## MAXIMUM RATINGS

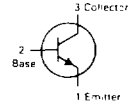
| Rating | Symbol | 2N2219 2N2222 | 2N2218A 2N2219A 2N2222A | Unit |
|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 30 | 40 | Vdc |
| Collector-Base Voltage | $V_{CBO}$ | 60 | 75 | Vdc |
| Emitter-Base Voltage | $V_{EBO}$ | 5.0 | 6.0 | Vdc |
| Collector Current — Continuous | $I_C$ | 800 | 800 | mAdc |
| | | 2N2218A 2N2219,A | 2N2222,A | |
| Total Device Dissipation @ $T^A$ = 25°C<br>Derate above 25°C | $P_D$ | 0.8<br>4.57 | 0.4<br>2.28 | Watt<br>mW/°C |
| Total Device Dissipation @ $T^C$ = 25°C<br>Derate above 25°C | $P_D$ | 3.0<br>17.1 | 1.2<br>6.85 | Watts<br>mW/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | −65 to +200 | | °C |

## THERMAL CHARACTERISTICS

| Characteristic | Symbol | 2N2218A 2N2219,A | 2N2222,A | Unit |
|---|---|---|---|---|
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 219 | 145.8 | °C/W |
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 58 | 437.5 | °C/W |

# 2N2218A,2N2219,A★ 2N2222,A★

**2N2218, A/2N2219,A**
**CASE 79-04**
**TO-39 (TO-205AD)**
**STYLE 1**



**A/2N2222,A**
**CASE 22-03**
**TO-18 (TO-206AA)**
**STYLE 1**

**GENERAL PURPOSE TRANSISTORS**
**NPN SILICON**

★2N2219A and 2N2222A are Motorola designated preferred devices.

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector-Emitter Breakdown Voltage ($I_C$ = 10 mAdc, $I_B$ = 0) | Non-A Suffix | $V_{(BR)CEO}$ | 30 | — | Vdc |
| | A-Suffix | | 40 | — | |
| Collector-Base Breakdown Voltage ($I_C$ = 10 μAdc, $I_E$ = 0) | Non-A Suffix | $V_{(BR)CBO}$ | 60 | — | Vdc |
| | A-Suffix | | 75 | — | |
| Emitter-Base Breakdown Voltage ($I_E$ = 10 μAdc, $I_C$ = 0) | Non-A Suffix | $V_{(BR)EBO}$ | 5.0 | — | Vdc |
| | A-Suffix | | 6.0 | — | |
| Collector Cutoff Current ($V_{CE}$ = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc) | A-Suffix | $I_{CEX}$ | — | 10 | nAdc |
| Collector Cutoff Current | | $I_{CBO}$ | | | μAdc |
| ($V_{CB}$ = 50 Vdc, $I_E$ = 0) | Non-A Suffix | | — | 0.01 | |
| ($V_{CB}$ = 60 Vdc, $I_E$ = 0) | A-Suffix | | — | 0.01 | |
| ($V_{CB}$ = 50 Vdc, $I_E$ = 0, $T_A$ = 150°C) | Non-A Suffix | | — | 10 | |
| ($V_{CB}$ = 60 Vdc, $I_E$ = 0, $T_A$ = 150°C) | A-Suffix | | — | 10 | |
| Emitter Cutoff Current ($V_{EB}$ = 3.0 Vdc, $I_C$ = 0) | A-Suffix | $I_{EBO}$ | — | 10 | nAdc |
| Base Cutoff Current ($V_{CE}$ = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc) | A-Suffix | $I_{BL}$ | — | 20 | nAdc |
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain | | $h_{FE}$ | | | — |
| ($I_C$ = 0.1 mAdc, $V_{CE}$ = 10 Vdc) | 2N2218A | | 20 | — | |
| | 2N2219,A, 2N2222,A | | 35 | — | |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc) | 2N2218A | | 25 | — | |
| | 2N2219,A, 2N2222,A | | 50 | — | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc)(1) | 2N2218A | | 35 | — | |
| | 2N2219,A, 2N2222,A | | 75 | — | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, $T_A$ = −55°C)(1) | 2N2218A | | 15 | — | |
| | 2N2219,A, 2N2222,A | | 35 | — | |
| ($I_C$ = 150 mAdc, $V_{CE}$ = 10 Vdc)(1) | 2N2218A | | 40 | 120 | |
| | 2N2219,A, 2N2222,A | | 100 | 300 | |

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| ($I_C$ = 150 mAdc, $V_{CE}$ = 1.0 Vdc)(1) | 2N2218A | | 20 | — | |
| | 2N2219,A, 2N2222,A | | 50 | — | |
| ($I_C$ = 500 mAdc, $V_{CE}$ = 10 Vdc)(1) | 2N2219, 2N2222 | | 30 | — | |
| | 2N2218A | | 25 | — | |
| | 2N2219A, 2N2222A | | 40 | — | |
| Collector-Emitter Saturation Voltage(1) | | $V_{CE(sat)}$ | | | Vdc |
| ($I_C$ = 150 mAdc, $I_B$ = 15 mAdc) | Non-A Suffix | | — | 0.4 | |
| | A-Suffix | | — | 0.3 | |
| ($I_C$ = 500 mAdc, $I_B$ = 50 mAdc) | Non-A Suffix | | — | 1.6 | |
| | A-Suffix | | — | 1.0 | |
| Base-Emitter Saturation Voltage(1) | | $V_{BE(sat)}$ | | | Vdc |
| ($I_C$ = 150 mAdc, $I_B$ = 15 mAdc) | Non-A Suffix | | 0.6 | 1.3 | |
| | A-Suffix | | 0.6 | 1.2 | |
| ($I_C$ = 500 mAdc, $I_B$ = 50 mAdc) | Non-A Suffix | | — | 2.6 | |
| | A-Suffix | | — | 2.0 | |
| **SMALL-SIGNAL CHARACTERISTICS** | | | | | |
| Current Gain — Bandwidth Product(2) | | $f_T$ | | | MHz |
| ($I_C$ = 20 mAdc, $V_{CE}$ = 20 Vdc, f = 100 MHz) | All Types, Except | | 250 | — | |
| | 2N2219A, 2N2222A | | 300 | — | |
| Output Capacitance(3) | | $C_{obo}$ | — | 8.0 | pF |
| ($V_{CB}$ = 10 Vdc, $I_E$ = 0, f = 1.0 MHz) | | | | | |
| Input Capacitance(3) | | $C_{ibo}$ | | | pF |
| ($V_{EB}$ = 0.5 Vdc, $I_C$ = 0, f = 1.0 MHz) | Non-A Suffix | | — | 30 | |
| | A-Suffix | | — | 25 | |
| Input Impedance | | $h_{ie}$ | | | kohms |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | 2N2218A | | 1.0 | 3.5 | |
| | 2N2219A, 2N2222A | | 2.0 | 8.0 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | 2N2218A | | 0.2 | 1.0 | |
| | 2N2219A, 2N2222A | | 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) | 2N2218A | | — | 5.0 | |
| | 2N2219A, 2N2222A | | — | 8.0 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | 2N2218A | | — | 2.5 | |
| | 2N2219A, 2N2222A | | — | 4.0 | |
| Small-Signal Current Gain | | $h_{fe}$ | | | — |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | 2N2218A | | 30 | 150 | |
| | 2N2219A, 2N2222A | | 50 | 300 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | 2N2218A | | 50 | 300 | |
| | 2N2219A, 2N2222A | | 75 | 375 | |
| *Output Admittance* | | $h_{oe}$ | | | *μmhos* |
| ($I_C$ = 1.0 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | 2N2218A | | 3.0 | 15 | |
| | 2N2219A, 2N2222A | | 5.0 | 35 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 1.0 kHz) | 2N2218A | | 10 | 100 | |
| | 2N2219A, 2N2222A | | 15 | 200 | |
| *Collector Base Time Constant* | | $rb'C_c$ | — | 150 | *ps* |
| ($I_E$ = 20 mAdc, $V_{CB}$ = 20Vdc, f = 31.8 MHz) | A-Suffix | | | | |
| Noise Figure | | NF | — | 4.0 | dB |
| ($I_C$ = 100 μAdc, $V_{CE}$ = 10 Vdc, | | | | | |
| $R_S$ = 1.0 kohm, f = 1.0 kHz) | 2N2222A | | | | |
| Real Part of Common-Emitter | | $Re(h_{je})$ | — | 60 | Ohms |
| High Frequency Input Impedance | | | | | |
| ($I_C$ = 20 mAdc, $V_{CE}$ = 20 Vdc, f = 300 MHz) | 2N2218A, 2N2219A | | | | |
| | 2N2222A | | | | |

(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.
(3) 2N5581 and 2N5582 are Listed $C_{cb}$ and $C_{eb}$ for these conditions and values.

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS** | | | | | |
| Delay Time | ($V_{CC}$ = 30 Vdc, $V_{BE(off)}$ = −0.5 Vdc, $I_C$ = 150 mAdc, $I_{B1}$ = 15 mAdc) (Figure 12) | $t_d$ | — | 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 13) | $t_s$ | — | 225 | ns |
| Fall Time | | $t_f$ | — | 60 | ns |
| Active Region Time Constant ($I_C$ = 150 mAdc, $V_{CE}$ = 30 Vdc) (See Figure 11 for 2N2218A, 2N2219A, 2N2221A, 2N2222A) | | $T_A$ | — | 2.5 | ns |

3

FIGURE 1 – NORMALIZED DC CURRENT GAIN

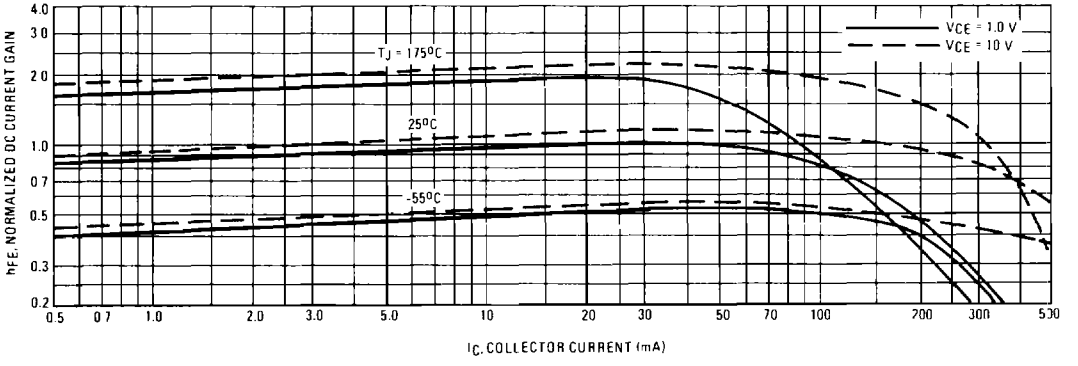
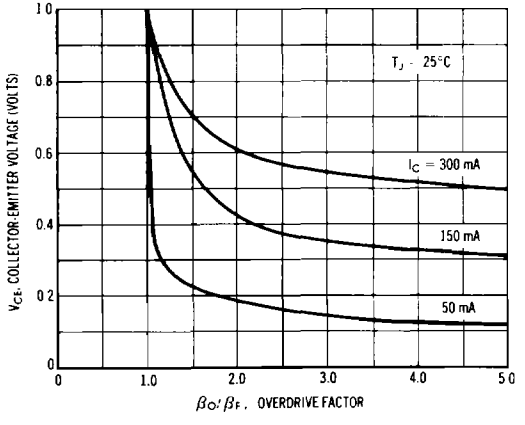



FIGURE 2 – COLLECTOR CHARACTERISTICS IN SATURATION REGION




This graph shows the effect of base current on collector current. $\beta_o$ (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and $\beta_f$ (forced gain) is the ratio of $I_c/I_b$ in a circuit.

EXAMPLE: For type 2N2219, estimate a base current ($I_b$) to insure saturation at a temperature of 25°C and a collector current of 150 mA.

Observe that at $I_c$ = 150 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 approximately 0.62 of $h_{fe}$ @ 10 volts. Using the guaranteed minimum gain of 100 @ 150 mA and 10 V, $\beta_o$ = 62 and substituting values in the overdrive equation, we find:

$$\frac{\beta_o}{\beta_f} = \frac{h_{fe}\ @\ 1.0\ V}{I_c/I_b} \qquad 2.5 = \frac{62}{150/I_b} \qquad I_b \approx 6.0\ mA$$

FIGURE 3 – "ON" VOLTAGES

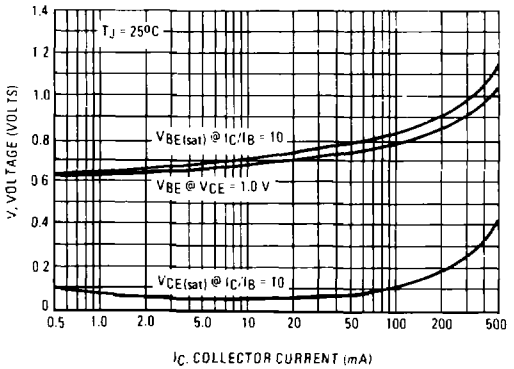
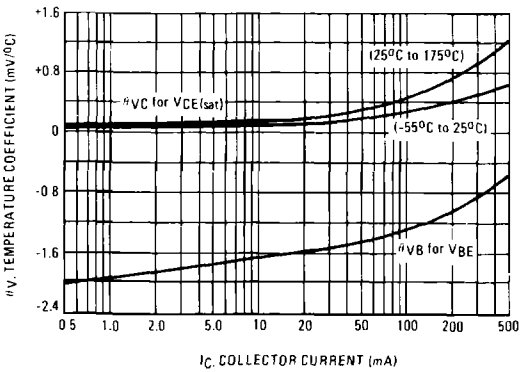



FIGURE 4 – TEMPERATURE COEFFICIENTS




3

## h PARAMETERS

$V_{CE}$ = 10 Vdc, f = 1.0 kHz, $T_A$ = 25°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 and the same units were used to develop the correspondingly numbered curves on each graph.

FIGURE 5 — INPUT IMPEDANCE

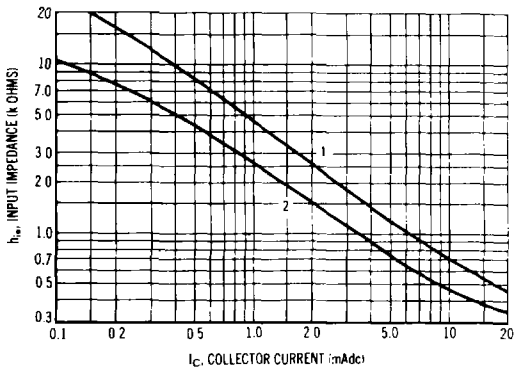



FIGURE 6 — VOLTAGE FEEDBACK RATIO

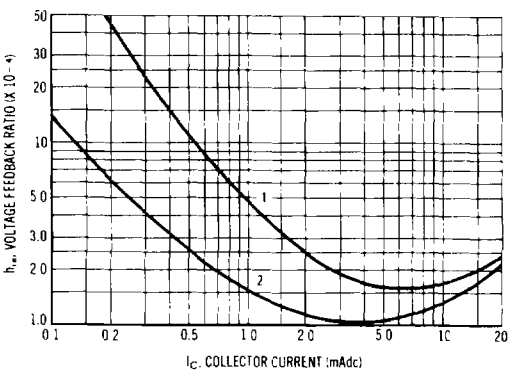



FIGURE 7 — CURRENT GAIN

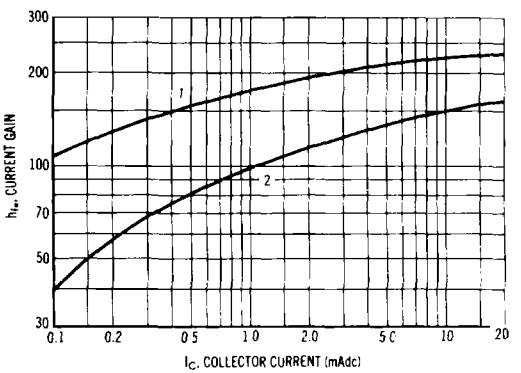
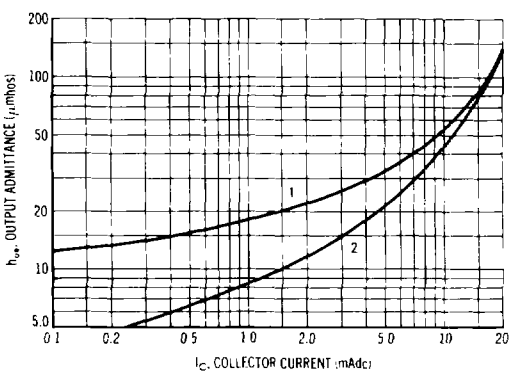



FIGURE 8 — OUTPUT ADMITTANCE



## SWITCHING TIME CHARACTERISTICS

FIGURE 9 — TURN-ON TIME

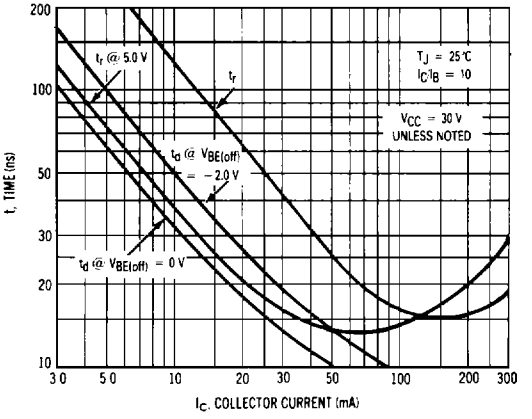



FIGURE 10 — CHARGE DATA

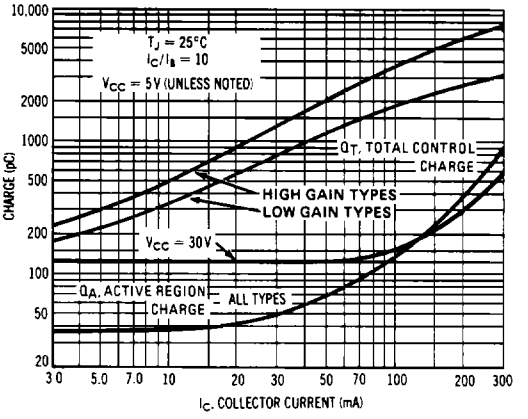



FIGURE 11 — TURN-OFF BEHAVIOR

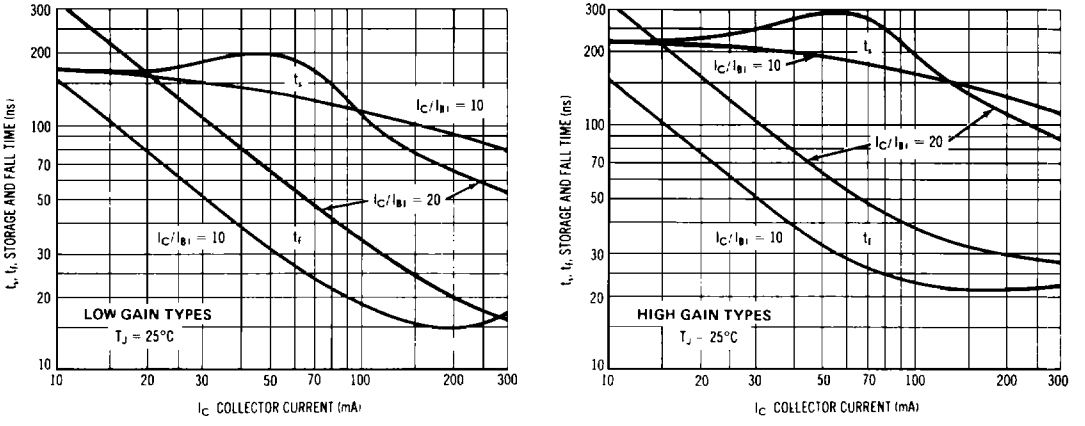



FIGURE 12 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

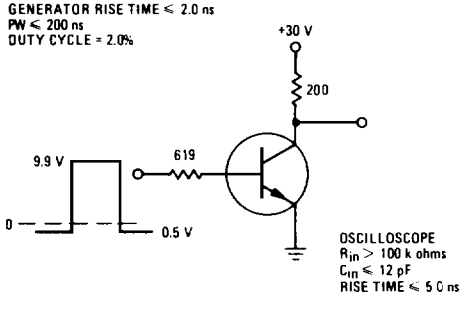



FIGURE 13 — STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT