

# P2N2222A

## Amplifier Transistors

### NPN Silicon

#### Features

- These are Pb-Free Devices\*

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

| Characteristic                                                                         | Symbol         | Value          | Unit                       |
|----------------------------------------------------------------------------------------|----------------|----------------|----------------------------|
| Collector – Emitter Voltage                                                            | $V_{CEO}$      | 40             | Vdc                        |
| Collector – Base Voltage                                                               | $V_{CBO}$      | 75             | Vdc                        |
| Emitter – Base Voltage                                                                 | $V_{EBO}$      | 6.0            | Vdc                        |
| Collector Current – Continuous                                                         | $I_C$          | 600            | mA dc                      |
| Total Device Dissipation @ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 625<br>5.0     | mW<br>mW/ $^\circ\text{C}$ |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 1.5<br>12      | W<br>mW/ $^\circ\text{C}$  |
| Operating and Storage Junction<br>Temperature Range                                    | $T_J, T_{stg}$ | -55 to<br>+150 | $^\circ\text{C}$           |

#### THERMAL CHARACTERISTICS

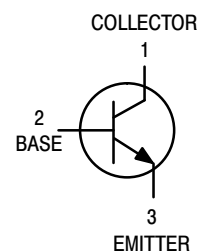
| Characteristic                          | Symbol          | Max  | Unit               |
|-----------------------------------------|-----------------|------|--------------------|
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 200  | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction to Case    | $R_{\theta JC}$ | 83.3 | $^\circ\text{C/W}$ |

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.

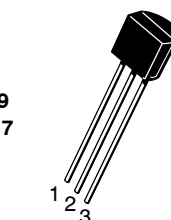


ON Semiconductor®

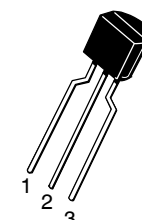
<http://onsemi.com>



TO-92  
CASE 29  
STYLE 17

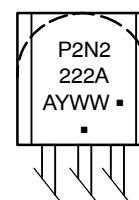


STRAIGHT LEAD  
BULK PACK



BENT LEAD  
TAPE & REEL  
AMMO PACK

#### MARKING DIAGRAM



A = Assembly Location

Y = Year

WW = Work Week

▪ = Pb-Free Package

(Note: Microdot may be in either location)

#### ORDERING INFORMATION

| Device       | Package            | Shipping†        |
|--------------|--------------------|------------------|
| P2N2222AG    | TO-92<br>(Pb-Free) | 5000 Units/Bulk  |
| P2N2222ARL1G | TO-92<br>(Pb-Free) | 2000/Tape & Ammo |

†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.

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

# P2N2222A

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

| Characteristic                                                                                                                               | Symbol        | Min    | Max        | Unit            |
|----------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------|------------|-----------------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                   |               |        |            |                 |
| Collector – Emitter Breakdown Voltage<br>( $I_C = 10\text{ mA}$ , $I_B = 0$ )                                                                | $V_{(BR)CEO}$ | 40     | –          | Vdc             |
| Collector – Base Breakdown Voltage<br>( $I_C = 10\text{ }\mu\text{A}$ , $I_E = 0$ )                                                          | $V_{(BR)CBO}$ | 75     | –          | Vdc             |
| Emitter – Base Breakdown Voltage<br>( $I_E = 10\text{ }\mu\text{A}$ , $I_C = 0$ )                                                            | $V_{(BR)EBO}$ | 6.0    | –          | Vdc             |
| Collector Cutoff Current<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{EB(off)} = 3.0\text{ Vdc}$ )                                                    | $I_{CEX}$     | –      | 10         | nAdc            |
| Collector Cutoff Current<br>( $V_{CB} = 60\text{ Vdc}$ , $I_E = 0$ )<br>( $V_{CB} = 60\text{ Vdc}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ ) | $I_{CBO}$     | –<br>– | 0.01<br>10 | $\mu\text{Adc}$ |
| Emitter Cutoff Current<br>( $V_{EB} = 3.0\text{ Vdc}$ , $I_C = 0$ )                                                                          | $I_{EBO}$     | –      | 10         | nAdc            |
| Collector Cutoff Current<br>( $V_{CE} = 10\text{ V}$ )                                                                                       | $I_{CEO}$     | –      | 10         | nAdc            |
| Base Cutoff Current<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{EB(off)} = 3.0\text{ Vdc}$ )                                                         | $I_{BEX}$     | –      | 20         | nAdc            |

## ON CHARACTERISTICS

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |               |                                         |                                   |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-----------------------------------|-----|
| DC Current Gain<br>( $I_C = 0.1\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $T_A = -55^\circ\text{C}$ )<br>( $I_C = 150\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) (Note 1)<br>( $I_C = 150\text{ mA}$ , $V_{CE} = 1.0\text{ Vdc}$ ) (Note 1)<br>( $I_C = 500\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ ) (Note 1) | $h_{FE}$      | 35<br>50<br>75<br>35<br>100<br>50<br>40 | –<br>–<br>–<br>–<br>300<br>–<br>– | –   |
| Collector – Emitter Saturation Voltage (Note 1)<br>( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ )<br>( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ )                                                                                                                                                                                                                                                                                                                       | $V_{CE(sat)}$ | –<br>–                                  | 0.3<br>1.0                        | Vdc |
| Base – Emitter Saturation Voltage (Note 1)<br>( $I_C = 150\text{ mA}$ , $I_B = 15\text{ mA}$ )<br>( $I_C = 500\text{ mA}$ , $I_B = 50\text{ mA}$ )                                                                                                                                                                                                                                                                                                                            | $V_{BE(sat)}$ | 0.6<br>–                                | 1.2<br>2.0                        | Vdc |

## SMALL-SIGNAL CHARACTERISTICS

|                                                                                                                                                                                        |           |             |             |                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------------|------------------|
| Current – Gain – Bandwidth Product (Note 2)<br>( $I_C = 20\text{ mA}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ )C                                                             | $f_T$     | 300         | –           | MHz              |
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )                                                                                                  | $C_{obo}$ | –           | 8.0         | pF               |
| Input Capacitance<br>( $V_{EB} = 0.5\text{ Vdc}$ , $I_C = 0$ , $f = 1.0\text{ MHz}$ )                                                                                                  | $C_{ibo}$ | –           | 25          | pF               |
| Input Impedance<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )           | $h_{ie}$  | 2.0<br>0.25 | 8.0<br>1.25 | k $\Omega$       |
| Voltage Feedback Ratio<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )    | $h_{re}$  | –<br>–      | 8.0<br>4.0  | $\times 10^{-4}$ |
| Small-Signal Current Gain<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) | $h_{fe}$  | 50<br>75    | 300<br>375  | –                |
| Output Admittance<br>( $I_C = 1.0\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mA}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )         | $h_{oe}$  | 5.0<br>25   | 35<br>200   | $\mu\text{Mhos}$ |
| Collector Base Time Constant<br>( $I_E = 20\text{ mA}$ , $V_{CB} = 20\text{ Vdc}$ , $f = 31.8\text{ MHz}$ )                                                                            | $r_b'C_c$ | –           | 150         | ps               |
| Noise Figure<br>( $I_C = 100\text{ }\mu\text{A}$ , $V_{CE} = 10\text{ Vdc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )                                                      | $N_F$     | –           | 4.0         | dB               |

1. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .
2.  $f_T$  is defined as the frequency at which  $|h_{fe}|$  extrapolates to unity.

# P2N2222A

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

| Characteristic                   | Symbol | Min | Max | Unit |
|----------------------------------|--------|-----|-----|------|
| <b>SWITCHING CHARACTERISTICS</b> |        |     |     |      |
| Delay Time                       | $t_d$  | —   | 10  | ns   |
| Rise Time                        | $t_r$  | —   | 25  | ns   |
| Storage Time                     | $t_s$  | —   | 225 | ns   |
| Fall Time                        | $t_f$  | —   | 60  | ns   |

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

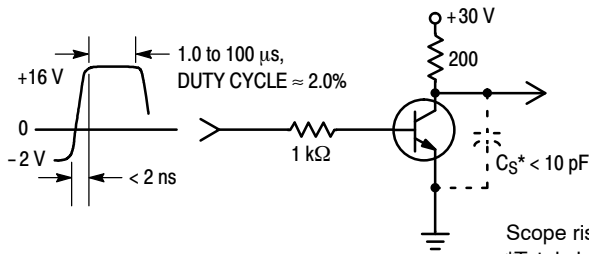


Figure 1. Turn-On Time

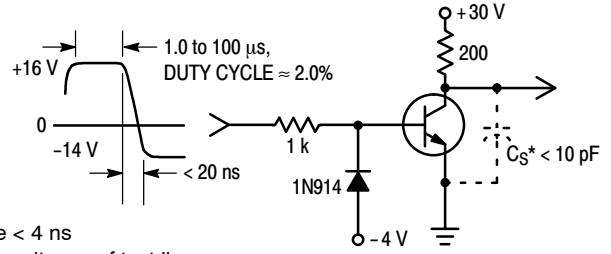


Figure 2. Turn-Off Time

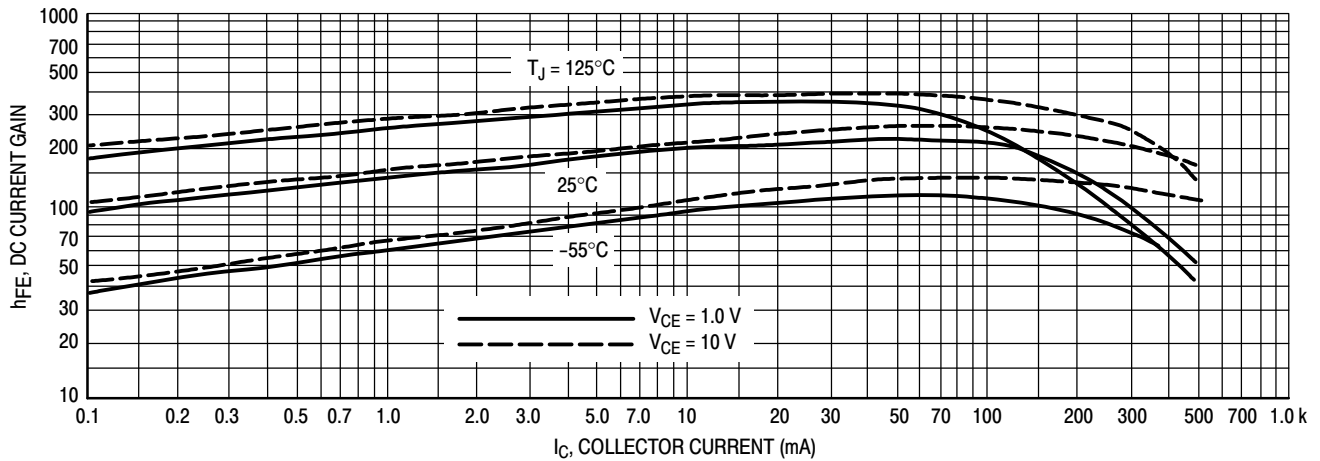
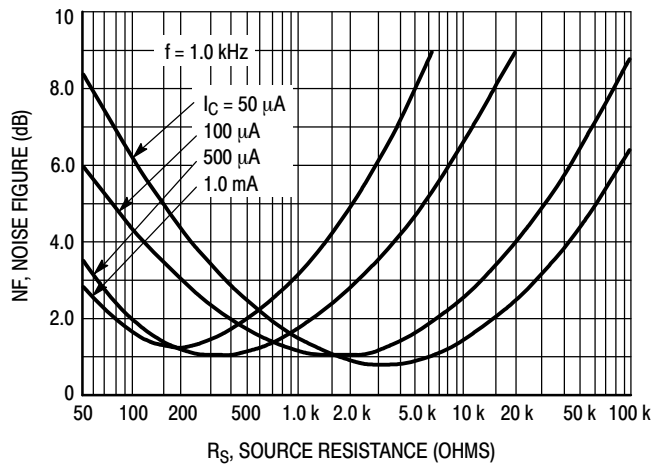
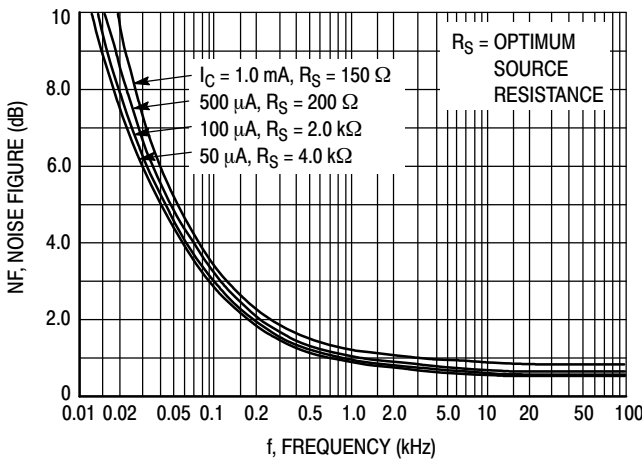
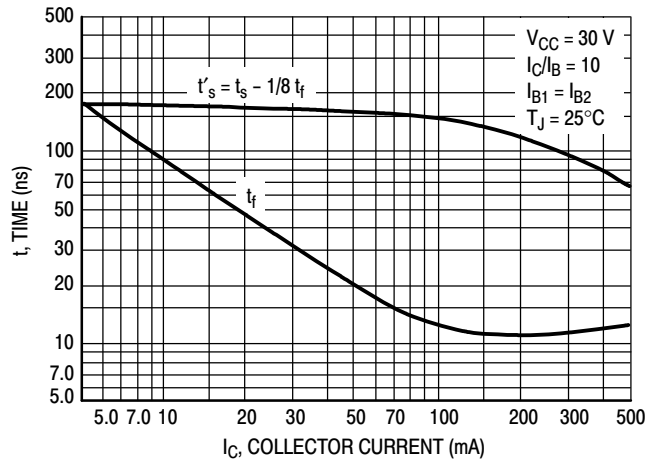
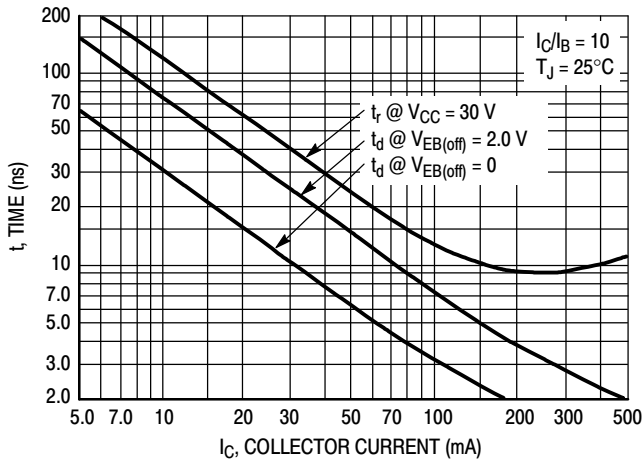
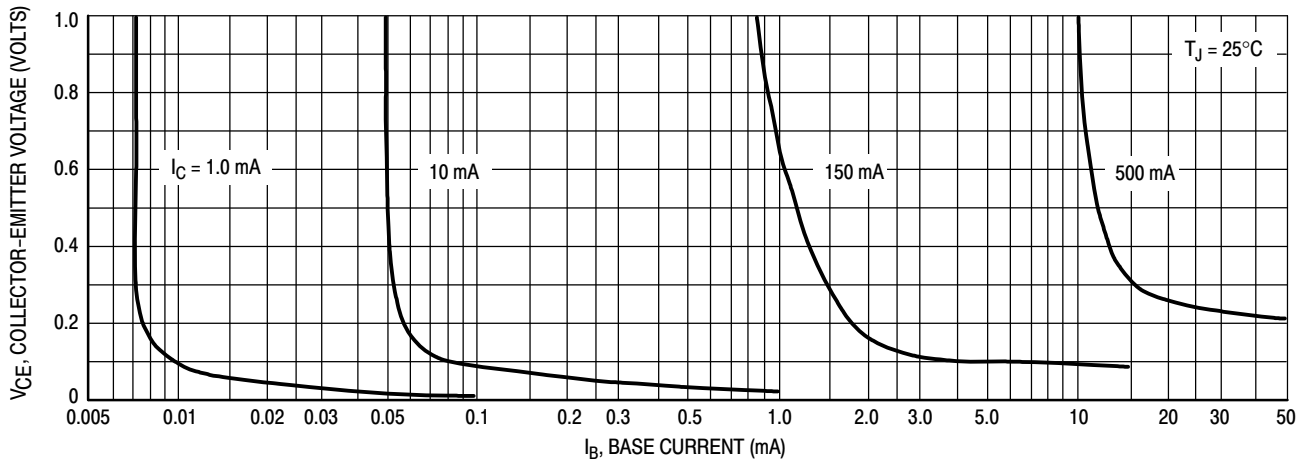


Figure 3. DC Current Gain

# P2N2222A



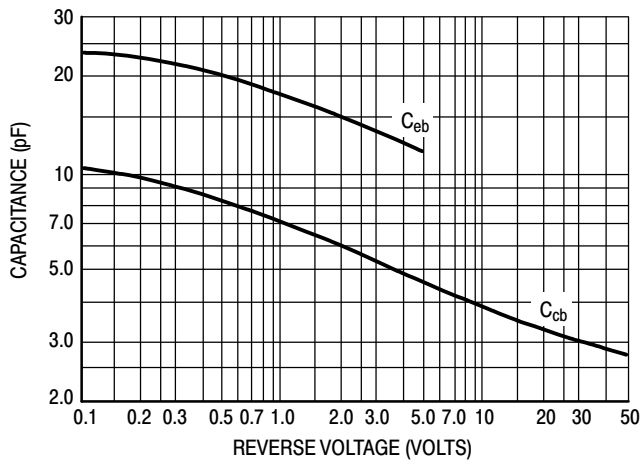


Figure 9. Capacitances

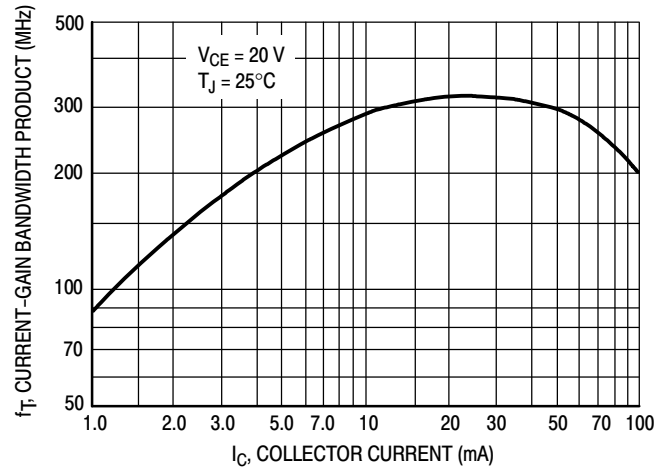


Figure 10. Current-Gain Bandwidth Product

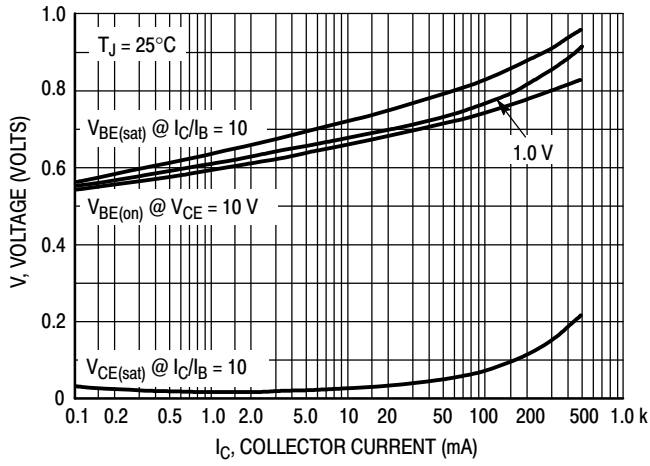


Figure 11. "On" Voltages

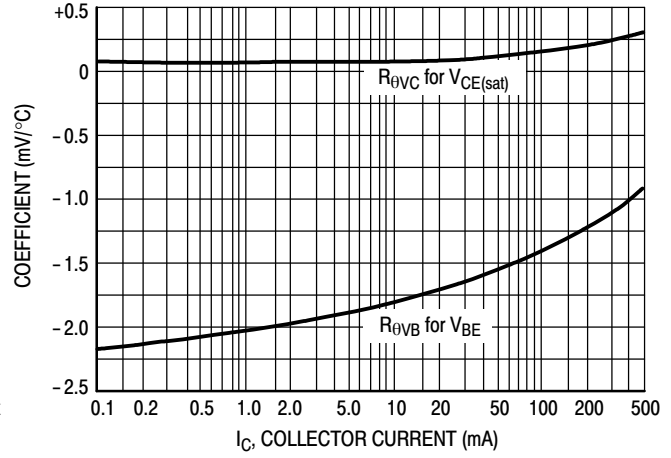
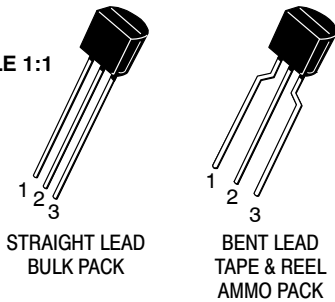


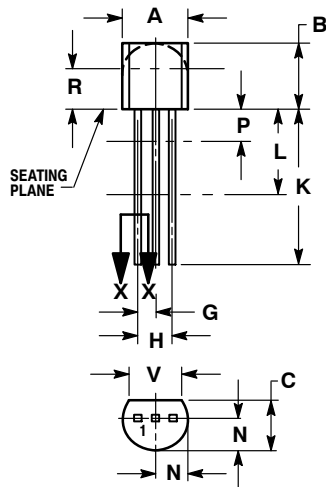
Figure 12. Temperature Coefficients

SCALE 1:1

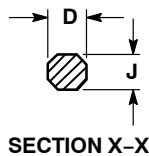


TO-92 (TO-226)  
CASE 29-11  
ISSUE AM

DATE 09 MAR 2007



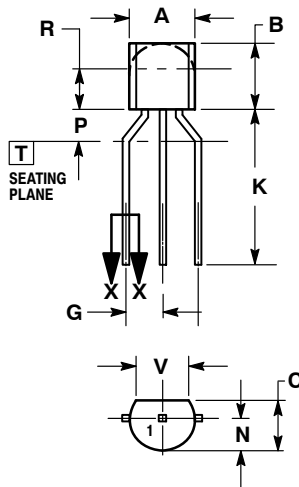
STRAIGHT LEAD  
BULK PACK



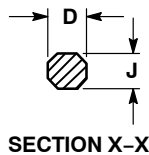
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.175  | 0.205 | 4.45        | 5.20  |
| B   | 0.170  | 0.210 | 4.32        | 5.33  |
| C   | 0.125  | 0.165 | 3.18        | 4.19  |
| D   | 0.016  | 0.021 | 0.407       | 0.533 |
| G   | 0.045  | 0.055 | 1.15        | 1.39  |
| H   | 0.095  | 0.105 | 2.42        | 2.66  |
| J   | 0.015  | 0.020 | 0.39        | 0.50  |
| K   | 0.500  | ---   | 12.70       | ---   |
| L   | 0.250  | ---   | 6.35        | ---   |
| N   | 0.080  | 0.105 | 2.04        | 2.66  |
| P   | ---    | 0.100 | ---         | 2.54  |
| R   | 0.115  | ---   | 2.93        | ---   |
| V   | 0.135  | ---   | 3.43        | ---   |



BENT LEAD  
TAPE & REEL  
AMMO PACK



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 4.45        | 5.20 |
| B   | 4.32        | 5.33 |
| C   | 3.18        | 4.19 |
| D   | 0.40        | 0.54 |
| G   | 2.40        | 2.80 |
| J   | 0.39        | 0.50 |
| K   | 12.70       | ---  |
| N   | 2.04        | 2.66 |
| P   | 1.50        | 4.00 |
| R   | 2.93        | ---  |
| V   | 3.43        | ---  |

STYLES ON PAGE 2

|                  |                |                                                                                                                                                                                     |
|------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOCUMENT NUMBER: | 98ASB42022B    | 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:     | TO-92 (TO-226) | PAGE 1 OF 2                                                                                                                                                                         |

onsemi and onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

**TO-92 (TO-226)**  
**CASE 29-11**  
**ISSUE AM**

DATE 09 MAR 2007

|                                                                      |                                                                             |                                                                     |                                                                        |                                                                    |
|----------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------|
| <b>STYLE 1:</b><br>PIN 1. EMITTER<br>2. BASE<br>3. COLLECTOR         | <b>STYLE 2:</b><br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR                | <b>STYLE 3:</b><br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE           | <b>STYLE 4:</b><br>PIN 1. CATHODE<br>2. CATHODE<br>3. ANODE            | <b>STYLE 5:</b><br>PIN 1. DRAIN<br>2. SOURCE<br>3. GATE            |
| <b>STYLE 6:</b><br>PIN 1. GATE<br>2. SOURCE & SUBSTRATE<br>3. DRAIN  | <b>STYLE 7:</b><br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE                     | <b>STYLE 8:</b><br>PIN 1. DRAIN<br>2. GATE<br>3. SOURCE & SUBSTRATE | <b>STYLE 9:</b><br>PIN 1. BASE 1<br>2. EMITTER<br>3. BASE 2            | <b>STYLE 10:</b><br>PIN 1. CATHODE<br>2. GATE<br>3. ANODE          |
| <b>STYLE 11:</b><br>PIN 1. ANODE<br>2. CATHODE & ANODE<br>3. CATHODE | <b>STYLE 12:</b><br>PIN 1. MAIN TERMINAL 1<br>2. GATE<br>3. MAIN TERMINAL 2 | <b>STYLE 13:</b><br>PIN 1. ANODE 1<br>2. GATE<br>3. CATHODE 2       | <b>STYLE 14:</b><br>PIN 1. EMITTER<br>2. COLLECTOR<br>3. BASE          | <b>STYLE 15:</b><br>PIN 1. ANODE 1<br>2. CATHODE<br>3. ANODE 2     |
| <b>STYLE 16:</b><br>PIN 1. ANODE<br>2. GATE<br>3. CATHODE            | <b>STYLE 17:</b><br>PIN 1. COLLECTOR<br>2. BASE<br>3. EMITTER               | <b>STYLE 18:</b><br>PIN 1. ANODE<br>2. CATHODE<br>3. NOT CONNECTED  | <b>STYLE 19:</b><br>PIN 1. GATE<br>2. ANODE<br>3. CATHODE              | <b>STYLE 20:</b><br>PIN 1. NOT CONNECTED<br>2. CATHODE<br>3. ANODE |
| <b>STYLE 21:</b><br>PIN 1. COLLECTOR<br>2. EMITTER<br>3. BASE        | <b>STYLE 22:</b><br>PIN 1. SOURCE<br>2. GATE<br>3. DRAIN                    | <b>STYLE 23:</b><br>PIN 1. GATE<br>2. SOURCE<br>3. DRAIN            | <b>STYLE 24:</b><br>PIN 1. EMITTER<br>2. COLLECTOR/ANODE<br>3. CATHODE | <b>STYLE 25:</b><br>PIN 1. MT 1<br>2. GATE<br>3. MT 2              |
| <b>STYLE 26:</b><br>PIN 1. $V_{CC}$<br>2. GROUND 2<br>3. OUTPUT      | <b>STYLE 27:</b><br>PIN 1. MT<br>2. SUBSTRATE<br>3. MT                      | <b>STYLE 28:</b><br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE           | <b>STYLE 29:</b><br>PIN 1. NOT CONNECTED<br>2. ANODE<br>3. CATHODE     | <b>STYLE 30:</b><br>PIN 1. DRAIN<br>2. GATE<br>3. SOURCE           |
| <b>STYLE 31:</b><br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE             | <b>STYLE 32:</b><br>PIN 1. BASE<br>2. COLLECTOR<br>3. EMITTER               | <b>STYLE 33:</b><br>PIN 1. RETURN<br>2. INPUT<br>3. OUTPUT          | <b>STYLE 34:</b><br>PIN 1. INPUT<br>2. GROUND<br>3. LOGIC              | <b>STYLE 35:</b><br>PIN 1. GATE<br>2. COLLECTOR<br>3. EMITTER      |

|                         |                       |                                                                                                                                                                                     |
|-------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NUMBER:</b> | <b>98ASB42022B</b>    | Electronic versions are uncontrolled except when accessed directly from the Document Repository.<br>Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| <b>DESCRIPTION:</b>     | <b>TO-92 (TO-226)</b> | <b>PAGE 2 OF 2</b>                                                                                                                                                                  |

**onsemi** and **onsemi** are trademarks of Semiconductor Components Industries, LLC dba **onsemi** or its subsidiaries in the United States and/or other countries. **onsemi** reserves the right to make changes without further notice to any products herein. **onsemi** makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. **onsemi** does not convey any license under its patent rights nor the rights of others.

**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

### ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at  
[www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)