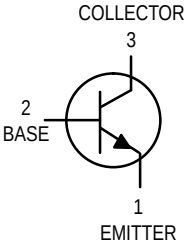
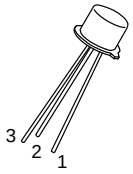
# Switching Transistors
## NPN Silicon

**2N2369**
**2N2369A***

***Motorola Preferred Device**




**CASE 22–03, STYLE 1**
**TO–18 (TO–206AA)**

**MAXIMUM RATINGS**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector–Emitter Voltage | $V_{CEO}$ | 15 | Vdc |
| Collector–Emitter Voltage | $V_{CES}$ | 40 | Vdc |
| Collector–Base Voltage | $V_{CBO}$ | 40 | Vdc |
| Emitter–Base Voltage | $V_{EBO}$ | 4.5 | Vdc |
| Collector Current (10 μs pulse) | $I_{C(Peak)}$ | 500 | mA |
| Collector Current — Continuous | $I_C$ | 200 | mA |
| 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 @ $T_C$ = 100°C<br>Derate above 100°C | $P_D$ | 0.68<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 | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 486 | °C/W |
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 147 | °C/W |

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector–Emitter Breakdown Voltage ($I_C$ = 10 μA, $V_{BE}$ = 0) | | $V_{(BR)CES}$ | 40 | — | Vdc |
| Collector–Emitter Sustaining Voltage(1) ($I_C$ = 10 mAdc, $I_B$ = 0) | | $V_{CEO(sus)}$ | 15 | — | Vdc |
| Collector–Base Breakdown Voltage ($I_C$ = 10 μA, $I_B$ = 0) | | $V_{(BR)CBO}$ | 40 | — | Vdc |
| Emitter–Base Breakdown Voltage ($I_E$ = 10 μAdc, $I_C$ = 0) | | $V_{(BR)EBO}$ | 4.5 | — | Vdc |
| Collector Cutoff Current | | $I_{CBO}$ | | | μAdc |
| ($V_{CB}$ = 20 Vdc, $I_E$ = 0) | 2N2369 | | — | 0.4 | |
| ($V_{CB}$ = 20 Vdc, $I_E$ = 0, $T_A$ = 150°C) | 2N2369A | | — | 30 | |
| Collector Cutoff Current<br>($V_{CE}$ = 20 Vdc, $V_{BE}$ = 0) | 2N2369A | $I_{CES}$ | — | 0.4 | μAdc |
| Base Current<br>($V_{CE}$ = 20 Vdc, $V_{BE}$ = 0) | 2N2369A | $I_B$ | — | 0.4 | μAdc |

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

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

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

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain(1) | | $h_{FE}$ | | | — |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N2369 | | 40 | 120 | |
| | 2N2369A | | — | 120 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc, $T_A$ = –55°C) | 2N2369 | | 20 | — | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 0.35 Vdc, $T_A$ = –55°C) | 2N2369A | | 20 | — | |
| ($I_C$ = 30 mAdc, $V_{CE}$ = 0.4 Vdc) | 2N2369A | | 30 | — | |
| ($I_C$ = 100 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N2369A | | 20 | — | |
| ($I_C$ = 100 mAdc, $V_{CE}$ = 2.0 Vdc) | 2N2369 | | 20 | — | |
| Collector–Emitter Saturation Voltage(1) | | $V_{CE(sat)}$ | | | Vdc |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | 2N2369 | | — | 0.25 | |
| | 2N2369A | | — | 0.20 | |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc, $T_A$ = +125°C) | 2N2369A | | — | 0.30 | |
| ($I_C$ = 30 mAdc, $I_B$ = 3.0 mAdc) | 2N2369A | | — | 0.25 | |
| ($I_C$ = 100 mAdc, $I_B$ = 10 mAdc) | 2N2369A | | — | 0.50 | |
| Base–Emitter Saturation Voltage(1) | | $V_{BE(sat)}$ | | | Vdc |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc) | All Types | | 0.70 | 0.85 | |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc, $T_A$ = +125°C) | 2N2369A | | 0.59 | — | |
| ($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc, $T_A$ = –55°C) | 2N2369A | | — | 1.02 | |
| ($I_C$ = 30 mAdc, $I_B$ = 3.0 mAdc) | 2N2369A | | — | 1.15 | |
| ($I_C$ = 100 mAdc, $I_B$ = 10 mAdc) | 2N2369A | | — | 1.60 | |
| **SMALL–SIGNAL CHARACTERISTICS** | | | | | |
| Current–Gain — Bandwidth Product ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 100 MHz) | | $f_T$ | 500 | — | MHz |
| Output Capacitance ($V_{CB}$ = 5.0 Vdc, $I_E$ = 0, f = 1.0 MHz) | | $C_{obo}$ | — | 4.0 | pF |
| Input Capacitance ($V_{EB}$ = 1.0 Vdc, $I_C$ = 0, f = 1.0 MHz) | | $C_{ibo}$ | — | 4.0 | pF |
| **SWITCHING CHARACTERISTICS** | | | | | |
| Storage Time ($I_C$ = $I_{B1}$ = 10 mAdc, $I_{B2}$ = –10 mAdc) | | $t_s$ | — | 13 | ns |
| Turn–On Time ($I_C$ = 10 mAdc, $I_{B1}$ = 3.0 mA, $I_{B2}$ = –1.5 mA, $V_{CC}$ = 3.0 Vdc) | | $t_{on}$ | — | 12 | ns |
| Turn–Off Time ($I_C$ = 10 mAdc, $I_{B1}$ = 3.0 mA, $I_{B2}$ = –1.5 mA, $V_{CC}$ = 3.0 Vdc) | | $t_{off}$ | — | 18 | ns |

1. Pulse Test: Pulse Width $\leq$ 300 μs, Duty Cycle $\leq$ 2.0%.

## SWITCHING TIME EQUIVALENT TEST CIRCUITS FOR 2N2369, 2N3227

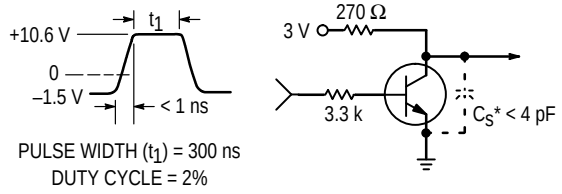



**Figure 1. $t_{on}$ Circuit — 10 mA**

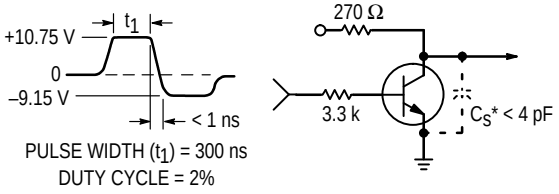



**Figure 3. $t_{off}$ Circuit — 10 mA**

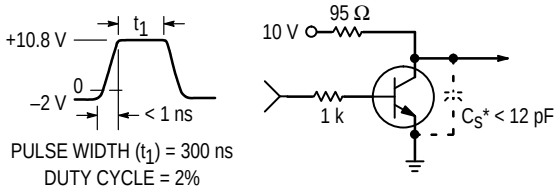



**Figure 2. $t_{on}$ Circuit — 100 mA**

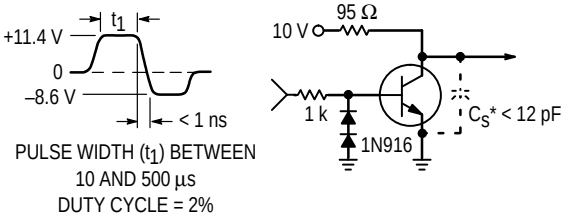



**Figure 4. $t_{off}$ Circuit — 100 mA**

* Total shunt capacitance of test jig and connectors.

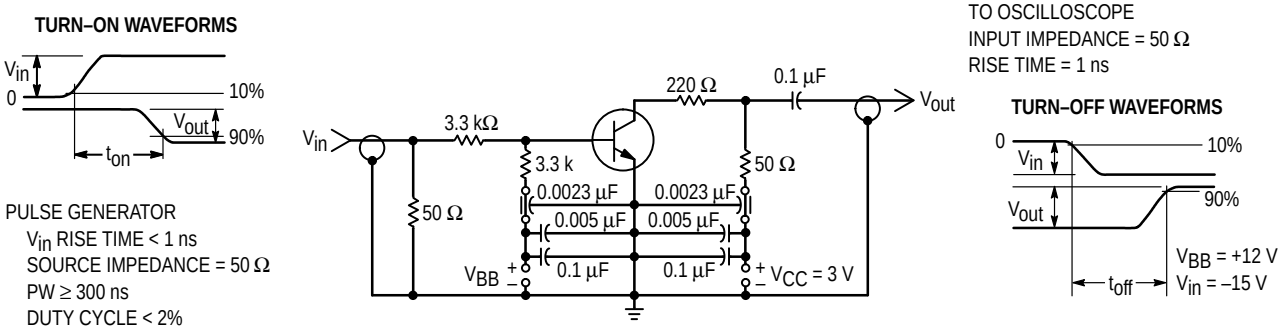



**Figure 5. Turn–On and Turn–Off Time Test Circuit**

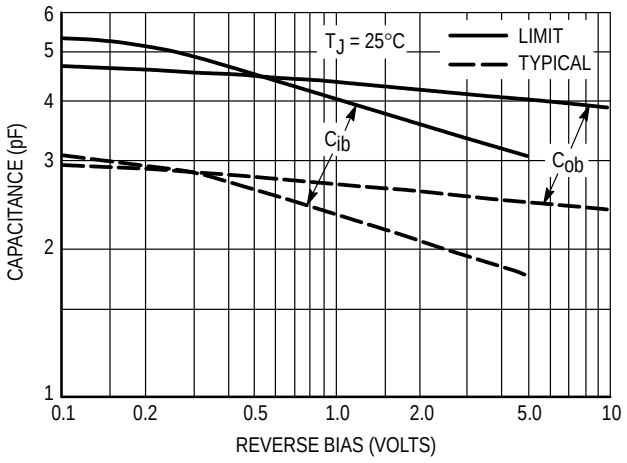



**Figure 6. Junction Capacitance Variations**

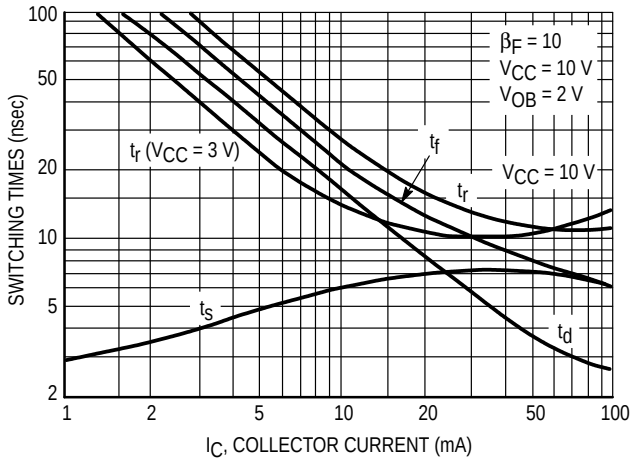



**Figure 7. Typical Switching Times**

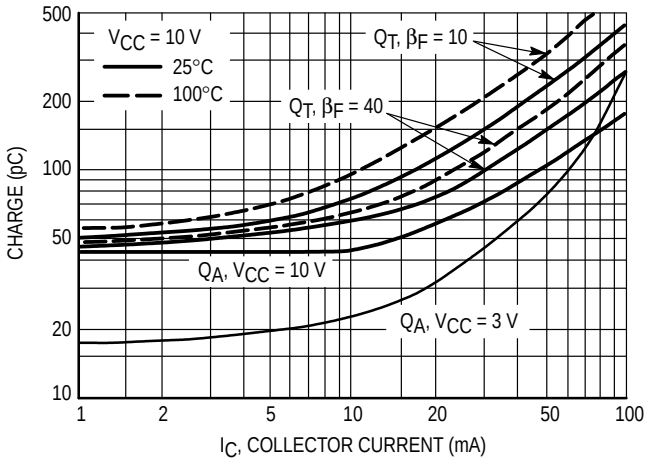



**Figure 8. Maximum Charge Data**

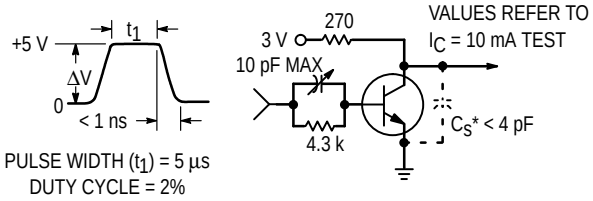



**Figure 9. $Q_T$ Test Circuit**

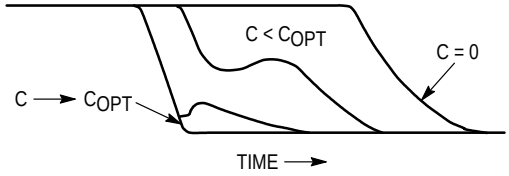



**Figure 10. Turn–Off Waveform**

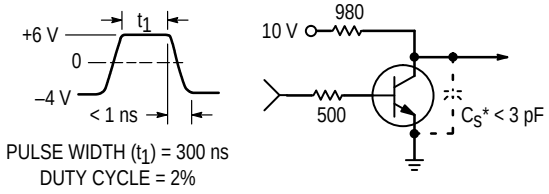



**Figure 11. Storage Time Equivalent Test Circuit**

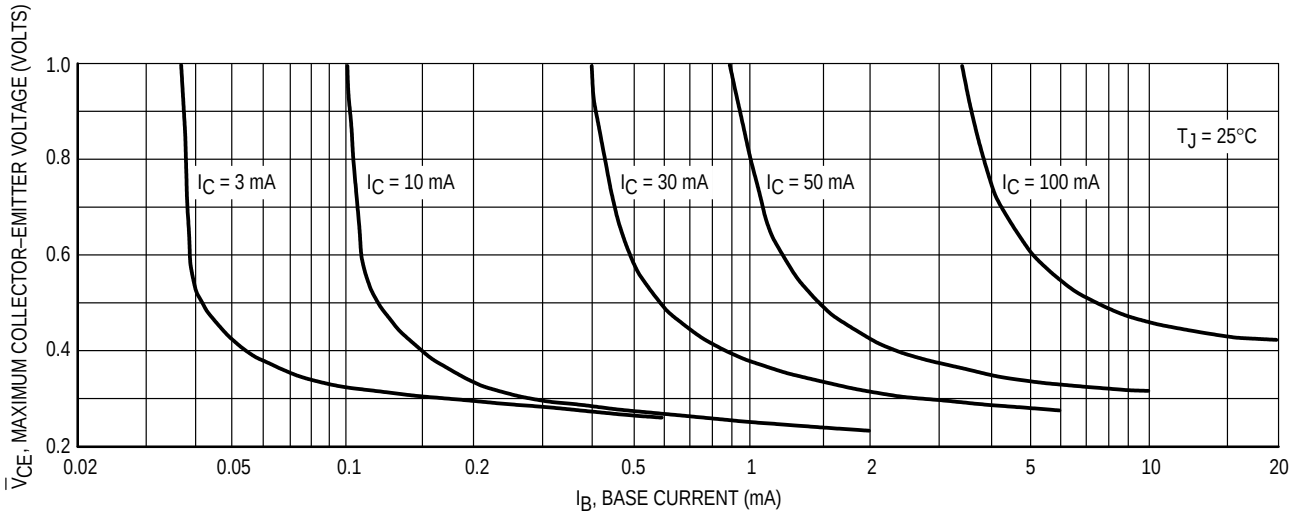



**Figure 12. Maximum Collector Saturation Voltage Characteristics**

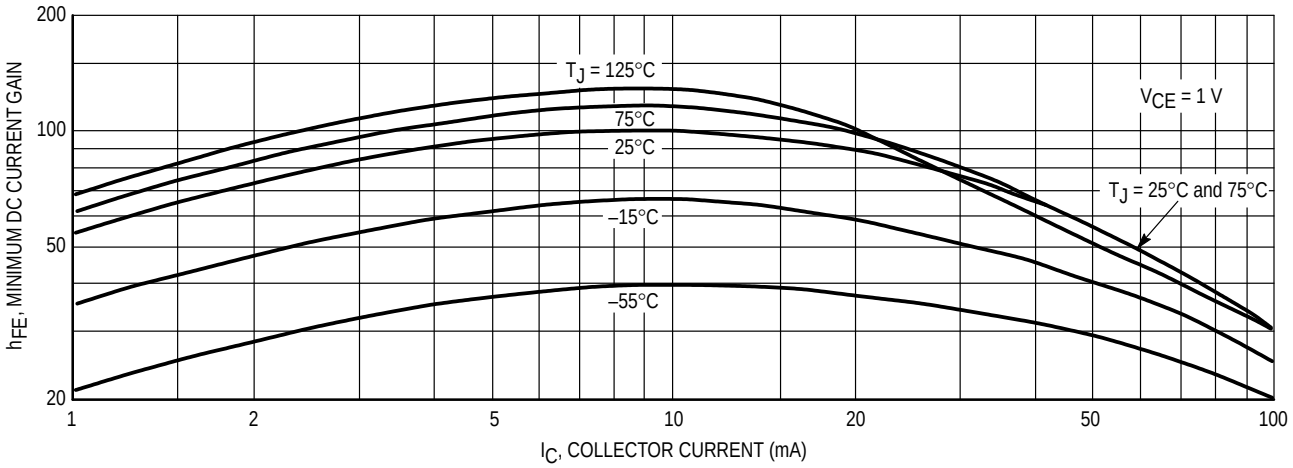



**Figure 13. Minimum Current Gain Characteristics**

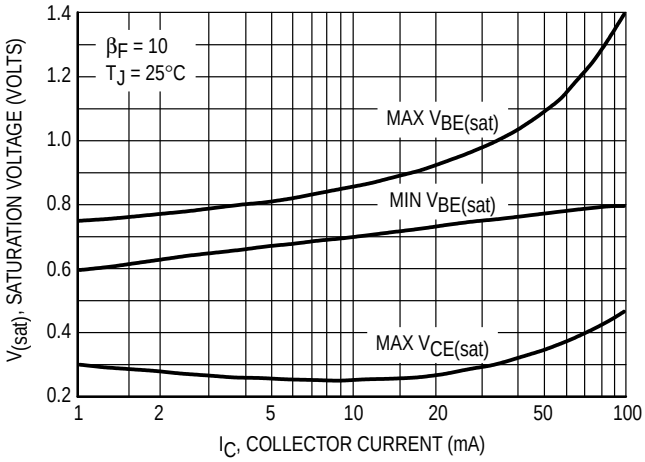



**Figure 14. Saturation Voltage Limits**

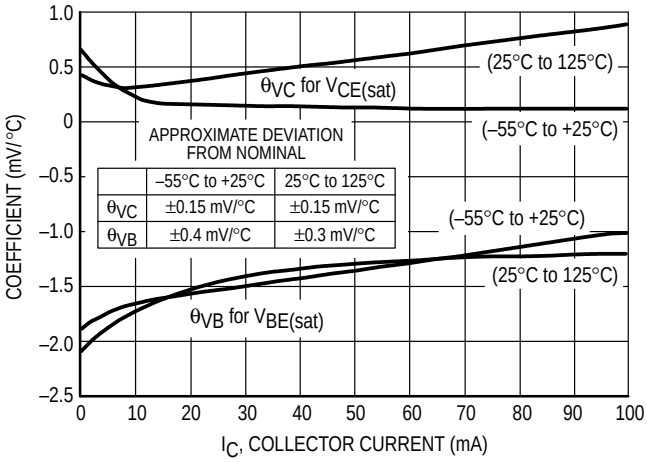
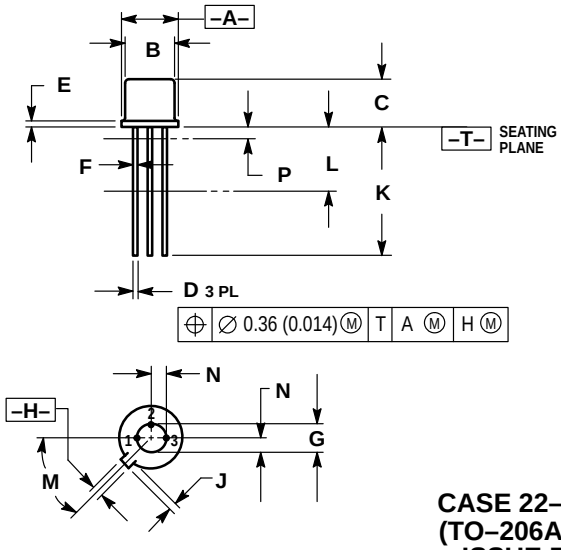



**Figure 15. Typical Temperature Coefficients**

## PACKAGE DIMENSIONS




**CASE 22–03**
**(TO–206AA)**
**ISSUE R**

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

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.
5. DIMENSION E INCLUDES THE TAB THICKNESS. (TAB THICKNESS IS 0.51(0.002) MAXIMUM).

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.209 | 0.230 | 5.31 | 5.84 |
| B | 0.178 | 0.195 | 4.52 | 4.95 |
| C | 0.170 | 0.210 | 4.32 | 5.33 |
| D | 0.016 | 0.021 | 0.406 | 0.533 |
| E | — | 0.030 | — | 0.762 |
| F | 0.016 | 0.019 | 0.406 | 0.483 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.036 | 0.046 | 0.914 | 1.17 |
| J | 0.028 | 0.048 | 0.711 | 1.22 |
| K | 0.500 | — | 12.70 | — |
| L | 0.250 | — | 6.35 | — |
| M | 45 ° BSC | | 45 ° BSC | |
| N | 0.050 BSC | | 1.27 BSC | |
| P | — | 0.050 | — | 1.27 |



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