

# PN2222, PN2222A

## General Purpose Transistors

### NPN Silicon

#### Features

- Pb-Free Packages are Available\*

#### MAXIMUM RATINGS

| Rating  | Symbol         | Value       | Unit                       |
|---|----------------|-------------|----------------------------|
| Collector-Emitter Voltage<br>PN2222<br>PN2222A  | $V_{CEO}$      | 30<br>40    | Vdc                        |
| Collector-Base Voltage<br>PN2222<br>PN2222A   | $V_{CBO}$      | 60<br>75    | Vdc                        |
| Emitter-Base Voltage<br>PN2222<br>PN2222A   | $V_{EBO}$      | 5.0<br>6.0  | Vdc                        |
| Collector Current - Continuous  | $I_C$          | 600         | mAdc                       |
| Total Device Dissipation<br>@ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 625<br>5.0  | mW<br>mW/ $^\circ\text{C}$ |
| Total Device Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 1.5<br>12   | W<br>mW/ $^\circ\text{C}$  |
| Operating and Storage Junction Temperature Range  | $T_J, T_{stg}$ | -55 to +150 | $^\circ\text{C}$           |

#### THERMAL CHARACTERISTICS

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

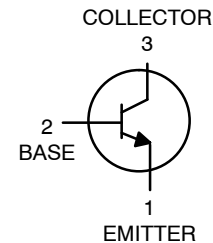
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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

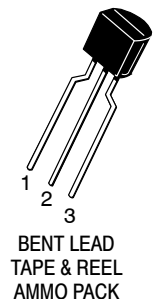
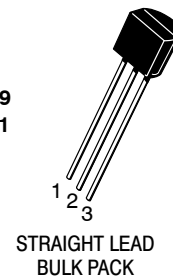


ON Semiconductor®

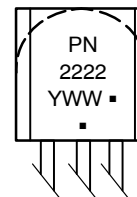
<http://onsemi.com>



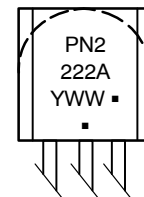
TO-92  
CASE 29  
STYLE 1



#### MARKING DIAGRAM



PN2222



PN2222A

Y = Year  
WW = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

# PN2222, PN2222A

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

| Characteristic   |  | Symbol               | Min              | Max                      | Unit             |
|--|--|----------------------|------------------|--------------------------|------------------|
| <b>OFF CHARACTERISTICS</b>   |  |                      |                  |                          |                  |
| Collector - Emitter Breakdown Voltage<br>(I <sub>C</sub> = 10 mA <sub>dc</sub> , I <sub>B</sub> = 0)   | PN2222<br>PN2222A                      | V <sub>(BR)CEO</sub> | 30<br>40         | -<br>-                   | V <sub>dc</sub>  |
| Collector - Base Breakdown Voltage<br>(I <sub>C</sub> = 10 μA <sub>dc</sub> , I <sub>E</sub> = 0)  | PN2222<br>PN2222A                      | V <sub>(BR)CBO</sub> | 60<br>75         | -<br>-                   | V <sub>dc</sub>  |
| Emitter - Base Breakdown Voltage<br>(I <sub>E</sub> = 10 μA <sub>dc</sub> , I <sub>C</sub> = 0)  | PN2222<br>PN2222A                      | V <sub>(BR)EBO</sub> | 5.0<br>6.0       | -<br>-                   | V <sub>dc</sub>  |
| Collector Cutoff Current<br>(V <sub>CE</sub> = 60 V <sub>dc</sub> , V <sub>EB(off)</sub> = 3.0 V <sub>dc</sub> )   | PN2222A                                | I <sub>CEX</sub>     | -                | 10                       | nA <sub>dc</sub> |
| Collector Cutoff Current<br>(V <sub>CB</sub> = 50 V <sub>dc</sub> , I <sub>E</sub> = 0)<br>(V <sub>CB</sub> = 60 V <sub>dc</sub> , I <sub>E</sub> = 0)<br>(V <sub>CB</sub> = 50 V <sub>dc</sub> , I <sub>E</sub> = 0, T <sub>A</sub> = 125°C)<br>(V <sub>CB</sub> = 50 V <sub>dc</sub> , I <sub>E</sub> = 0, T <sub>A</sub> = 125°C) | PN2222<br>PN2222A<br>PN2222<br>PN2222A | I <sub>CBO</sub>     | -<br>-<br>-<br>- | 0.01<br>0.01<br>10<br>10 | μA <sub>dc</sub> |
| Emitter Cutoff Current<br>(V <sub>EB</sub> = 3.0 V <sub>dc</sub> , I <sub>C</sub> = 0)   | PN2222A                                | I <sub>EBO</sub>     | -                | 100                      | nA <sub>dc</sub> |
| Base Cutoff Current<br>(V <sub>CE</sub> = 60 V <sub>dc</sub> , V <sub>EB(off)</sub> = 3.0 V <sub>dc</sub> )  | PN2222A                                | I <sub>BL</sub>      | -                | 20                       | nA <sub>dc</sub> |

## ON CHARACTERISTICS

|  |   |                      |   |  |                 |
|--|---|----------------------|---|--|-----------------|
| DC Current Gain<br>(I <sub>C</sub> = 0.1 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )<br>(I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )<br>(I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> )<br>(I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , T <sub>A</sub> = -55°C)<br>(I <sub>C</sub> = 150 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (Note 1)<br>(I <sub>C</sub> = 150 mA <sub>dc</sub> , V <sub>CE</sub> = 1.0 V <sub>dc</sub> ) (Note 1)<br>(I <sub>C</sub> = 500 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> ) (Note 1) | PN2222A only<br><br><br><br><br>PN2222<br>PN2222A | h <sub>FE</sub>      | 35<br>50<br>75<br>35<br>100<br>50<br>30<br>40 | -<br>-<br>-<br>-<br>300<br>-<br>-<br>- | -               |
| Collector - Emitter Saturation Voltage (Note 1)<br>(I <sub>C</sub> = 150 mA <sub>dc</sub> , I <sub>B</sub> = 15 mA <sub>dc</sub> )<br><br>(I <sub>C</sub> = 500 mA <sub>dc</sub> , I <sub>B</sub> = 50 mA <sub>dc</sub> )  | PN2222<br>PN2222A<br>PN2222<br>PN2222A            | V <sub>CE(sat)</sub> | -<br>-<br>-<br>-                              | 0.4<br>0.3<br>1.6<br>1.0               | V <sub>dc</sub> |
| Base - Emitter Saturation Voltage (Note 1)<br>(I <sub>C</sub> = 150 mA <sub>dc</sub> , I <sub>B</sub> = 15 mA <sub>dc</sub> )<br><br>(I <sub>C</sub> = 500 mA <sub>dc</sub> , I <sub>B</sub> = 50 mA <sub>dc</sub> )   | PN2222<br>PN2222A<br>PN2222<br>PN2222A            | V <sub>BE(sat)</sub> | -<br>0.6<br>-<br>-                            | 1.3<br>1.2<br>2.6<br>2.0               | V <sub>dc</sub> |

## SMALL-SIGNAL CHARACTERISTICS

|  |                    |                  |             |             |                    |
|--|--------------------|------------------|-------------|-------------|--------------------|
| Current - Gain - Bandwidth Product (Note 2)<br>(I <sub>C</sub> = 20 mA <sub>dc</sub> , V <sub>CE</sub> = 20 V <sub>dc</sub> , f = 100 MHz)   | PN2222<br>PN2222A  | f <sub>T</sub>   | 250<br>300  | -<br>-      | MHz                |
| Output Capacitance<br>(V <sub>CB</sub> = 10 V <sub>dc</sub> , I <sub>E</sub> = 0, f = 1.0 MHz)   |                    | C <sub>obo</sub> | -           | 8.0         | pF                 |
| Input Capacitance<br>(V <sub>EB</sub> = 0.5 V <sub>dc</sub> , I <sub>C</sub> = 0, f = 1.0 MHz)   | PN2222<br>PN2222A  | C <sub>ibo</sub> | -<br>-      | 30<br>25    | pF                 |
| Input Impedance<br>(I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)<br>(I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)           | PN2222A<br>PN2222A | h <sub>ie</sub>  | 2.0<br>0.25 | 8.0<br>1.25 | kΩ                 |
| Voltage Feedback Ratio<br>(I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)<br>(I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)    | PN2222A<br>PN2222A | h <sub>re</sub>  | -<br>-      | 8.0<br>4.0  | X 10 <sup>-4</sup> |
| Small-Signal Current Gain<br>(I <sub>C</sub> = 1.0 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz)<br>(I <sub>C</sub> = 10 mA <sub>dc</sub> , V <sub>CE</sub> = 10 V <sub>dc</sub> , f = 1.0 kHz) | PN2222A<br>PN2222A | h <sub>fe</sub>  | 50<br>75    | 300<br>375  | -                  |

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. f<sub>T</sub> is defined as the frequency at which |h<sub>fe</sub>| extrapolates to unity.

# PN2222, PN2222A

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

| Characteristic   | Symbol   | Min       | Max       | Unit             |
|--|----------|-----------|-----------|------------------|
| <b>SMALL-SIGNAL CHARACTERISTICS</b>  |          |           |           |                  |
| Output Admittance<br>( $I_C = 1.0\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) | $h_{oe}$ | 5.0<br>25 | 35<br>200 | $\mu\text{Mhos}$ |
| Collector Base Time Constant<br>( $I_E = 20\text{ mAdc}$ , $V_{CB} = 20\text{ Vdc}$ , $f = 31.8\text{ MHz}$ )  | $rb'C_c$ | –         | 150       | ps               |
| Noise Figure<br>( $I_C = 100\text{ }\mu\text{Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )  | NF       | –         | 4.0       | dB               |

## SWITCHING CHARACTERISTICS (PN2222A only)

|              |   |       |   |     |    |
|--------------|---|-------|---|-----|----|
| Delay Time   | ( $V_{CC} = 30\text{ Vdc}$ , $V_{BE(\text{off})} = -0.5\text{ Vdc}$ ,<br>$I_C = 150\text{ mAdc}$ , $I_{B1} = 15\text{ mAdc}$ ) (Figure 1) | $t_d$ | – | 10  | ns |
| Rise Time    |   | $t_r$ | – | 25  | ns |
| Storage Time | ( $V_{CC} = 30\text{ Vdc}$ , $I_C = 150\text{ mAdc}$ ,<br>$I_{B1} = I_{B2} = 15\text{ mAdc}$ ) (Figure 2)                                 | $t_s$ | – | 225 | ns |
| Fall Time    |   | $t_f$ | – | 60  | ns |

## ORDERING INFORMATION

| Device       | Package            | Shipping <sup>†</sup>  |
|--------------|--------------------|------------------------|
| PN2222G      | TO-92<br>(Pb-Free) | 5000 Units / Bulk      |
| PN2222AG     | TO-92<br>(Pb-Free) | 5000 Units / Bulk      |
| PN2222ARLRA  | TO-92              | 2000 / Tape & Reel     |
| PN2222ARLRAG | TO-92<br>(Pb-Free) | 2000 / Tape & Reel     |
| PN2222ARLRM  | TO-92              | 2000 / Tape & Ammo Box |
| PN2222ARLRMG | TO-92<br>(Pb-Free) | 2000 / Tape & Ammo Box |
| PN2222ARLRPG | TO-92<br>(Pb-Free) | 2000 / Tape & Ammo Box |

<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.

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

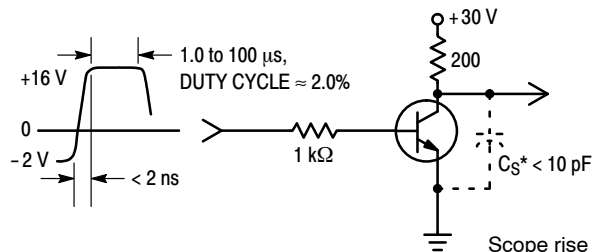


Figure 1. Turn-On Time

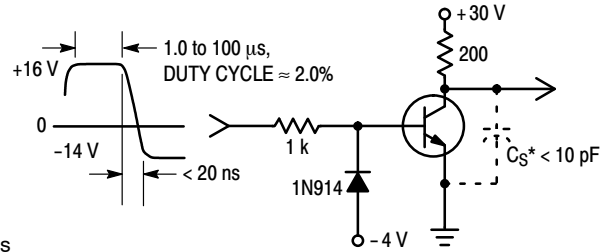


Figure 2. Turn-Off Time

# PN2222, PN2222A

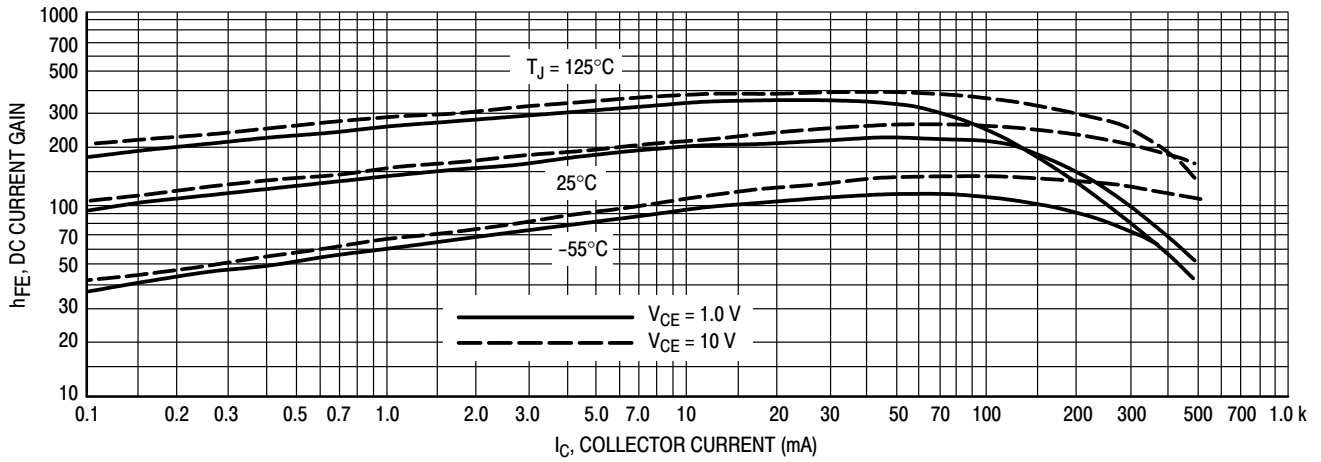


Figure 3. DC Current Gain

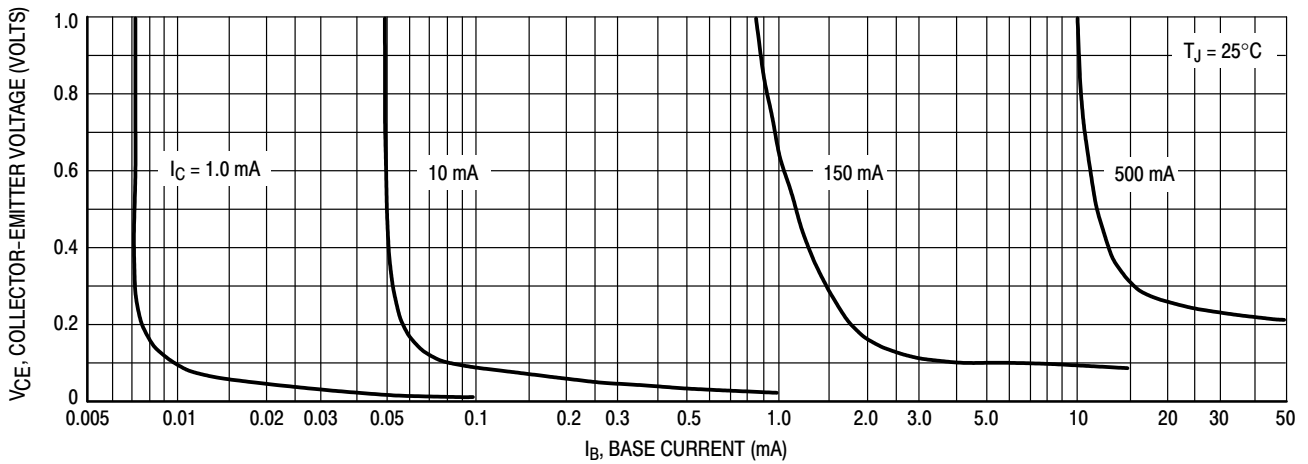


Figure 4. Collector Saturation Region

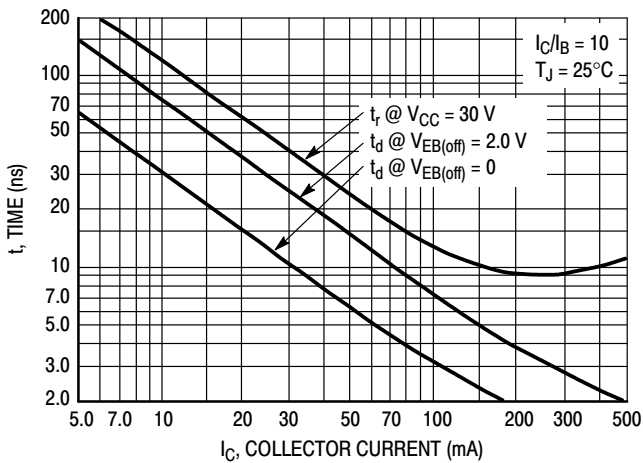


Figure 5. Turn-On Time

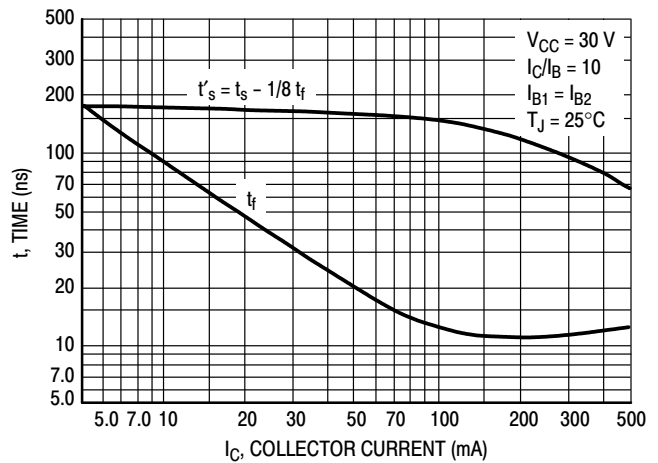


Figure 6. Turn-Off Time

# PN2222, PN2222A

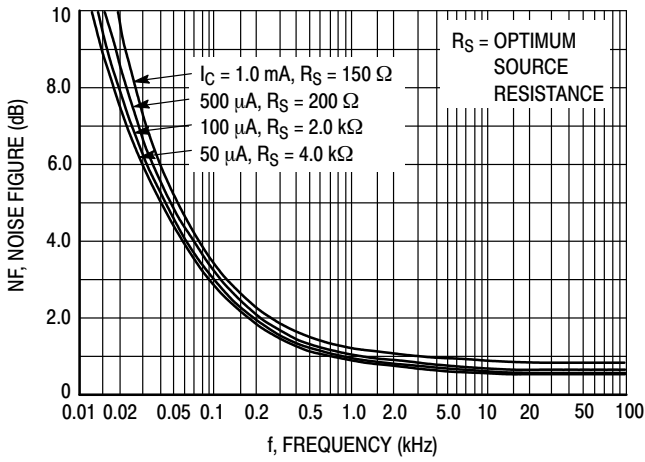


Figure 7. Frequency Effects

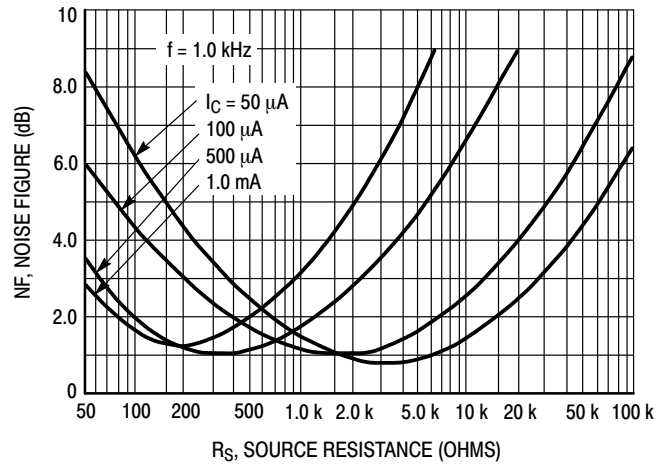


Figure 8. Source Resistance Effects

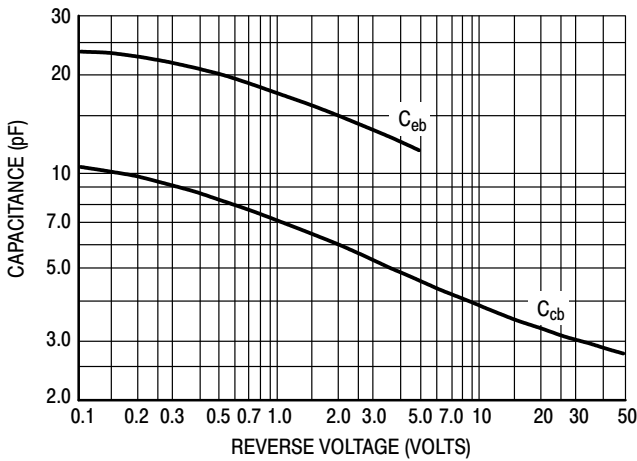


Figure 9. Capacitances

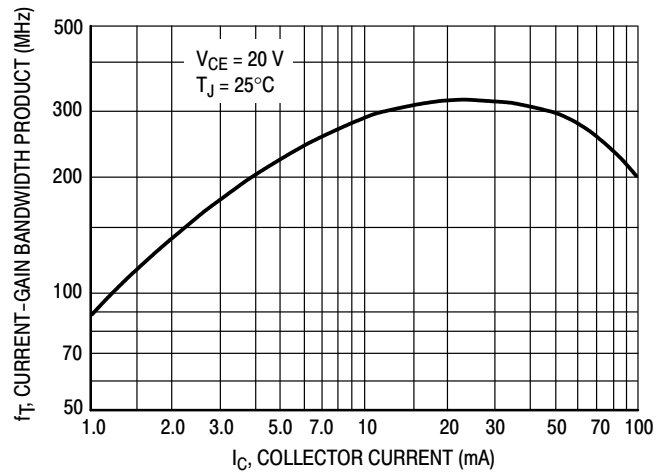


Figure 10. Current-Gain Bandwidth Product

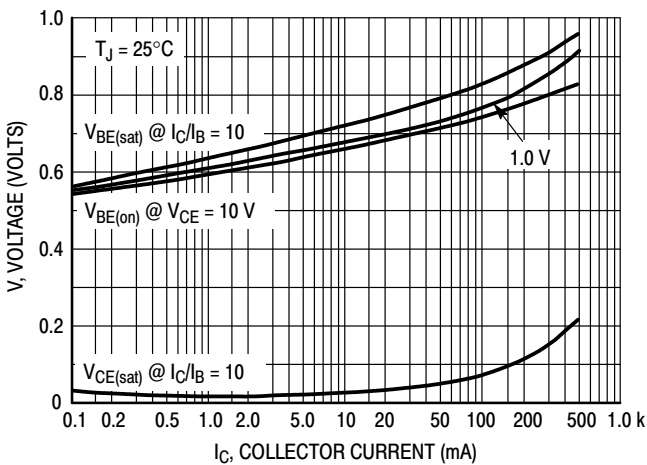


Figure 11. "On" Voltages

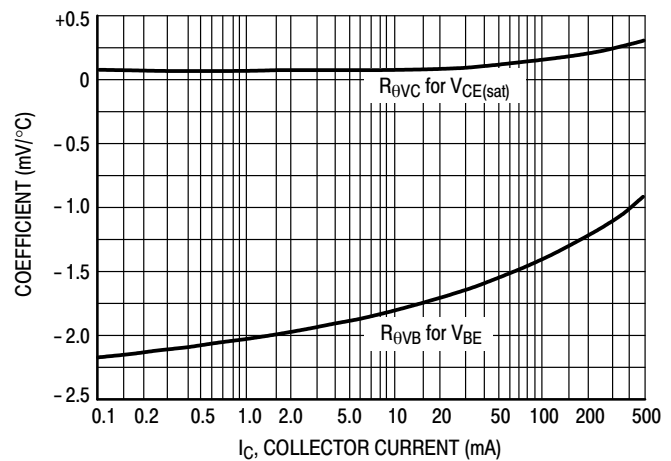
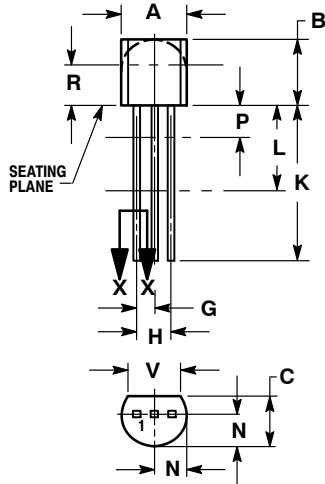


Figure 12. Temperature Coefficients

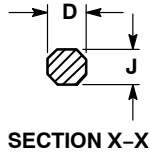
# PN2222, PN2222A

## PACKAGE DIMENSIONS

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



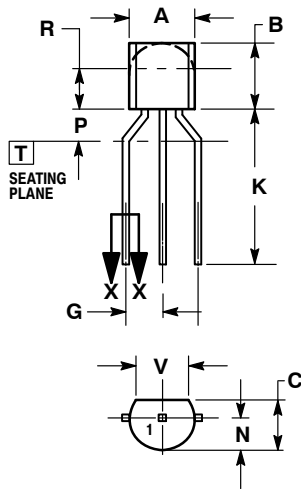
STRAIGHT LEAD  
BULK PACK



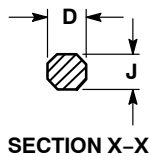
NOTES:

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        | ---  |

STYLE 1:

1. PIN 1. EMITTER
2. BASE
3. COLLECTOR

ON Semiconductor and are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC 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. "Typical" parameters which may be provided in SCILLC 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. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC 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 SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

### PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT:**  
Literature Distribution Center for ON Semiconductor  
P.O. Box 5163, Denver, Colorado 80217 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** orderlit@onsemi.com

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
Phone: 81-3-5773-3850

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
For additional information, please contact your local Sales Representative

PN2222/D