

# P2N2222A

## Amplifier Transistors

### NPN Silicon

#### Features

- Pb-Free Packages are Available\*

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

| Characteristic   | Symbol         | Value          | Unit                       |
|--|----------------|----------------|----------------------------|
| Collector – Emitter Voltage  | $V_{CE0}$      | 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

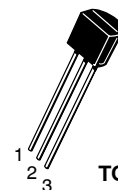
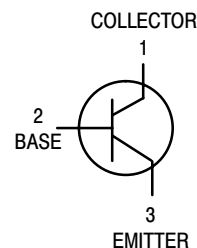
| Characteristic                          | Symbol          | Max  | Unit               |
|---|-----------------|------|--------------------|
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 200  | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction to Case    | $R_{\theta JC}$ | 83.3 |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

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.



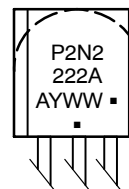
ON Semiconductor®

<http://onsemi.com>



TO-92  
(T0-226AA)  
CASE 29-11  
STYLE 17

#### MARKING DIAGRAM



P2N2 = Device Code  
222A = Specific Device  
A = Assembly Location  
Y = Year  
WW = Work Week  
■ = Pb-Free Package

(Note: Microdot may be in either location)

#### ORDERING INFORMATION

| Device       | Package            | Shipping†          |
|--------------|--------------------|--------------------|
| P2N2222A     | TO-92              | 5000 Units / Bulk  |
| P2N2222AG    | TO-92<br>(Pb-Free) | 5000 Units / Bulk  |
| P2N2222ARL1  | TO-92              | 2000 / Tape & Ammo |
| P2N2222ARL1G | TO-92<br>(Pb-Free) | 2000 / Tape & Ammo |
| P2N2222AZL1  | TO-92              | 2000 / Tape & Reel |
| P2N2222AZL1G | TO-92<br>(Pb-Free) | 2000 Units / Tube  |

†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.

**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>( $I_C = 10\text{ mAdc}$ , $I_B = 0$ )  | $V_{(BR)CEO}$ | 40     | –          | Vdc             |
| Collector – Base Breakdown Voltage<br>( $I_C = 10\text{ }\mu\text{Adc}$ , $I_E = 0$ )  | $V_{(BR)CBO}$ | 75     | –          | Vdc             |
| Emitter – Base Breakdown Voltage<br>( $I_E = 10\text{ }\mu\text{Adc}$ , $I_C = 0$ )  | $V_{(BR)EBO}$ | 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>( $I_C = 0.1\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 1.0\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $T_A = -55^\circ\text{C}$ )<br>( $I_C = 150\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ ) (Note 1)<br>( $I_C = 150\text{ mAdc}$ , $V_{CE} = 1.0\text{ Vdc}$ ) (Note 1)<br>( $I_C = 500\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ ) (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>( $I_C = 150\text{ mAdc}$ , $I_B = 15\text{ mAdc}$ )<br>( $I_C = 500\text{ mAdc}$ , $I_B = 50\text{ mAdc}$ )   | $V_{CE(sat)}$ | –<br>–                                  | 0.3<br>1.0                        | Vdc |
| Base – Emitter Saturation Voltage (Note 1)<br>( $I_C = 150\text{ mAdc}$ , $I_B = 15\text{ mAdc}$ )<br>( $I_C = 500\text{ mAdc}$ , $I_B = 50\text{ mAdc}$ )  | $V_{BE(sat)}$ | 0.6<br>–                                | 1.2<br>2.0                        | Vdc |

**SMALL-SIGNAL CHARACTERISTICS**

|  |           |             |             |                  |
|--|-----------|-------------|-------------|------------------|
| Current – Gain – Bandwidth Product (Note 2)<br>( $I_C = 20\text{ mAdc}$ , $V_{CE} = 20\text{ Vdc}$ , $f = 100\text{ MHz}$ )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>( $I_C = 1.0\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )           | $h_{ie}$  | 2.0<br>0.25 | 8.0<br>1.25 | k $\Omega$       |
| Voltage Feedback Ratio<br>( $I_C = 1.0\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )    | $h_{re}$  | –<br>–      | 8.0<br>4.0  | $\times 10^{-4}$ |
| Small-Signal Current Gain<br>( $I_C = 1.0\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )<br>( $I_C = 10\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ ) | $h_{fe}$  | 50<br>75    | 300<br>375  | –                |
| 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>( $I_C = 100\text{ }\mu\text{Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $R_S = 1.0\text{ k}\Omega$ , $f = 1.0\text{ kHz}$ )  | $N_F$     | –           | 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 |
|----------------|--------|-----|-----|------|
|----------------|--------|-----|-----|------|

### SWITCHING CHARACTERISTICS

|              |  |       |   |     |    |
|--------------|--|-------|---|-----|----|
| Delay Time   | $(V_{CC} = 30\text{ Vdc}, V_{BE(\text{off})} = -2.0\text{ Vdc},$ | $t_d$ | — | 10  | ns |
| Rise Time    | $I_C = 150\text{ mA}, I_{B1} = 15\text{ mA}$ ) (Figure 1)        | $t_r$ | — | 25  | ns |
| Storage Time | $(V_{CC} = 30\text{ Vdc}, I_C = 150\text{ mA},$                  | $t_s$ | — | 225 | ns |
| Fall Time    | $I_{B1} = I_{B2} = 15\text{ mA}$ ) (Figure 2)                    | $t_f$ | — | 60  | ns |

### SWITCHING TIME EQUIVALENT TEST CIRCUITS

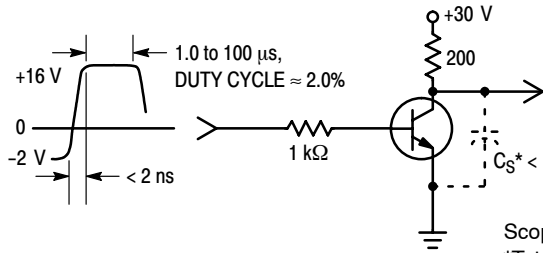


Figure 1. Turn-On Time

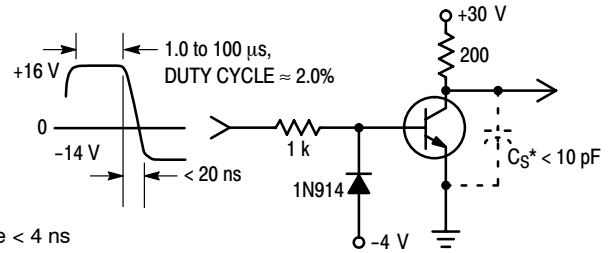


Figure 2. Turn-Off Time

Scope rise time < 4 ns  
\*Total shunt capacitance of test jig, connectors, and oscilloscope.

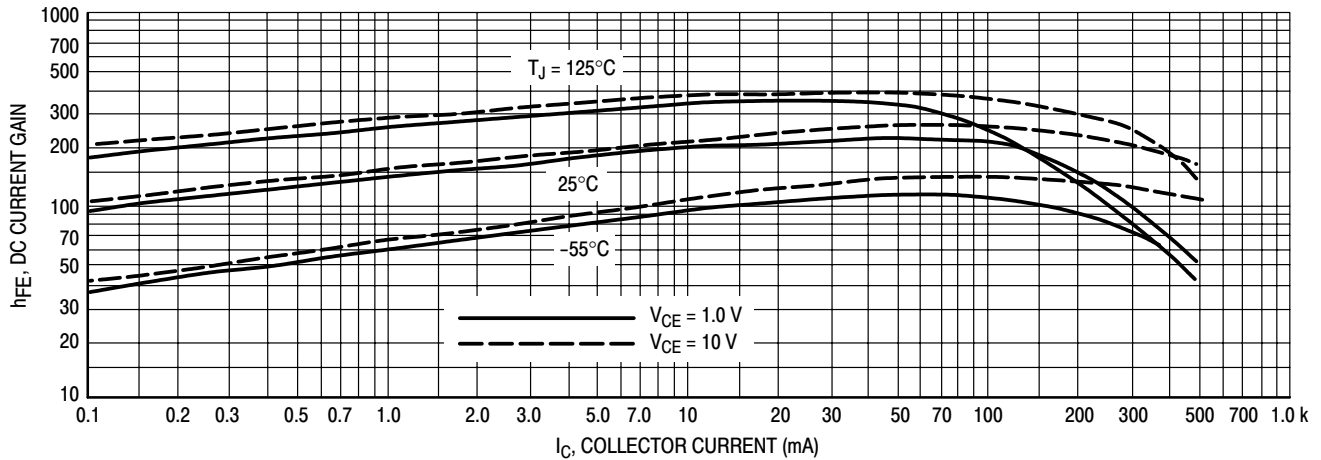


Figure 4. DC Current Gain

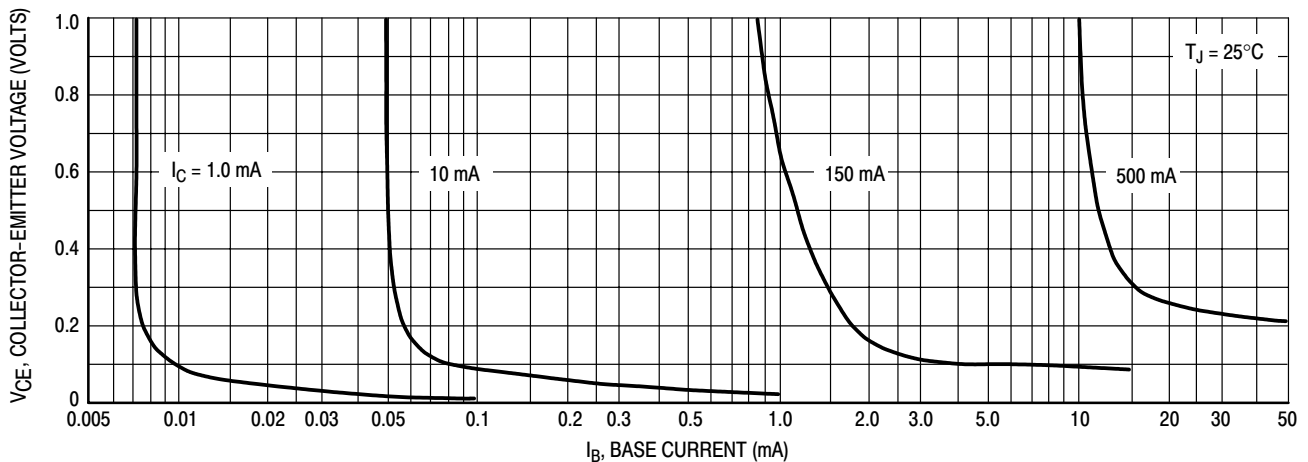


Figure 3. Collector Saturation Region

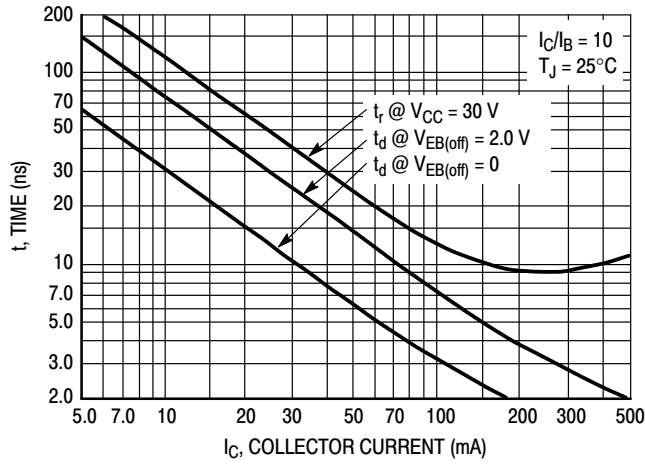


Figure 5. Turn-On Time

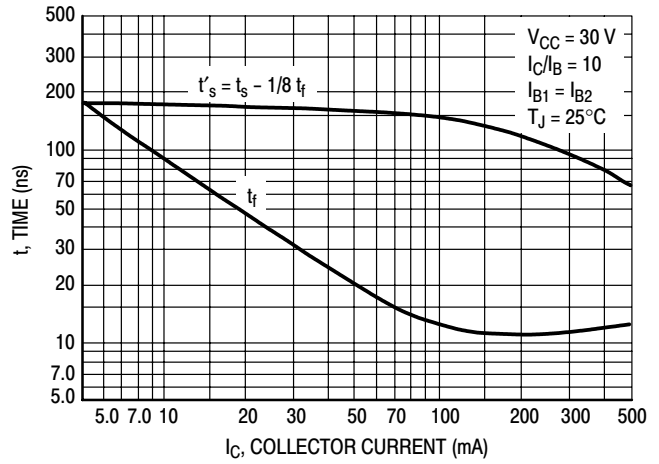


Figure 6. Turn-Off Time

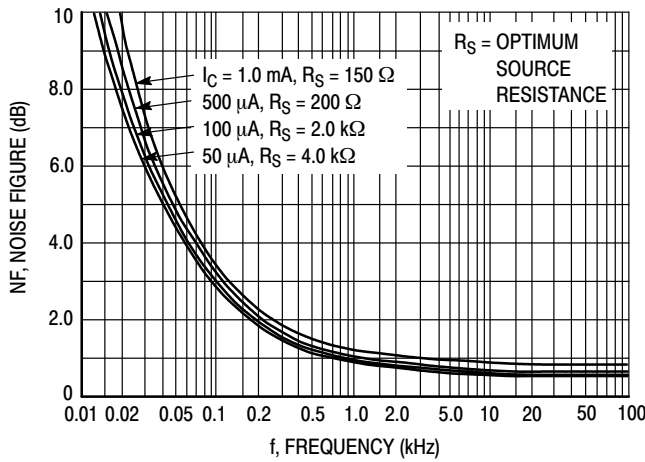


Figure 7. Frequency Effects

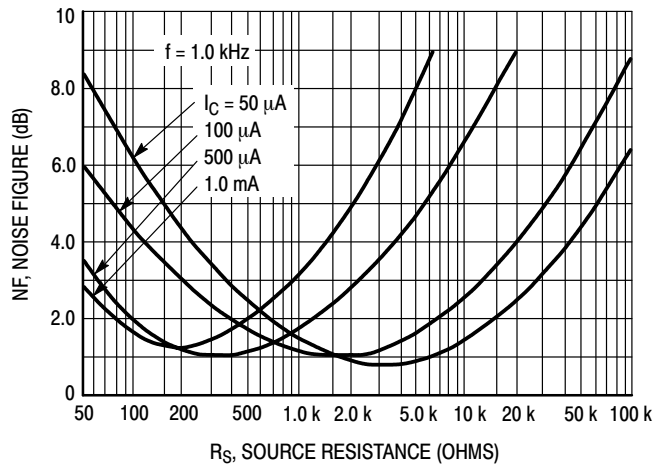


Figure 8. Source Resistance Effects

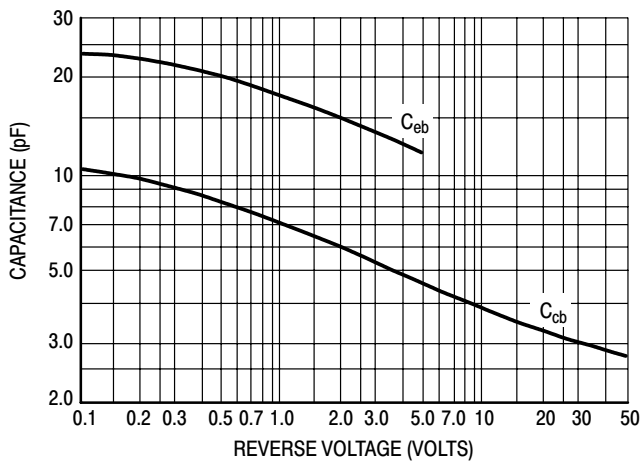


Figure 9. Capacitances

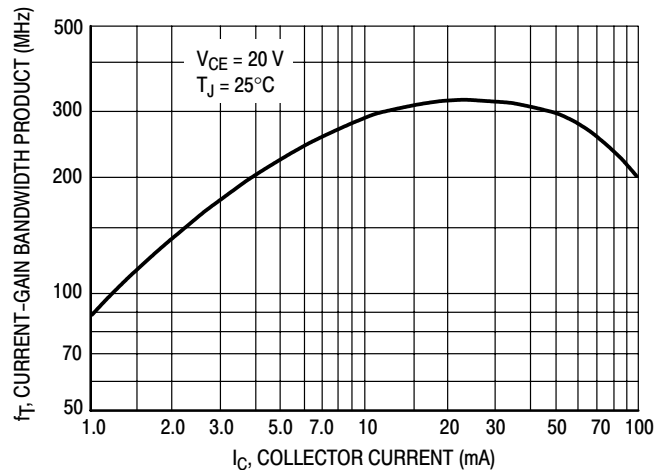


Figure 10. Current-Gain Bandwidth Product

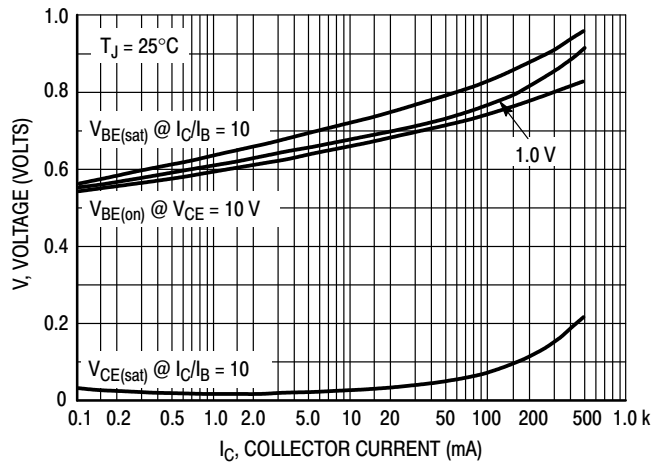


Figure 11. "On" Voltages

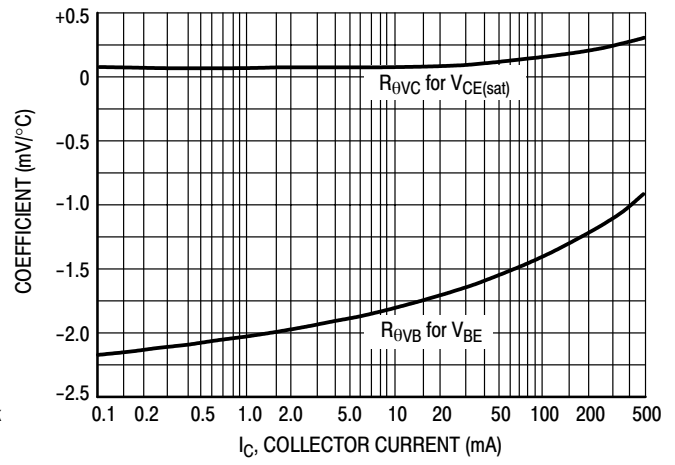
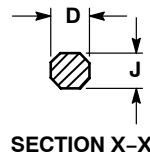
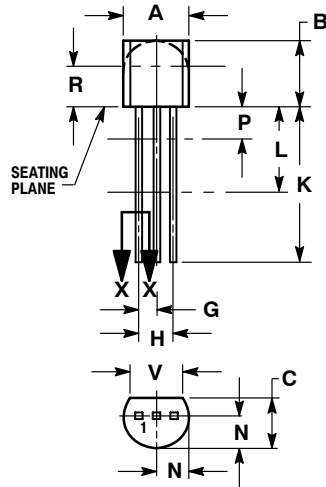


Figure 12. Temperature Coefficients

# P2N2222A

## PACKAGE DIMENSIONS

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




### 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        | ---   |

### STYLE 17:

1. COLLECTOR
2. BASE
3. EMITTER

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