# TYPES 2N4398, 2N4399
# P-N-P SINGLE-DIFFUSED SILICON POWER TRANSISTORS



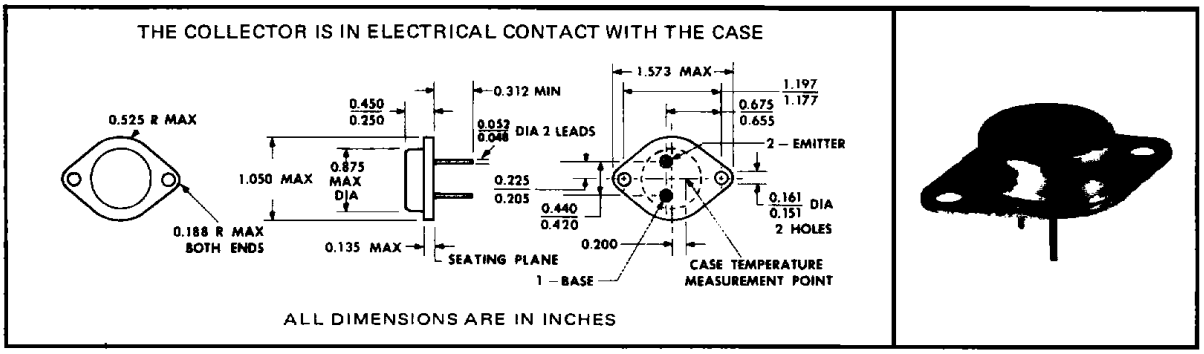


**FOR POWER-AMPLIFIER AND HIGH-SPEED-SWITCHING APPLICATIONS**
**DESIGNED FOR COMPLEMENTARY USE WITH 2N5301, 2N5302**

- **200 Watts at 25°C Case Temperature**
- **30 A Rated Continuous Collector Current**
- **Min $f_T$ of 4 MHz at 10 V, 1 A**

***mechanical data**

The case outline is the same as JEDEC TO-3 except for lead diameter.




**absolute maximum ratings at 25°C case temperature (unless otherwise noted)**

| | 2N4398 | 2N4399 |
|---|---|---|
| *Collector-Base Voltage | -40 V | -60 V |
| *Collector-Emitter Voltage (See Note 1) | -40 V | -60 V |
| *Collector-Emitter Voltage (See Note 2) | -40 V | -60 V |
| *Emitter-Base Voltage | ← -5 V → | |
| *Continuous Collector Current | ← -30 A → | |
| *Peak Collector Current (See Note 3) | ← -50 A → | |
| *Continuous Base Current | ← -7.5 A → | |
| *Peak Base Current (See Note 3) | ← -15 A → | |
| Safe Operating Region at (or below) 25°C Case Temperature | See Figure 2 | |
| *Continuous Device Dissipation at (or below) 25°C Case Temperature (See Note 4) | ← 200 W → | |
| Continuous Device Dissipation at (or below) 25°C Free-Air Temperature (See Note 5) | ← 5 W → | |
| *Operating Collector Junction Temperature Range | -65°C to 200°C | |
| *Storage Temperature Range | -65°C to 200°C | |
| *Lead Temperature 1/16 Inch from Case for 10 Seconds | ← 235°C → | |

NOTES: 1. These values apply when the base-emitter voltage $V_{BE}$ = 1.5 V.
2. These values apply when the base-emitter diode is open-circuited.
3. This value applies for $t_p \leq 0.3$ ms, duty cycle $\leq 10\%$.
4. Derate linearly to 200°C case temperature at the rate of 1.15 W/deg.
5. Derate linearly to 200°C free-air temperature at the rate of 28.6 mW/deg.

*Indicates JEDEC registered data

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## *electrical characteristics at 25°C case temperature (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | 2N4398 MIN | 2N4398 MAX | 2N4399 MIN | 2N4399 MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage | $I_C$ = -200 mA, $I_B$ = 0 | See Note 6 | -40 | | -60 | | V |
| $I_{CBO}$ | Collector Cutoff Current | $V_{CB}$ = -40 V, $I_E$ = 0 | | | -1 | | | mA |
| | | $V_{CB}$ = -60 V, $I_E$ = 0 | | | | | -1 | |
| $I_{CEO}$ | Collector Cutoff Current | $V_{CE}$ = -40 V, $I_B$ = 0 | | | -5 | | | mA |
| | | $V_{CE}$ = -60 V, $I_B$ = 0 | | | | | -5 | |
| $I_{CEV}$ | Collector Cutoff Current | $V_{CE}$ = -40 V, $V_{BE}$ = 1.5 V | | | -5 | | | mA |
| | | $V_{CE}$ = -60 V, $V_{BE}$ = 1.5 V | | | | | -5 | |
| | | $V_{CE}$ = -30 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C | | | -10 | | -10 | |
| $I_{EBO}$ | Emitter Cutoff Current | $V_{EB}$ = -5 V, $I_C$ = 0 | | | -5 | | -5 | mA |
| $h_{FE}$ | Static Forward Current Transfer Ratio | $V_{CE}$ = -2 V, $I_C$ = -1 A | See Notes 6 and 7 | 40 | | 40 | | |
| | | $V_{CE}$ = -4 V, $I_C$ = -15 A | | 15 | 60 | 15 | 60 | |
| | | $V_{CE}$ = -4 V, $I_C$ = -30 A | | 5 | | 5 | | |
| $V_{BE}$ | Base-Emitter Voltage | $I_B$ = -1.5 A, $I_C$ = -15 A | See Notes 6 and 7 | | -1.85 | | -1.85 | V |
| | | $V_{CE}$ = -2 V, $I_C$ = -15 A | | | -1.7 | | -1.7 | |
| | | $V_{CE}$ = -4 V, $I_C$ = -30 A | | | -3 | | -3 | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_B$ = -1 A, $I_C$ = -10 A | See Notes 6 and 7 | | -0.75 | | -0.75 | V |
| | | $I_B$ = -1.5 A, $I_C$ = -15 A | | | -1 | | -1 | |
| | | $I_B$ = -6 A, $I_C$ = -30 A | | | -4 | | -4 | |
| $h_{fe}$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{CE}$ = -10 V, $I_C$ = -1 A, f = 1 kHz | | 40 | | 40 | | |
| $\|h_{fe}\|$ | Small-Signal Common-Emitter Forward Current Transfer Ratio | $V_{CE}$ = -10 V, $I_C$ = -1 A, f = 1 MHz | | 4 | | 4 | | |

NOTES: 6. These parameters must be measured using pulse techniques, $t_p$ = 300 μs, duty cycle ≤ 2%.

7. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

## thermal characteristics

| PARAMETER | | MAX | UNIT |
|---|---|---|---|
| $\theta_{J-C}$ | Junction-to-Case Thermal Resistance | 0.875 | deg/W |
| $\theta_{J-A}$ | Junction-to-Free-Air Thermal Resistance | 35 | |

## *switching characteristics at 25°C case temperature

| PARAMETER | | TEST CONDITIONS† | MAX | UNIT |
|---|---|---|---|---|
| $t_r$ | Rise Time | $I_C$ = -10 A, $I_{B(1)}$ = -1 A, $V_{BE(off)}$ = 2 V, $R_L$ = 3 Ω, See Figure 1 | 0.4 | μs |
| $t_s$ | Storage Time | $I_C$ = -10 A, $I_{B(1)}$ = -1 A, $I_{B(2)}$ = 1 A, $R_L$ = 3 Ω, See Figure 2 | 1.5 | |
| $t_f$ | Fall Time | | 0.6 | |

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

*Indicates JEDEC registered data



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## *PARAMETER MEASUREMENT INFORMATION

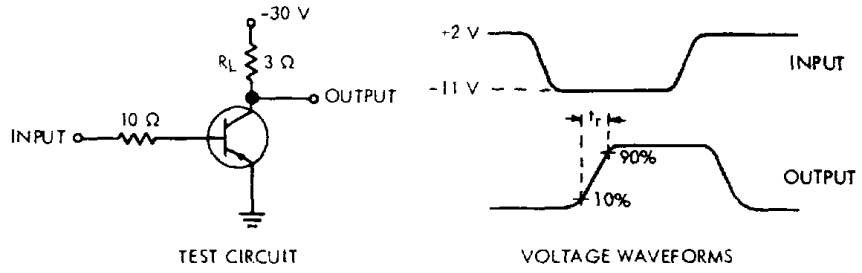


FIGURE 1 – RISE TIME

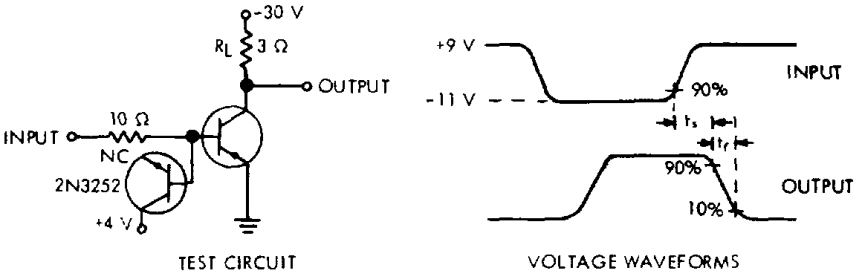


FIGURE 2 – STORAGE AND FALL TIMES

NOTES: a. The input waveforms have the following characteristics: $t_r \leq 20$ ns, $t_f \leq 20$ ns, $t_p$ = 10 μs to 100 μs, duty cycle ≤ 2%.
b. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 20$ ns, $R_{in} \geq 10$ kΩ, $C_{in} \leq 11.5$ pF.
c. Resistors must be noninductive types.
d. The d-c power supplies may require additional bypassing in order to minimize ringing.
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## MAXIMUM SAFE OPERATING REGION

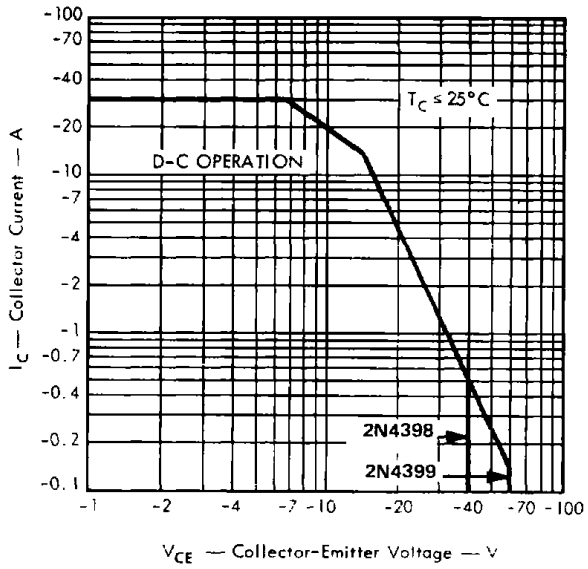


FIGURE 3

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## TYPICAL CHARACTERISTICS

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

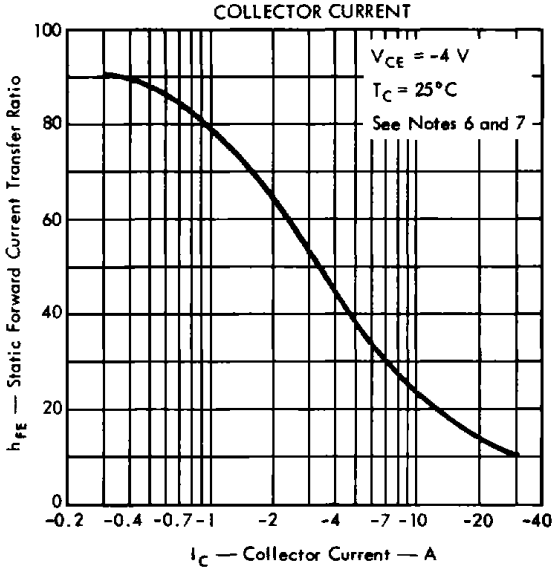


FIGURE 4

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

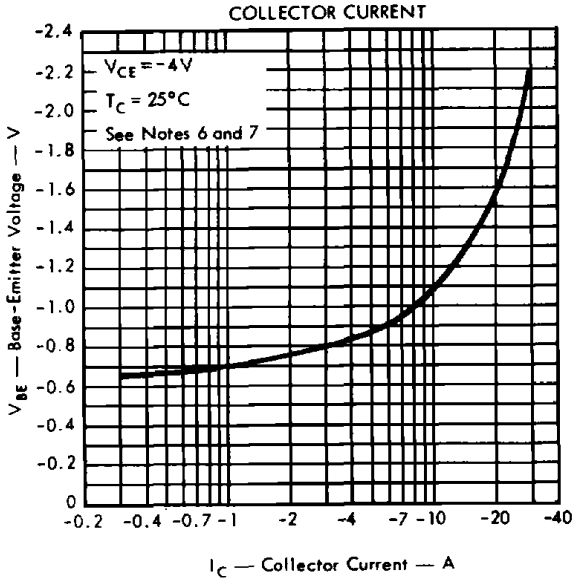


FIGURE 5

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

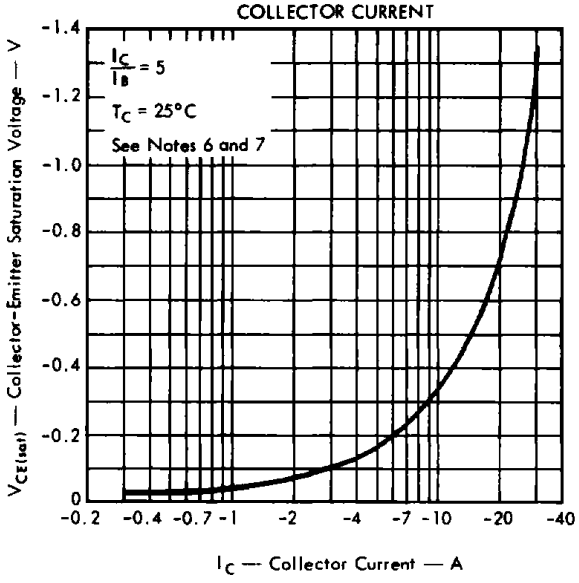


FIGURE 6

NOTES: 6. These parameters must be measured using pulse techniques. $t_p$ = 300 μs, duty cycle ≤ 2%.

7. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.



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