

# NSS60601MZ4

## Low $V_{CE(sat)}$ Transistor, NPN, 60 V, 6.0 A

ON Semiconductor's e<sup>2</sup>PowerEdge family of low  $V_{CE(sat)}$  transistors are surface mount devices featuring ultra low saturation voltage ( $V_{CE(sat)}$ ) and high current gain capability. These are designed for use in low voltage, high speed switching applications where affordable efficient energy control is important.

Typical applications are DC-DC converters and power management in portable and battery powered products such as cellular and cordless phones, PDAs, computers, printers, digital cameras and MP3 players. Other applications are low voltage motor controls in mass storage products such as disc drives and tape drives. In the automotive industry they can be used in air bag deployment and in the instrument cluster. The high current gain allows e<sup>2</sup>PowerEdge devices to be driven directly from PMU's control outputs, and the Linear Gain (Beta) makes them ideal components in analog amplifiers.

### Features

- NSV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant\*
- Complementary to NSS60600MZ4

### MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ )

| Rating                         | Symbol    | Max  | Unit |
|--------------------------------|-----------|------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 60   | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 100  | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 6.0  | Vdc  |
| Collector Current - Continuous | $I_C$     | 6.0  | A    |
| Collector Current - Peak       | $I_{CM}$  | 12.0 | A    |

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.

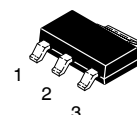
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



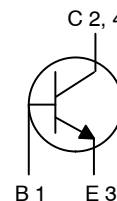
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**60 VOLTS, 6.0 AMPS  
2.0 WATTS  
NPN LOW  $V_{CE(sat)}$  TRANSISTOR  
EQUIVALENT  $R_{DS(on)} 50\text{ m}\Omega$**

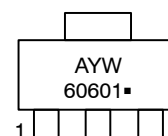


SOT-223  
CASE 318E  
STYLE 1



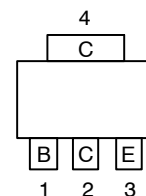
Schematic

### MARKING DIAGRAM



- A = Assembly Location
- Y = Year
- W = Work Week
- 60601 = Specific Device Code
- = Pb-Free Package

### PIN ASSIGNMENT



Top View Pinout

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

# NSS60601MZ4

## THERMAL CHARACTERISTICS

| Characteristic                                                                          | Symbol                           | Max         | Unit                       |
|-----------------------------------------------------------------------------------------|----------------------------------|-------------|----------------------------|
| Total Device Dissipation<br>$T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$ (Note 1)                   | 800<br>6.5  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance,<br>Junction-to-Ambient                                              | $R_{\theta JA}$ (Note 1)         | 155         | $^\circ\text{C/W}$         |
| Total Device Dissipation<br>$T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$ (Note 2)                   | 2<br>15.6   | W<br>mW/ $^\circ\text{C}$  |
| Thermal Resistance,<br>Junction-to-Ambient                                              | $R_{\theta JA}$ (Note 2)         | 64          | $^\circ\text{C/W}$         |
| Total Device Dissipation<br>(Single Pulse < 10 sec.)                                    | $P_{D\text{single}}$<br>(Note 3) | 710         | mW                         |
| Junction and Storage Temperature Range                                                  | $T_J, T_{\text{stg}}$            | -55 to +150 | $^\circ\text{C}$           |

1. FR-4 @ 7.6 mm<sup>2</sup>, 1 oz. copper traces.
2. FR-4 @ 645 mm<sup>2</sup>, 1 oz. copper traces.
3. Thermal response.

## ORDERING INFORMATION

| Device          | Package              | Shipping <sup>†</sup> |
|-----------------|----------------------|-----------------------|
| NSS60601MZ4T1G  | SOT-223<br>(Pb-Free) | 1,000 / Tape & Reel   |
| NSV60601MZ4T1G* | SOT-223<br>(Pb-Free) | 1,000 / Tape & Reel   |
| NSS60601MZ4T3G  | SOT-223<br>(Pb-Free) | 4,000 / Tape & Reel   |
| NSV60601MZ4T3G* | SOT-223<br>(Pb-Free) | 4,000 / 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.

\*NSV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable.

# NSS60601MZ4

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

| Characteristic                                                                   | Symbol        | Min | Typ | Max | Unit            |
|----------------------------------------------------------------------------------|---------------|-----|-----|-----|-----------------|
| <b>OFF CHARACTERISTICS</b>                                                       |               |     |     |     |                 |
| Collector - Emitter Breakdown Voltage<br>( $I_C = 10 \text{ mAdc}$ , $I_B = 0$ ) | $V_{(BR)CEO}$ | 60  | -   | -   | Vdc             |
| Collector - Base Breakdown Voltage<br>( $I_C = 0.1 \text{ mAdc}$ , $I_E = 0$ )   | $V_{(BR)CBO}$ | 100 | -   | -   | Vdc             |
| Emitter - Base Breakdown Voltage<br>( $I_E = 0.1 \text{ mAdc}$ , $I_C = 0$ )     | $V_{(BR)EBO}$ | 6.0 | -   | -   | Vdc             |
| Collector Cutoff Current<br>( $V_{CB} = 100 \text{ Vdc}$ , $I_E = 0$ )           | $I_{CBO}$     | -   | -   | 0.1 | $\mu\text{Adc}$ |
| Emitter Cutoff Current<br>( $V_{EB} = 6.0 \text{ Vdc}$ )                         | $I_{EBO}$     | -   | -   | 0.1 | $\mu\text{Adc}$ |

## ON CHARACTERISTICS

|                                                                                                                                                                                                                                                                                                                               |               |                         |                               |                                           |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------|-------------------------------|-------------------------------------------|-----|
| DC Current Gain (Note 4)<br>( $I_C = 500 \text{ mA}$ , $V_{CE} = 2.0 \text{ V}$ )<br>( $I_C = 1.0 \text{ A}$ , $V_{CE} = 2.0 \text{ V}$ )<br>( $I_C = 2.0 \text{ A}$ , $V_{CE} = 2.0 \text{ V}$ )<br>( $I_C = 6.0 \text{ A}$ , $V_{CE} = 2.0 \text{ V}$ )                                                                     | $h_{FE}$      | 150<br>120<br>100<br>50 | -<br>-<br>-<br>-              | -<br>360<br>-<br>-                        | -   |
| Collector - Emitter Saturation Voltage (Note 4)<br>( $I_C = 0.1 \text{ A}$ , $I_B = 2.0 \text{ mA}$ )<br>( $I_C = 1.0 \text{ A}$ , $I_B = 0.100 \text{ A}$ )<br>( $I_C = 2.0 \text{ A}$ , $I_B = 0.200 \text{ A}$ )<br>( $I_C = 3.0 \text{ A}$ , $I_B = 60 \text{ mA}$ )<br>( $I_C = 6.0 \text{ A}$ , $I_B = 0.6 \text{ A}$ ) | $V_{CE(sat)}$ | -<br>-<br>-<br>-<br>-   | -<br>0.045<br>0.085<br>-<br>- | 0.040<br>0.060<br>0.100<br>0.220<br>0.300 | V   |
| Base - Emitter Saturation Voltage (Note 4)<br>( $I_C = 1.0 \text{ A}$ , $I_B = 0.1 \text{ A}$ )                                                                                                                                                                                                                               | $V_{BE(sat)}$ | -                       | -                             | 0.900                                     | V   |
| Base - Emitter Turn-on Voltage (Note 4)<br>( $I_C = 1.0 \text{ A}$ , $V_{CE} = 2.0 \text{ V}$ )                                                                                                                                                                                                                               | $V_{BE(on)}$  | -                       | -                             | 0.900                                     | V   |
| Cutoff Frequency<br>( $I_C = 500 \text{ mA}$ , $V_{CE} = 10 \text{ V}$ , $f = 1.0 \text{ MHz}$ )                                                                                                                                                                                                                              | $f_T$         | 100                     | -                             | -                                         | MHz |
| Input Capacitance ( $V_{EB} = 5.0 \text{ V}$ , $f = 1.0 \text{ MHz}$ )                                                                                                                                                                                                                                                        | $C_{ibo}$     | -                       | 400                           | -                                         | pF  |
| Output Capacitance ( $V_{CB} = 10 \text{ V}$ , $f = 1.0 \text{ MHz}$ )                                                                                                                                                                                                                                                        | $C_{obo}$     | -                       | 37                            | -                                         | pF  |

## SWITCHING CHARACTERISTICS

|                                                                                         |       |   |      |   |    |
|-----------------------------------------------------------------------------------------|-------|---|------|---|----|
| Delay ( $V_{CC} = 30 \text{ V}$ , $I_C = 750 \text{ mA}$ , $I_{B1} = 15 \text{ mA}$ )   | $t_d$ | - | 85   | - | ns |
| Rise ( $V_{CC} = 30 \text{ V}$ , $I_C = 750 \text{ mA}$ , $I_{B1} = 15 \text{ mA}$ )    | $t_r$ | - | 115  | - | ns |
| Storage ( $V_{CC} = 30 \text{ V}$ , $I_C = 750 \text{ mA}$ , $I_{B1} = 15 \text{ mA}$ ) | $t_s$ | - | 1350 | - | ns |
| Fall ( $V_{CC} = 30 \text{ V}$ , $I_C = 750 \text{ mA}$ , $I_{B1} = 15 \text{ mA}$ )    | $t_f$ | - | 125  | - | ns |

4. Pulsed Condition: Pulse Width = 300 msec, Duty Cycle  $\leq$  2%.

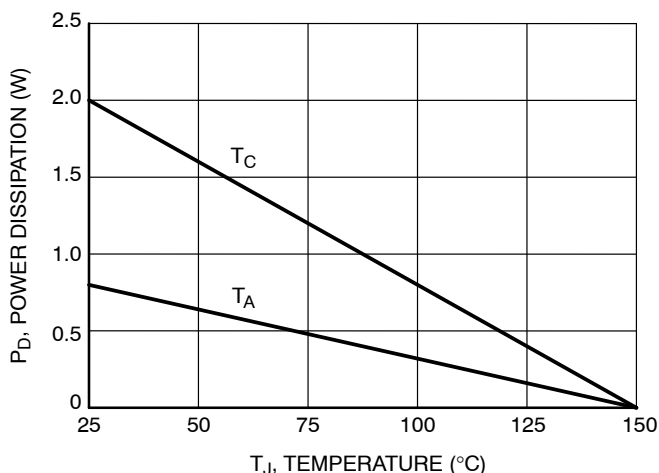


Figure 1. Power Derating

TYPICAL CHARACTERISTICS

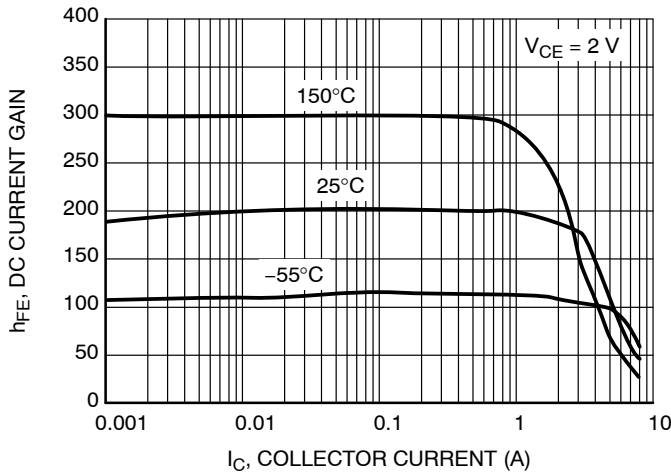


Figure 2. DC Current Gain

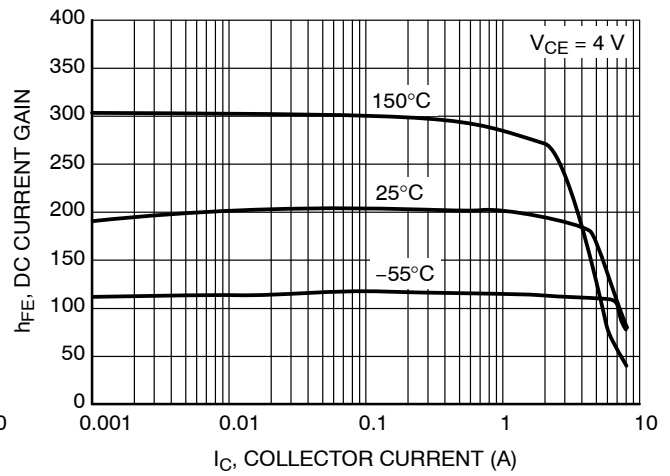


Figure 3. DC Current Gain

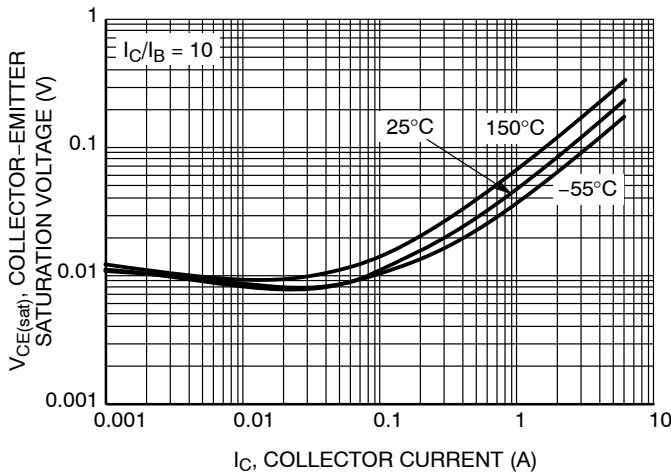


Figure 4. Collector-Emitter Saturation Voltage

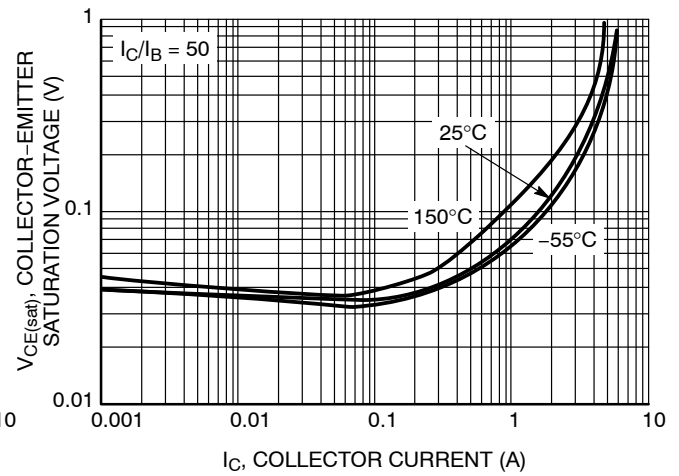


Figure 5. Collector-Emitter Saturation Voltage

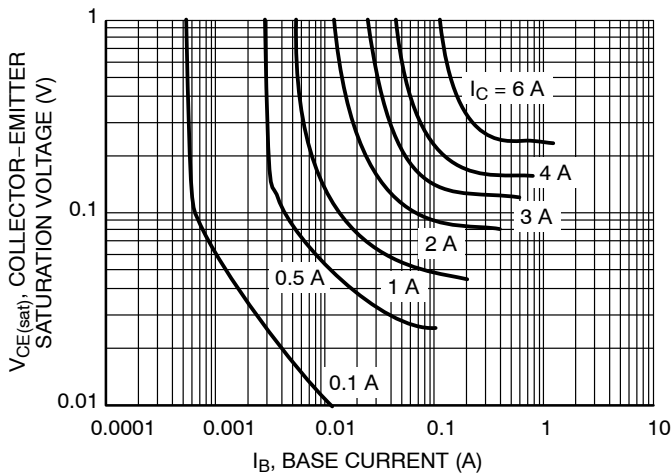


Figure 6. Collector Saturation Region

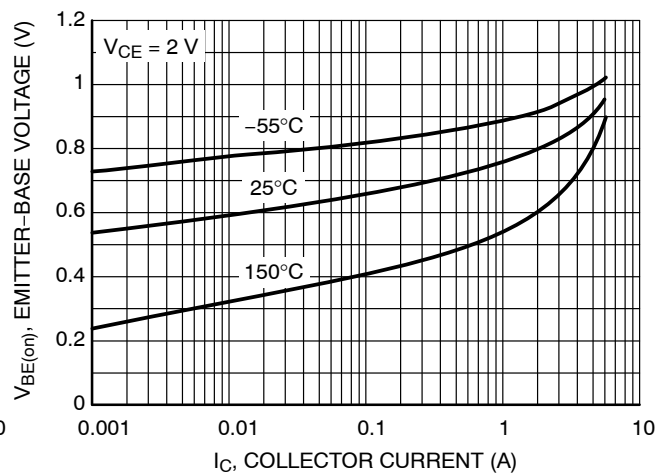


Figure 7.  $V_{BE(on)}$  Voltage

TYPICAL CHARACTERISTICS

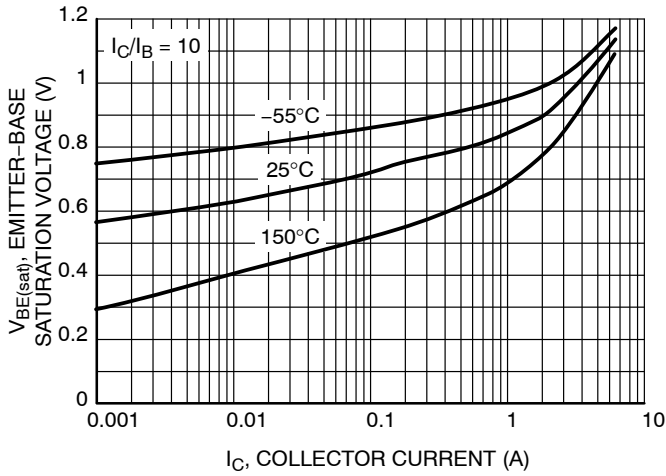


Figure 8. Base-Emitter Saturation Voltage

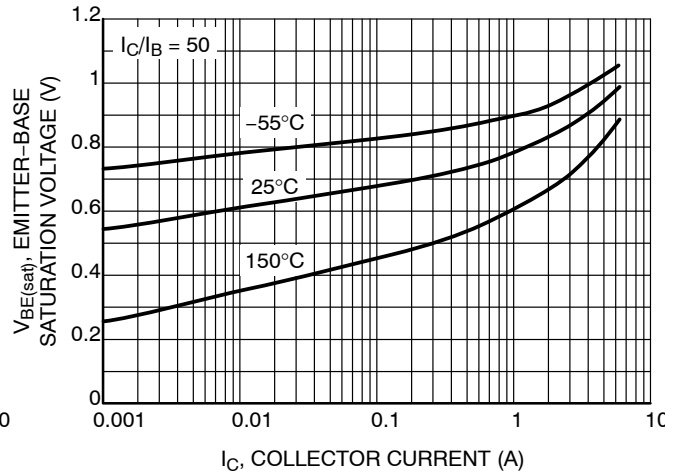


Figure 9. Base-Emitter Saturation Voltage

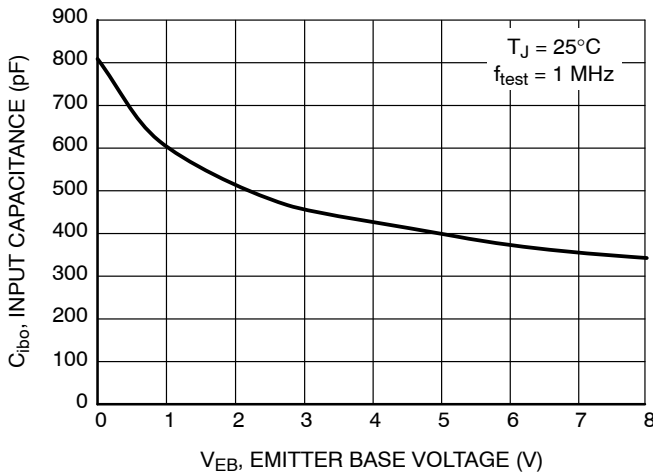


Figure 10. Input Capacitance

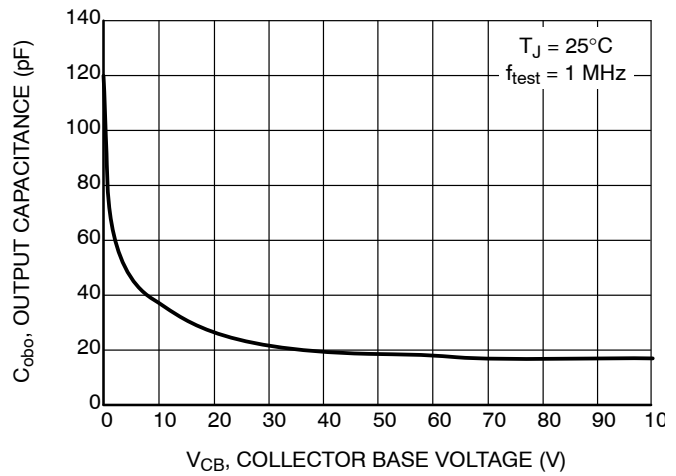


Figure 11. Output Capacitance

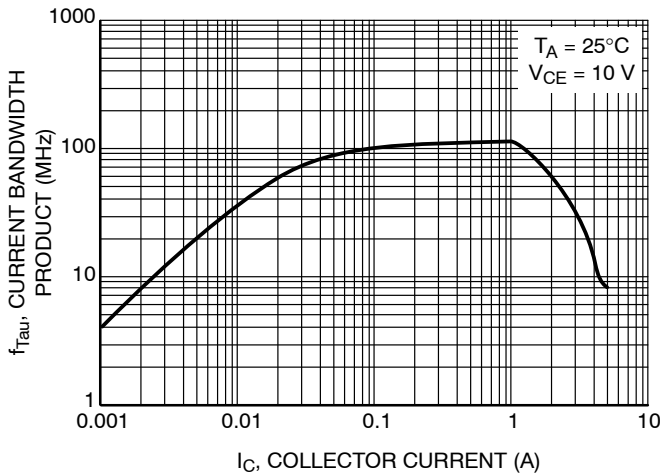


Figure 12. Current-Gain Bandwidth Product

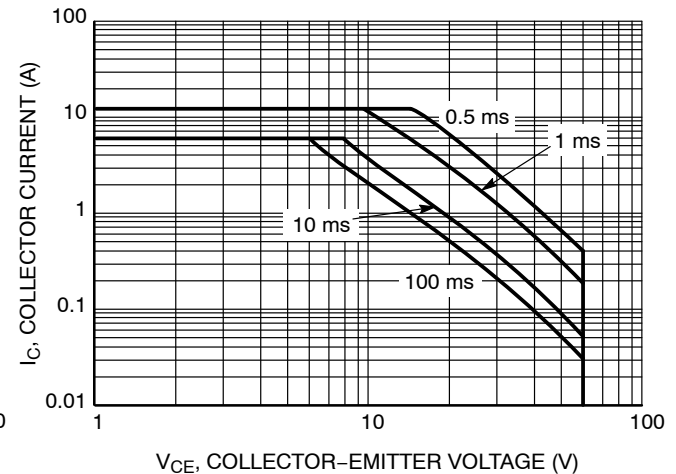


Figure 13. Safe Operating Area

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

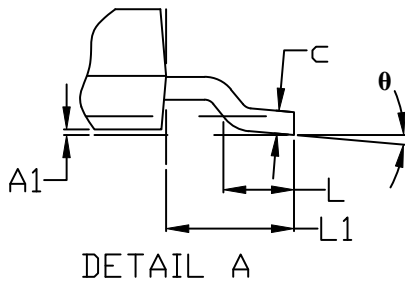
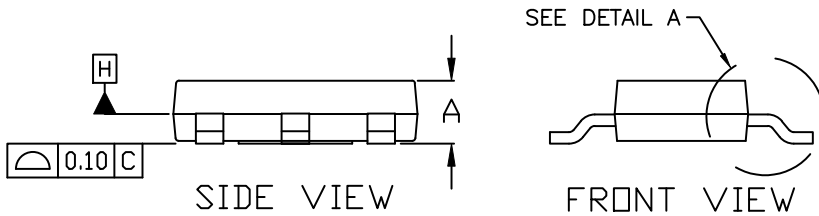
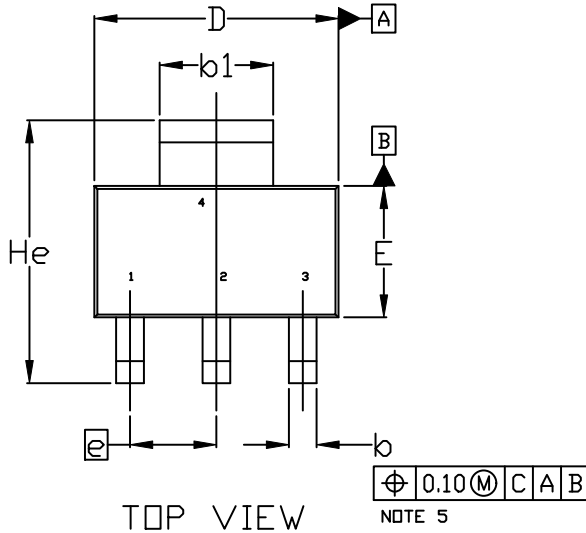
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SCALE 1:1

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

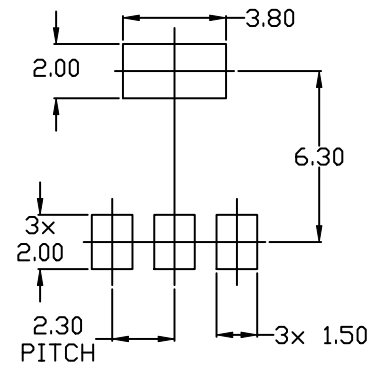
DATE 02 OCT 2018



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D & E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.200MM PER SIDE.
4. DATUMS A AND B ARE DETERMINED AT DATUM H.
5. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.
6. POSITIONAL TOLERANCE APPLIES TO DIMENSIONS b AND b1.

| MILLIMETERS |          |      |      |
|-------------|----------|------|------|
| DIM         | MIN.     | NOM. | MAX. |
| A           | 1.50     | 1.63 | 1.75 |
| A1          | 0.02     | 0.06 | 0.10 |
| b           | 0.60     | 0.75 | 0.89 |
| b1          | 2.90     | 3.06 | 3.20 |
| c           | 0.24     | 0.29 | 0.35 |
| D           | 6.30     | 6.50 | 6.70 |
| E           | 3.30     | 3.50 | 3.70 |
| e           | 2.30 BSC |      |      |
| L           | 0.20     | ---  | ---  |
| L1          | 1.50     | 1.75 | 2.00 |
| He          | 6.70     | 7.00 | 7.30 |
| θ           | 0°       | ---  | 10°  |



|                  |                  |                                                                                                                                                                                  |
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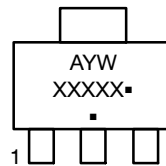
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**SOT-223 (TO-261)**  
**CASE 318E-04**  
**ISSUE R**

DATE 02 OCT 2018

- |                                                                              |                                                                             |                                                                               |                                                                       |                                                                       |
|------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------|
| <b>STYLE 1:</b><br>PIN 1. BASE<br>2. COLLECTOR<br>3. EMITTER<br>4. COLLECTOR | <b>STYLE 2:</b><br>PIN 1. ANODE<br>2. CATHODE<br>3. NC<br>4. CATHODE        | <b>STYLE 3:</b><br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE<br>4. DRAIN           | <b>STYLE 4:</b><br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE<br>4. DRAIN   | <b>STYLE 5:</b><br>PIN 1. DRAIN<br>2. GATE<br>3. SOURCE<br>4. GATE    |
| <b>STYLE 6:</b><br>PIN 1. RETURN<br>2. INPUT<br>3. OUTPUT<br>4. INPUT        | <b>STYLE 7:</b><br>PIN 1. ANODE 1<br>2. CATHODE<br>3. ANODE 2<br>4. CATHODE | <b>STYLE 8:</b><br>CANCELLED                                                  | <b>STYLE 9:</b><br>PIN 1. INPUT<br>2. GROUND<br>3. LOGIC<br>4. GROUND | <b>STYLE 10:</b><br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE<br>4. ANODE |
| <b>STYLE 11:</b><br>PIN 1. MT 1<br>2. MT 2<br>3. GATE<br>4. MT 2             | <b>STYLE 12:</b><br>PIN 1. INPUT<br>2. OUTPUT<br>3. NC<br>4. OUTPUT         | <b>STYLE 13:</b><br>PIN 1. GATE<br>2. COLLECTOR<br>3. EMITTER<br>4. COLLECTOR |                                                                       |                                                                       |

**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.

|                         |                         |                                                                                                                                                                                     |
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