

# BSX88-BSX88A

## HIGH FREQUENCY, HIGH SPEED TYPES

### NPN DIFFUSED SILICON PLANAR TRANSISTORS

**GENERAL DESCRIPTION** - The BSX88 is an NPN Silicon PLANAR Epitaxial Transistor specially designed as high-speed saturated logic switch. It features 15 Volts  $V_{CE0}$ , low saturation voltages, low storage time, and a minimum  $f_T$  of 300 MHz.

For improved performance use the BSX88A.

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

##### Maximum Temperatures

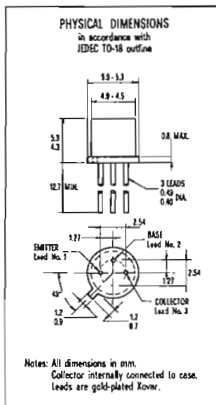
|           |                                                  |                 |
|-----------|--------------------------------------------------|-----------------|
| $T_{STG}$ | Storage Temperature                              | -55°C to +200°C |
| $T_J$     | Operating Junction Temperature                   | +200°C          |
| $T_L$     | Lead Temperature (Soldering, 10 sec. time limit) | +260°C          |

##### Maximum Power Dissipations (Notes 2 and 3)

|       |                                            |           |
|-------|--------------------------------------------|-----------|
| $P_D$ | Total Dissipation at 25°C Case Temperature | 1.2 Watt  |
|       | at 100°C Case Temperature                  | 0.68 Watt |
|       | at 25°C Ambient Temperature                | 0.36 Watt |

##### Maximum Voltages (25°C free air temperature)

|           | BSX88                                                          | BSX88A    |
|-----------|----------------------------------------------------------------|-----------|
| $V_{CBO}$ | Collector to Base Voltage                                      | 40 Volts  |
| $V_{CEO}$ | Collector to Emitter Voltage (Note 4)                          | 15 Volts  |
| $V_{CER}$ | Collector to Emitter Voltage ( $R_{BE} = 10 \Omega$ ) (Note 4) | 20 Volts  |
| $V_{EBO}$ | Emitter to Base Voltage                                        | 5 Volts   |
|           |                                                                | 5.5 Volts |



#### ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

| SYMBOL                           | CHARACTERISTIC                                          | BSX88 |      |      | BSX88A |      |      | UNIT          | TEST CONDITIONS                                   |
|----------------------------------|---------------------------------------------------------|-------|------|------|--------|------|------|---------------|---------------------------------------------------|
|                                  |                                                         | MIN.  | TYP. | MAX. | MIN.   | TYP. | MAX. |               |                                                   |
| $h_{FE}$                         | DC Current Gain                                         | 15    | 35   |      | 15     | 30   |      |               | $I_C = 0.5 \text{ mA}$ $V_{CE} = 1 \text{ V}$     |
| $h_{FE}$                         | DC Pulse Current Gain (Note 5)                          | 30    | 45   | 120  | 30     | 50   |      |               | $I_C = 10 \text{ mA}$ $V_{CE} = 1 \text{ V}$      |
| $h_{FE}$                         | DC Pulse Current Gain (Note 5)                          |       |      |      | 35     | 55   |      |               | $I_C = 100 \text{ mA}$ $V_{CE} = 1 \text{ V}$     |
| $h_{FE} (-55^\circ\text{C})$     | DC Pulse Current Gain (Note 5)                          | 15    | 25   |      | 15     | 25   |      |               | $I_C = 10 \text{ mA}$ $V_{CE} = 1 \text{ V}$      |
| $V_{BE sat} (-55^\circ\text{C})$ | Base Saturation Voltage (Note 5)                        |       | 0.86 | 0.9  |        | 0.9  |      | V             | $I_C = 7 \text{ mA}$ $I_B = 0.7 \text{ mA}$       |
| $V_{BE sat}$                     | Base Saturation Voltage (Note 5)                        | 0.72  | 0.77 | 0.8  | 0.72   | 0.77 | 0.8  | V             | $I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$        |
| $V_{BE sat}$                     | Base Saturation Voltage (Note 5)                        |       |      |      |        | 1.2  |      | V             | $I_C = 100 \text{ mA}$ $I_B = 10 \text{ mA}$      |
| $V_{CE sat}$                     | Collector Saturation Voltage (Note 5) (-55°C to +125°C) |       |      | 0.4  |        | 0.25 |      | V             | $I_C = 7 \text{ mA}$ $I_B = 0.7 \text{ mA}$       |
| $V_{CE sat}$                     | Collector Saturation Voltage (Note 5)                   |       |      | 0.4  | 0.15   | 0.18 |      | V             | $I_C = 10 \text{ mA}$ $I_B = 1 \text{ mA}$        |
| $V_{CE sat}$                     | Collector Saturation Voltage (Note 5)                   |       |      |      |        | 0.32 |      | V             | $I_C = 100 \text{ mA}$ $I_B = 10 \text{ mA}$      |
| $I_{CES}$                        | Collector Cutoff Current                                |       |      |      | 0.02   | 0.3  |      | $\mu\text{A}$ | $V_{CE} = 20 \text{ V}$ $V_{EB} = 0$              |
| $I_{CES} (125^\circ\text{C})$    | Collector Cutoff Current                                |       |      |      |        | 30   |      | $\mu\text{A}$ | $V_{CE} = 20 \text{ V}$ $V_{EB} = 0$              |
| $I_{CEX} (125^\circ\text{C})$    | Collector Cutoff Current                                |       |      | 10   |        |      |      | $\mu\text{A}$ | $V_{CE} = 20 \text{ V}$ $V_{BE} = 0.25 \text{ V}$ |
| $I_{EBO}$                        | Emitter Cutoff Current                                  |       |      | 0.1  |        |      |      | $\mu\text{A}$ | $I_C = 0$ $V_{EB} = 4 \text{ V}$                  |
| $I_{CBO}$                        | Collector Cutoff Current                                |       | 4    | 25   | 20     | 300  |      | nA            | $I_E = 0$ $V_{CB} = 20 \text{ V}$                 |
| $I_{CBO} (125^\circ\text{C})$    | Collector Cutoff Current                                |       | 1.5  | 15   |        | 30   |      | $\mu\text{A}$ | $I_E = 0$ $V_{CB} = 20 \text{ V}$                 |
| $BV_{CBO}$                       | Collector to Base Breakdown Voltage                     | 40    |      |      |        |      |      | V             | $I_C = 1 \text{ }\mu\text{A}$ $I_E = 0$           |
| $BV_{CBO}$                       | Collector to Base Breakdown Voltage                     |       |      |      | 40     |      |      | V             | $I_C = 100 \text{ }\mu\text{A}$ $I_E = 0$         |
| $BV_{EBO}$                       | Emitter to Base Breakdown Voltage                       | 5     |      |      |        |      |      | V             | $I_E = 10 \text{ }\mu\text{A}$ $I_C = 0$          |
| $BV_{EBO}$                       | Emitter to Base Breakdown Voltage                       |       |      |      | 5.5    |      |      | V             | $I_E = 100 \text{ }\mu\text{A}$ $I_C = 0$         |

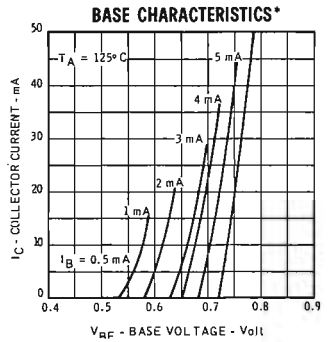
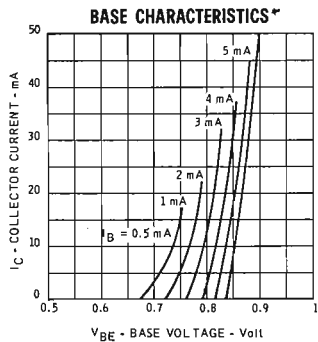
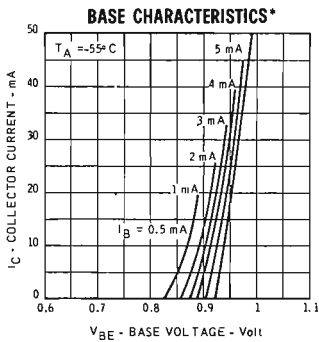
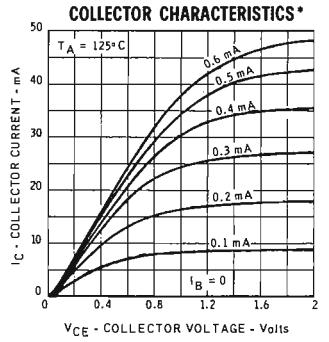
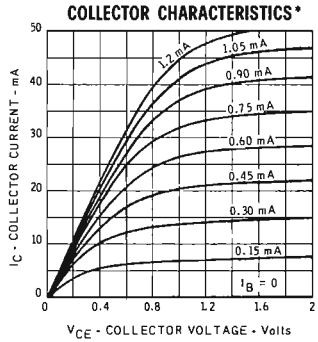
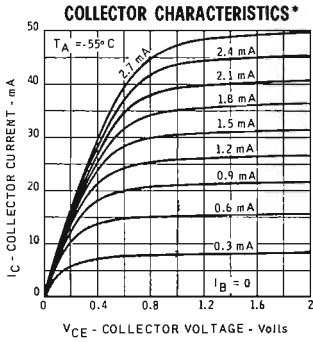
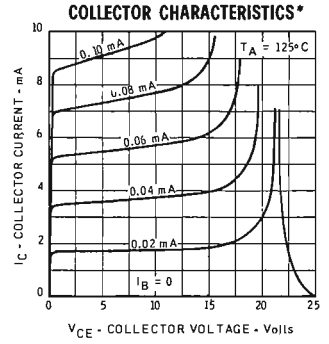
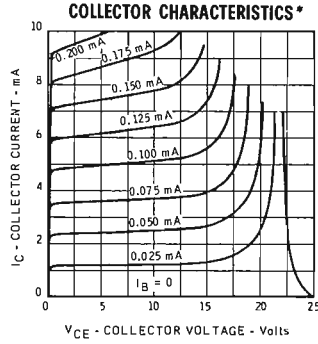
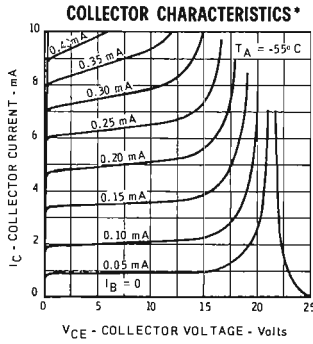
## ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

| SYMBOL            | CHARACTERISTIC                                             | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. | UNIT | TEST CONDITIONS                                                           |
|-------------------|------------------------------------------------------------|------|------|------|------|------|------|------|---------------------------------------------------------------------------|
| LV <sub>CER</sub> | Collector to Emitter Sustaining Voltage<br>(Notes 4 and 5) | 20   |      |      |      |      |      | V    | I <sub>C</sub> = 30 mA<br>(pulsed)<br>R <sub>BE</sub> ≤ 10 Ω              |
| LV <sub>CEO</sub> | Collector to Emitter Sustaining Voltage<br>(Notes 4 and 5) | 15   |      |      |      |      |      | V    | I <sub>C</sub> = 30 mA<br>(pulsed)<br>I <sub>B</sub> = 0                  |
| LV <sub>CEO</sub> | Collector to Emitter Sustaining Voltage<br>(Notes 4 and 5) |      |      | 20   |      |      |      | V    | I <sub>C</sub> = 10 mA<br>(pulsed)<br>I <sub>B</sub> = 0                  |
| h <sub>fe</sub>   | High Frequency Current Gain (f = 100 MHz)                  | 3    | 4    |      |      |      |      |      | I <sub>C</sub> = 10 mA<br>V <sub>CE</sub> = 10 V                          |
| h <sub>fe</sub>   | High Frequency Current Gain (f = 100 MHz)                  |      |      |      | 3.5  | 5.8  |      |      | I <sub>C</sub> = 30 mA<br>V <sub>CE</sub> = 10 V                          |
| C <sub>ob</sub>   | Base-Collector Capacitance                                 | 4    | 6    |      |      |      |      | pF   | I <sub>E</sub> = 0<br>V <sub>CB</sub> = 10 V                              |
| C <sub>ob</sub>   | Base-Collector Capacitance                                 |      |      |      | 3    | 5    |      | pF   | I <sub>E</sub> = 0<br>V <sub>CB</sub> = 5 V                               |
| C <sub>TE</sub>   | Emitter Transition Capacitance                             | 6    | 9    |      | 7    | 8    |      | pF   | I <sub>C</sub> = 0<br>V <sub>BE</sub> = -0.5 V                            |
| τ <sub>s</sub>    | Charge Storage Time Constant (Notes 6-7)                   |      | 25   |      | 10   | 20   |      | ns   | I <sub>C</sub> = I <sub>B1</sub> = I <sub>B2</sub> = 10 mA                |
| t <sub>on</sub>   | Turn On Time (Note 7)                                      |      | 40   |      | 18   | 30   |      | ns   | I <sub>C</sub> = 10 mA, I <sub>B1</sub> = 3 mA,<br>V <sub>BE</sub> = -2 V |
| t <sub>off</sub>  | Turn Off Time (Note 7)                                     |      | 75   |      | 50   | 70   |      | ns   | I <sub>C</sub> = 10 mA, I <sub>B1</sub> = 3 mA,<br>I <sub>B2</sub> = 1 mA |
| r <sub>b'</sub>   | Base Spreading Resistance (Note 8)                         |      | 50   |      |      |      |      | Ω    | I <sub>C</sub> = 10 mA<br>V <sub>CE</sub> = 10 V                          |

## NOTES:

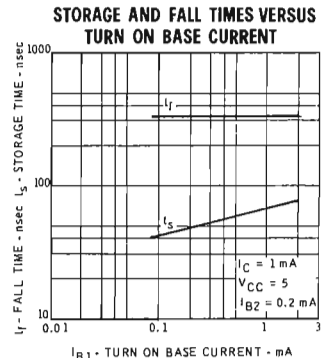
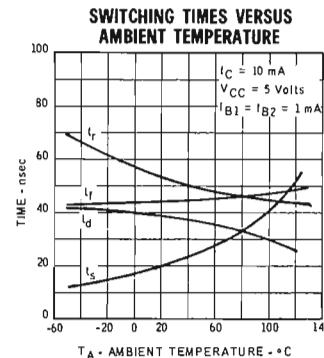
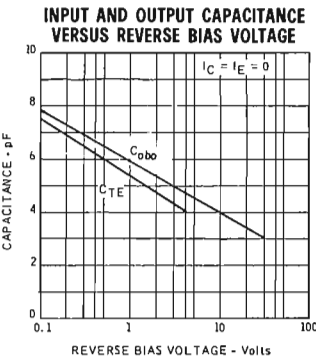
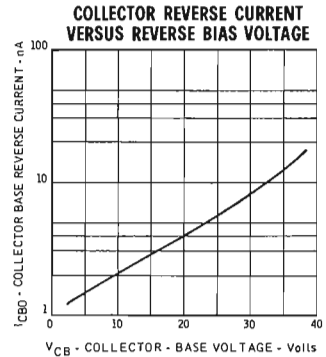
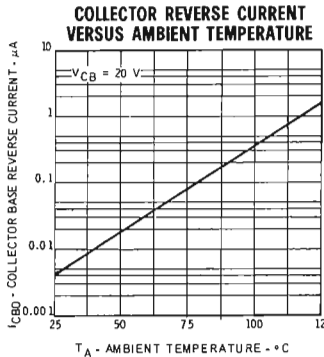
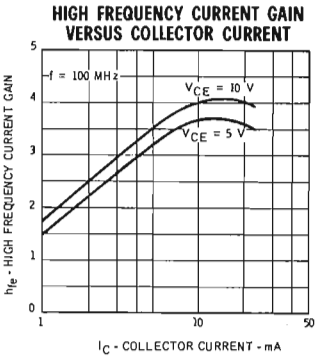
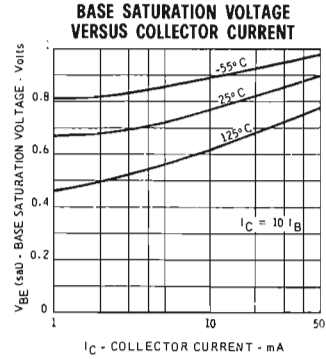
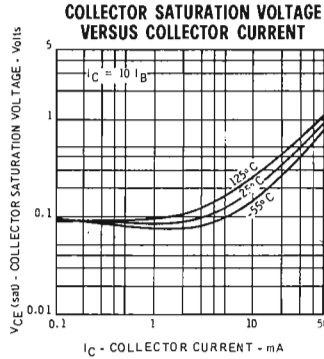
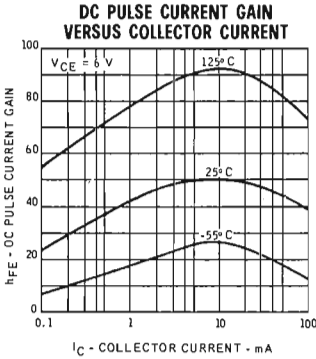
- (1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
- (2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
- (3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/watt (derating factor of 6.85 mW/°C); junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.06 mW/°C).
- (4) These ratings refer to a high-current point where collector-to-emitter voltage is lowest. For more information send for SGS-AR 5.
- (5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
- (6) Measured on Sampling Scope PW ≤ 400 ns.
- (7) See switching circuit for exact values of I<sub>C</sub>, I<sub>B1</sub> and I<sub>B2</sub>.
- (8) r<sub>b'</sub> = h<sub>ie</sub> (Real Part).

TYPICAL ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

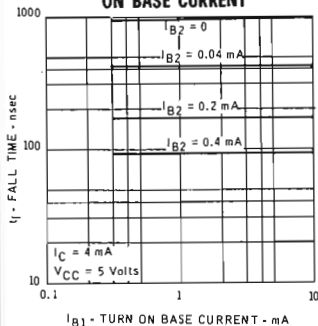
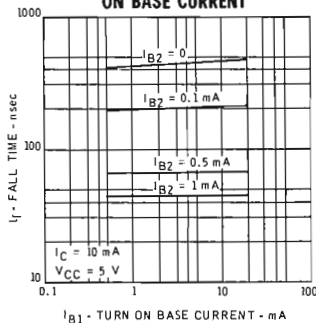
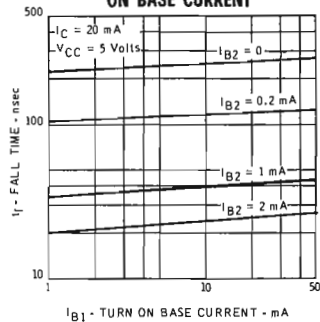
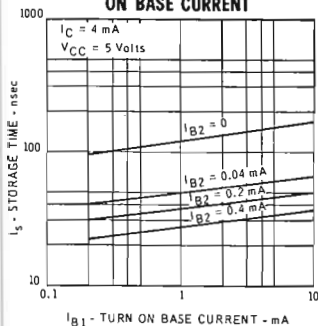
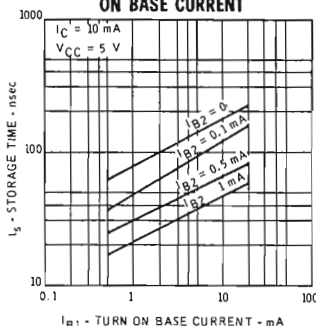
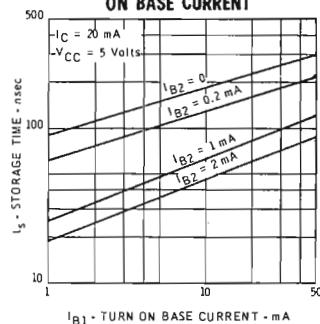
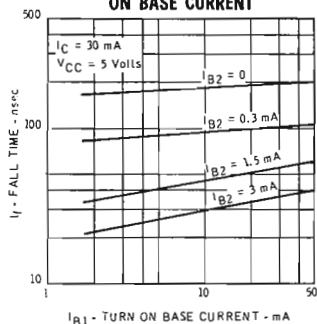
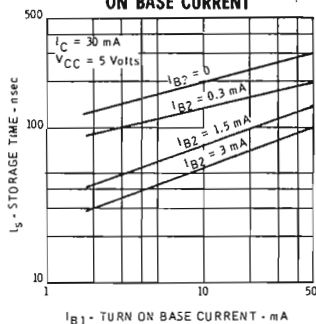


\* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

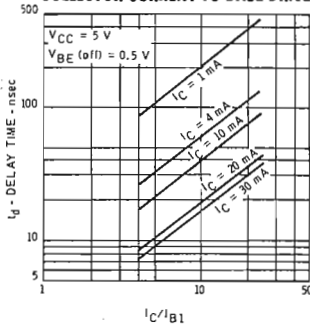


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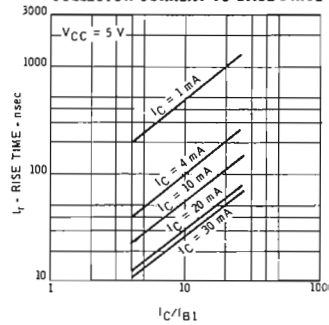
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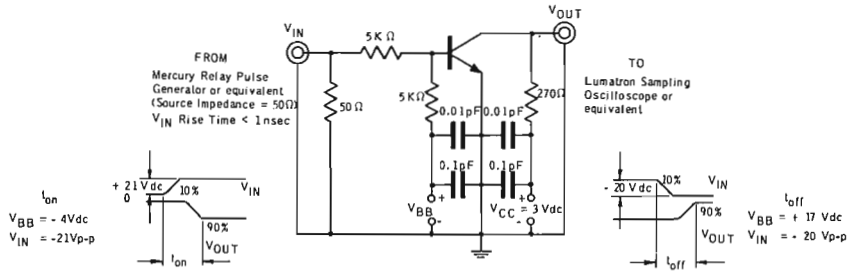
**DELAY TIME VERSUS RATIO OF COLLECTOR CURRENT TO BASE DRIVE**



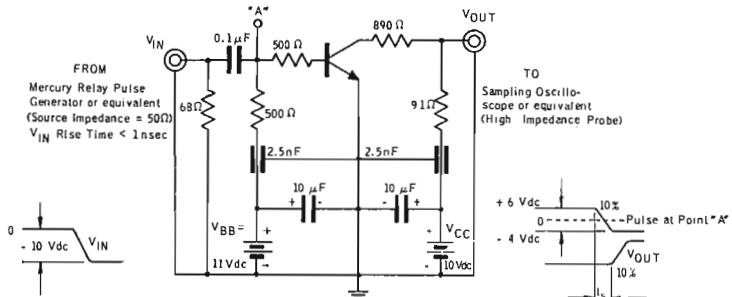
**RISE TIME VERSUS RATIO OF COLLECTOR CURRENT TO BASE DRIVE**



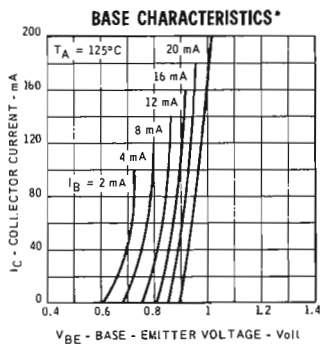
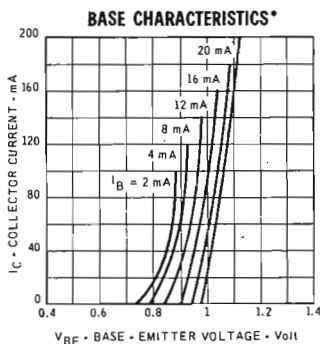
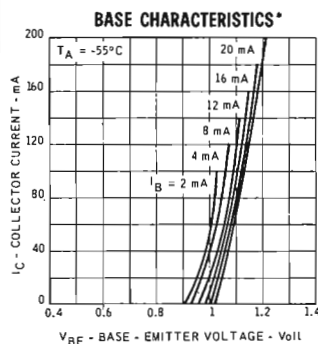
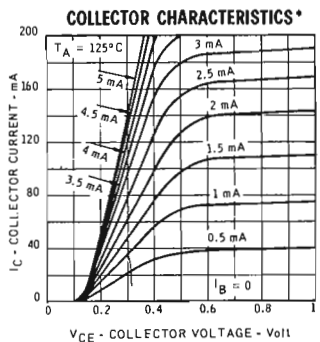
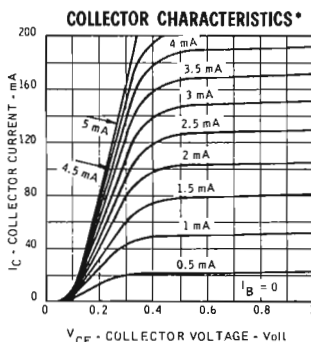
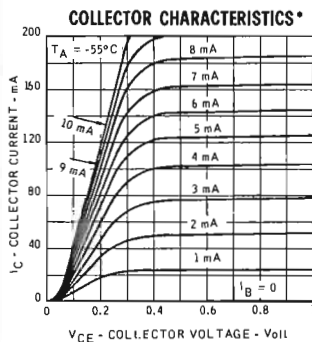
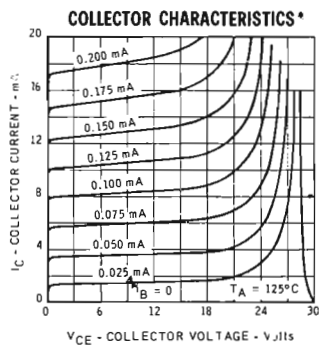
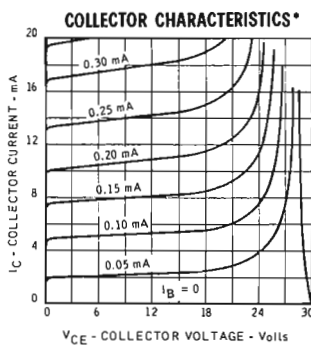
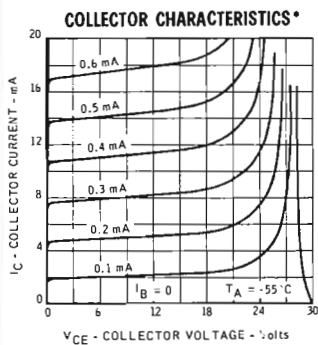
**TURN ON AND TURN OFF TIMES TEST CIRCUIT**



**CHARGE STORAGE TIME CONSTANT TEST CIRCUIT**

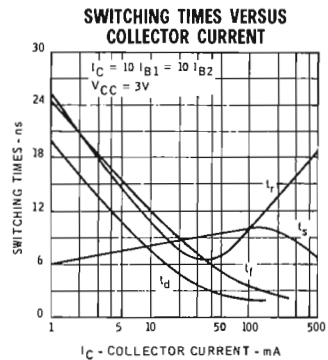
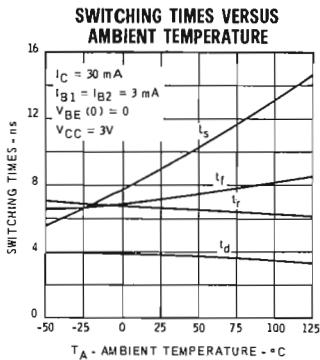
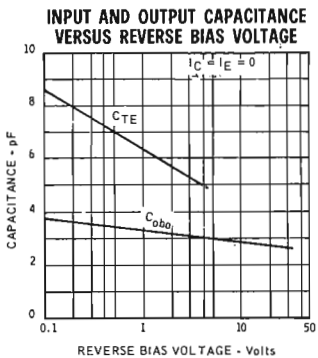
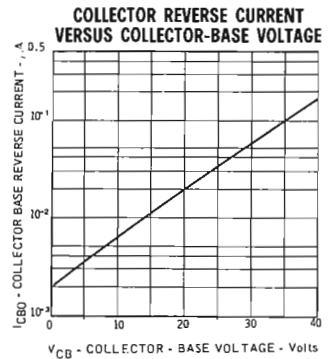
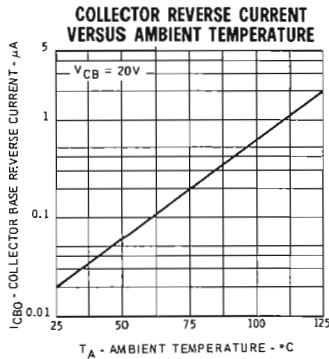
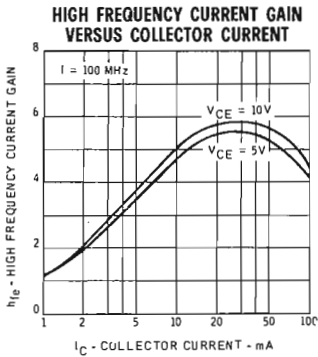
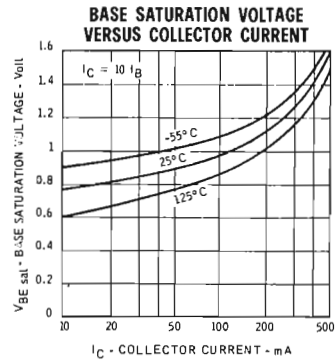
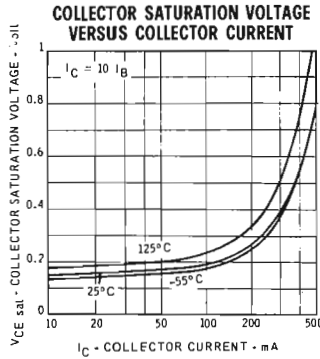
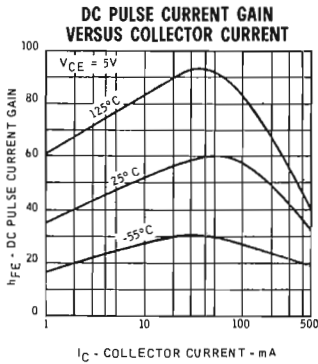


## TYPICAL ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)



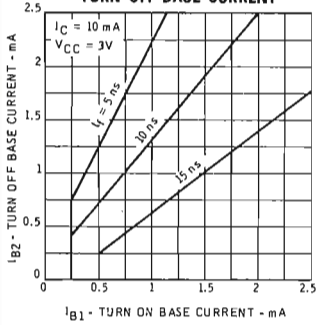
\*Single family characteristics on Transistor Curve Tracer.

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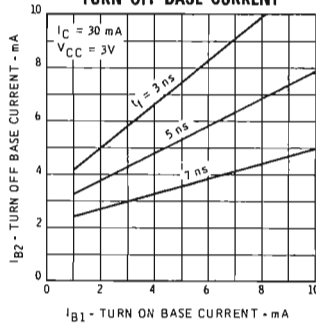


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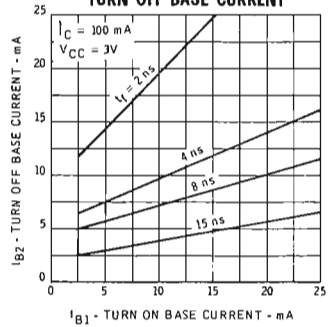
**FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT**



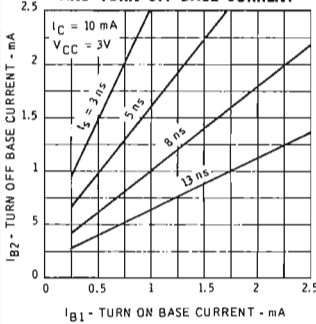
**FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT**



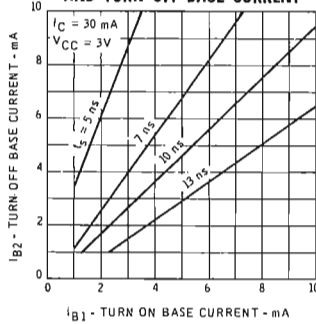
**FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT**



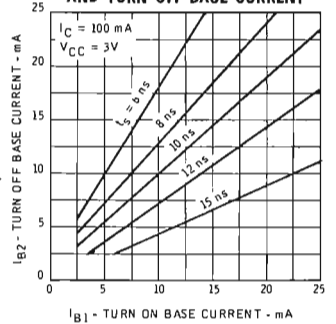
**STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT**



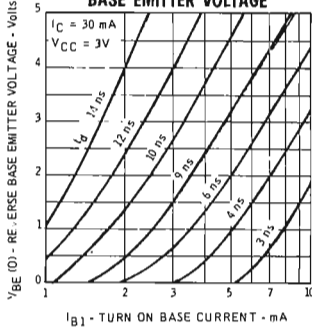
**STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT**



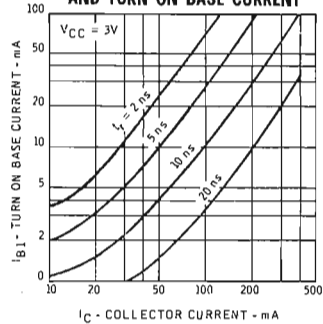
**STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT**



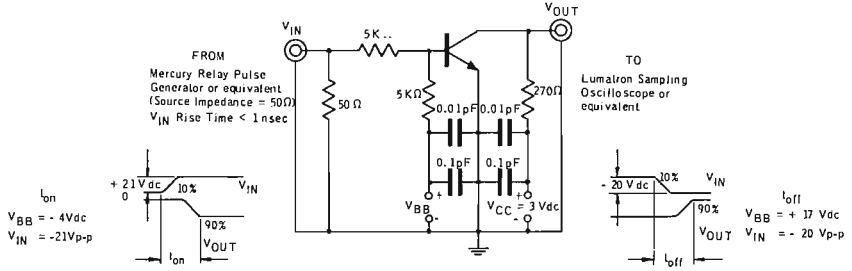
**DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE**



**RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT**



### TURN ON AND TURN OFF TIMES TEST CIRCUIT



### CHARGE STORAGE TIME CONSTANT TEST CIRCUIT

