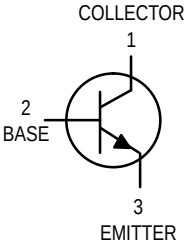
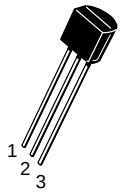
# Amplifier Transistors

## NPN Silicon

**P2N2222A**




**CASE 29–04, STYLE 17**
**TO–92 (TO–226AA)**

**MAXIMUM RATINGS**

| Rating | 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 | mAdc |
| Total Device Dissipation @ $T_A$ = 25°C<br>Derate above 25°C | $P_D$ | 625<br>5.0 | mW<br>mW/°C |
| Total Device Dissipation @ $T_C$ = 25°C<br>Derate above 25°C | $P_D$ | 1.5<br>12 | Watts<br>mW/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | –55 to +150 | °C |

**THERMAL CHARACTERISTICS**

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

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | |
| Collector–Emitter Breakdown Voltage<br>($I_C$ = 10 mAdc, $I_B$ = 0) | $V_{(BR)CEO}$ | 40 | — | Vdc |
| Collector–Base Breakdown Voltage<br>($I_C$ = 10 μAdc, $I_E$ = 0) | $V_{(BR)CBO}$ | 75 | — | Vdc |
| Emitter–Base Breakdown Voltage<br>($I_E$ = 10 μAdc, $I_C$ = 0) | $V_{(BR)EBO}$ | 6.0 | — | Vdc |
| Collector Cutoff Current<br>($V_{CE}$ = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc) | $I_{CEX}$ | — | 10 | nAdc |
| Collector Cutoff Current<br>($V_{CB}$ = 60 Vdc, $I_E$ = 0)<br>($V_{CB}$ = 60 Vdc, $I_E$ = 0, $T_A$ = 150°C) | $I_{CBO}$ | <br>—<br>— | <br>0.01<br>10 | μAdc |
| Emitter Cutoff Current<br>($V_{EB}$ = 3.0 Vdc, $I_C$ = 0) | $I_{EBO}$ | — | 10 | nAdc |
| Collector Cutoff Current<br>($V_{CE}$ = 10 V) | $I_{CEO}$ | — | 10 | nAdc |
| Base Cutoff Current<br>($V_{CE}$ = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc) | $I_{BEX}$ | — | 20 | nAdc |

**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted) (Continued)

| Characteristic | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| **ON CHARACTERISTICS** | | | | |
| DC Current Gain | $h_{FE}$ | | | — |
| ($I_C$ = 0.1 mAdc, $V_{CE}$ = 10 Vdc) | | 35 | — | |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc) | | 50 | — | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc) | | 75 | — | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, $T_A$ = –55°C) | | 35 | — | |
| ($I_C$ = 150 mAdc, $V_{CE}$ = 10 Vdc)(1) | | 100 | 300 | |
| ($I_C$ = 150 mAdc, $V_{CE}$ = 1.0 Vdc)(1) | | 50 | — | |
| ($I_C$ = 500 mAdc, $V_{CE}$ = 10 Vdc)(1) | | 40 | — | |
| Collector–Emitter Saturation Voltage(1) | $V_{CE(sat)}$ | | | Vdc |
| ($I_C$ = 150 mAdc, $I_B$ = 15 mAdc) | | — | 0.3 | |
| ($I_C$ = 500 mAdc, $I_B$ = 50 mAdc) | | — | 1.0 | |
| Base–Emitter Saturation Voltage(1) | $V_{BE(sat)}$ | | | Vdc |
| ($I_C$ = 150 mAdc, $I_B$ = 15 mAdc) | | 0.6 | 1.2 | |
| ($I_C$ = 500 mAdc, $I_B$ = 50 mAdc) | | — | 2.0 | |
| **SMALL–SIGNAL CHARACTERISTICS** | | | | |
| Current–Gain — Bandwidth Product(2) ($I_C$ = 20 mAdc, $V_{CE}$ = 20 Vdc, f = 100 MHz) | $f_T$ | 300 | — | MHz |
| Output Capacitance ($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 1.0 MHz) | $C_{obo}$ | — | 8.0 | pF |
| Input Capacitance ($V_{EB}$ = 0.5 Vdc, $I_C$ = 0, f = 1.0 MHz) | $C_{ibo}$ | — | 25 | pF |
| Input Impedance | $h_{ie}$ | | | kΩ |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | 2.0 | 8.0 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | 0.25 | 1.25 | |
| Voltage Feedback Ratio | $h_{re}$ | | | X $10^{-4}$ |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | — | 8.0 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | — | 4.0 | |
| Small–Signal Current Gain | $h_{fe}$ | | | — |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | 50 | 300 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | 75 | 375 | |
| Output Admittance | $h_{oe}$ | | | μmhos |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | 5.0 | 35 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | | 25 | 200 | |
| Collector Base Time Constant ($I_E$ = 20 mAdc, $V_{CB}$ = 20 Vdc, f = 31.8 MHz) | $rb'C_c$ | — | 150 | ps |
| Noise Figure ($I_C$ = 100 μAdc, $V_{CE}$ = 10 Vdc, $R_S$ = 1.0 kΩ, f = 1.0 kHz) | $N_F$ | — | 4.0 | dB |
| **SWITCHING CHARACTERISTICS** | | | | |
| Delay Time | ($V_{CC}$ = 30 Vdc, $V_{BE(off)}$ = –2.0 Vdc, $I_C$ = 150 mAdc, $I_{B1}$ = 15 mAdc) (Figure 1) | $t_d$ | — | 10 | ns |
| Rise Time | | $t_r$ | — | 25 | ns |
| Storage Time | ($V_{CC}$ = 30 Vdc, $I_C$ = 150 mAdc, $I_{B1}$ = $I_{B2}$ = 15 mAdc) (Figure 2) | $t_s$ | — | 225 | ns |
| Fall Time | | $t_f$ | — | 60 | ns |

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

## SWITCHING TIME EQUIVALENT TEST CIRCUITS

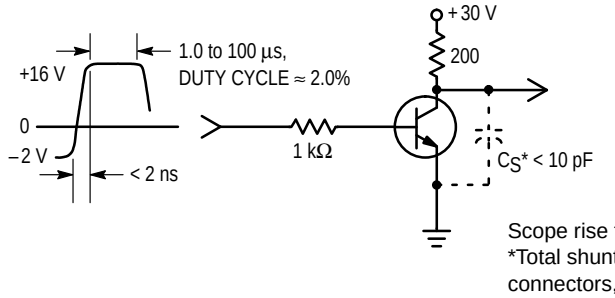
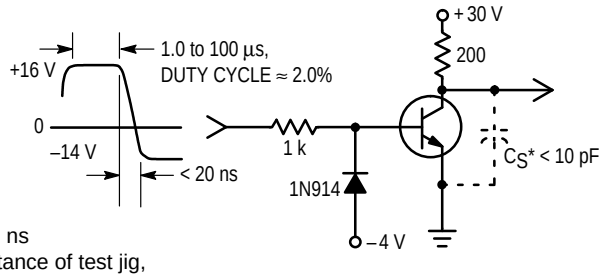



**Figure 1. Turn–On Time**




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

**Figure 2. Turn–Off Time**

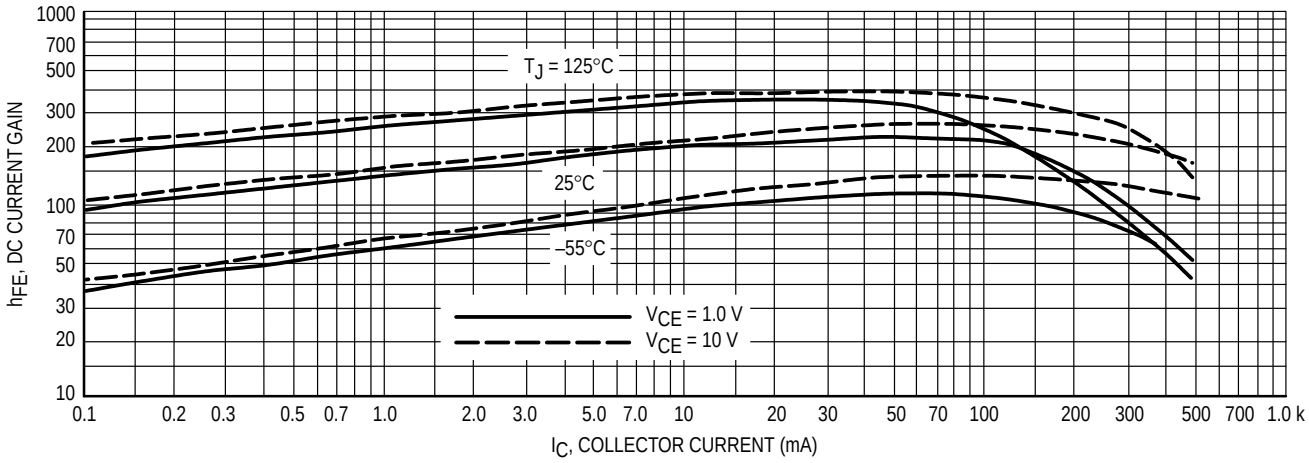



**Figure 3. DC Current Gain**

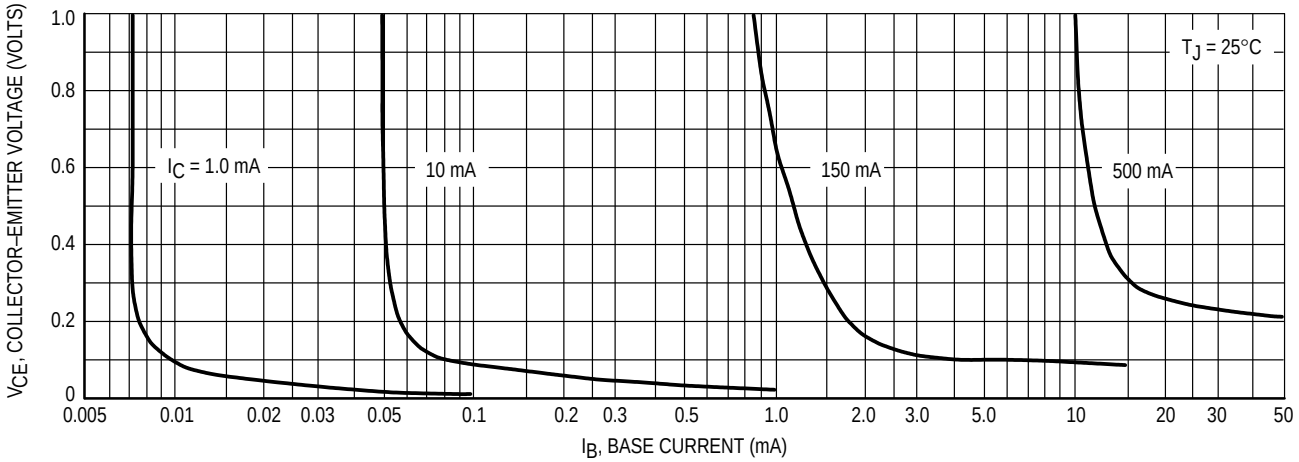



**Figure 4. Collector Saturation Region**

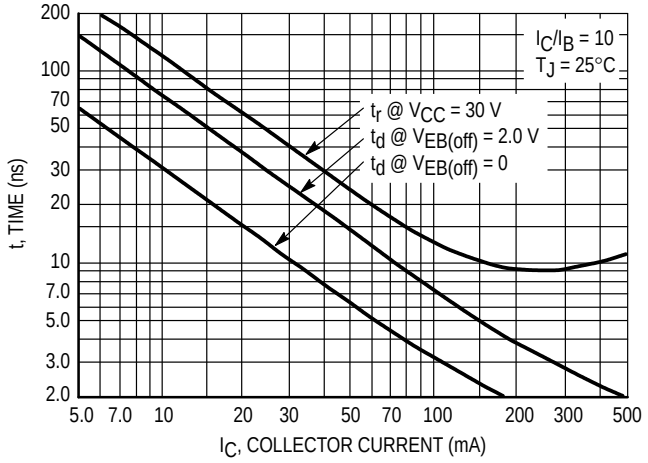



**Figure 5. Turn – On Time**

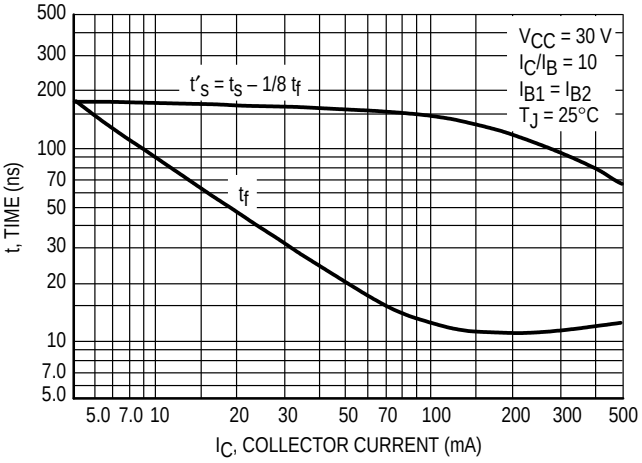



**Figure 6. Turn – Off Time**

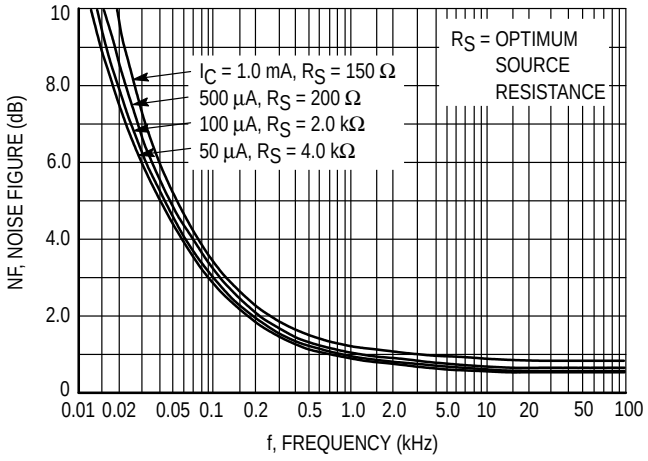



**Figure 7. Frequency Effects**

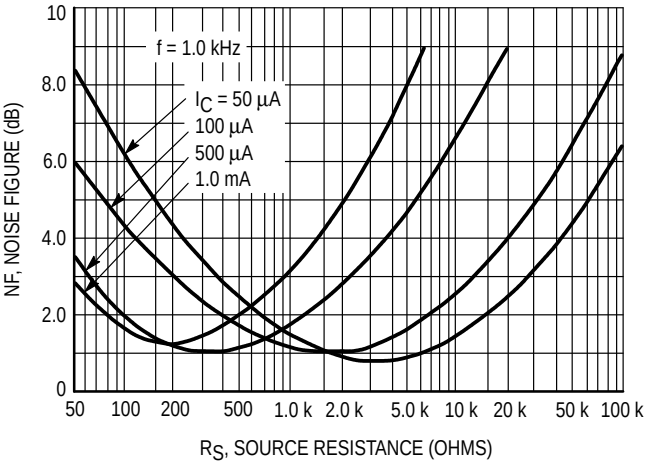



**Figure 8. Source Resistance Effects**

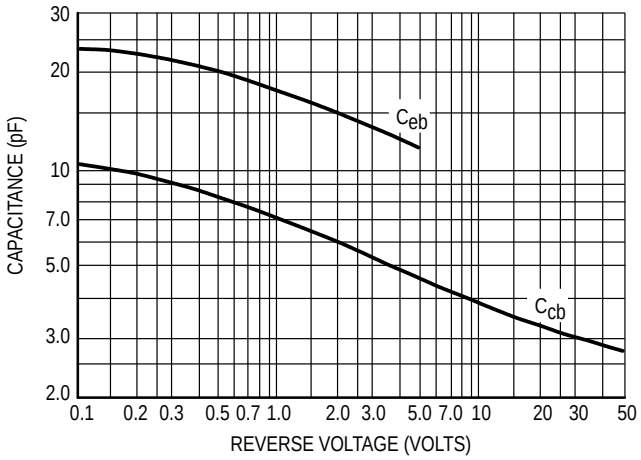



**Figure 9. Capacitances**

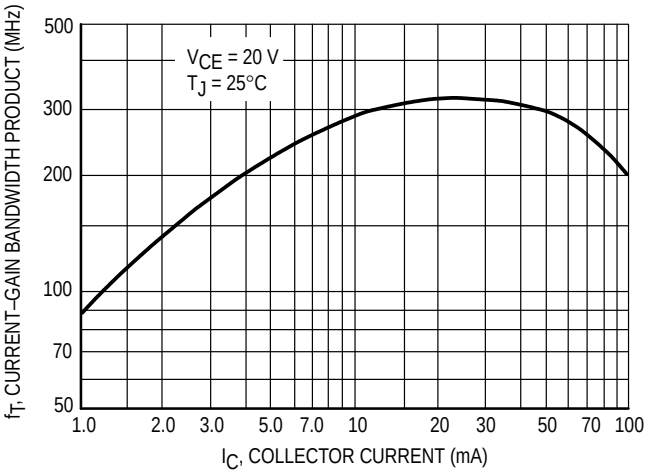



**Figure 10. Current–Gain Bandwidth Product**

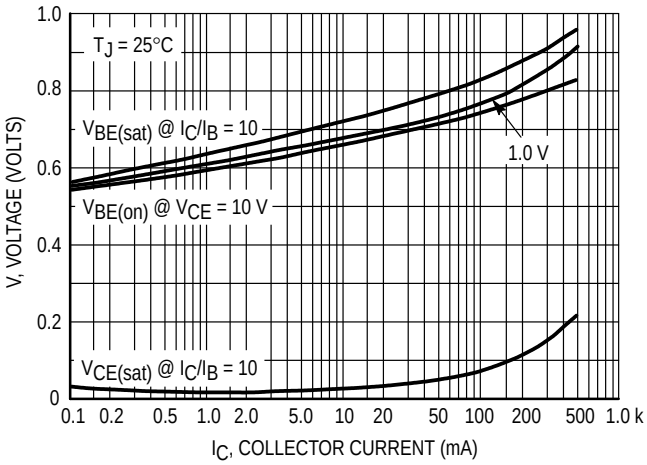



**Figure 11. “On” Voltages**

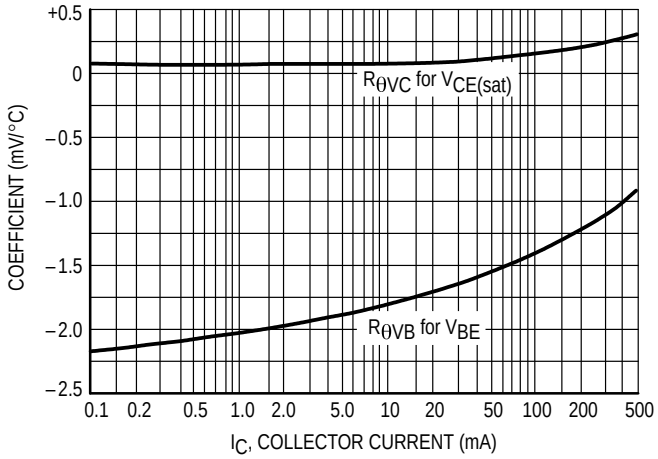
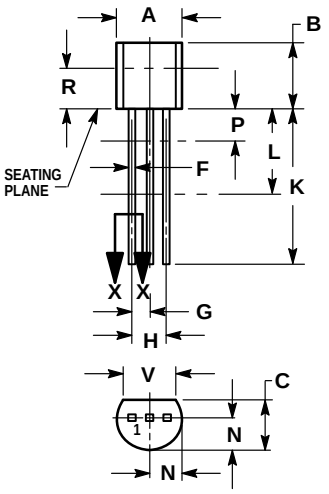
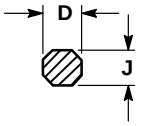



**Figure 12. Temperature Coefficients**

## PACKAGE DIMENSIONS




SECTION X–X

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.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | 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 | — |

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

STYLE 17:
PIN 1. COLLECTOR
2. BASE
3. EMITTER



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