |     |   |    |
|-----------|------------------------------|----------------------------------------------------------------------|---|-----|---|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | – | 214 | – | pF |
| $C_{oss}$ | Output Capacitance           |                                                                      | – | 70  | – | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                      | – | 27  | – | pF |

## SWITCHING CHARACTERISTICS (Note 2)

|              |                     |                                                                                                  |   |     |    |    |
|--------------|---------------------|--------------------------------------------------------------------------------------------------|---|-----|----|----|
| $t_{d(on)}$  | Turn–On Delay Time  | $V_{DD} = 30\text{ V}, I_D = 3\text{ A},$<br>$V_{GEN} = 10\text{ V}, R_{GEN} = 12\text{ }\Omega$ | – | 6   | 12 | ns |
| $t_r$        | Turn–On Rise Time   |                                                                                                  | – | 14  | 25 | ns |
| $t_{d(off)}$ | Turn–Off Delay Time |                                                                                                  | – | 15  | 28 | ns |
| $t_f$        | Turn–Off Fall Time  |                                                                                                  | – | 10  | 18 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 10\text{ V}, I_D = 2.8\text{ A},$<br>$V_{GS} = 4.5\text{ V}$                           | – | 36  | 5  | nC |
| $Q_{gs}$     | Gate–Source Charge  |                                                                                                  | – | 0.8 | –  | nC |
| $Q_{gd}$     | Gate–Drain Charge   |                                                                                                  | – | 1.4 | –  | nC |

## DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

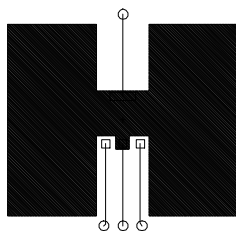
|                 |                                                       |                                                                                           |   |      |     |    |
|-----------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------|---|------|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain–Source Diode Forward Current |                                                                                           | – | –    | 2.3 | A  |
| V <sub>SD</sub> | Drain–Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 2.3 A (Note 2)                                    | – | 0.85 | 1.3 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>F</sub> = 2.3 A, d <sub>I</sub> F/d <sub>t</sub> = 100 A/μs | – | –    | 140 | ns |

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.

- $R_{\theta JA}$  is the sum of the junction–to–case and case–to–ambient resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.

$$P_D(t) = \frac{T_J - T_A}{R_{\theta JA}(t)} = \frac{T_J - T_A}{R_{\theta JC} + R_{\theta CA}(t)} = I_D^2(t) \times R_{DS(on)}@T_J$$

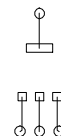
Applications on 4.5"x5" FR-4 PCB under still air environment, typical  $R_{\theta JA}$  is found to be:



a.  $42^\circ\text{C}/\text{W}$  with  $1\text{ in}^2$  of 2 oz copper mounting pad.



b.  $95^\circ\text{C}/\text{W}$  with  $0.066\text{ in}^2$  of 2 oz copper mounting pad.



c.  $110^\circ\text{C}/\text{W}$  with  $0.0123\text{ in}^2$  of 2 oz copper mounting pad.

Scale 1 : 1 on letter size paper

- Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

TYPICAL CHARACTERISTICS

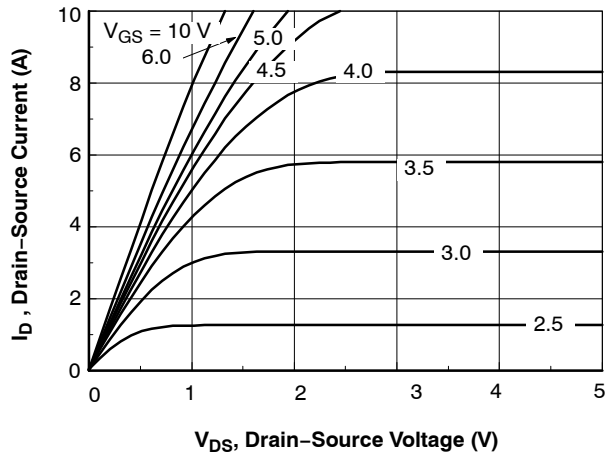


Figure 1. On-Region Characteristics

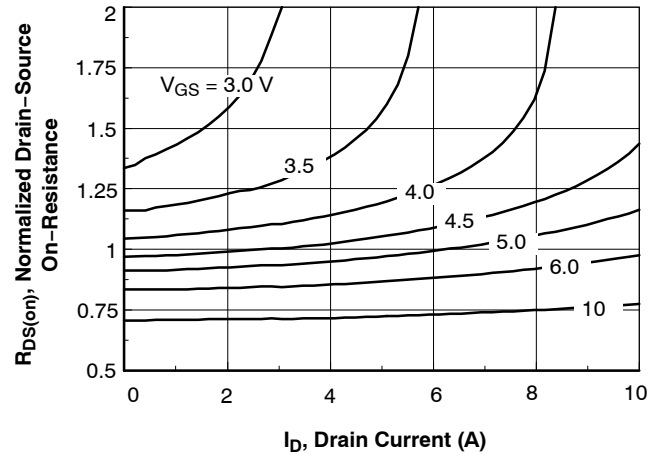


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

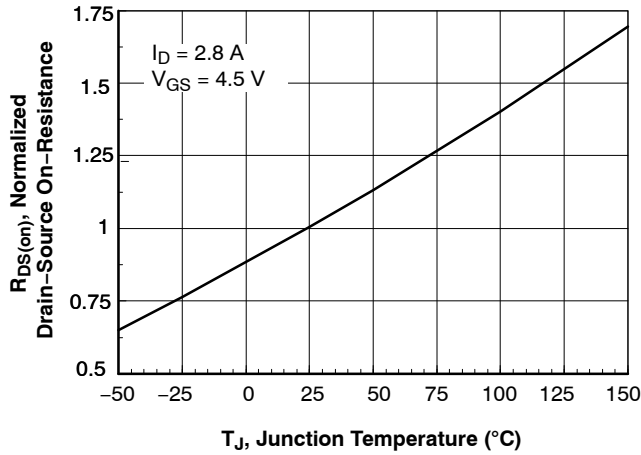


Figure 3. On-Resistance Variation with Temperature

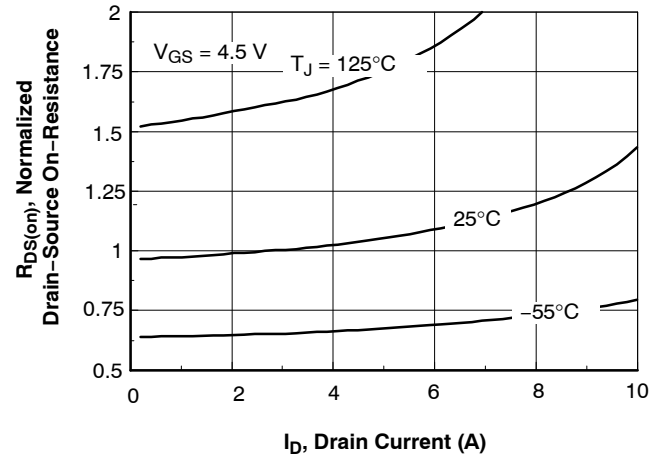


Figure 4. On-Resistance Variation with Drain Current and Temperature

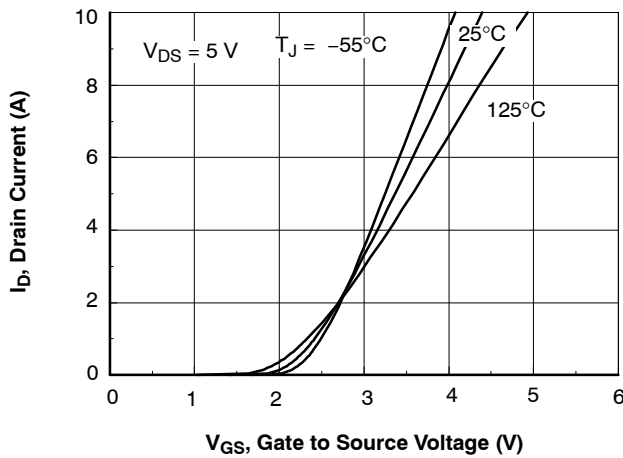


Figure 5. Transfer Characteristics

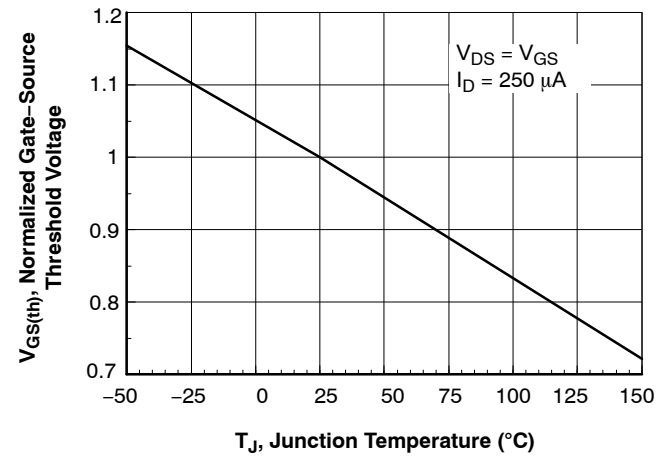


Figure 6. Gate Threshold Variation with Temperature

TYPICAL CHARACTERISTICS (continued)

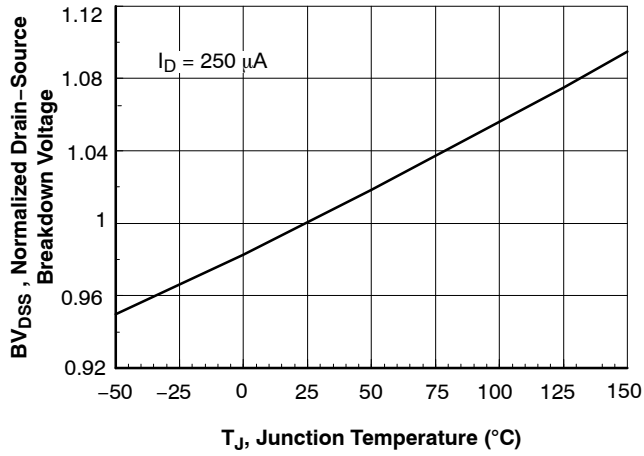


Figure 7. Breakdown Voltage Variation with Temperature

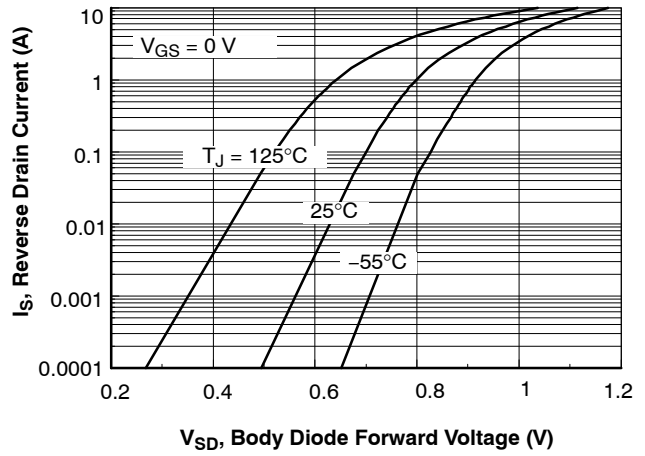


Figure 8. Body Diode Forward Voltage Variation with Current and Temperature

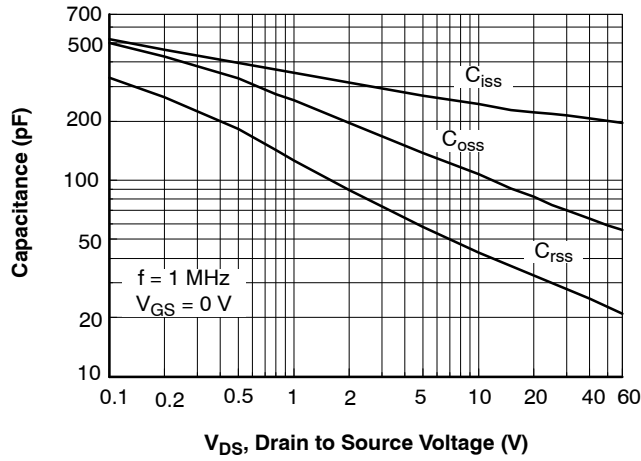


Figure 9. Capacitance Characteristics

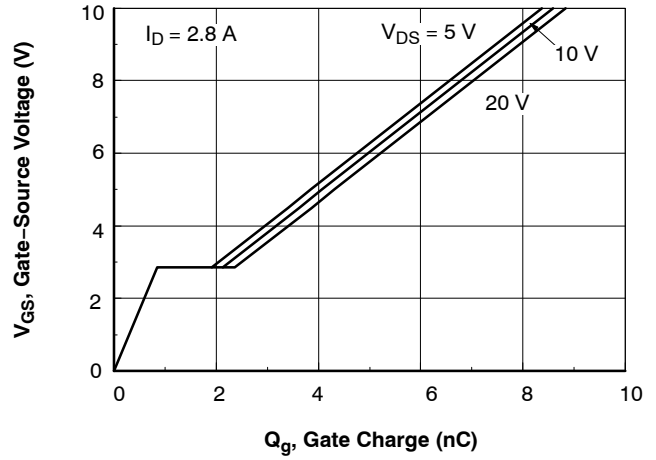


Figure 10. Gate Charge Characteristics

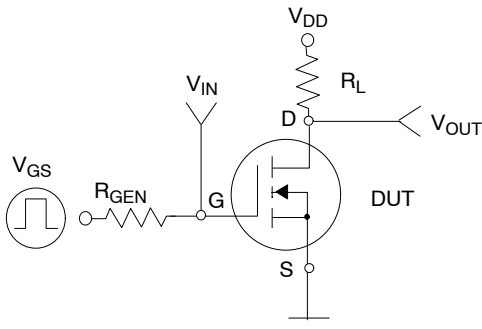


Figure 11. Switching Test Circuit

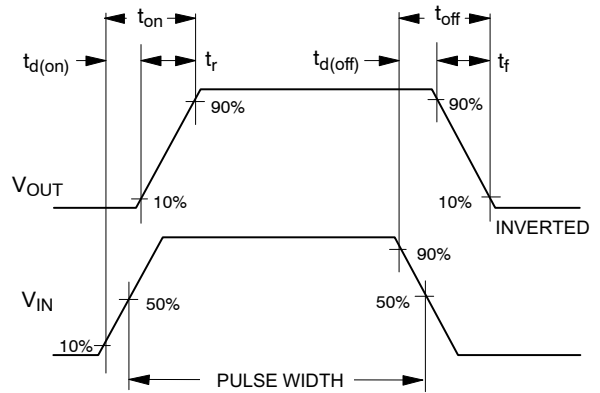


Figure 12. Switching Waveforms

TYPICAL CHARACTERISTICS (continued)

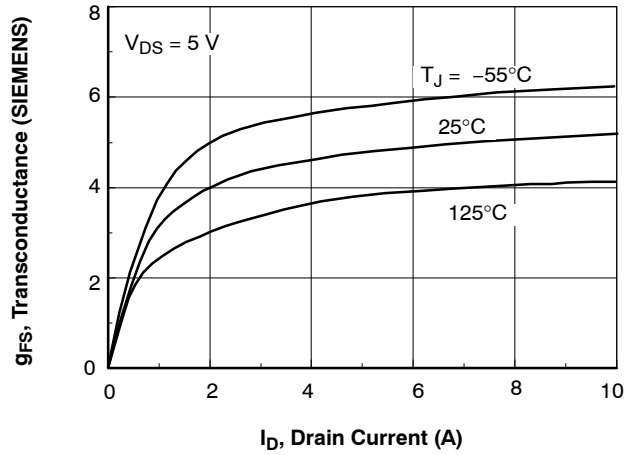


Figure 13. Transconductance Variation with Drain Current and Temperature

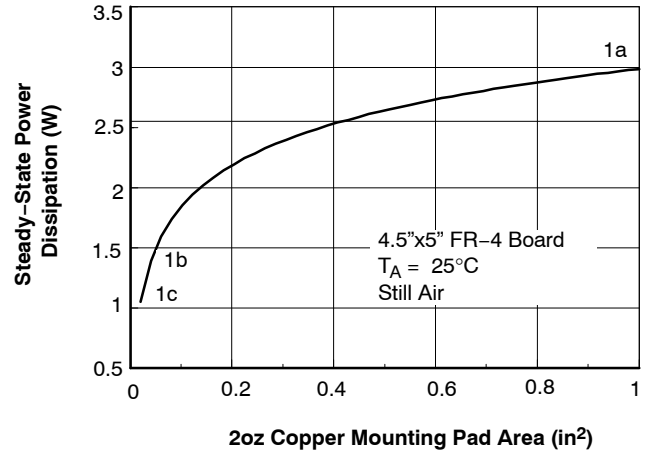


Figure 14. SOT-223 Maximum Steady-State Power Dissipation versus Copper Mounting Pad Area

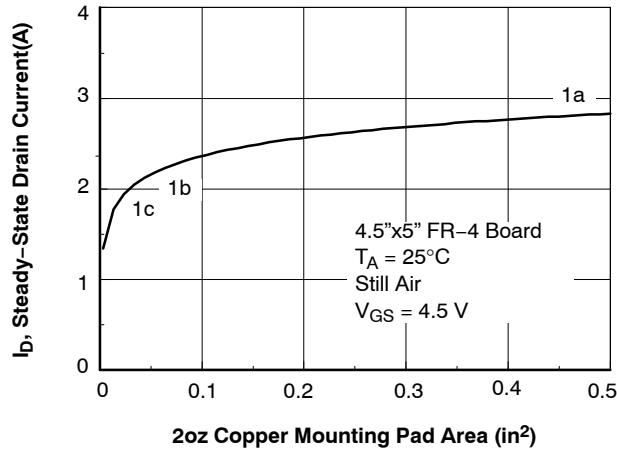


Figure 15. Maximum Steady-State Drain Current versus Copper Mounting Pad Area

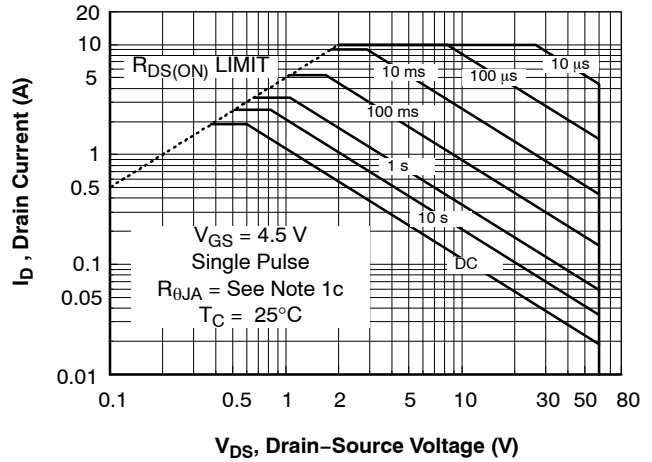


Figure 16. Maximum Safe Operating Area

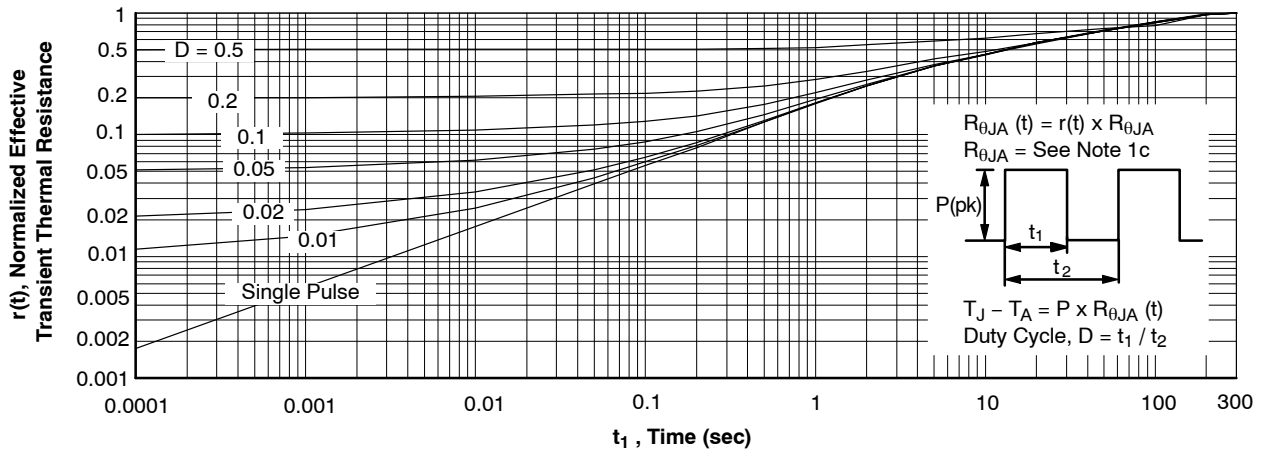
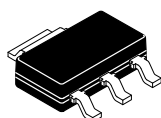


Figure 17. Typical Transient Thermal Impedance Curve

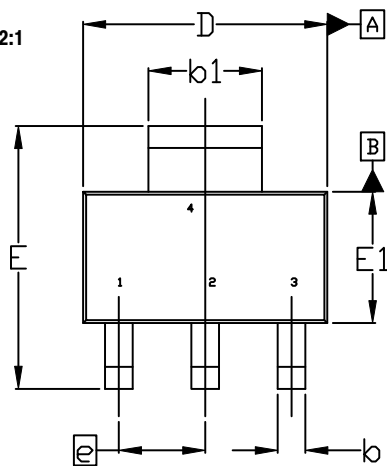
Thermal characterization performed under the conditions of Note 1c. Should better thermal design employs,  $R_{\theta JA}$  will be lower and reach thermal equivalent sooner.



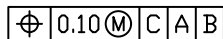
### SOT-223 CASE 318H ISSUE B

DATE 13 MAY 2020

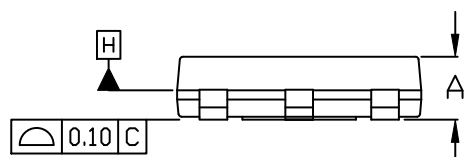
SCALE 2:1



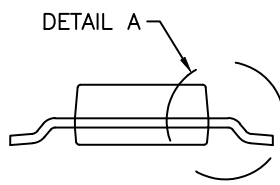
TOP VIEW



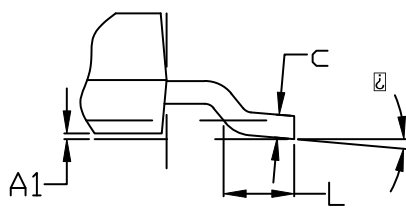
NOTE 7



SIDE VIEW

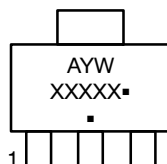


END VIEW



DETAIL A

#### GENERIC MARKING DIAGRAM\*



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

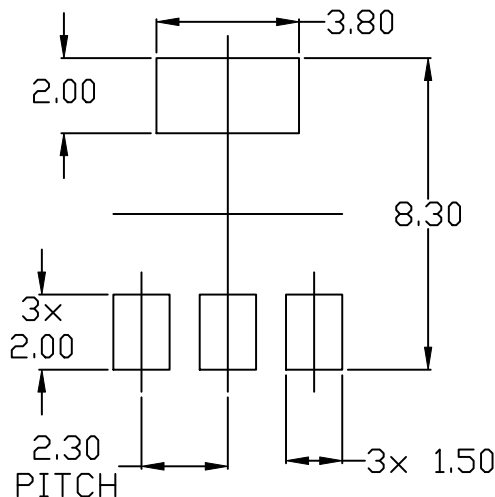
(Note: Microdot may be in either location)

\*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. DIMENSIONS D & E1 ARE DETERMINED AT DATUM H. DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. SHALL NOT EXCEED 0.23mm PER SIDE.
4. LEAD DIMENSIONS b AND b1 DO NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION IS 0.08mm PER SIDE.
5. DATUMS A AND B ARE DETERMINED AT DATUM H.
6. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.
7. POSITIONAL TOLERANCE APPLIES TO DIMENSIONS b AND b1.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | ---         | ---  | 1.80 |
| A1  | 0.02        | 0.06 | 0.11 |
| b   | 0.60        | 0.74 | 0.88 |
| b1  | 2.90        | 3.00 | 3.10 |
| c   | 0.24        | ---  | 0.35 |
| D   | 6.30        | 6.50 | 6.70 |
| E   | 6.70        | 7.00 | 7.30 |
| E1  | 3.30        | 3.50 | 3.70 |
| e   | 2.30 BSC    |      |      |
| L   | 0.25        | ---  | ---  |
| ⌀   | 0°          | ---  | 10°  |



#### RECOMMENDED MOUNTING FOOTPRINT

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

|                  |             |                                                                                                                                                                                  |
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