4

# 2N3250,A
# 2N3251,A

**2N3250A,2N3251A**
**JAN, JTX, JTXV AVAILABLE**

**CASE 22, STYLE 1**
**TO-18 (TO-206AA)**

**GENERAL PURPOSE TRANSISTOR**
**PNP SILICON**

**MAXIMUM RATINGS**

| Rating | Symbol | 2N3250 2N3251 | 2N3250A 2N3251A | Unit |
|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 40 | 60 | Vdc |
| Collector-Base Voltage | $V_{CBO}$ | 50 | 60 | Vdc |
| Emitter-Base Voltage | $V_{EBO}$ | 5.0 | | Vdc |
| Collector Current | $I_C$ | 200 | | mAdc |
| Total Device Dissipation @ $T_A = 25°C$<br>Derate above 25°C | $P_D$ | 0.36<br>2.06 | | Watt<br>mW/°C |
| Total Device Dissipation @ $T_C = 25°C$<br>Derate above 25°C | $P_D$ | 1.2<br>6.9 | | Watts<br>mW/°C |
| Operating and Storage Temperature<br>Temperature Range | $T_J, T_{stg}$ | −65 to +200 | | °C |

**THERMAL CHARACTERISTICS**

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 0.15 | mW/°C |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 0.49 | mW/°C |

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector-Emitter Breakdown Voltage (1)<br>($I_C$ = 10 mAdc) | 2N3250, 2N3251<br>2N3250A, 2N3251A | $V_{(BR)CEO}$ | 40<br>60 | — | Vdc |
| Collector-Base Breakdown Voltage<br>($I_C$ = 10 μAdc) | 2N3250, 2N3251<br>2N3250A, 2N3251A | $V_{(BR)CBO}$ | 50<br>60 | — | Vdc |
| Emitter-Base Breakdown Voltage<br>($I_E$ = 10 μAdc) | | $V_{(BR)EBO}$ | 5.0 | — | Vdc |
| Collector Cutoff Current<br>($V_{CE}$ = 40 Vdc, $V_{BE}$ = 3.0 Vdc) | | $I_{CEX}$ | — | 20 | Adc |
| Base Cutoff Current<br>($V_{CE}$ = 40 Vdc, $V_{BE}$ = 3.0 Vdc) | | $I_{BL}$ | — | 50 | nAdc |
| **ON CHARACTERISTICS** | | | | | |
| DC Forward Current Transfer Radio (1)<br>($I_C$ = 0.1 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N3250, 2N3250A<br>2N3251, 2N3251A | $h_{FE}$ | 40<br>80 | —<br>— | — |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N3250, 2N3250A<br>2N3251, 2N3251A | | 45<br>90 | —<br>— | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N3250, 2N3250A<br>2N3251, 2N3251A | | 50<br>100 | 150<br>300 | |
| ($I_C$ = 50 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N3250, 2N3250A<br>2N3251, 2N3251A | | 15<br>30 | —<br>— | |
| Collector-Emitter Saturation Voltage (1)<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc)<br>($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | | $V_{CE(sat)}$ | —<br>— | 0.25<br>0.5 | Vdc |
| Base-Emitter Saturation Voltage (1)<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc)<br>($I_C$ = 50 mAdc, $I_B$ = 5.0 mAdc) | | $V_{BE(sat)}$ | 0.6<br>— | 0.9<br>1.2 | Vdc |
| **SMALL-SIGNAL CHARACTERISTICS** | | | | | |
| Current-Gain — Bandwidth Product<br>($I_C$ = 10 mAdc, $V_{CE}$ = 20 Vdc, f = 100 MHz) | 2N3250, 2N3250A<br>2N3251, 2N3251A | $f_T$ | 250<br>300 | —<br>— | MHz |
| Output Capacitance<br>($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 100 kHz) | | $C_{obo}$ | — | 6.0 | pF |
| Input Capacitance<br>($V_{CB}$ = 1.0 Vdc, $I_C$ = 0, f = 100 kHz) | | $C_{ibo}$ | — | 8.0 | pF |

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| Input Impedance ($I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A<br>2N3251, 2N3251A | $h_{ie}$ | 1.0<br>2.0 | 6.0<br>12 | kohms |
| Voltage Feedback Ratio ($I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A<br>2N3251, 2N3251A | $h_{re}$ | —<br>— | 10<br>20 | X $10^{-4}$ |
| Small-Signal Current Gain ($I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A<br>2N3251, 2N3251A | $h_{fe}$ | 50<br>100 | 200<br>400 | — |
| Output Admittance ($I_C$ = 1.0 mA, $V_{CE}$ = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A<br>2N3251, 2N3251A | $h_{oe}$ | 4.0<br>10 | 40<br>60 | μmhos |
| Collector Base Time Constant ($I_C$ = 10 mA, $V_{CE}$ = 20 V) | | $rb'C_C$ | — | 250 | ps |
| Noise Figure ($I_C$ = 100 μA, $V_{CE}$ = 5.0 V, $R_S$ = 1.0 k Ω, f = 100 Hz) | | NF | — | 6.0 | dB |

**SWITCHING CHARACTERISTICS**

| Characteristic | | | Symbol | Max | Unit |
|---|---|---|---|---|---|
| Delay Time | ($V_{CC}$ = 3.0 Vdc, $V_{BE}$ = 0.5 Vdc $I_C$ = 10 mAdc, $I_{B1}$ = 1.0 mA) | | $t_d$ | 35 | ns |
| Rise Time | | | $t_r$ | 35 | ns |
| Storage Time | ($I_C$ = 10 mAdc, $I_{B1}$ = $I_{B2}$ = 1.0 mAdc $V_{CC}$ = 3.0 V) | 2N3250, 2N3250A<br>2N3251, 2N3251A | $t_s$ | 175<br>200 | ns |
| Fall Time | | | $t_f$ | 50 | ns |

(1) Pulse Test: PW = 300 μs, Duty Cycle = 2.0%.

## SWITCHING TIME CHARACTERISTICS

**FIGURE 1 — DELAY AND RISE TIME**

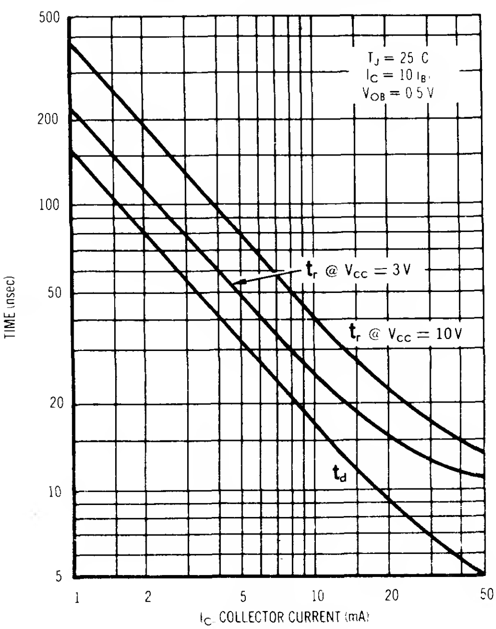
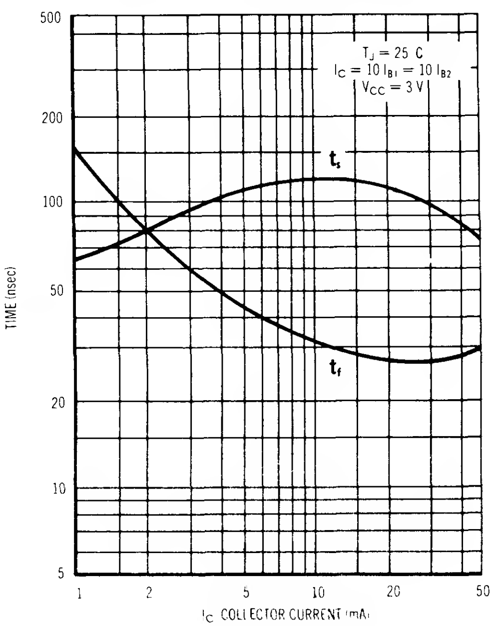



**FIGURE 2 — STORAGE AND FALL TIME**




4

4

## AUDIO SMALL SIGNAL CHARACTERISTICS
## NOISE FIGURE VARIATIONS
($V_{CE}$ = 6 V, $T_A$ = 25°C)

**FIGURE 3 — FREQUENCY**

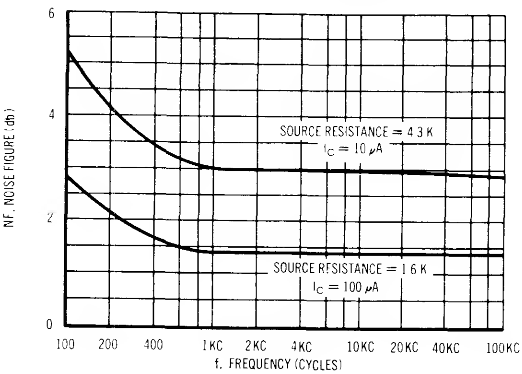
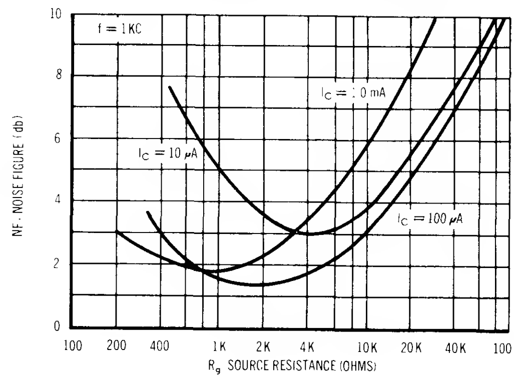



**FIGURE 4 — SOURCE RESISTANCE**




## h PARAMETERS
$V_{CE}$ = 10 V, f = 1 kc, $T_A$ = 25°C

**FIGURE 5 — CURRENT GAIN**

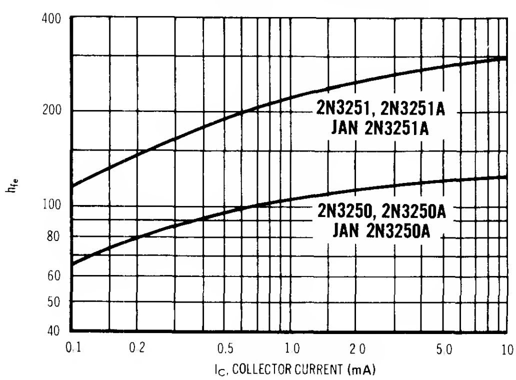



**FIGURE 6 — OUTPUT ADMITTANCE**

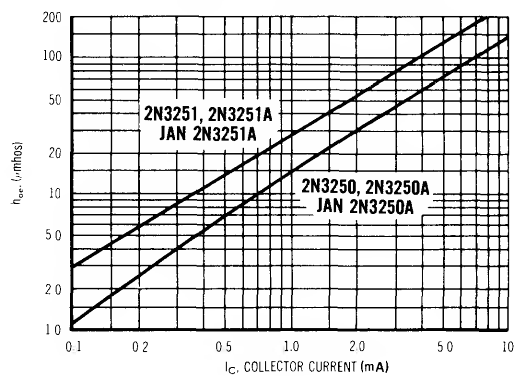



**FIGURE 7 — VOLTAGE FEEDBACK RATIO**

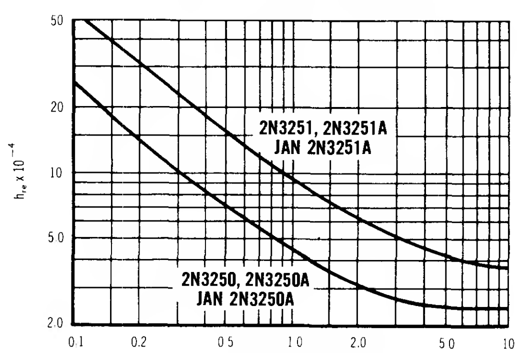



**FIGURE 8 — INPUT IMPEDANCE**

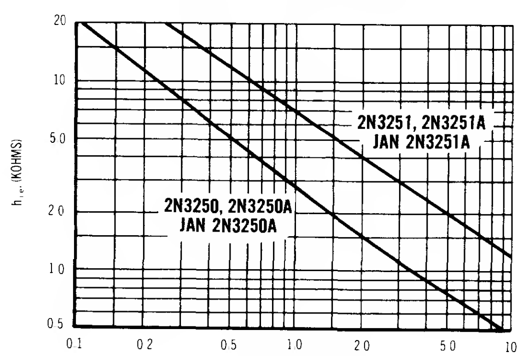


FIGURE 9 — NORMALIZED CURRENT GAIN CHARACTERISTICS

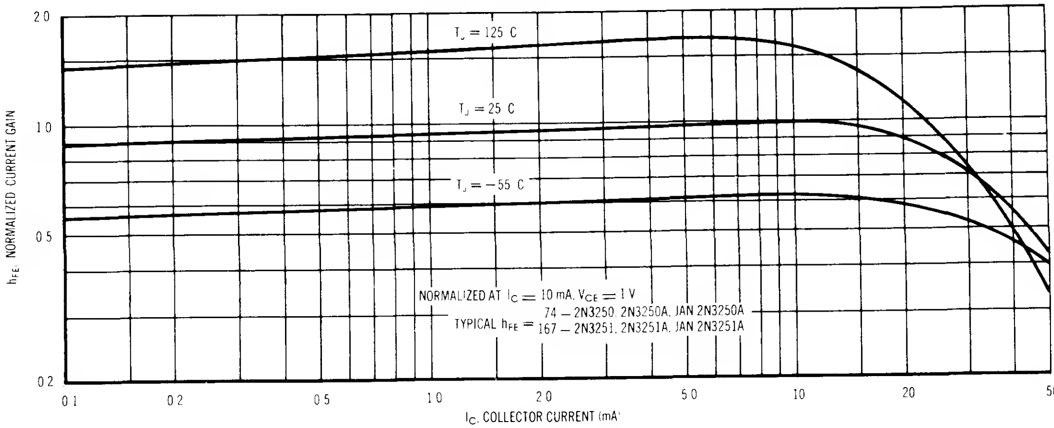
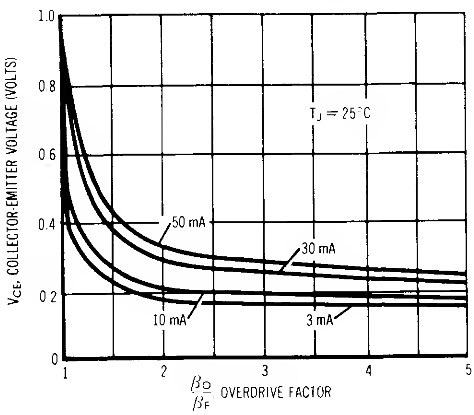





FIGURE 10 — COLLECTOR SATURATION REGION




This graph shows the effect of base current on collector current. $\beta_O$ is the current gain of the transistor at 1 volt, and $\beta_F$ (forced gain) is the ratio of $I_C/I_{BF}$ in a circuit. EXAMPLE: For type 2N3251, estimate a base current ($I_{BF}$) to insure saturation at a temperature of 25 C and a collector current of 10 mA.

Observe that at $I_C$ = 10 mA an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that $h_{FE}$ @ 1 volt is typically 167 (guaranteed limits from the Table of Characteristics can be used for "worst-case" design).

$$\frac{\beta_O}{\beta_F} = \frac{h_{FE} \text{ @ 1 Volt}}{I_C/I_{BF}} \qquad 2.5 = \frac{167}{10\,\text{mA}/I_{BF}} \qquad I_{BF} \approx 6.68\,\text{mA typ}$$

FIGURE 11 — SATURATION VOLTAGES

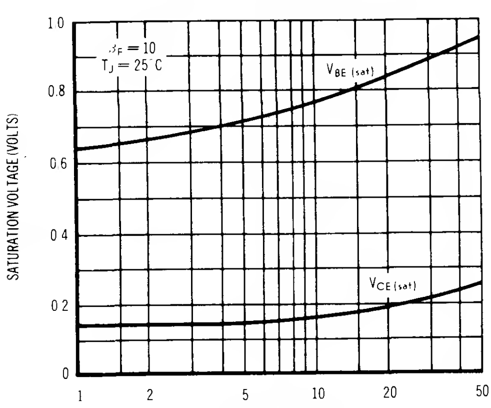



FIGURE 12 — TEMPERATURE COEFFICIENTS

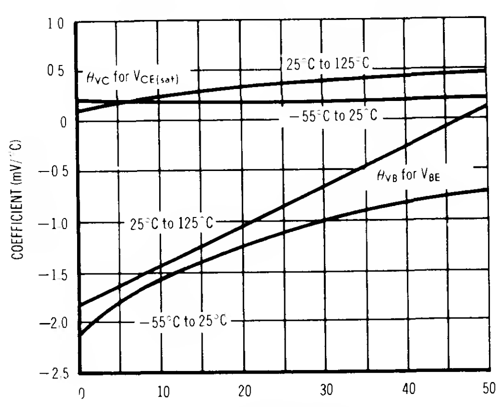


FIGURE 13 — $f_T$ AND $r_b'C_C$ versus $I_C$

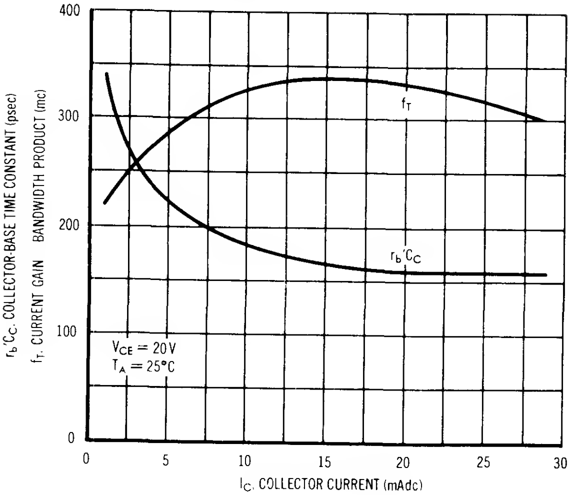



FIGURE 14 — 30 MC EQUIVALENT CIRCUIT

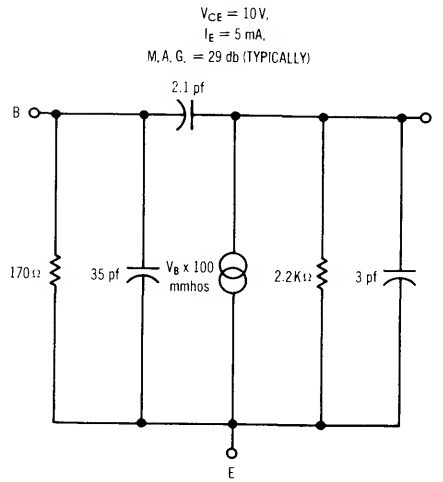



FIGURE 15 — JUNCTION CAPACITANCE

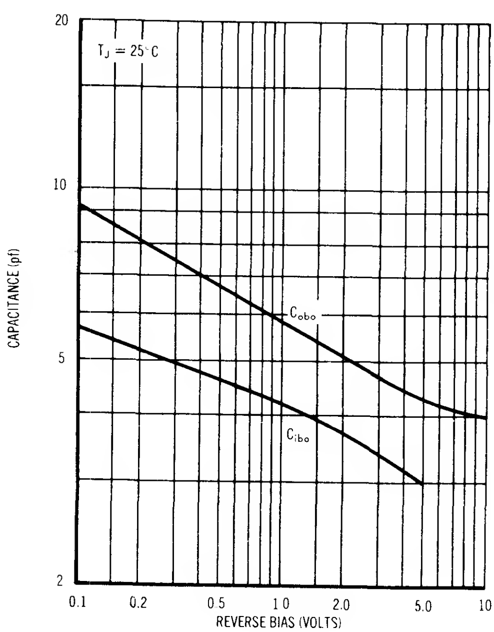



FIGURE 16 — CHARGE DATA