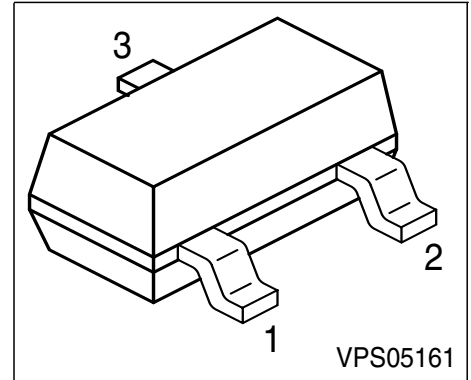


NPN Silicon AF Transistors

- For AF input stages and driver applications
- High current gain
- Low collector-emitter saturation voltage
- Low noise between 30 Hz and 15 kHz
- Complementary types: BCW61, BCX71 (PNP)



| Type    | Marking | Pin Configuration |       |       | Package |
|---------|---------|-------------------|-------|-------|---------|
| BCW60A  | AAs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCW60B  | ABs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCW60C  | ACs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCW60D  | ADs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCW60FF | AFs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCW60FN | ANs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCX70G  | AGs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCX70H  | AHs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCX70J  | AJs     | 1 = B             | 2 = E | 3 = C | SOT23   |
| BCX70K  | AKs     | 1 = B             | 2 = E | 3 = C | SOT23   |

**Maximum Ratings**

| Parameter                                     | Symbol    | BCW60       | BCW60FF | BCX70 | Unit |
|---|-----------|-------------|---------|-------|------|
| Collector-emitter voltage                     | $V_{CEO}$ | 32          | 32      | 45    | V    |
| Collector-base voltage                        | $V_{CBO}$ | 32          | 32      | 45    |      |
| Emitter-base voltage                          | $V_{EBO}$ | 5           | 5       | 5     |      |
| DC collector current                          | $I_C$     | 100         |         |       | mA   |
| Peak collector current                        | $I_{CM}$  | 200         |         |       |      |
| Peak base current                             | $I_{BM}$  | 200         |         |       |      |
| Total power dissipation, $T_S = 71\text{ °C}$ | $P_{tot}$ | 330         |         |       | mW   |
| Junction temperature                          | $T_j$     | 150         |         |       | °C   |
| Storage temperature                           | $T_{stg}$ | -65 ... 150 |         |       |      |

**Thermal Resistance**

|  |            |      |     |
|--|------------|------|-----|
| Junction - soldering point <sup>1)</sup> | $R_{thJS}$ | ≤240 | K/W |
|--|------------|------|-----|

**Electrical Characteristics** at  $T_A = 25\text{ °C}$ , unless otherwise specified.

| Parameter   | Symbol        | Values |      |      | Unit |
|---|---------------|--------|------|------|------|
|   |               | min.   | typ. | max. |      |
| <b>DC Characteristics</b>   |               |        |      |      |      |
| Collector-emitter breakdown voltage<br>$I_C = 10\text{ mA}$ , $I_B = 0$       | $V_{(BR)CEO}$ |        |      |      | V    |
| <b>BCW60/60FF</b>   | 32            | -      | -    |      |      |
| <b>BCX70</b>  | 45            | -      | -    |      |      |
| Collector-base breakdown voltage<br>$I_C = 10\text{ }\mu\text{A}$ , $I_B = 0$ | $V_{(BR)CBO}$ |        |      |      |      |
| <b>BCW60/60FF</b>   | 32            | -      | -    |      |      |
| <b>BCX70</b>  | 45            | -      | -    |      |      |
| Emitter-base breakdown voltage<br>$I_E = 1\text{ }\mu\text{A}$ , $I_C = 0$    | $V_{(BR)EBO}$ | 5      | -    | -    |      |

<sup>1</sup>For calculation of  $R_{thJA}$  please refer to Application Note Thermal Resistance

**Electrical Characteristics** at  $T_A = 25^\circ\text{C}$ , unless otherwise specified.

| Parameter  | Symbol                         | Values |      |      | Unit          |
|--|--------------------------------|--------|------|------|---------------|
|  |                                | min.   | typ. | max. |               |
| <b>AC Characteristics</b>  |                                |        |      |      |               |
| Collector cutoff current<br>$V_{CB} = 32\text{ V}, I_E = 0$<br>$V_{CB} = 45\text{ V}, I_E = 0$   | $I_{CBO}$                      | -      | -    | 20   | nA            |
|  | <b>BCW60 /60FF</b>             | -      | -    | 20   |               |
|  | <b>BCX70</b>                   | -      | -    | 20   |               |
| Collector cutoff current<br>$V_{CB} = 32\text{ V}, I_E = 0, T_A = 150^\circ\text{C}$<br>$V_{CB} = 45\text{ V}, I_E = 0, T_A = 150^\circ\text{C}$ | $I_{CBO}$                      | -      | -    | 20   | $\mu\text{A}$ |
|  | <b>BCW60 / 60FF</b>            | -      | -    | 20   |               |
|  | <b>BCX70</b>                   | -      | -    | 20   |               |
| Emitter cutoff current<br>$V_{EB} = 4\text{ V}, I_C = 0$   | $I_{EBO}$                      | -      | -    | 20   | nA            |
| DC current gain 1)<br>$I_C = 10\ \mu\text{A}, V_{CE} = 5\text{ V}$   | $h_{FE}$                       |        |      |      | -             |
|  | $h_{FE}$ -grp. <b>A/ G</b>     | 20     | 140  | -    |               |
|  | $h_{FE}$ -grp. <b>B/ H</b>     | 20     | 200  | -    |               |
|  | $h_{FE}$ -grp. <b>C/ J/ FF</b> | 40     | 300  | -    |               |
|  | $h_{FE}$ -grp. <b>D/ K/ FN</b> | 100    | 460  | -    |               |
| DC current gain 1)<br>$I_C = 2\text{ mA}, V_{CE} = 5\text{ V}$   | $h_{FE}$                       |        |      |      |               |
|  | $h_{FE}$ -grp. <b>A/ G</b>     | 120    | 170  | 220  |               |
|  | $h_{FE}$ -grp. <b>B/ H</b>     | 180    | 250  | 310  |               |
|  | $h_{FE}$ -grp. <b>C/ J/ FF</b> | 250    | 350  | 460  |               |
|  | $h_{FE}$ -grp. <b>D/ K/ FN</b> | 380    | 500  | 630  |               |
| DC current gain 1)<br>$I_C = 50\text{ mA}, V_{CE} = 1\text{ V}$  | $h_{FE}$                       |        |      |      |               |
|  | $h_{FE}$ -grp. <b>A/ G</b>     | 50     | -    | -    |               |
|  | $h_{FE}$ -grp. <b>B/ H</b>     | 70     | -    | -    |               |
|  | $h_{FE}$ -grp. <b>C/ J/ FF</b> | 90     | -    | -    |               |
|  | $h_{FE}$ -grp. <b>D/ K/ FN</b> | 100    | -    | -    |               |

1) Pulse test:  $t \leq 300\ \mu\text{s}$ ,  $D = 2\%$

**Electrical Characteristics** at  $T_A = 25^\circ\text{C}$ , unless otherwise specified.

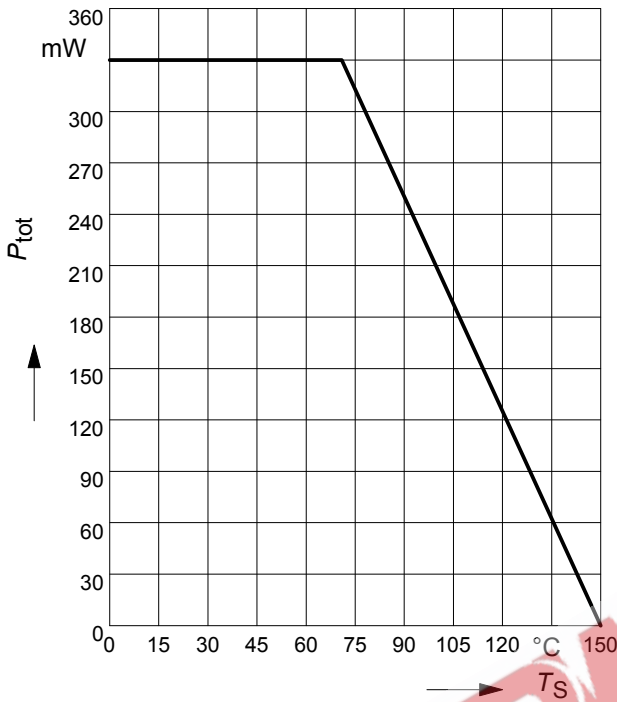
| Parameter  | Symbol  | Values         |                               |                  | Unit       |
|--|---|----------------|-------------------------------|------------------|------------|
|  |   | min.           | typ.                          | max.             |            |
| <b>DC Characteristics</b>  |   |                |                               |                  |            |
| Collector-emitter saturation voltage <sup>1)</sup><br>$I_C = 10\text{ mA}, I_B = 0.25\text{ mA}$<br>$I_C = 50\text{ mA}, I_B = 1.25\text{ mA}$                         | $V_{CEsat}$   | -              | 0.12<br>0.2                   | 0.25<br>0.55     | V          |
| Base-emitter saturation voltage 1)<br>$I_C = 10\text{ mA}, I_B = 0.25\text{ mA}$<br>$I_C = 50\text{ mA}, I_B = 1.25\text{ mA}$   | $V_{BEsat}$   | -              | 0.7<br>0.83                   | 0.85<br>1.05     |            |
| Base-emitter voltage 1)<br>$I_C = 10\text{ }\mu\text{A}, V_{CE} = 5\text{ V}$<br>$I_C = 2\text{ mA}, V_{CE} = 5\text{ V}$<br>$I_C = 50\text{ mA}, V_{CE} = 1\text{ V}$ | $V_{BE(ON)}$  | -<br>0.55<br>- | 0.52<br>0.65<br>0.78          | -<br>0.75<br>-   |            |
| <b>AC Characteristics</b>  |   |                |                               |                  |            |
| Transition frequency<br>$I_C = 20\text{ mA}, V_{CE} = 5\text{ V}, f = 100\text{ MHz}$  | $f_T$   | -              | 250                           | -                | MHz        |
| Collector-base capacitance<br>$V_{CB} = 10\text{ V}, f = 1\text{ MHz}$   | $C_{cb}$  | -              | 3                             | -                | pF         |
| Emitter-base capacitance<br>$V_{EB} = 0.5\text{ V}, f = 1\text{ MHz}$  | $C_{eb}$  | -              | 8                             | -                |            |
| Short-circuit input impedance<br>$I_C = 2\text{ mA}, V_{CE} = 5\text{ V}, f = 1\text{ kHz}$  | $h_{FE-grp.}$<br><b>A / G</b><br><b>B / H</b><br><b>C / J / FF</b><br><b>D / K / FN</b> | $h_{11e}$      | -<br>2.7<br>3.6<br>4.5<br>7.5 | -<br>-<br>-<br>- | k $\Omega$ |
| Open-circuit reverse voltage transf.ratio<br>$I_C = 2\text{ mA}, V_{CE} = 5\text{ V}, f = 1\text{ kHz}$  | $h_{FE-grp.}$<br><b>A / G</b><br><b>B / H</b><br><b>C / J/FF</b><br><b>D / K / FN</b>   | $h_{12e}$      | -<br>1.5<br>2<br>2<br>3       | -<br>-<br>-<br>- | $10^{-4}$  |

 1) Pulse test:  $t \leq 300\mu\text{s}$ ,  $D = 2\%$

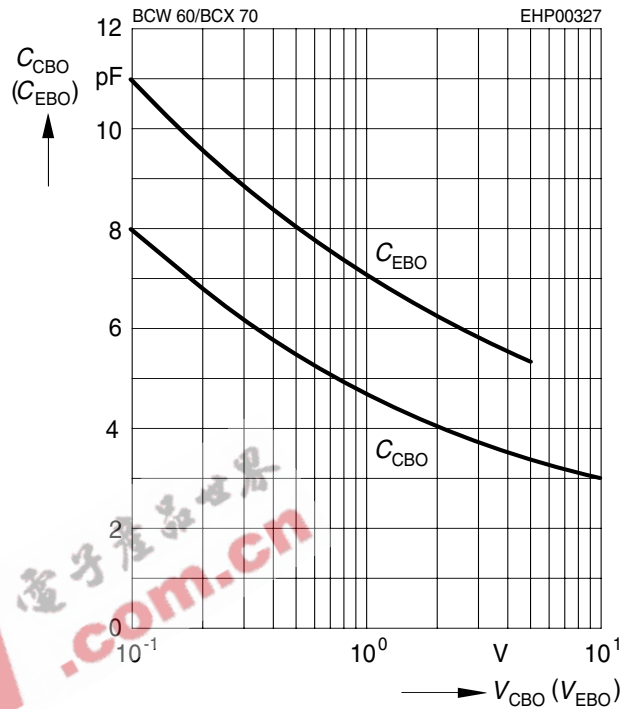
**Electrical Characteristics** at  $T_A = 25^\circ\text{C}$ , unless otherwise specified.

| Parameter  | Symbol                      | Values |      |       | Unit          |
|--|-----------------------------|--------|------|-------|---------------|
|  |                             | min.   | typ. | max.  |               |
| <b>AC Characteristics</b>  |                             |        |      |       |               |
| Short-circuit forward current transf.ratio   $h_{FE}$ -grp.<br>$I_C = 2\text{ mA}$ , $V_{CE} = 5\text{ V}$ , $f = 1\text{ kHz}$                        | $h_{21e}$                   |        |      |       | -             |
| <b>A / G</b>   |                             | -      | 200  | -     |               |
| <b>B / H</b>   |                             | -      | 260  | -     |               |
| <b>C / J / FF</b>  |                             | -      | 330  | -     |               |
| <b>D / K / FN</b>  |                             | -      | 520  | -     |               |
| Open-circuit output admittance<br>$I_C = 2\text{ mA}$ , $V_{CE} = 5\text{ V}$ , $f = 1\text{ kHz}$   | $h_{FE}$ -grp.<br>$h_{22e}$ |        |      |       | $\mu\text{S}$ |
| <b>A / G</b>   |                             | -      | 18   | -     |               |
| <b>B / H</b>   |                             | -      | 24   | -     |               |
| <b>C / J / FF</b>  |                             | -      | 30   | -     |               |
| <b>D / K / FN</b>  |                             | -      | 50   | -     |               |
| Noise figure<br>$I_C = 100\text{ }\mu\text{A}$ , $V_{CE} = 5\text{ V}$ , $R_S = 1\text{ k}\Omega$ ,<br>$f = 1\text{ kHz}$ , $\Delta f = 200\text{ Hz}$ | $h_{FE}$ -grp.<br>$F$       |        |      |       | dB            |
| <b>A - K</b>   |                             | -      | 2    | -     |               |
| <b>FF - FN</b>   |                             | -      | 1    | 2     |               |
| Equivalent noise voltage<br>$I_C = 200\text{ }\mu\text{A}$ , $V_{CE} = 5\text{ V}$ , $R_S = 2\text{ k}\Omega$ ,<br>$f = 10 \dots 50\text{ Hz}$         | $h_{FE}$ -grp.<br>$V_n$     |        |      |       | $\mu\text{V}$ |
| <b>FF / FN</b>   |                             | -      | -    | 0.135 |               |

Total power dissipation  $P_{tot} = f(T_S)$

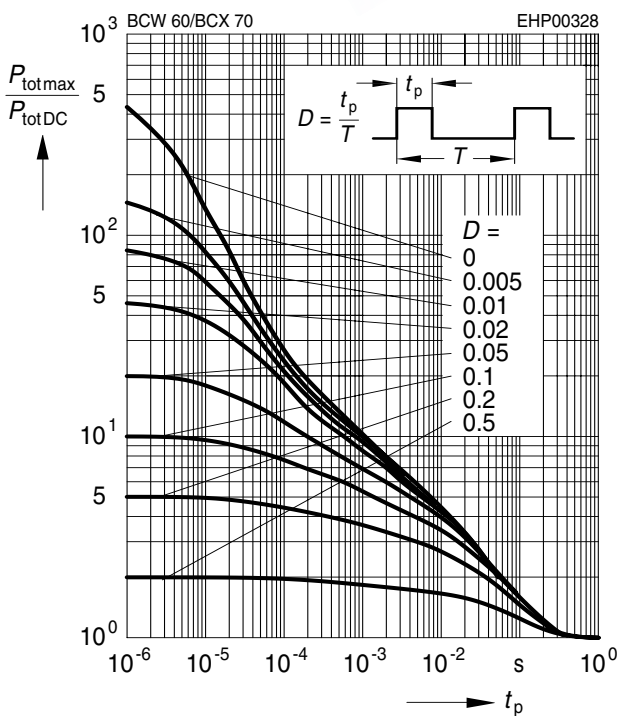


Collector-base capacitance  $C_{CB} = f(V_{CBO})$   
 Emitter-base capacitance  $C_{EB} = f(V_{EBO})$



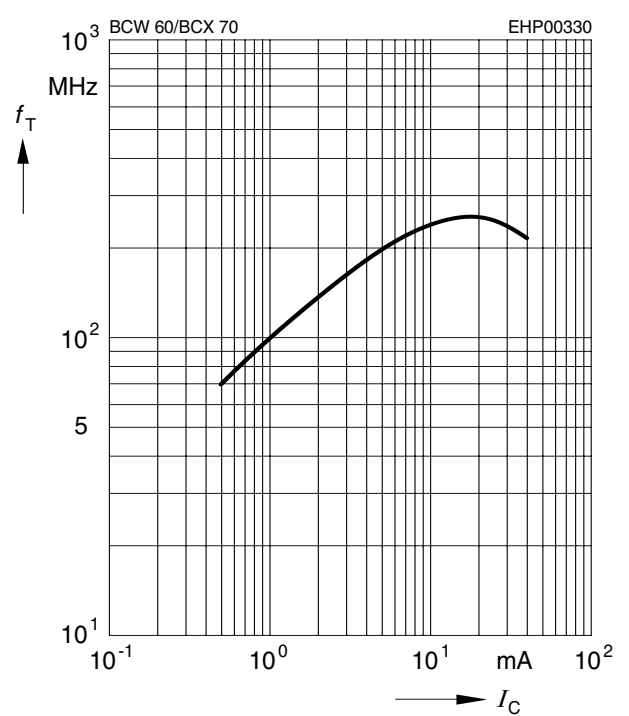
Permissible pulse load

$P_{totmax} / P_{totDC} = f(t_p)$



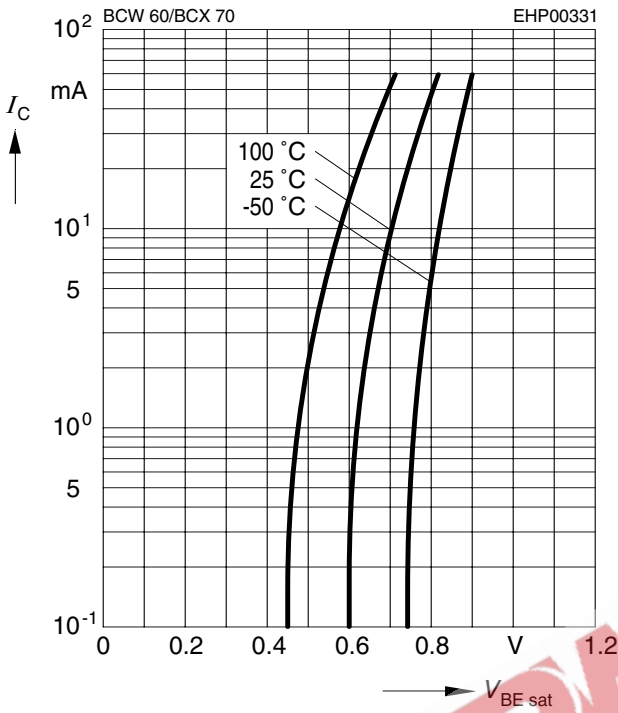
Transition frequency  $f_T = f(I_C)$

$V_{CE} = 5V$



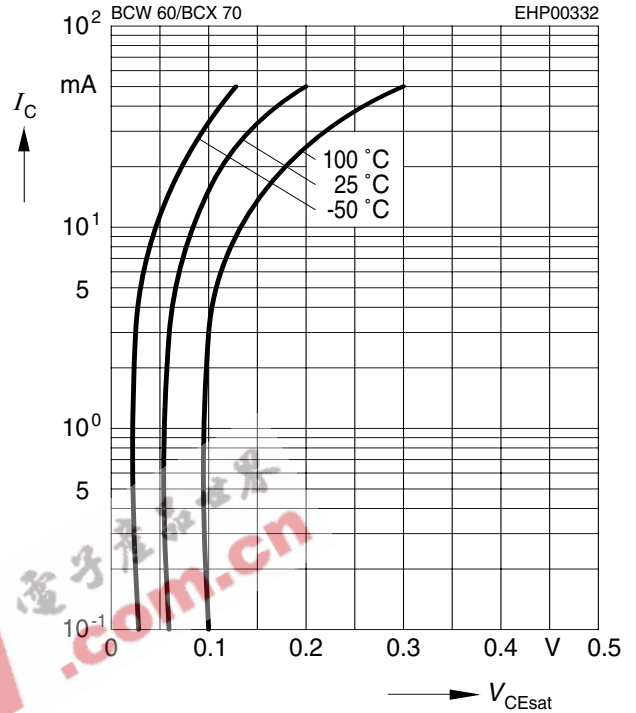
**Base-emitter saturation voltage**

$I_C = f(V_{BEsat}), h_{FE} = 40$



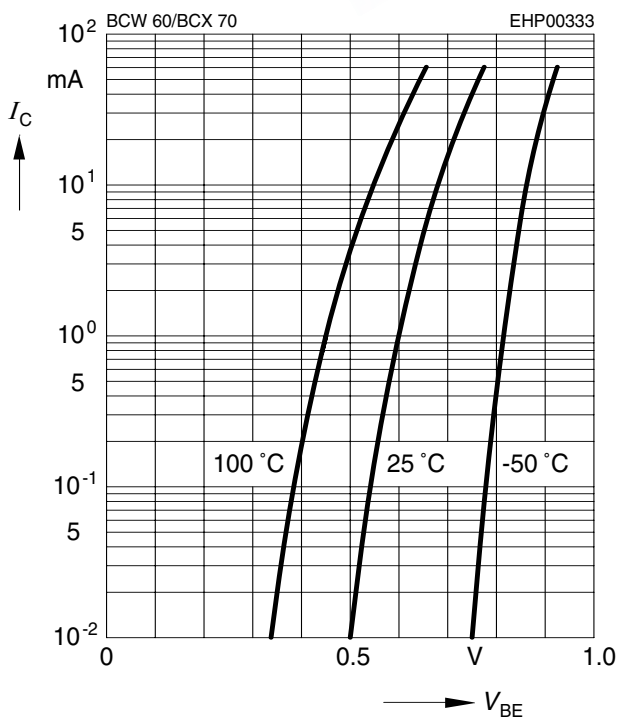
**Collector-emitter saturation voltage**

$I_C = f(V_{CEsat}), h_{FE} = 40$



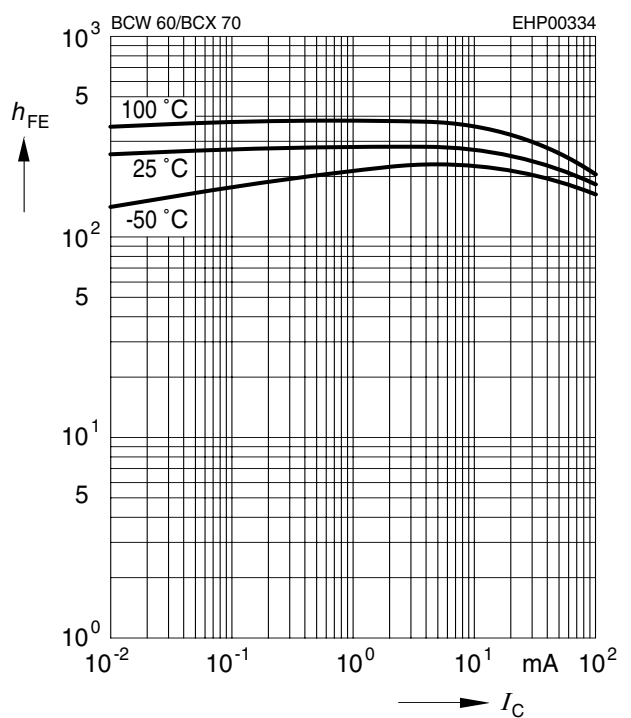
**Collector current  $I_C = f(V_{BE})$**

$V_{CE} = 5V$



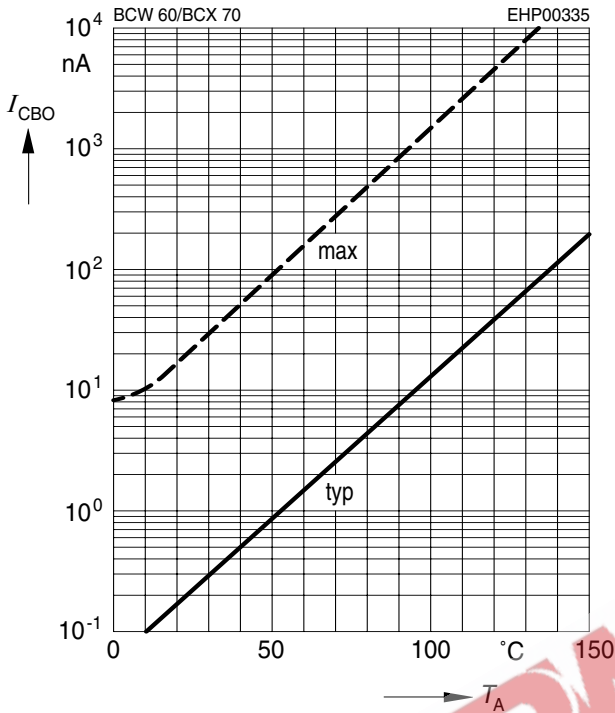
**DC current gain  $h_{FE} = f(I_C)$**

$V_{CE} = 5V$



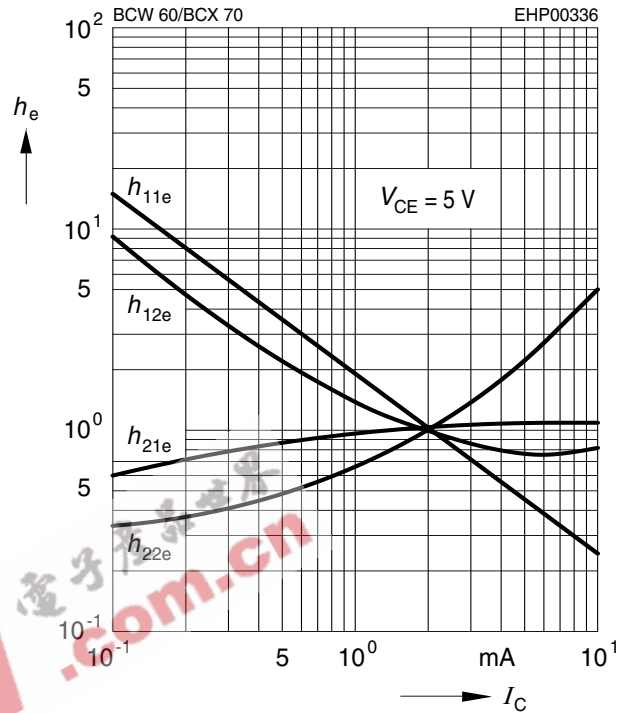
**Collector cutoff current  $I_{CBO} = f(T_A)$**

$V_{CB} = V_{CEmax}$



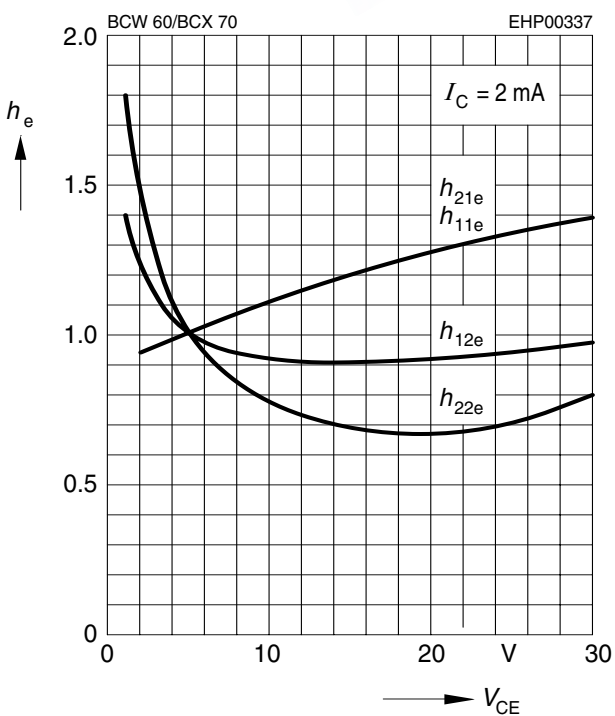
**h parameter  $h_e = f(I_C)$  normalized**

$V_{CE} = 5V$



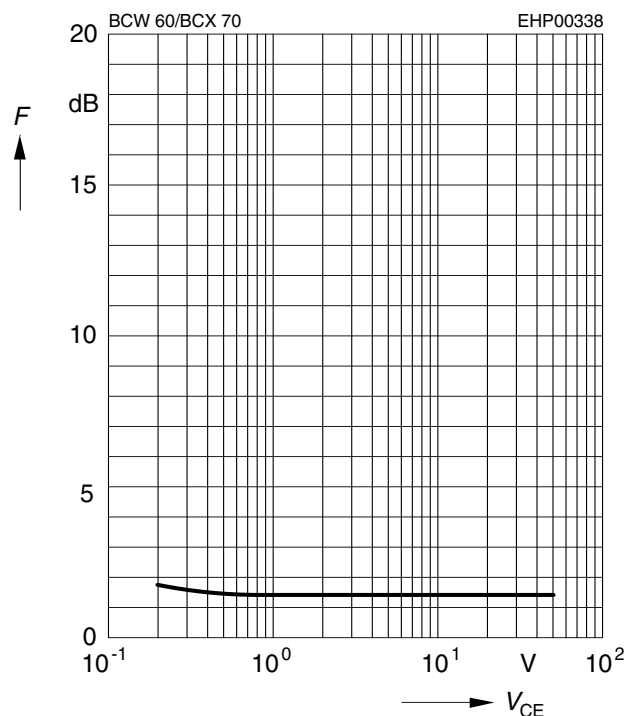
**h parameter  $h_e = f(V_{CE})$  normalized**

$I_C = 2mA$



**Noise figure  $F = f(V_{CE})$**

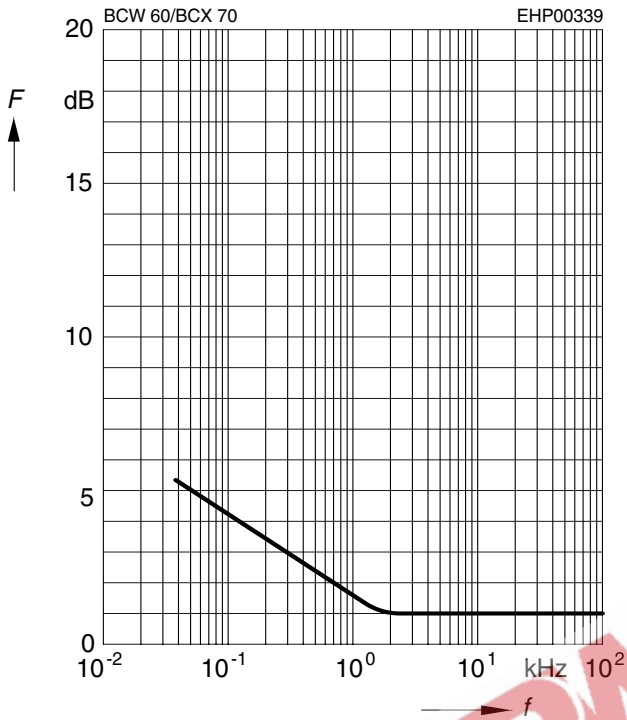
$I_C = 0.2mA, R_S = 2k\Omega, f = 1kHz$





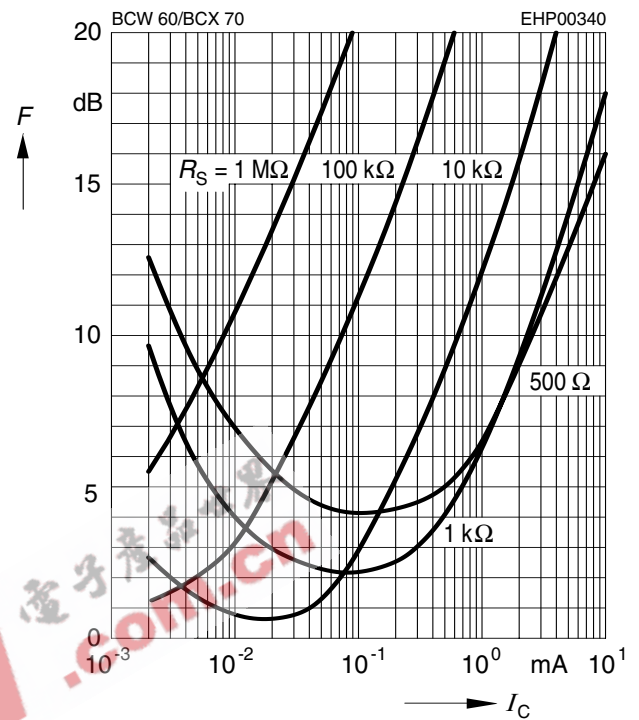
**Noise figure  $F = f(f)$**

$I_C = 0.2\text{mA}$ ,  $V_{CE} = 5\text{V}$ ,  $R_S = 2\text{k}\Omega$



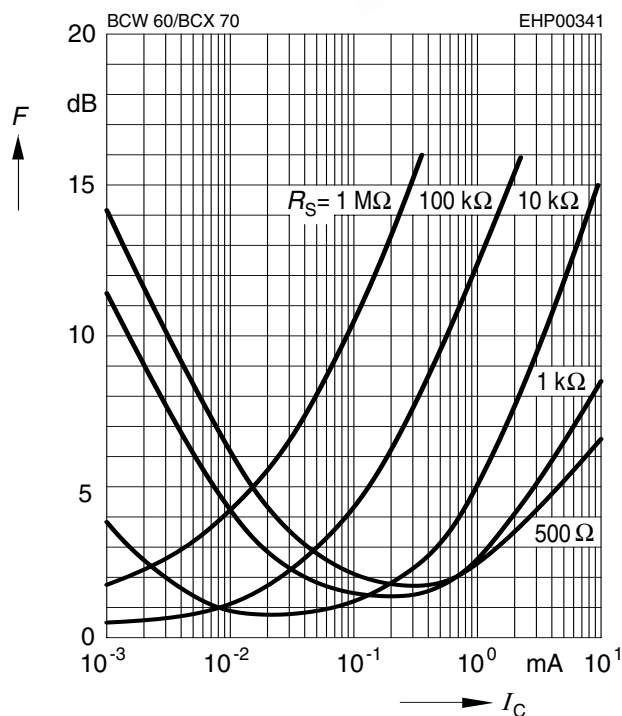
**Noise figure  $F = f(I_C)$**

$V_{CE} = 5\text{V}$ ,  $f = 120\text{Hz}$



**Noise figure  $F = f(I_C)$**

$V_{CE} = 5\text{V}$ ,  $f = 1\text{kHz}$



**Noise figure  $F = f(I_C)$**

$V_{CE} = 5\text{V}$ ,  $f = 10\text{kHz}$

