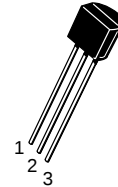
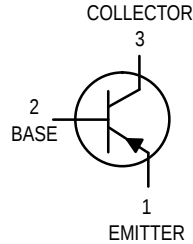


# General Purpose Transistors

## PNP Silicon

**2N4402**  
**2N4403\***

\*Motorola Preferred Device



CASE 29-04, STYLE 1  
TO-92 (TO-226AA)

### MAXIMUM RATINGS

| Rating                                                                                 | Symbol         | Value       | Unit                         |
|----------------------------------------------------------------------------------------|----------------|-------------|------------------------------|
| Collector–Emitter Voltage                                                              | $V_{CEO}$      | 40          | Vdc                          |
| Collector–Base Voltage                                                                 | $V_{CBO}$      | 40          | Vdc                          |
| Emitter–Base Voltage                                                                   | $V_{EBO}$      | 5.0         | Vdc                          |
| Collector Current — Continuous                                                         | $I_C$          | 600         | mA <sub>dc</sub>             |
| 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   | Watt<br>mW/ $^\circ\text{C}$ |
| Operating and Storage Junction<br>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  | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction to Case    | $R_{\theta JC}$ | 83.3 | $^\circ\text{C/W}$ |

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

| Characteristic | Symbol | Min | Max | Unit |
|----------------|--------|-----|-----|------|
|----------------|--------|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                                                   |               |     |     |                    |
|---------------------------------------------------------------------------------------------------|---------------|-----|-----|--------------------|
| Collector–Emitter Breakdown Voltage <sup>(1)</sup><br>( $I_C = 1.0 \text{ mA}_{dc}$ , $I_B = 0$ ) | $V_{(BR)CEO}$ | 40  | —   | Vdc                |
| Collector–Base Breakdown Voltage<br>( $I_C = 0.1 \text{ mA}_{dc}$ , $I_E = 0$ )                   | $V_{(BR)CBO}$ | 40  | —   | Vdc                |
| Emitter–Base Breakdown Voltage<br>( $I_E = 0.1 \text{ mA}_{dc}$ , $I_C = 0$ )                     | $V_{(BR)EBO}$ | 5.0 | —   | Vdc                |
| Base Cutoff Current<br>( $V_{CE} = 35 \text{ Vdc}$ , $V_{EB} = 0.4 \text{ Vdc}$ )                 | $I_{BEV}$     | —   | 0.1 | $\mu\text{A}_{dc}$ |
| Collector Cutoff Current<br>( $V_{CE} = 35 \text{ Vdc}$ , $V_{EB} = 0.4 \text{ Vdc}$ )            | $I_{CEX}$     | —   | 0.1 | $\mu\text{A}_{dc}$ |

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

Preferred devices are Motorola recommended choices for future use and best overall value.

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

| Characteristic                                                                                                                                                  | Symbol        | Min       | Max         | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------|-------------|------|
| <b>ON CHARACTERISTICS</b>                                                                                                                                       |               |           |             |      |
| DC Current Gain<br>( $I_C = 0.1 \text{ mA}$ , $V_{CE} = 1.0 \text{ Vdc}$ )                                                                                      | $h_{FE}$      | 30        | —           | —    |
| ( $I_C = 1.0 \text{ mA}$ , $V_{CE} = 1.0 \text{ Vdc}$ )                                                                                                         |               | 30        | —           | —    |
| ( $I_C = 10 \text{ mA}$ , $V_{CE} = 1.0 \text{ Vdc}$ )                                                                                                          |               | 60        | —           | —    |
| ( $I_C = 150 \text{ mA}$ , $V_{CE} = 2.0 \text{ Vdc}$ ) <sup>(1)</sup>                                                                                          |               | 50        | —           | —    |
| ( $I_C = 500 \text{ mA}$ , $V_{CE} = 2.0 \text{ Vdc}$ ) <sup>(1)</sup>                                                                                          |               | 100       | —           | —    |
| Collector–Emitter Saturation Voltage <sup>(1)</sup><br>( $I_C = 150 \text{ mA}$ , $I_B = 15 \text{ mA}$ )<br>( $I_C = 500 \text{ mA}$ , $I_B = 50 \text{ mA}$ ) | $V_{CE(sat)}$ | —         | 0.4<br>0.75 | Vdc  |
| Base–Emitter Saturation Voltage <sup>(1)</sup><br>( $I_C = 150 \text{ mA}$ , $I_B = 15 \text{ mA}$ )<br>( $I_C = 500 \text{ mA}$ , $I_B = 50 \text{ mA}$ )      | $V_{BE(sat)}$ | 0.75<br>— | 0.95<br>1.3 | Vdc  |

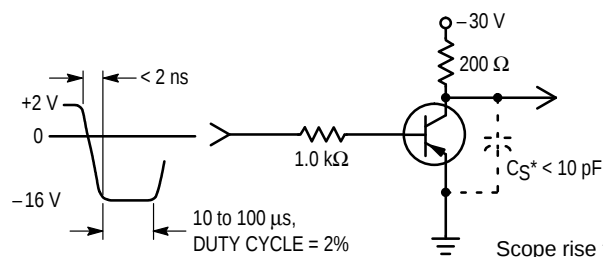
**SMALL–SIGNAL CHARACTERISTICS**

|                                                                                                                   |          |              |               |                  |
|-------------------------------------------------------------------------------------------------------------------|----------|--------------|---------------|------------------|
| Current–Gain — Bandwidth Product<br>( $I_C = 20 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 100 \text{ MHz}$ ) | $f_T$    | 150<br>200   | —             | MHz              |
| Collector–Base Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )                      | $C_{cb}$ | —            | 8.5           | pF               |
| Emitter–Base Capacitance ( $V_{EB} = 0.5 \text{ Vdc}$ , $I_C = 0$ , $f = 1.0 \text{ MHz}$ )                       | $C_{eb}$ | —            | 30            | pF               |
| Input Impedance<br>( $I_C = 1.0 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )                 | $h_{ie}$ | 750<br>1.5 k | 7.5 k<br>15 k | ohms             |
| Voltage Feedback Ratio ( $I_C = 1.0 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )             | $h_{re}$ | 0.1          | 8.0           | $\times 10^{-4}$ |
| Small–Signal Current Gain<br>( $I_C = 1.0 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )       | $h_{fe}$ | 30<br>60     | 250<br>500    | —                |
| Output Admittance ( $I_C = 1.0 \text{ mA}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ kHz}$ )                  | $h_{oe}$ | 1.0          | 100           | $\mu\text{mhos}$ |

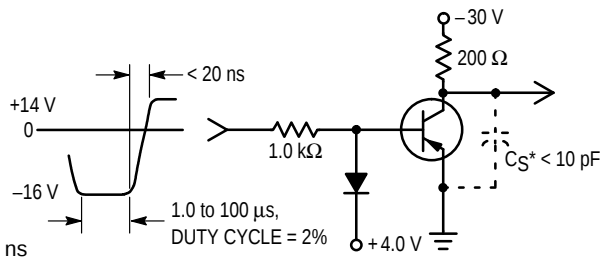
**SWITCHING CHARACTERISTICS**

|              |                                                                                                                   |       |   |     |    |
|--------------|-------------------------------------------------------------------------------------------------------------------|-------|---|-----|----|
| Delay Time   | $(V_{CC} = 30 \text{ Vdc}$ , $V_{BE} = +2.0 \text{ Vdc}$ ,<br>$I_C = 150 \text{ mA}$ , $I_{B1} = 15 \text{ mA}$ ) | $t_d$ | — | 15  | ns |
| Rise Time    |                                                                                                                   | $t_r$ | — | 20  | ns |
| Storage Time | $(V_{CC} = 30 \text{ Vdc}$ , $I_C = 150 \text{ mA}$ ,<br>$I_{B1} = 15 \text{ mA}$ , $I_{B2} = 15 \text{ mA}$ )    | $t_s$ | — | 225 | ns |
| Fall Time    |                                                                                                                   | $t_f$ | — | 30  | ns |

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

**SWITCHING TIME EQUIVALENT TEST CIRCUIT**


**Figure 1. Turn–On Time**



**Figure 2. Turn–Off Time**

## TRANSIENT CHARACTERISTICS

— 25°C    - - - 100°C

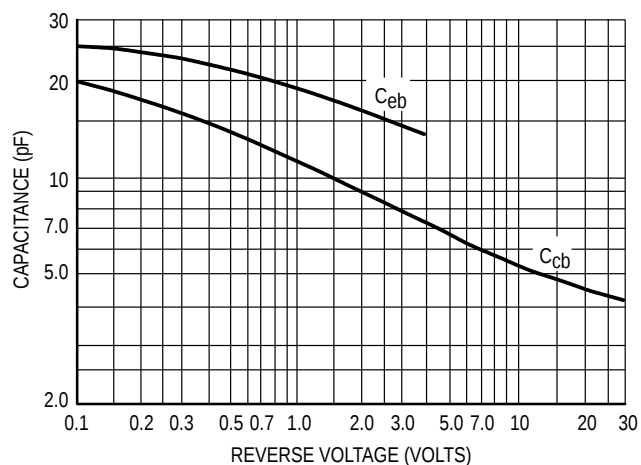


Figure 3. Capacitances

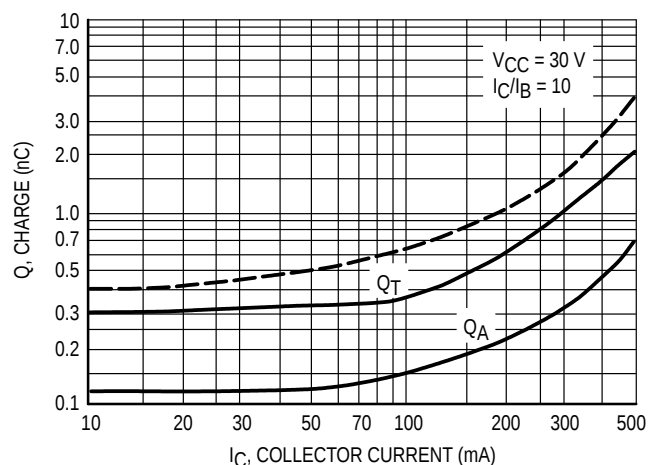


Figure 4. Charge Data

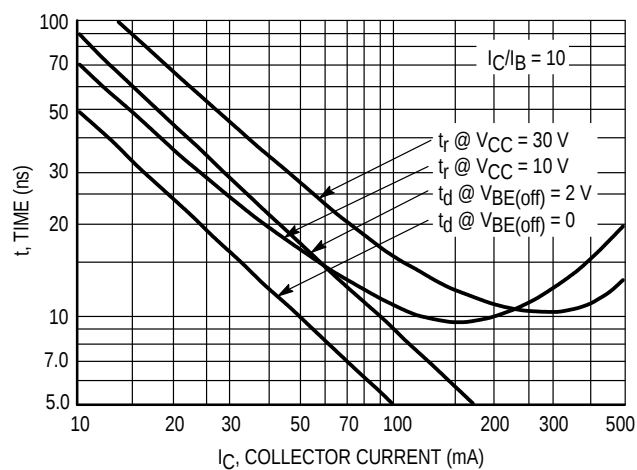


Figure 5. Turn-On Time

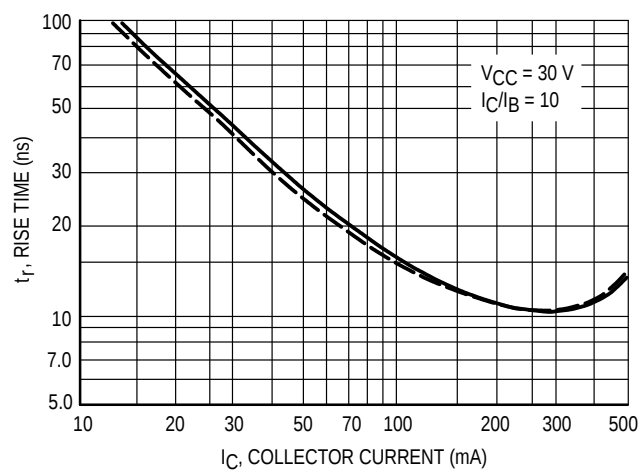


Figure 6. Rise Time

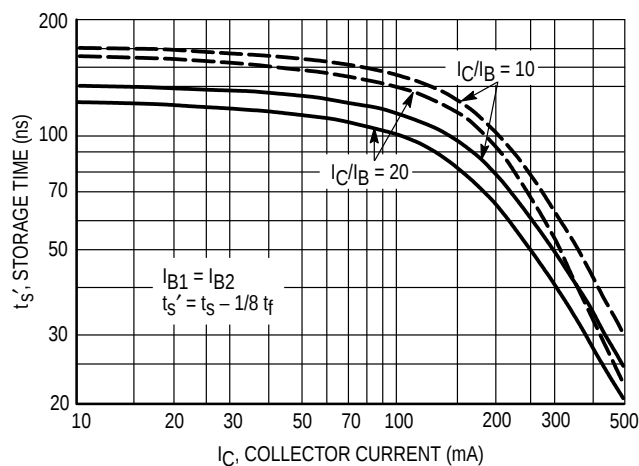


Figure 7. Storage Time

## SMALL-SIGNAL CHARACTERISTICS

## NOISE FIGURE

$$V_{CE} = -10 \text{ Vdc}, T_A = 25^\circ\text{C}$$

Bandwidth = 1.0 Hz

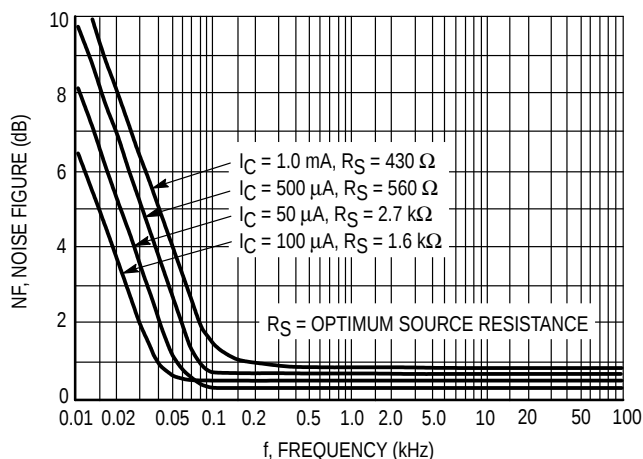


Figure 8. Frequency Effects

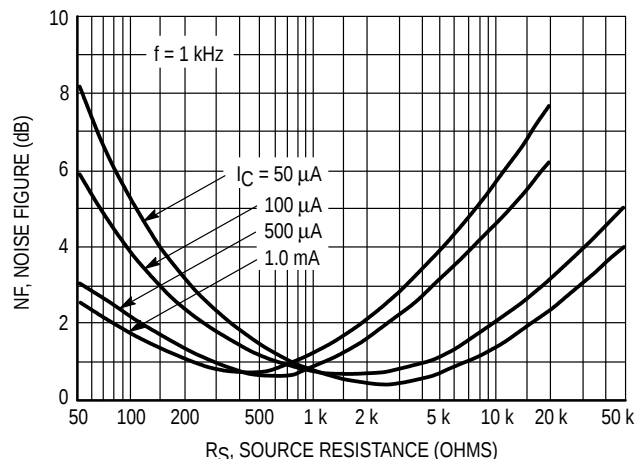


Figure 9. Source Resistance Effects

## h PARAMETERS

$$V_{CE} = -10 \text{ Vdc}, f = 1.0 \text{ kHz}, T_A = 25^\circ\text{C}$$

This group of graphs illustrates the relationship between  $h_{fe}$  and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were

selected from both the 2N4402 and 2N4403 lines, and the same units were used to develop the correspondingly-numbered curves on each graph.

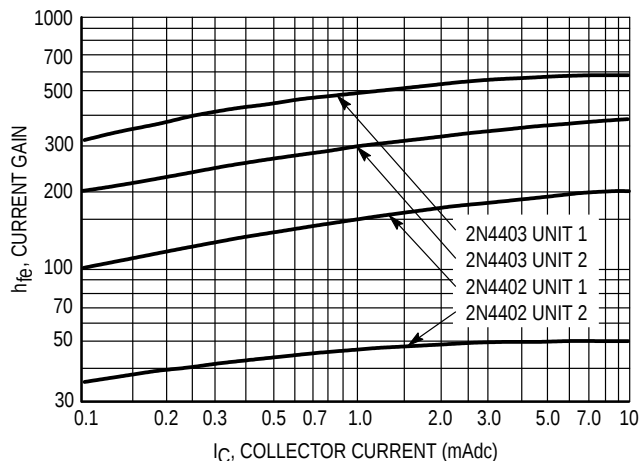


Figure 10. Current Gain

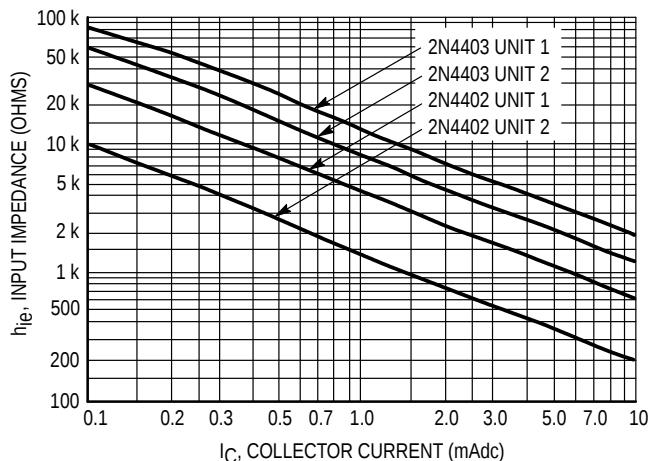


Figure 11. Input Impedance

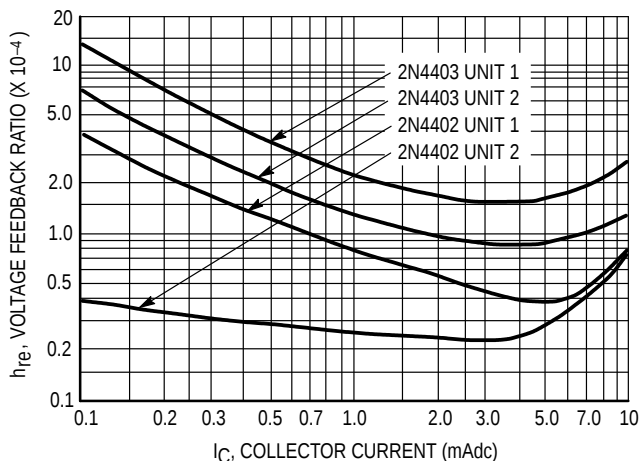


Figure 12. Voltage Feedback Ratio

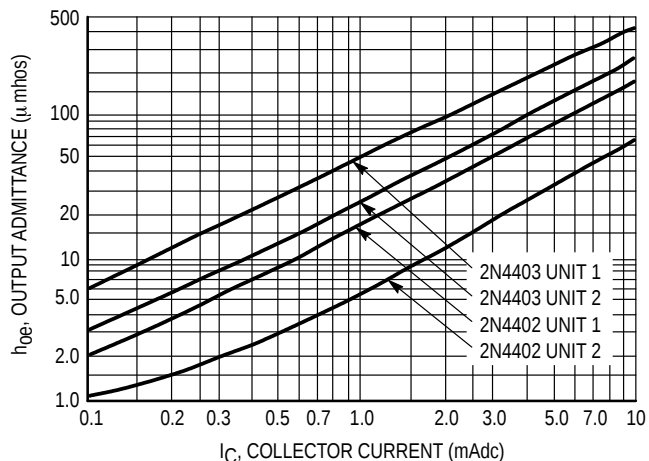


Figure 13. Output Admittance

## STATIC CHARACTERISTICS

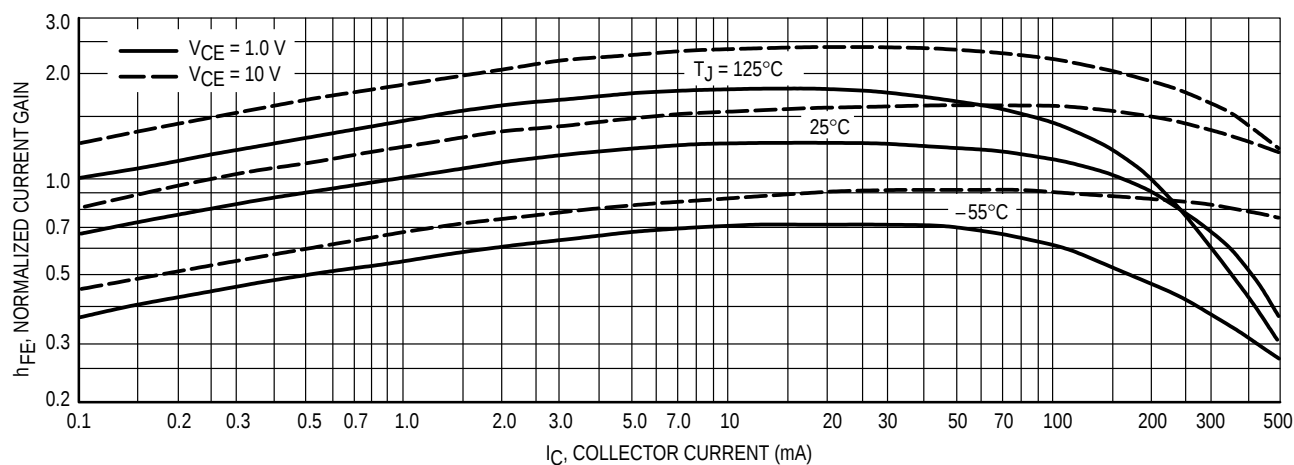


Figure 14. DC Current Gain

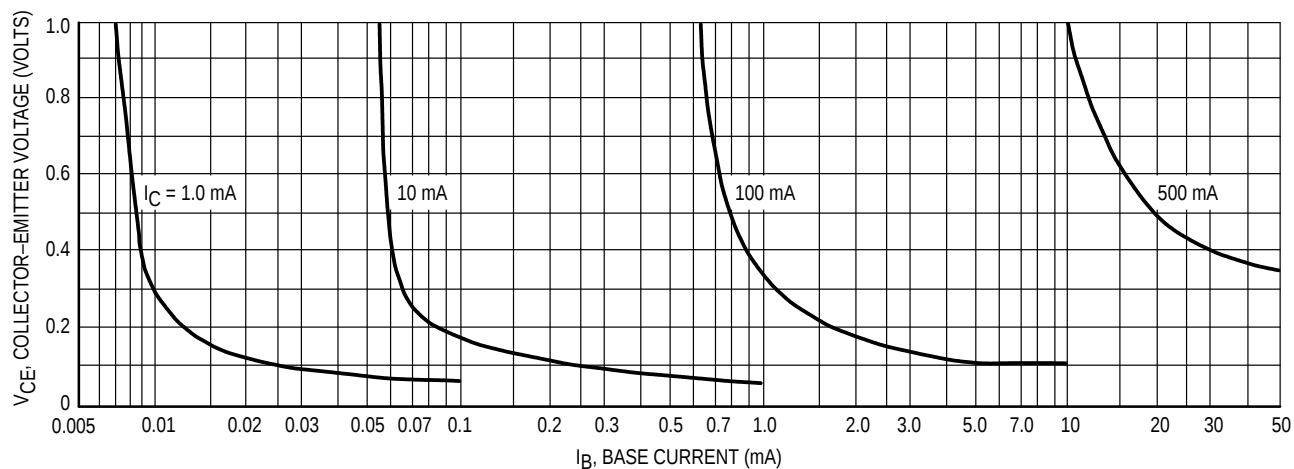


Figure 15. Collector Saturation Region

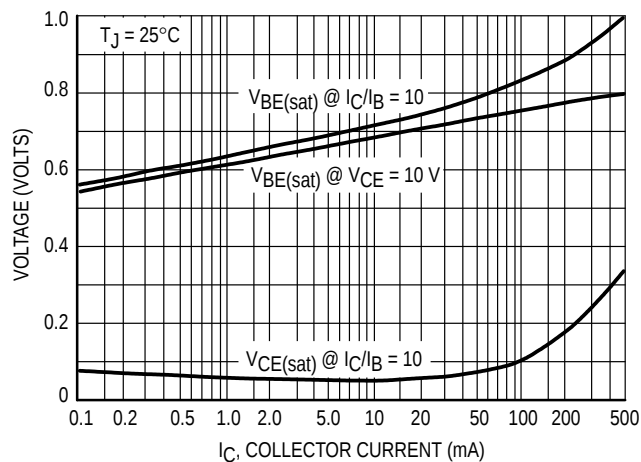


Figure 16. "On" Voltages

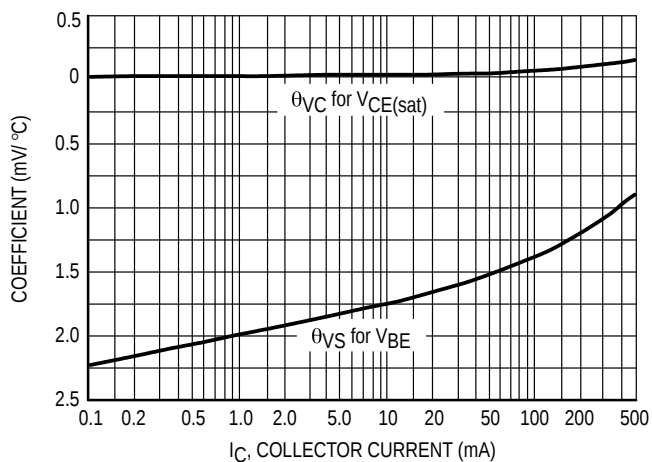
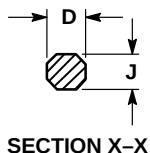
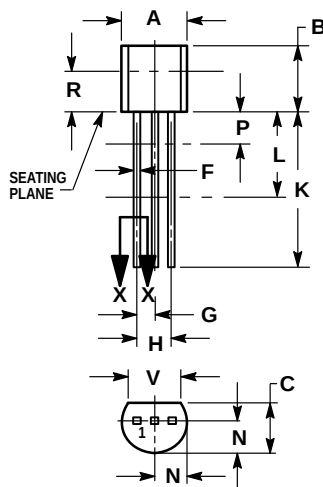


Figure 17. Temperature Coefficients

## PACKAGE DIMENSIONS



**CASE 029-04  
(TO-226AA)  
ISSUE AD**

## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSION D AND J APPLY BETWEEN L AND K. MINIMUM 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  | 0.022 | 0.41        | 0.55 |
| F   | 0.016  | 0.019 | 0.41        | 0.48 |
| 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 1:

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

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