MOTOROLA

# 2N2369 (SILICON)
# 2N3227

**CASE 22**
(TO-18)

NPN silicon annular transistors for low-current, high-speed switching applications.

Collector connected to case

## MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector-Base Voltage | $V_{CB}$ | 40 | Vdc |
| Collector-Emitter Voltage | $V_{CES}$ | 40 | Vdc |
| Collector-Emitter Voltage 2N2369<br>2N3227 | $V_{CEO}$ | 15<br>20 | Vdc |
| Emitter-Base Voltage 2N2369<br>2N3227 | $V_{EB}$ | 4.5<br>6.0 | Vdc |
| Collector Current (10 $\mu$sec pulse) | $I_{C(Peak)}$ | 500 | mA |
| Total Device Dissipation<br>@ 25°C Ambient Temperature<br>Derating Factor Above 25°C | $P_D$ | <br>0.36<br>2.06 | <br>Watt<br>mW/°C |
| Total Device Dissipation<br>@ 25°C Case Temperature<br>Derating Factor Above 25°C | $P_D$ | <br>1.2<br>6.85 | <br>Watts<br>mW/°C |
| Junction Temperature, Operating | $T_J$ | +200 | °C |
| Storage Temperature Range | $T_{stg}$ | -65 to +200 | °C |



## SWITCHING TIME EQUIVALENT TEST CIRCUITS

**FIGURE 1 – $t_{on}$ CIRCUIT – 10 mA**

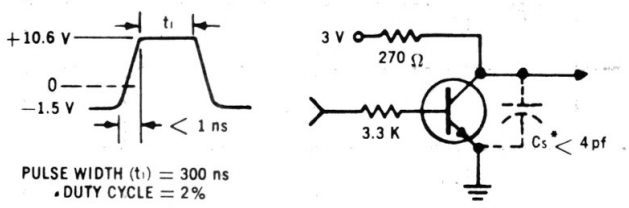



**FIGURE 2 – $t_{on}$ CIRCUIT – 100 mA**

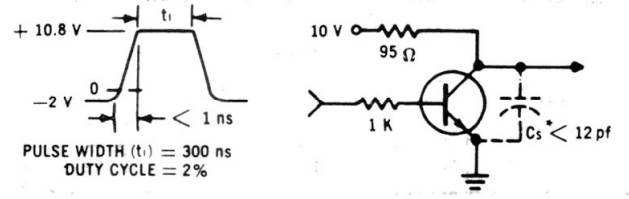



**FIGURE 3 – $t_{off}$ CIRCUIT – 10 mA**

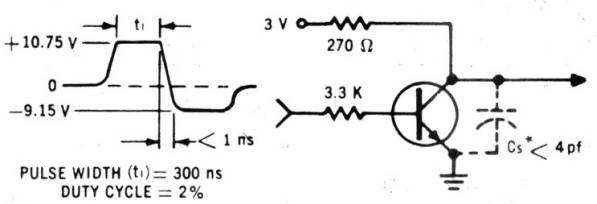
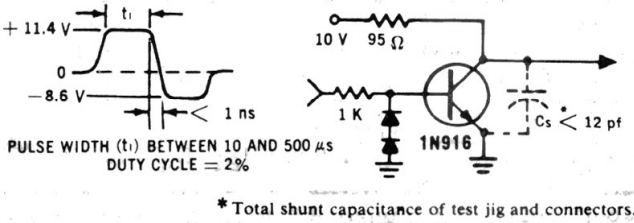



**FIGURE 4 – $t_{off}$ CIRCUIT – 100 mA**




* Total shunt capacitance of test jig and connectors.

## ELECTRICAL CHARACTERISTICS

| Characteristic | | Fig. No. | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|---|
| Collector Cutoff Current ($V_{CB}$ = 20 Vdc) | 2N2369 | | $I_{CBO}$ | — | 0.4 | μAdc |
| | 2N3227 | | | — | 0.2 | |
| ($V_{CB}$ = 20 Vdc, $T_A$ = 150°C) | 2N2369 | | | — | 30 | |
| | 2N3227 | | | — | 50 | |
| Collector Cutoff Current ($V_{CE}$ = 20 Vdc, $V_{EB(off)}$ = 3 Vdc) | 2N3227 | | $I_{CEX}$ | — | 0.2 | μAdc |
| Base Cutoff Current ($V_{CE}$ = 20 Vdc, $V_{EB(off)}$ = 3 Vdc) | 2N3227 | | $I_{BL}$ | — | 0.5 | μAdc |
| Collector-Base Breakdown Voltage ($I_C$ = 10μ Adc, $I_B$ = 0) | | | $BV_{CBO}$ | 40 | — | Vdc |
| Emitter-Base Breakdown Voltage ($I_E$ = 10μ Adc, $I_C$ = 0) | 2N2369 | | $BV_{EBO}$ | 4.5 | — | Vdc |
| | 2N3227 | | | 6.0 | — | |
| Collector-Emitter Breakdown Voltage * ($I_C$ = 10 mAdc) | 2N2369 | | $BV_{CEO}$* | 15 | — | Vdc |
| | 2N3227 | | | 20 | — | |
| Collector-Emitter Voltage ($I_C$ = 10μ Adc, $I_B$ = 0) | | | $BV_{CES}$ | 40 | — | Vdc |
| Collector-Emitter Saturation Voltage * ($I_C$ = 10 mAdc, $I_B$ = 1 mAdc) | Both Types | 11,13 | $V_{CE(sat)}$* | — | 0.25 | Vdc |
| ($I_C$ = 100 mAdc, $I_B$ = 10 mAdc) | 2N3227 | | | — | 0.45 | |
| Base-Emitter Saturation Voltage * ($I_C$ = 10 mAdc, $I_B$ = 1 mAdc) | Both Types | 13 | $V_{BE(sat)}$* | 0.70 | 0.85 | Vdc |
| ($I_C$ = 100 mAdc, $I_B$ = 10 mAdc) | 2N3227 | | | 0.8 | 1.4 | |
| DC Current Gain* ($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N2369 | | $h_{FE}$* | 40 | 120 | — |
| | 2N3227 | 12 | | 100 | 300 | |
| ($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc, $T_A$ = -55°C) | 2N2369 | | | 20 | — | |
| | 2N3227 | 12 | | 40 | — | |
| ($I_C$ = 100 mAdc, $V_{CE}$ = 1.0 Vdc) | 2N3227 | 12 | | 30 | — | |
| ($I_C$ = 100 mAdc, $V_{CE}$ = 2 Vdc) | 2N2369 | | | 20 | — | |
| Small Signal Current Gain ($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 100 MHz) | | | $h_{fe}$ | 5 | — | — |
| Output Capacitance ($V_{CB}$ = 5 Vdc, $I_E$ = 0, f = 140 kHz) | | 5 | $C_{ob}$ | — | 4 | pF |
| Input Capacitance ($V_{BE}$ = 1 Vdc, $I_C$ = 0, f = 140 kHz) | 2N3227 | | $C_{ib}$ | | 4 | pF |
| Storage Time ($I_C$ = $I_{B1}$ = $I_{B2}$ = 10 mA) | | 10 | $t_s$ | — | 13 | ns |
| Turn-On Time ($I_C$ = 10 mA, $I_{B1}$ = 3 mA, $V_{CC}$ = 3 V, $V_{EB(off)}$ = 1.5 Vdc) | | 1,6 | $t_{on}$ | — | 12 | ns |
| Turn-Off Time ($I_C$ = 10 mA, $I_{B1}$ = 3 mA, $I_{B2}$ = 1.5 mA, $V_{CC}$ = 3 V) | | 3,6 | $t_{off}$ | — | 18 | ns |
| Total Control Charge ($I_C$ = 10 mA, $I_B$ = 1 mA, $V_{CC}$ = 3 V) | 2N3227 | 7,8 | $Q_T$ | — | 50 | pC |
| Delay Time | $V_{CC}$ = 10 V, $V_{EB(off)}$ = 2 Vdc, $I_C$ = 100 mA, $I_{B1}$ = 10 mA | 2,6 | $t_d$ | — | 5 | ns |
| Rise Time | | | $t_r$ | — | 18 | ns |
| Storage Time | $V_{CC}$ = 10 V, $I_C$ = 100 mA, $I_{B1}$ = $I_{B2}$ = 10 mA | 4,6 | $t_s$ | — | 13 | ns |
| Fall Time | | | $t_f$ | — | 15 | ns |

| | | | | | | |
|---|---|---|---|---|---|---|
| Delay Time | $V_{CC}$ = 10 V, $V_{EB(off)}$ = 2 Vdc, $I_C$ = 100 mA, $I_{B1}$ = 10 mA | 2N3227 | 2,6 | $t_d$ | — | 5 | ns |
| Rise Time | | | | $t_r$ | — | 18 | ns |
| Storage Time | $V_{CC}$ = 10 V, $I_C$ = 100 mA, $I_{B1}$ = $I_{B2}$ = 10 mA | 2N3227 | 4,6 | $t_s$ | — | 13 | ns |
| Fall Time | | | | $t_f$ | — | 15 | ns |

***Pulse Test:** Pulse Width = 300 μs, Duty Cycle = 2%

**FIGURE 5 — JUNCTION CAPACITANCE VARIATIONS**

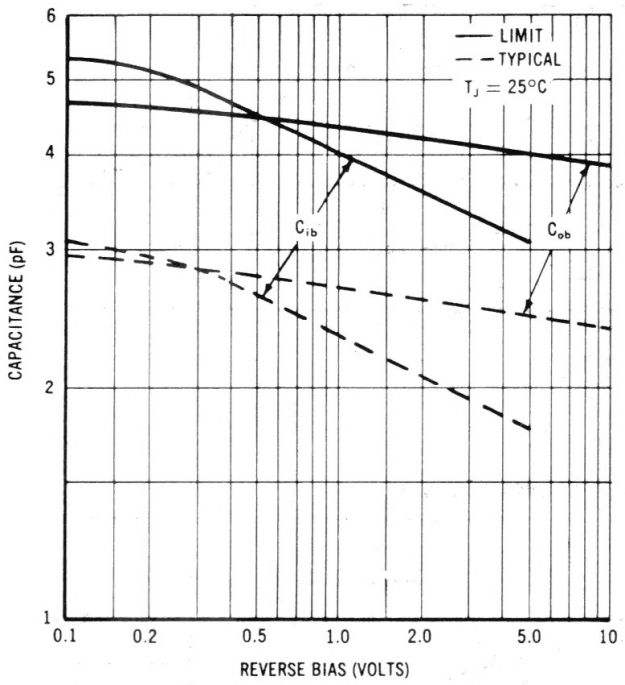



**FIGURE 6 — TYPICAL SWITCHING TIMES**

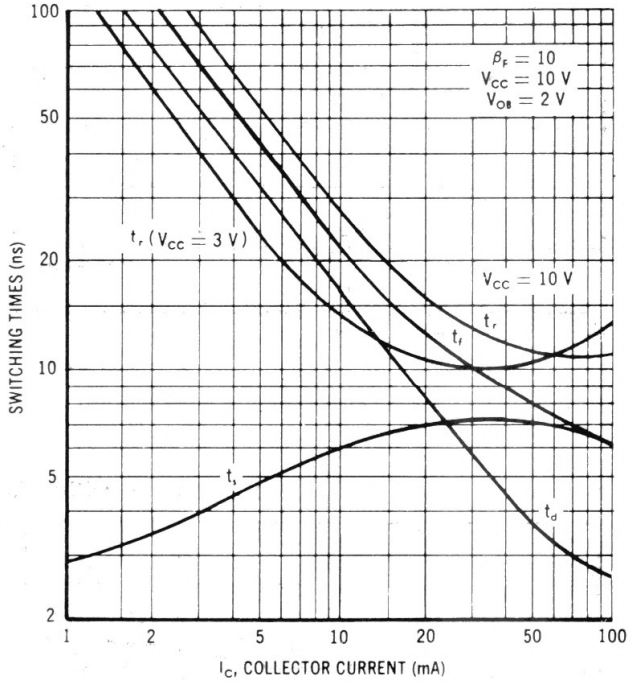



**FIGURE 7 — MAXIMUM CHARGE DATA**

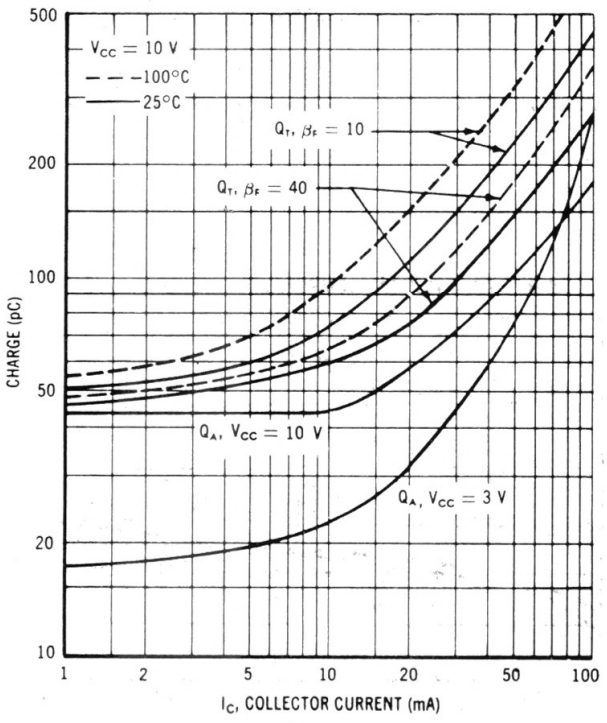



**FIGURE 8 — $Q_T$ TEST CIRCUIT**

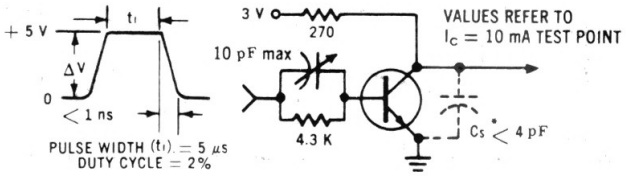



**FIGURE 9 — TURN-OFF WAVE FORM**

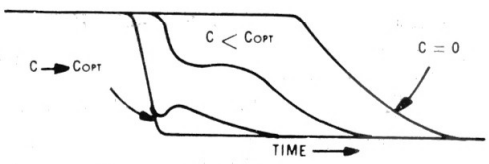
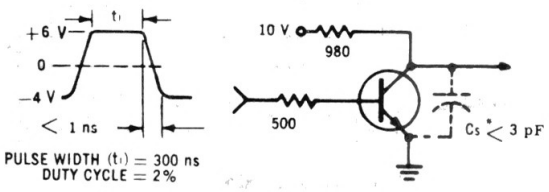



**FIGURE 10 — STORAGE TIME EQUIVALENT TEST CIRCUIT**




* Total shunt capacitance of test jig and connectors.

FIGURE 11 — MAXIMUM COLLECTOR SATURATION VOLTAGE CHARACTERISTICS

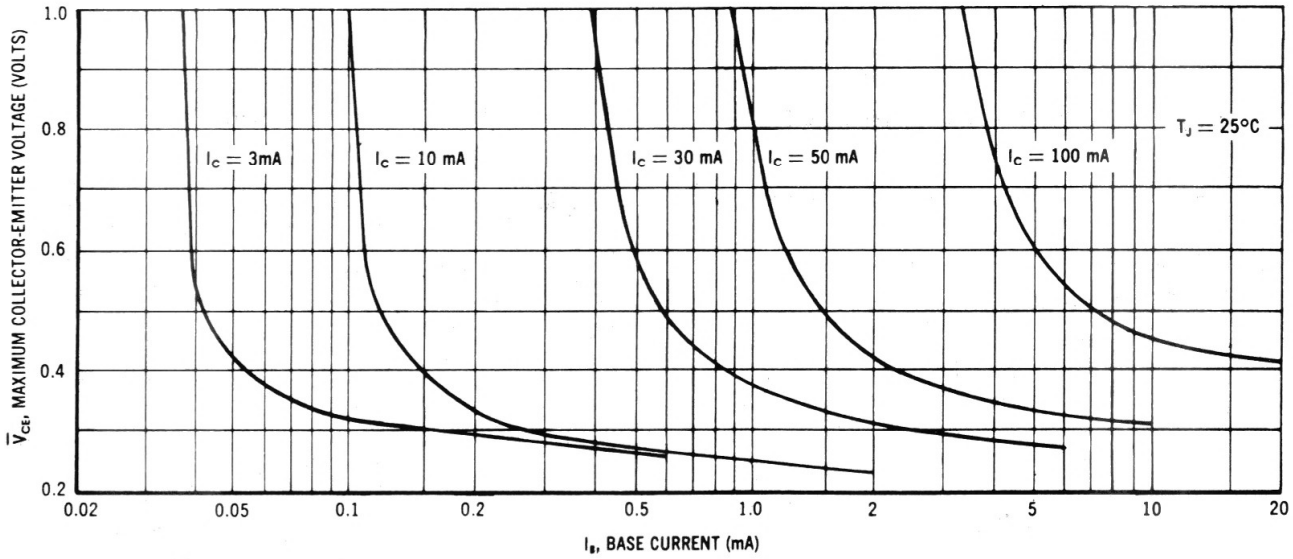



FIGURE 12 — MINIMUM CURRENT GAIN CHARACTERISTICS

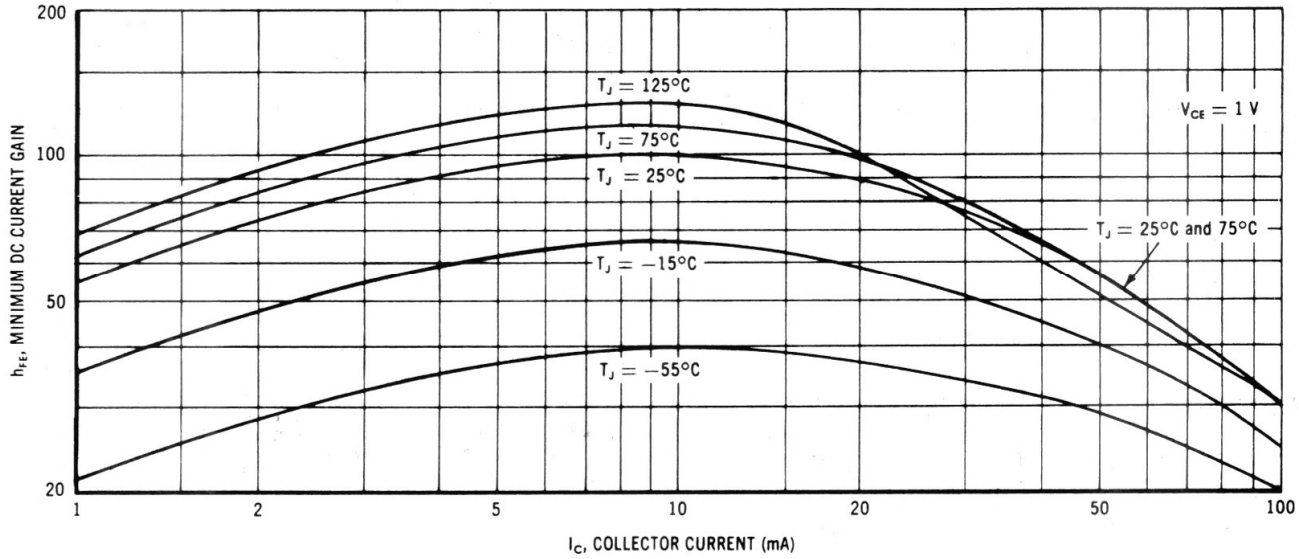



FIGURE 13 — SATURATION VOLTAGE LIMITS

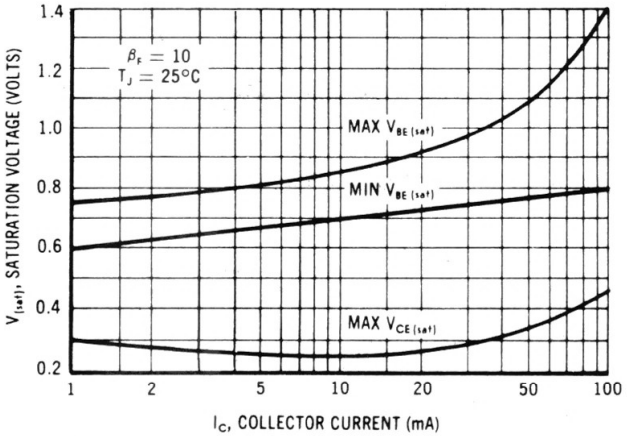



FIGURE 14 — TYPICAL TEMPERATURE COEFFICIENTS