

**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 |
|---------|---------|-------------------|-----|-----|---------|
|         |         | 1=B               | 2=E | 3=C |         |
| 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    |      |
| Emitter-base voltage                                 | $V_{EBO}$ | 6           |      |
| Collector current                                    | $I_C$     | 100         | mA   |
| Peak collector current, $t_p \leq 10$ ms             | $I_{CM}$  | 200         |      |
| Peak base current                                    | $I_{BM}$  | 200         |      |
| 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 |      |

**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.   |               |
| <b>DC Characteristics</b>   |               |  |  |  |               |
| 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>$V_{CB} = 32\text{ V}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ , BCW60, ...60FF<br>$V_{CB} = 45\text{ V}$ , $I_E = 0$ , $T_A = 150^\circ\text{C}$ , 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**

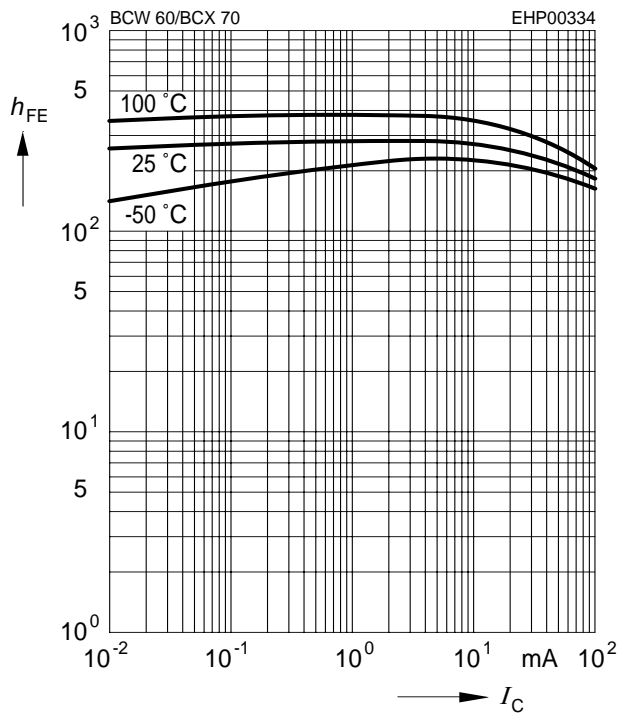
| Parameter   | Symbol       | Values         |                      |               | Unit |
|---|--------------|----------------|----------------------|---------------|------|
|   |              | min.           | typ.                 | max.          |      |
| <b>Characteristics</b>  |              |                |                      |               |      |
| Collector-emitter saturation voltage <sup>1)</sup><br>$I_C = 10 \text{ mA}, I_B = 0.25 \text{ mA}$<br>$I_C = 50 \text{ mA}, I_B = 1.25 \text{ mA}$                                      | $V_{CEsat}$  | -<br>-         | 0.12<br>0.2          | 0.25<br>0.55  | V    |
| Base emitter saturation voltage <sup>1)</sup><br>$I_C = 10 \text{ mA}, I_B = 0.25 \text{ mA}$<br>$I_C = 50 \text{ mA}, I_B = 1.25 \text{ mA}$   | $V_{BEsat}$  | -<br>-         | 0.7<br>0.83          | 0.85<br>1.05  |      |
| Base-emitter voltage <sup>1)</sup><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>0.58<br>- | 0.52<br>0.65<br>0.78 | -<br>0.7<br>- |      |

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

| <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>$V_{CB} = 10 \text{ V}, f = 1 \text{ MHz}$   | $C_{cb}$  | - | 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>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B/ H}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J /FF}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$               | $h_{11e}$ | - | 2.7<br>3.6<br>4.5<br>7.5 | -      | k $\Omega$    |
| Open-circuit reverse voltage transf. ratio<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B /H}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J/ FF}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$  | $h_{12e}$ | - | 1.5<br>2<br>2<br>3       | -      | $10^{-4}$     |
| Short-circuit forward current transf. ratio<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B/ H}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J/ FF}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$ | $h_{21e}$ | - | 200<br>260<br>330<br>520 | -      | -             |
| Open-circuit output admittance<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B/ H}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J/ FF}$<br>$I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$              | $h_{22e}$ | - | 18<br>24<br>30<br>50     | -      | $\mu\text{S}$ |
| Noise figure<br>$I_C = 200 \mu\text{A}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz},$<br>$\Delta f = 200 \text{ Hz}, R_S = 2 \text{ k}\Omega, h_{FE}\text{-grp. B - K}$<br>$I_C = 200 \mu\text{A}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz},$<br>$\Delta f = 200 \text{ Hz}, R_S = 2 \text{ k}\Omega, h_{FE}\text{-grp. FF}$  | $F$       | - | 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>$f = 10...50 \text{ Hz}, h_{FE}\text{-grp. FF}$   | $V_n$     | - | -                        | 0.135  | $\mu\text{V}$ |

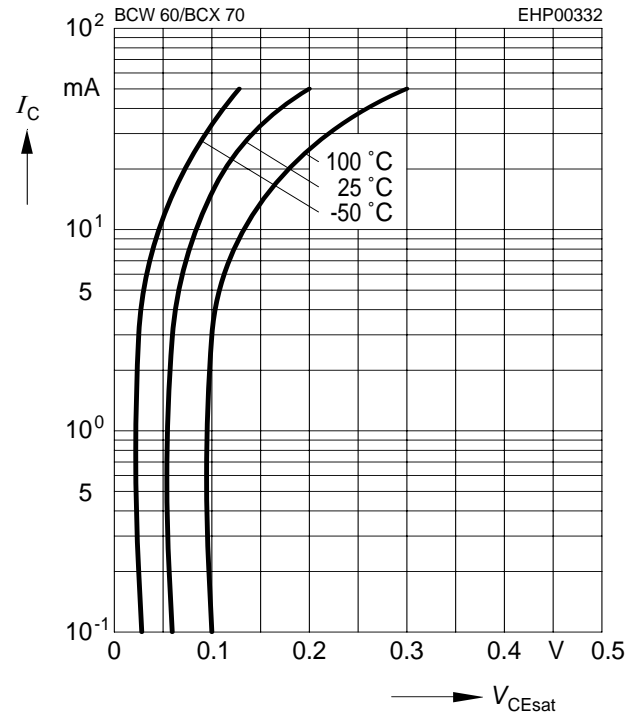
**DC current gain  $h_{FE} = f(I_C)$**

$V_{CE} = 5\text{ V}$



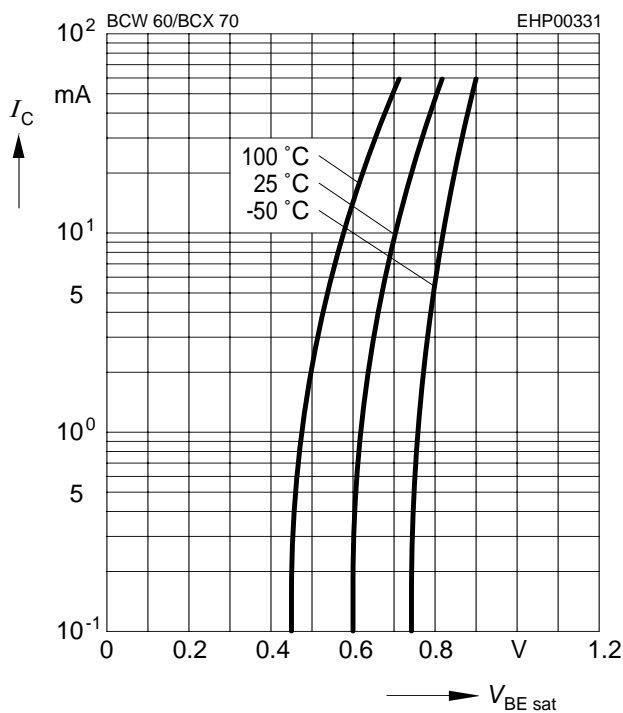
**Collector-emitter saturation voltage**

$I_C = f(V_{CEsat}), h_{FE} = 10$



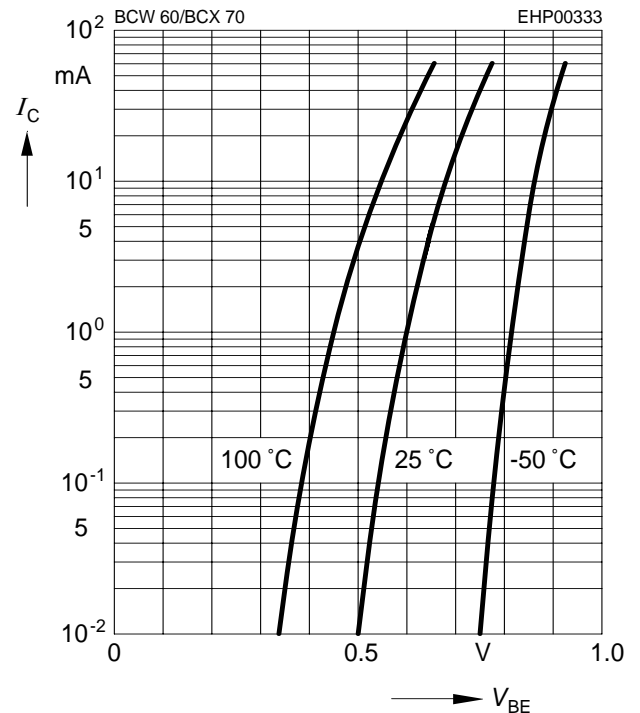
**Base-emitter saturation voltage**

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



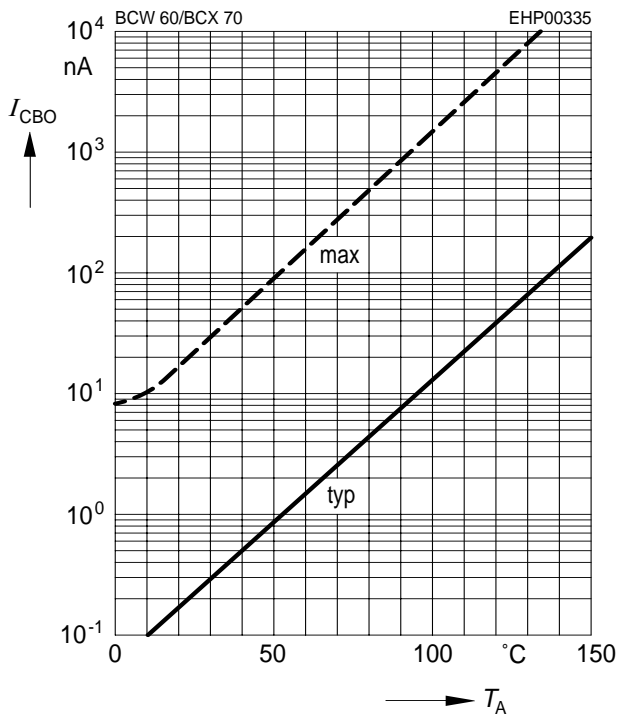
**Collector current  $I_C = f(V_{BE})$**

$V_{CE} = 5\text{ V}$



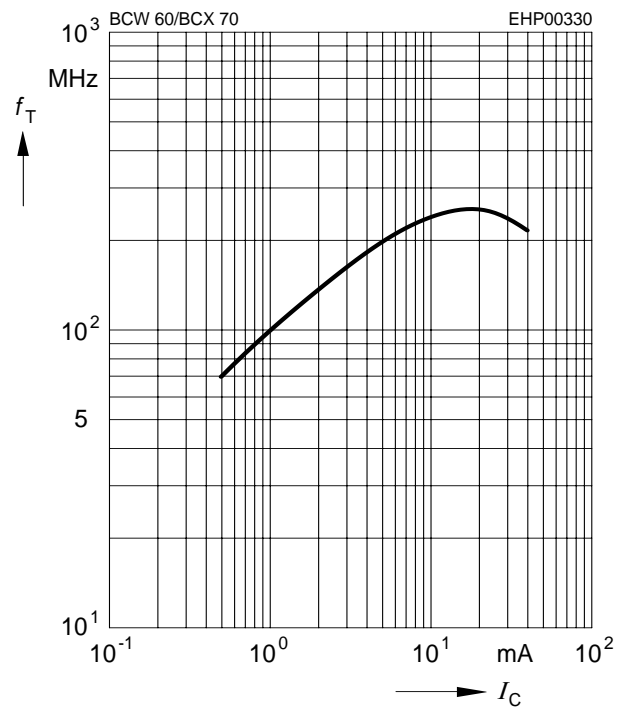
**Collector cutoff current  $I_{CBO} = f(T_A)$**

$V_{CB} = V_{CEmax}$



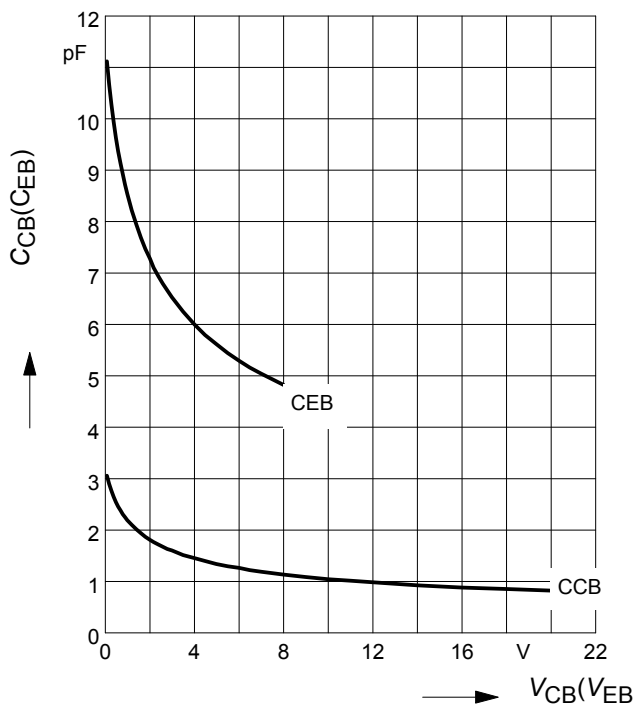
**Transition frequency  $f_T = f(I_C)$**

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

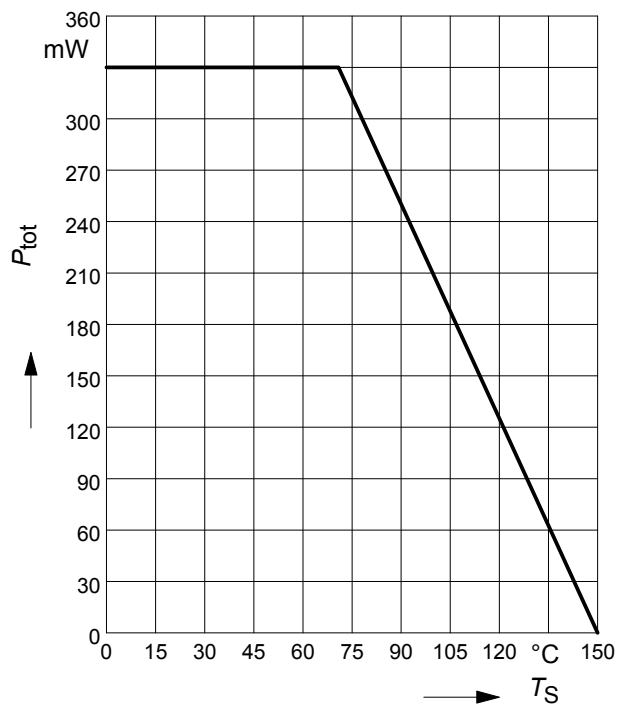


**Collector-base capacitance  $C_{cb} = f(V_{CB})$**

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

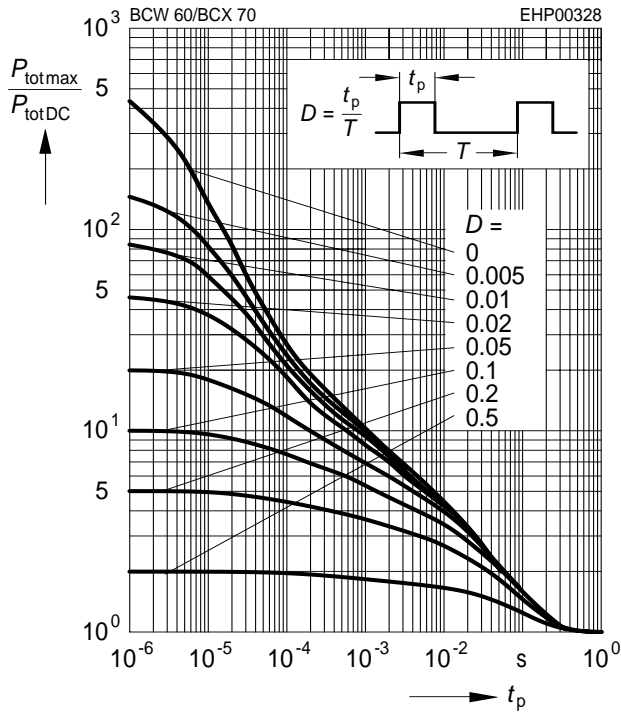


**Total power dissipation  $P_{tot} = f(T_S)$**



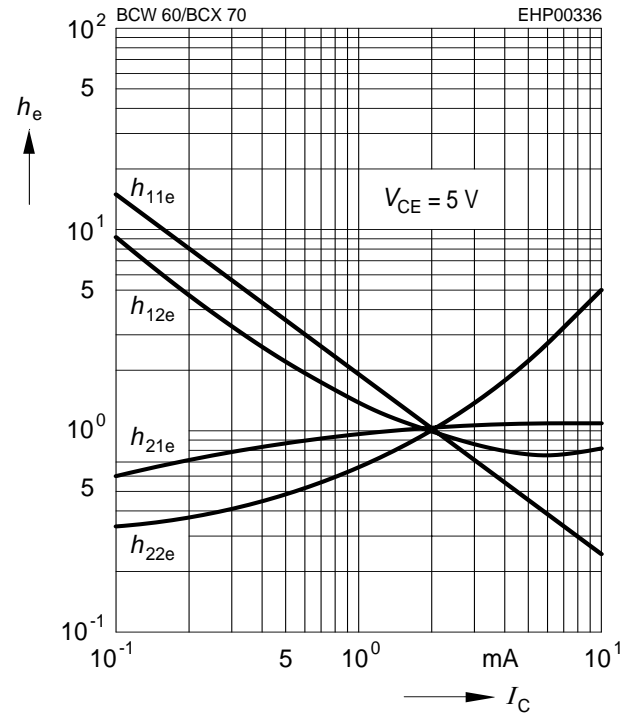
**Permissible Pulse Load**

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



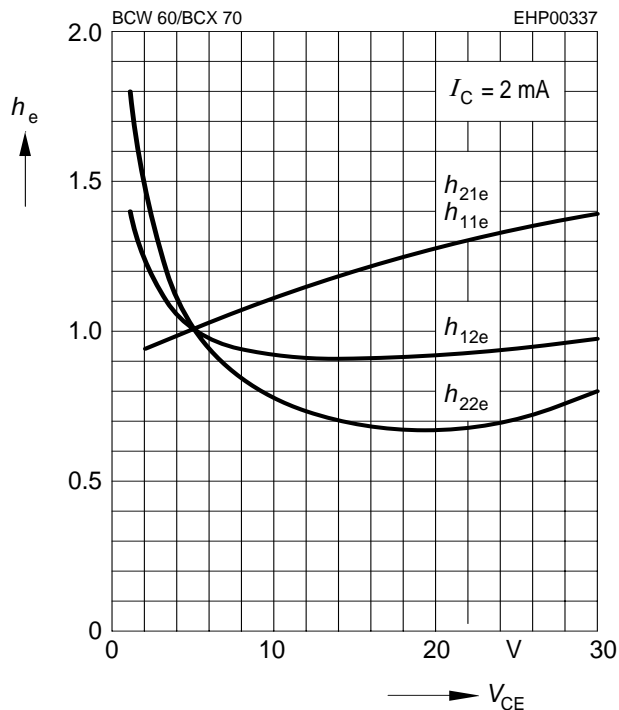
**h parameter  $h_e = f(I_C)$  normalized**

$$V_{CE} = 5V$$



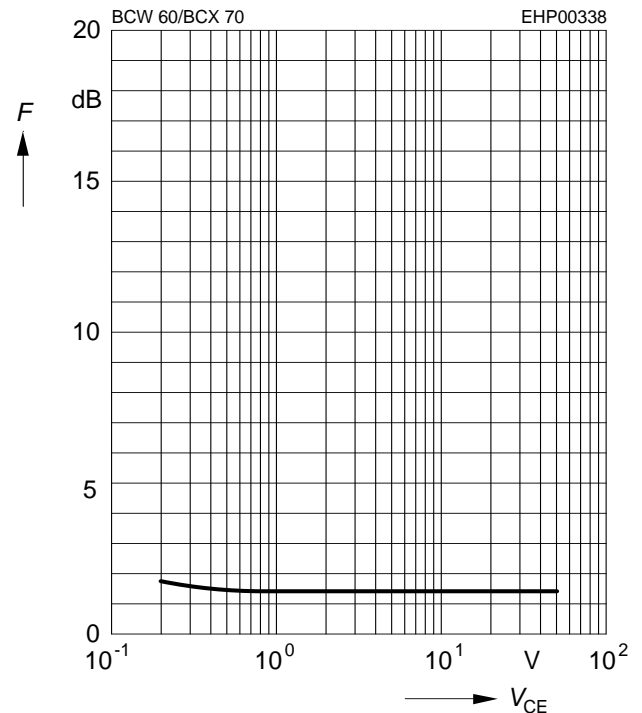
**h parameter  $h_e = f(V_{CE})$  normalized**

$$I_C = 2mA$$

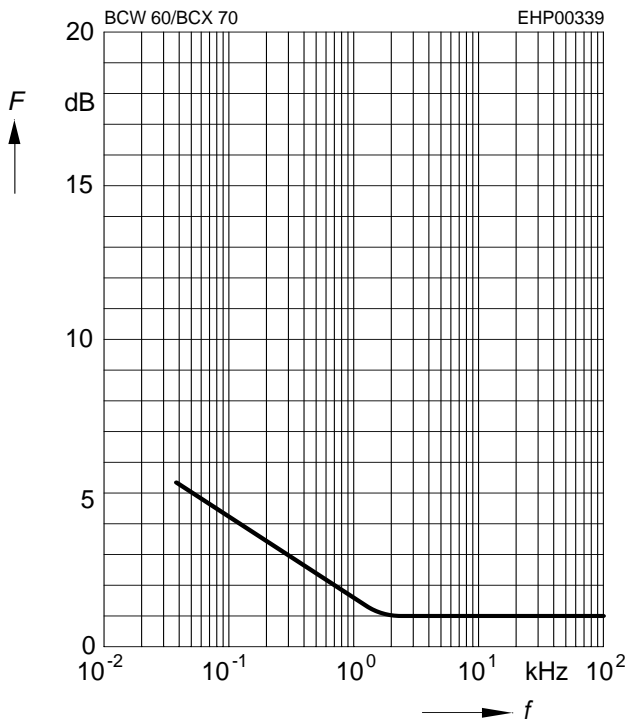
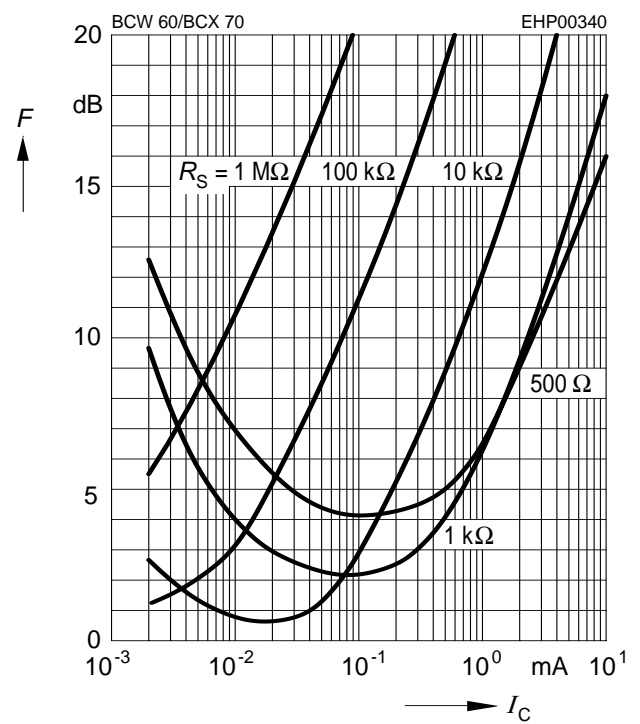
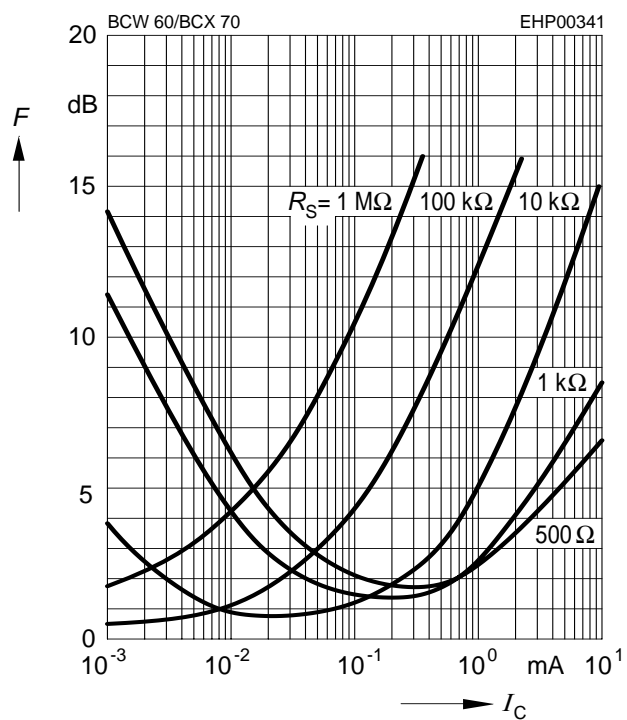
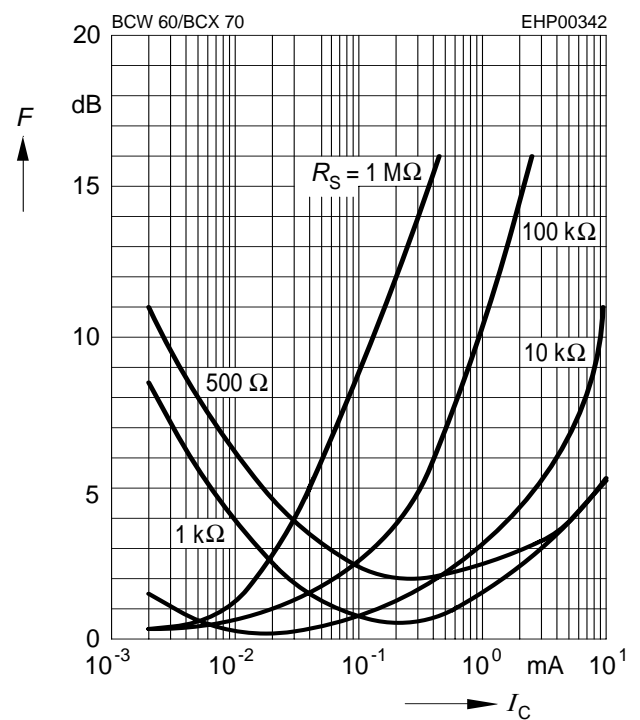


**Noise figure  $F = f(V_{CE})$**

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





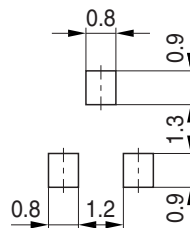
**Noise figure  $F = f(f)$** 
 $V_{CE} = 5V, Z_S = Z_{Sopt}$ 

**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

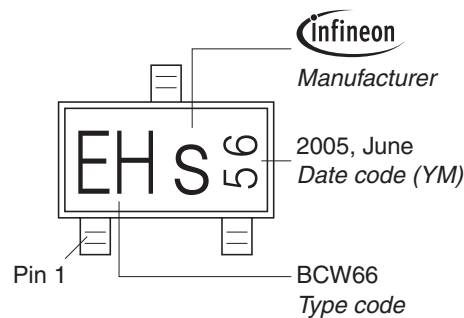


1) Lead width can be 0.6 max. in dambar area

Foot Print



Marking Layout (Example)



Standard Packing

Reel  $\varnothing$ 180 mm = 3.000 Pieces/Reel  
 Reel  $\varnothing$ 330 mm = 10.000 Pieces/Reel



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