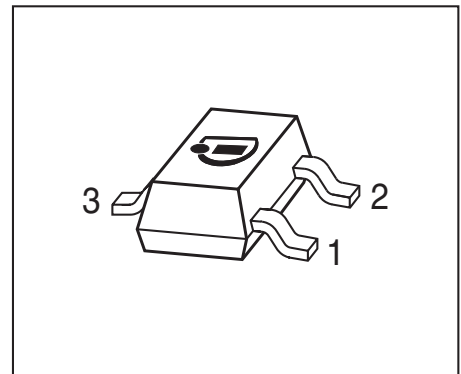


## NPN Silicon AF Transistors

- 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)
- Pb-free (RoHS compliant) package
- Qualified according AEC Q101



| Type    | Marking | Pin Configuration |     |     | Package |
|---------|---------|-------------------|-----|-----|---------|
| 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   |
| 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    | Value       | Unit |
|------------------------------------------------------|-----------|-------------|------|
| Collector-emitter voltage<br>BCW60, ...60FF<br>BCX70 | $V_{CEO}$ | 32<br>45    | V    |
| Collector-base voltage<br>BCW60, ...60FF<br>BCX70    | $V_{CBO}$ | 32<br>45    | V    |
| Emitter-base voltage                                 | $V_{EBO}$ | 6           | V    |
| Collector current                                    | $I_C$     | 100         | mA   |
| Peak collector current, $t_p \leq 10$ ms             | $I_{CM}$  | 200         | mA   |
| Peak base current                                    | $I_{BM}$  | 200         | mA   |
| Total power dissipation<br>$T_S \leq 71$ °C          | $P_{tot}$ | 330         | mW   |
| Junction temperature                                 | $T_j$     | 150         | °C   |
| Storage temperature                                  | $T_{stg}$ | -65 ... 150 | °C   |

**Thermal Resistance**

| Parameter                                | Symbol     | Value      | Unit |
|------------------------------------------|------------|------------|------|
| Junction - soldering point <sup>1)</sup> | $R_{thJS}$ | $\leq 240$ | K/W  |

<sup>1)</sup>For calculation of  $R_{thJA}$  please refer to Application Note AN077 (Thermal Resistance Calculation)

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

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Symbol        | Values                                                                     |                                                                          |                                                                  | Unit          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------|---------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               | min.                                                                       | typ.                                                                     | max.                                                             |               |
| DC Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                                                                            |                                                                          |                                                                  |               |
| Collector-emitter breakdown voltage<br>$I_C = 10\text{ mA}$ , $I_B = 0$ , BCW60, ...60FF<br>$I_C = 10\text{ mA}$ , $I_B = 0$ , BCX70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $V_{(BR)CEO}$ | 32<br>45                                                                   | -<br>-                                                                   | -<br>-                                                           | V             |
| Collector-base breakdown voltage<br>$I_C = 10\text{ }\mu\text{A}$ , $I_E = 0$ , BCW60, ...60FF<br>$I_C = 10\text{ }\mu\text{A}$ , $I_E = 0$ , BCX70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $V_{(BR)CBO}$ | 32<br>45                                                                   | -<br>-                                                                   | -<br>-                                                           |               |
| Emitter-base breakdown voltage<br>$I_E = 1\text{ }\mu\text{A}$ , $I_C = 0$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $V_{(BR)EBO}$ | 6                                                                          | -                                                                        | -                                                                |               |
| Collector-base cutoff current<br>$V_{CB} = 32\text{ V}$ , $I_E = 0$ , BCW60, ...60FF<br>$V_{CB} = 45\text{ V}$ , $I_E = 0$ , BCX70<br>$V_{CB} = 32\text{ V}$ , $I_E = 0$ , $T_A = 150\text{ }^{\circ}\text{C}$ , BCW60, ...60FF<br>$V_{CB} = 45\text{ V}$ , $I_E = 0$ , $T_A = 150\text{ }^{\circ}\text{C}$ , BCX70                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $I_{CBO}$     | -<br>-<br>-<br>-                                                           | -<br>-<br>-<br>-                                                         | 0.02<br>0.02<br>20<br>20                                         | $\mu\text{A}$ |
| Emitter-base cutoff current<br>$V_{EB} = 4\text{ V}$ , $I_C = 0$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | $I_{EBO}$     | -                                                                          | -                                                                        | 20                                                               | nA            |
| DC current gain-<br>$I_C = 10\text{ }\mu\text{A}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. G<br>$I_C = 10\text{ }\mu\text{A}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. B/ H<br>$I_C = 10\text{ }\mu\text{A}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. C/ J/ FF<br>$I_C = 10\text{ }\mu\text{A}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. D/ K<br>$I_C = 2\text{ mA}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. G<br>$I_C = 2\text{ mA}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. B/ H<br>$I_C = 2\text{ mA}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. C/ J/ FF<br>$I_C = 2\text{ mA}$ , $V_{CE} = 5\text{ V}$ , $h_{FE}$ -grp. D/ K<br>$I_C = 50\text{ mA}$ , $V_{CE} = 1\text{ V}$ , $h_{FE}$ -grp. G<br>$I_C = 50\text{ mA}$ , $V_{CE} = 1\text{ V}$ , $h_{FE}$ -grp. B/ H<br>$I_C = 50\text{ mA}$ , $V_{CE} = 1\text{ V}$ , $h_{FE}$ -grp. C/ J/ FF<br>$I_C = 50\text{ mA}$ , $V_{CE} = 1\text{ V}$ , $h_{FE}$ -grp. D/ K | $h_{FE}$      | 20<br>20<br>40<br>100<br>120<br>180<br>250<br>380<br>50<br>70<br>90<br>100 | 140<br>200<br>300<br>460<br>170<br>250<br>350<br>500<br>-<br>-<br>-<br>- | -<br>-<br>-<br>-<br>220<br>310<br>460<br>630<br>-<br>-<br>-<br>- | -             |

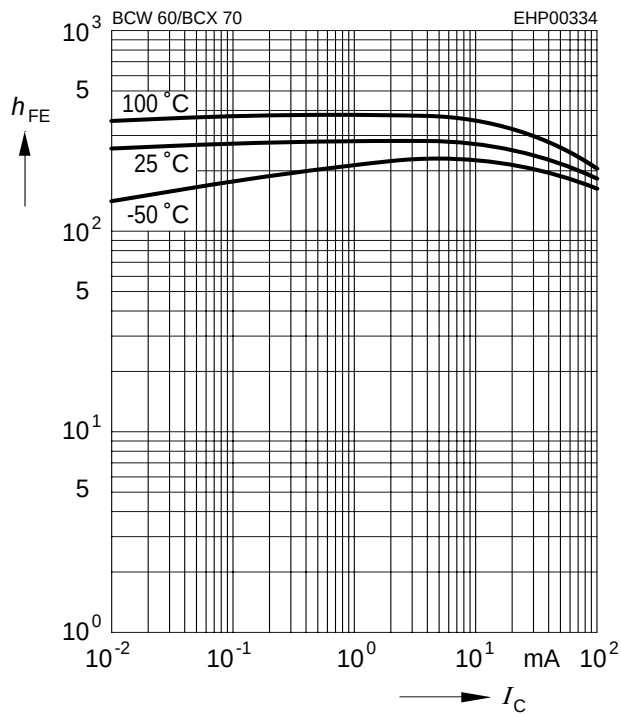
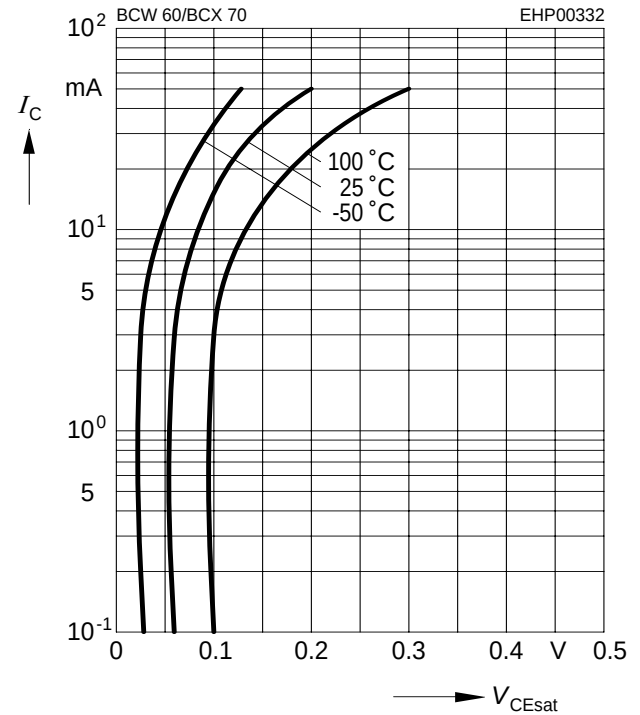
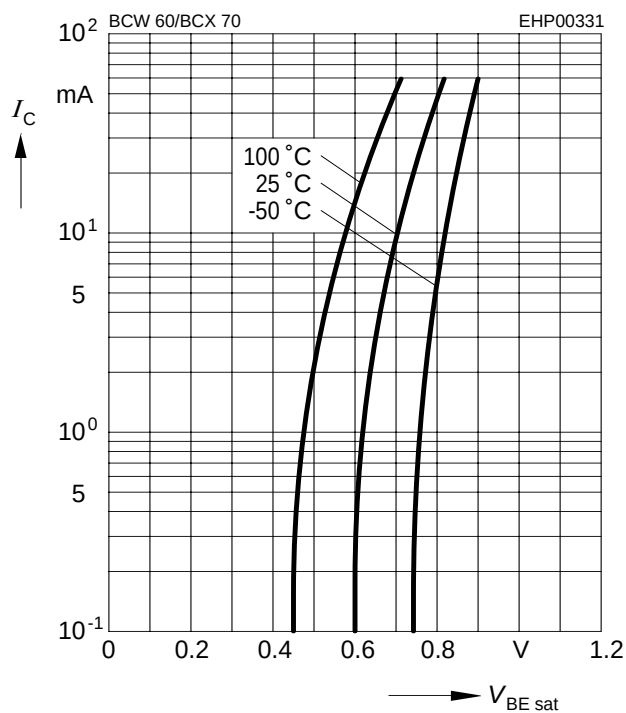
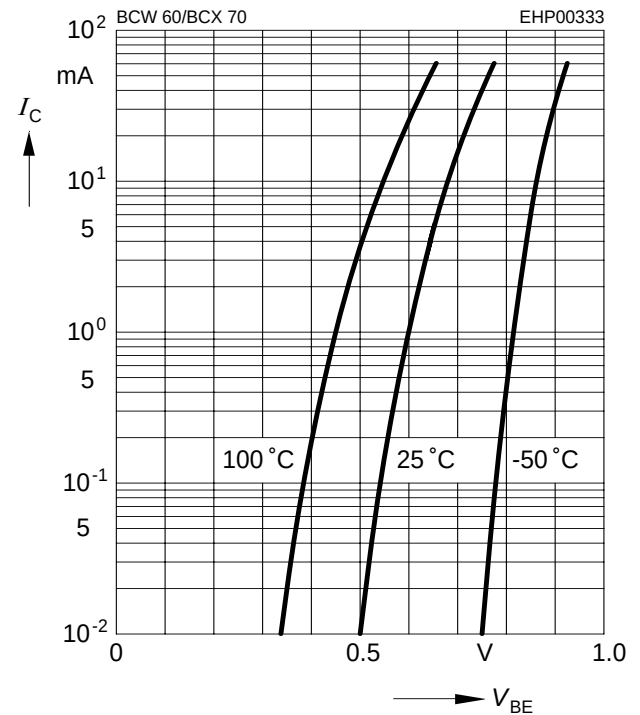
**DC Electrical Characteristics**

| Parameter                                          | Symbol              | Values |      |      | Unit |
|----------------------------------------------------|---------------------|--------|------|------|------|
|                                                    |                     | min.   | typ. | max. |      |
| Characteristics                                    |                     |        |      |      |      |
| Collector-emitter saturation voltage <sup>1)</sup> | V <sub>CEsat</sub>  |        |      |      | V    |
| I <sub>C</sub> = 10 mA, I <sub>B</sub> = 0.25 mA   |                     | -      | 0.12 | 0.25 |      |
| I <sub>C</sub> = 50 mA, I <sub>B</sub> = 1.25 mA   |                     | -      | 0.2  | 0.55 |      |
| Base emitter saturation voltage <sup>1)</sup>      | V <sub>BEsat</sub>  |        |      |      |      |
| I <sub>C</sub> = 10 mA, I <sub>B</sub> = 0.25 mA   |                     | -      | 0.7  | 0.85 |      |
| I <sub>C</sub> = 50 mA, I <sub>B</sub> = 1.25 mA   |                     | -      | 0.83 | 1.05 |      |
| Base-emitter voltage <sup>1)</sup>                 | V <sub>BE(ON)</sub> |        |      |      |      |
| I <sub>C</sub> = 10 μA, V <sub>CE</sub> = 5 V      |                     | -      | 0.52 | -    |      |
| I <sub>C</sub> = 2 mA, V <sub>CE</sub> = 5 V       |                     | 0.58   | 0.65 | 0.7  |      |
| I <sub>C</sub> = 50 mA, V <sub>CE</sub> = 1 V      |                     | -      | 0.78 | -    |      |

<sup>1)</sup>Pulse test:  $t < 300\mu\text{s}$ ;  $D < 2\%$

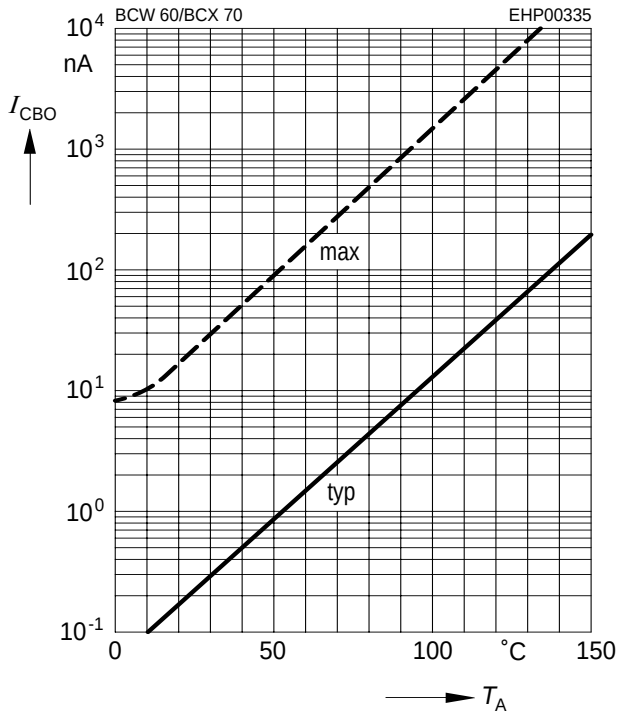
**AC Characteristics**

|                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                  |                          |                  |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------|--------------------------|------------------|---------------|
| 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>$V_{CB} = 10 \text{ V}$ , $f = 1 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                      | $C_{cb}$  | -                | 0.95                     | -                | pF            |
| Emitter-base capacitance<br>$V_{EB} = 0.5 \text{ V}$ , $f = 1 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                       | $C_{eb}$  | -                | 9                        | -                |               |
| Short-circuit input impedance<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. G<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. B/ H<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. C/ J /FF<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. D/ K               | $h_{11e}$ | -<br>-<br>-<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. G<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. B /H<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. C/ J/ FF<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. D/ K  | $h_{12e}$ | -<br>-<br>-<br>- | 1.5<br>2<br>2<br>3       | -<br>-<br>-<br>- | $10^{-4}$     |
| Short-circuit forward current transf. ratio<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. G<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. B/ H<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. C/ J/ FF<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. D/ K | $h_{21e}$ | -<br>-<br>-<br>- | 200<br>260<br>330<br>520 | -<br>-<br>-<br>- | -             |
| Open-circuit output admittance<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. G<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. B/ H<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. C/ J/ FF<br>$I_C = 2 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ , $h_{FE}$ -grp. D/ K              | $h_{22e}$ | -<br>-<br>-<br>- | 18<br>24<br>30<br>50     | -<br>-<br>-<br>- | $\mu\text{S}$ |
| Noise figure<br>$I_C = 200 \mu\text{A}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ ,<br>$\Delta f = 200 \text{ Hz}$ , $R_S = 2 \text{ k}\Omega$ , $h_{FE}$ -grp. B - K<br>$I_C = 200 \mu\text{A}$ , $V_{CE} = 5 \text{ V}$ , $f = 1 \text{ kHz}$ ,<br>$\Delta f = 200 \text{ Hz}$ , $R_S = 2 \text{ k}\Omega$ , $h_{FE}$ -grp. FF                                                                                            | $F$       | -<br>-           | 2<br>1                   | -<br>2           | dB            |
| Equivalent noise voltage<br>$I_C = 200 \mu\text{A}$ , $V_{CE} = 5 \text{ V}$ , $R_S = 2 \text{ k}\Omega$ ,<br>$f = 10 \dots 50 \text{ Hz}$ , $h_{FE}$ -grp. FF                                                                                                                                                                                                                                                                   | $V_n$     | -                | -                        | 0.135            | $\mu\text{V}$ |

**DC current gain  $h_{FE} = f(I_C)$** 
 $V_{CE} = 5\text{ V}$ 

**Collector-emitter saturation voltage**
 $I_C = f(V_{CEsat}), h_{FE} = 10$ 

**Base-emitter saturation voltage**
 $I_C = f(V_{BEsat}), h_{FE} = 40$ 

**Collector current  $I_C = f(V_{BE})$** 
 $V_{CE} = 5\text{ V}$ 


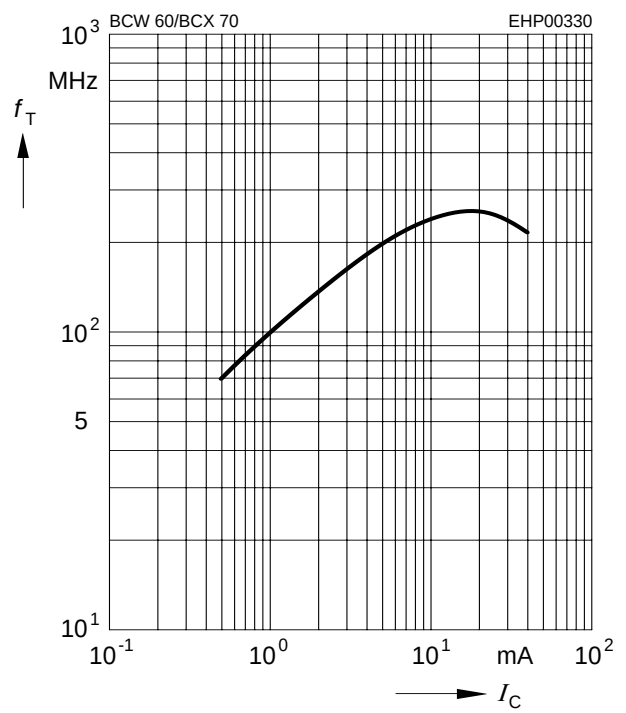
**Collector cutoff current**  $I_{CBO} = f(T_A)$

$V_{CB} = V_{CEmax}$



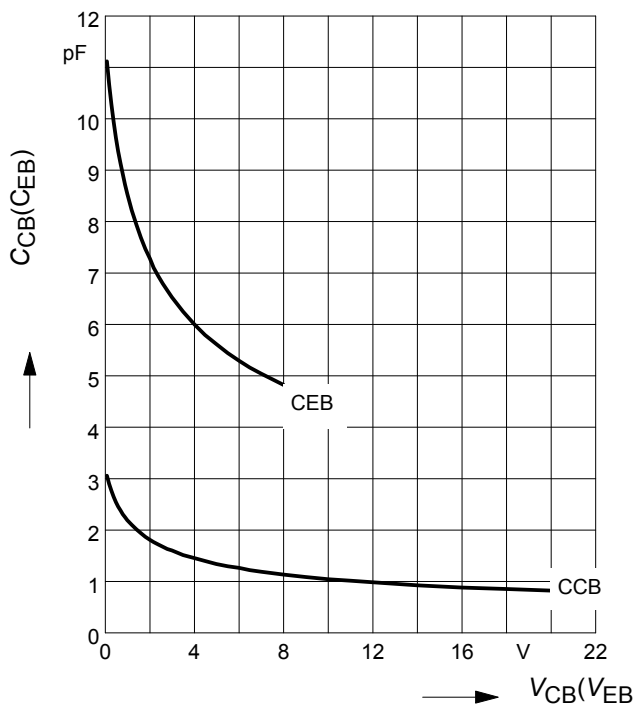
**Transition frequency**  $f_T = f(I_C)$

$V_{CE} = \text{parameter in V, } f = 2 \text{ GHz}$

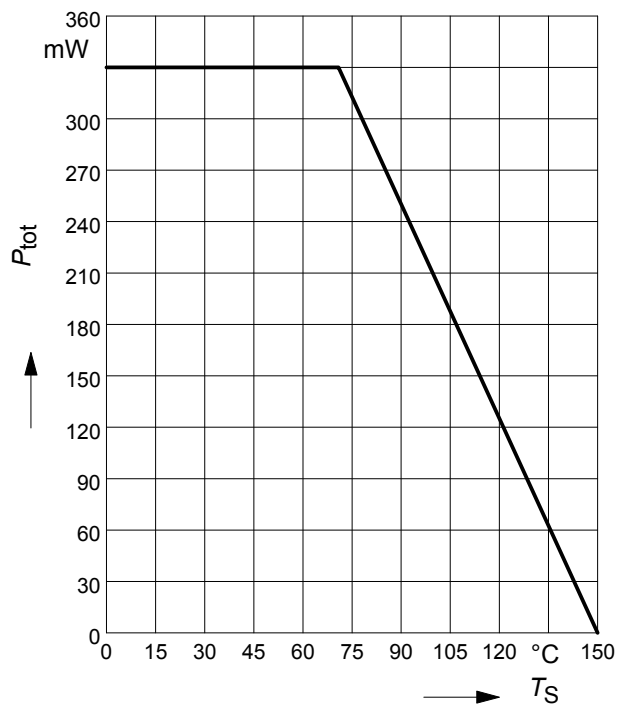


**Collector-base capacitance**  $C_{cb} = f(V_{CB})$

**Emitter-base capacitance**  $C_{eb} = f(V_{EB})$

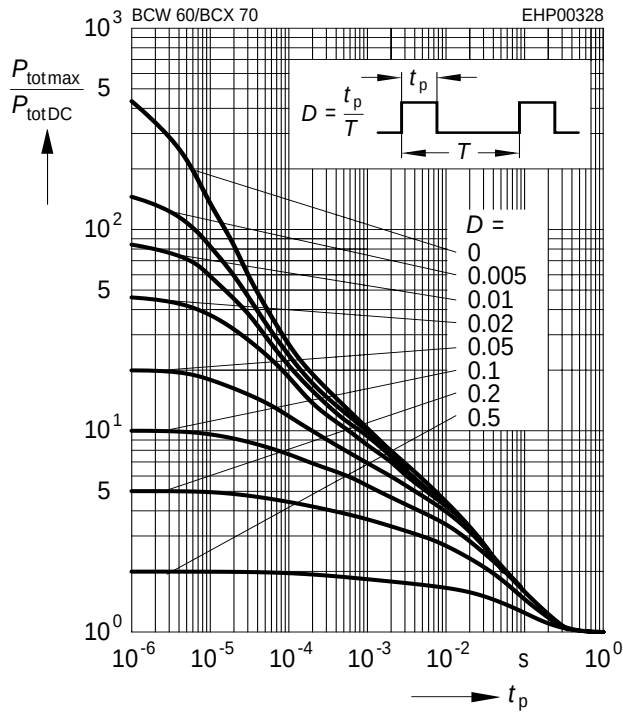


**Total power dissipation**  $P_{tot} = f(T_S)$



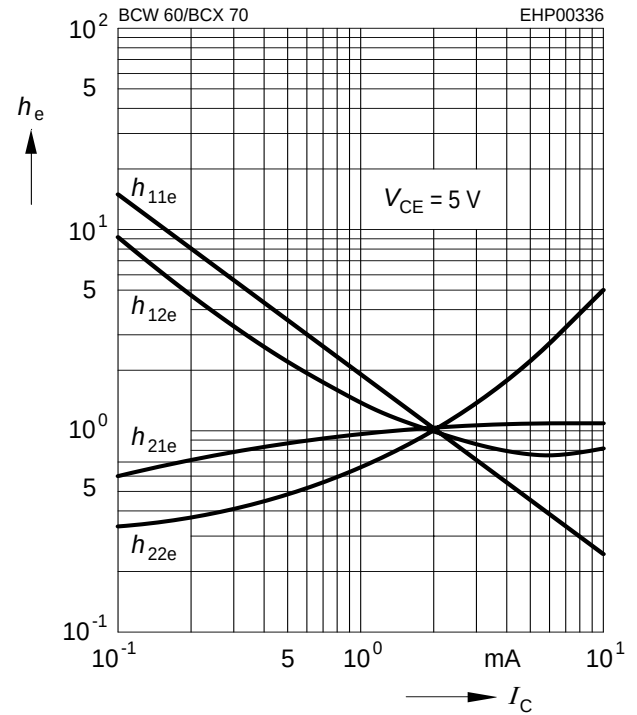
### Permissible Pulse Load

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



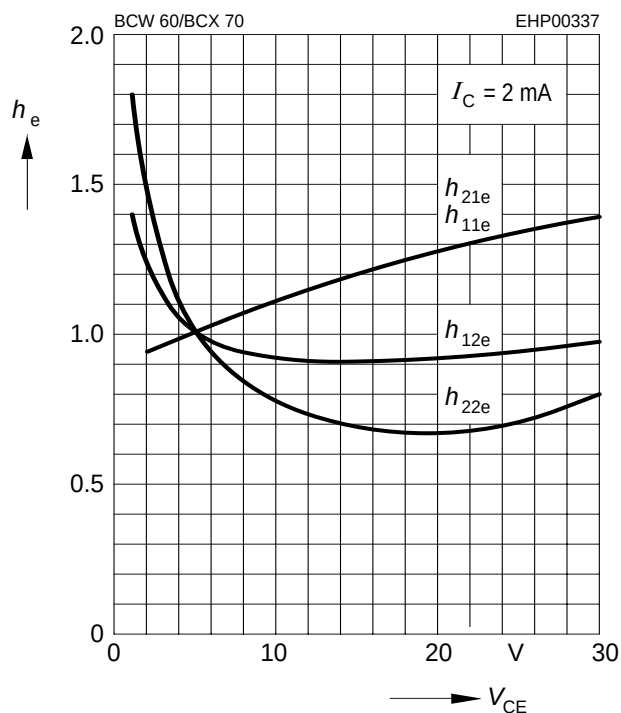
### h parameter $h_e = f(I_C)$ normalized

$$V_{CE} = 5V$$



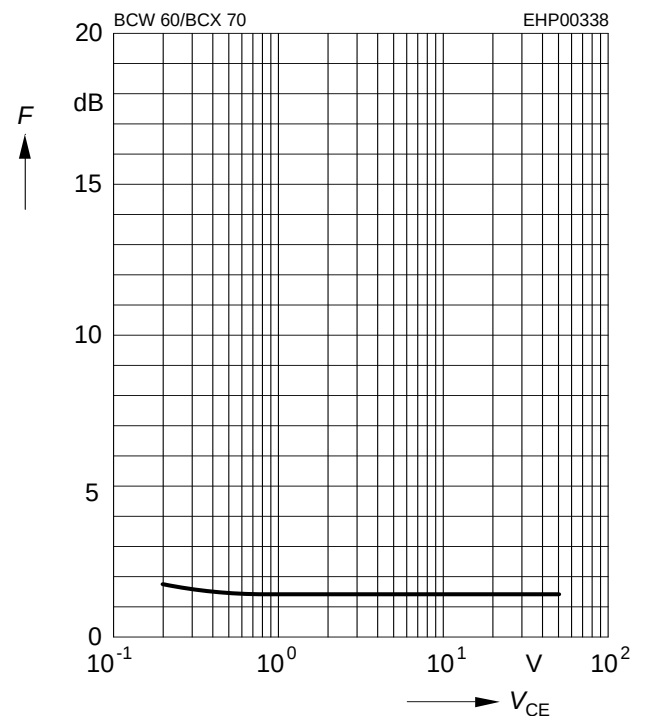
### h parameter $h_e = f(V_{CE})$ normalized

$$I_C = 2mA$$



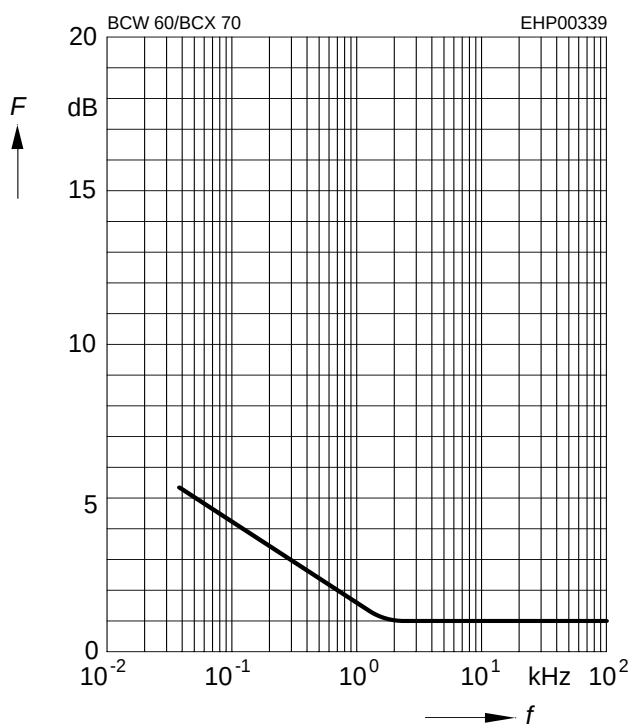
### Noise figure $F = f(V_{CE})$

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



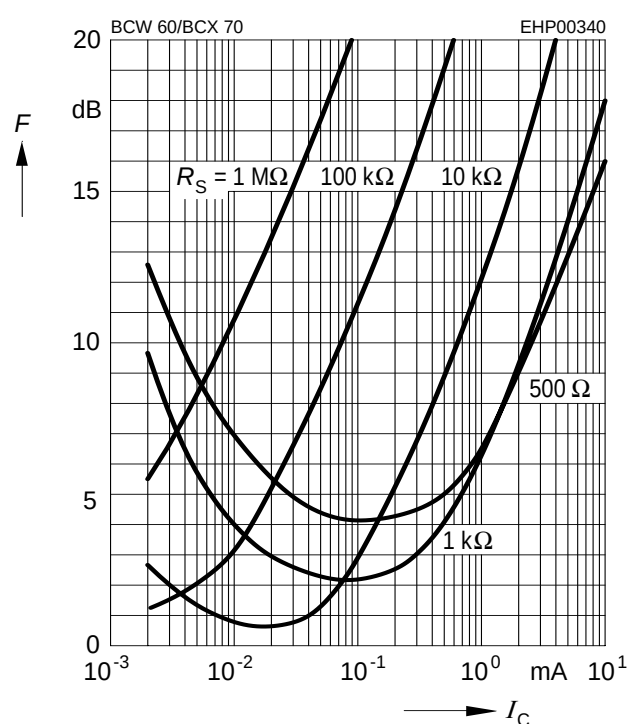
**Noise figure  $F = f(f)$**

$V_{CE} = 5V, Z_S = Z_{Sopt}$



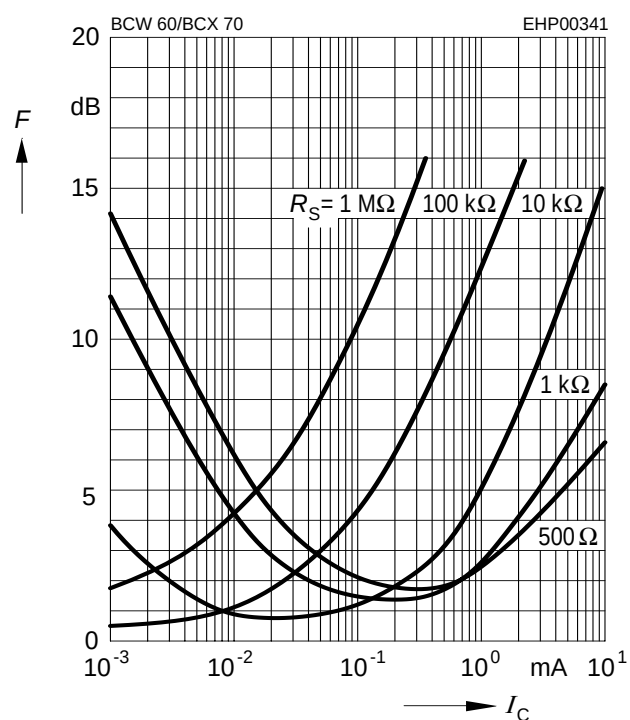
**Noise figure  $F = f(I_C)$**

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



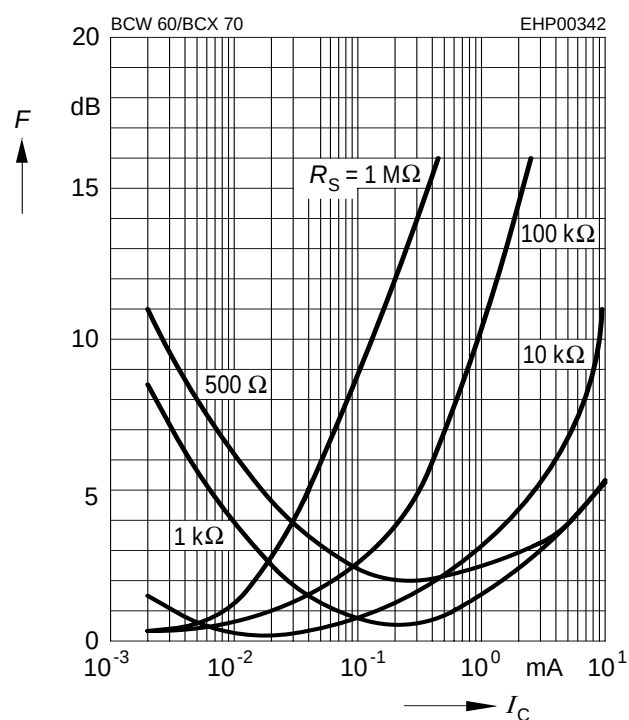
**Noise figure  $F = f(I_C)$**

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

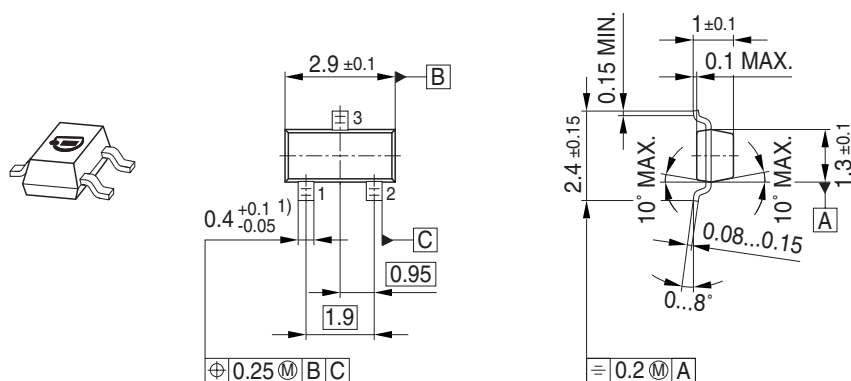


**Noise figure  $F = f(I_C)$**

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

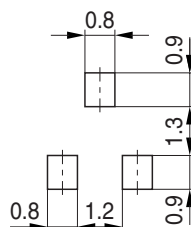


## Package Outline

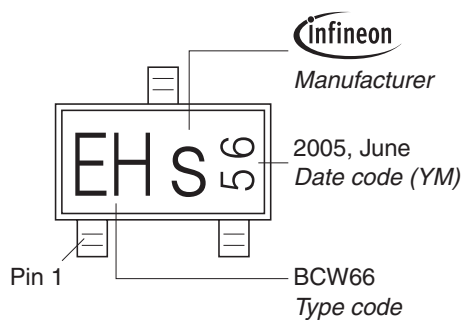


1) Lead width can be 0.6 max. in dambar area

## Foot Print

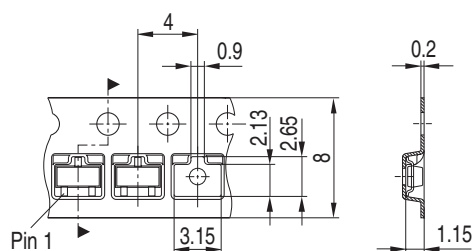


## Marking Layout (Example)



## Standard Packing

Reel ø180 mm = 3.000 Pieces/Reel  
Reel ø330 mm = 10.000 Pieces/Reel



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