

**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 <sup>1)</sup>
- 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

<sup>1</sup>Pb-containing package may be available upon special request

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Collector-emitter voltage BCW60, ...60FF BCX70	$V_{CEO}$	32 45	V
Collector-base voltage BCW60, ...60FF BCX70	$V_{CBO}$	32 45	
Emitter-base voltage	$V_{EBO}$	6	
Collector current	$I_C$	100	mA
Peak collector current	$I_{CM}$	200	
Peak base current	$I_{BM}$	200	
Total power dissipation $T_S \leq 71 \text{ }^\circ\text{C}$	$P_{tot}$	330	mW
Junction temperature	$T_j$	150	$^\circ\text{C}$
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 Thermal Resistance

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

**DC Electrical Characteristics**

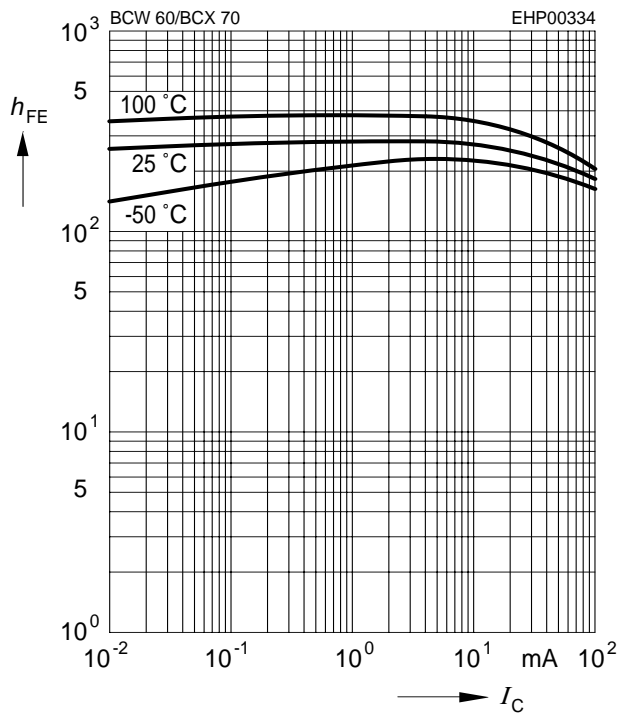
Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>Characteristics</b>					
Collector-emitter saturation voltage <sup>1)</sup> $I_C = 10 \text{ mA}, I_B = 0.25 \text{ mA}$ $I_C = 50 \text{ mA}, I_B = 1.25 \text{ mA}$	$V_{CEsat}$	- -	0.12 0.2	0.25 0.55	V
Base emitter saturation voltage <sup>1)</sup> $I_C = 10 \text{ mA}, I_B = 0.25 \text{ mA}$ $I_C = 50 \text{ mA}, I_B = 1.25 \text{ mA}$	$V_{BEsat}$	- -	0.7 0.83	0.85 1.05	
Base-emitter voltage <sup>1)</sup> $I_C = 10 \mu\text{A}, V_{CE} = 5 \text{ V}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}$ $I_C = 50 \text{ mA}, V_{CE} = 1 \text{ V}$	$V_{BE(ON)}$	- 0.58 -	0.52 0.65 0.78	- 0.7 -	

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

<b>AC Characteristics</b>					
Transition frequency $I_C = 20 \text{ mA}, V_{CE} = 5 \text{ V}, f = 100 \text{ MHz}$	$f_T$	-	250	-	MHz
Collector-base capacitance $V_{CB} = 10 \text{ V}, f = 1 \text{ MHz}$	$C_{cb}$	-	0.95	-	pF
Emitter-base capacitance $V_{EB} = 0.5 \text{ V}, f = 1 \text{ MHz}$	$C_{eb}$	-	9	-	
Short-circuit input impedance $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B/ H}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J /FF}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$	$h_{11e}$	-	2.7 3.6 4.5 7.5	-	k $\Omega$
Open-circuit reverse voltage transf. ratio $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B/ H}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J/ FF}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$	$h_{12e}$	-	1.5 2 2 3	-	$10^{-4}$
Short-circuit forward current transf. ratio $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B/ H}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J/ FF}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$	$h_{21e}$	-	200 260 330 520	-	-
Open-circuit output admittance $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. G}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. B/ H}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. C/ J/ FF}$ $I_C = 2 \text{ mA}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz}, h_{FE}\text{-grp. D/ K}$	$h_{22e}$	-	18 24 30 50	-	$\mu\text{S}$
Noise figure $I_C = 200 \mu\text{A}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz},$ $D f = 200 \text{ Hz}, R_S = 2 \text{ k}\Omega, h_{FE}\text{-grp. B - K}$ $I_C = 200 \mu\text{A}, V_{CE} = 5 \text{ V}, f = 1 \text{ kHz},$ $\Delta f = 200 \text{ Hz}, R_S = 2 \text{ k}\Omega, h_{FE}\text{-grp. FF}$	$F$	-	2 1	- 2	dB
Equivalent noise voltage $I_C = 200 \mu\text{A}, V_{CE} = 5 \text{ V}, R_S = 2 \text{ k}\Omega,$ $f = 10...50 \text{ Hz}, h_{FE}\text{-grp. FF}$	$V_n$	-	-	0.135	$\mu\text{V}$

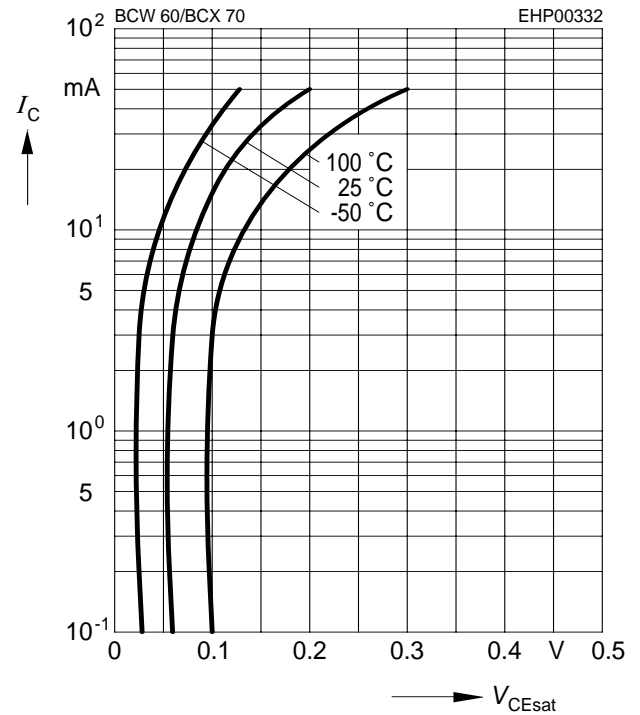
**DC current gain  $h_{FE} = f(I_C)$**

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



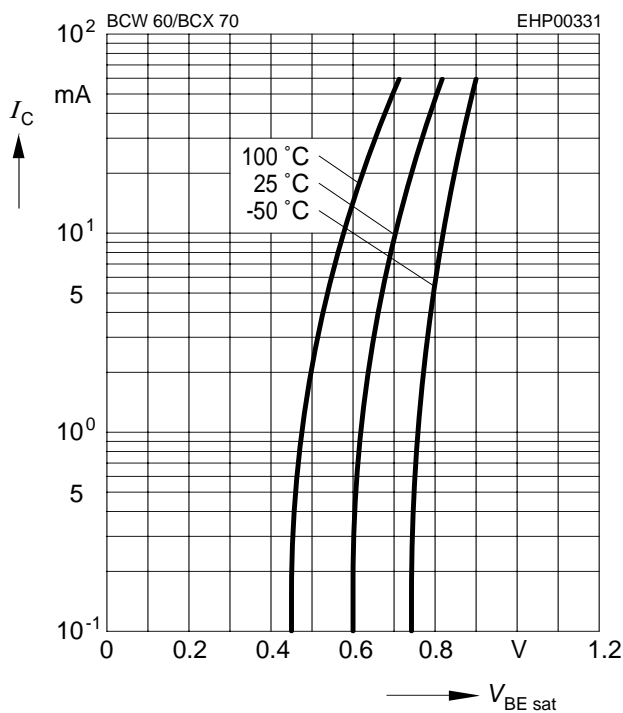
**Collector-emitter saturation voltage**

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



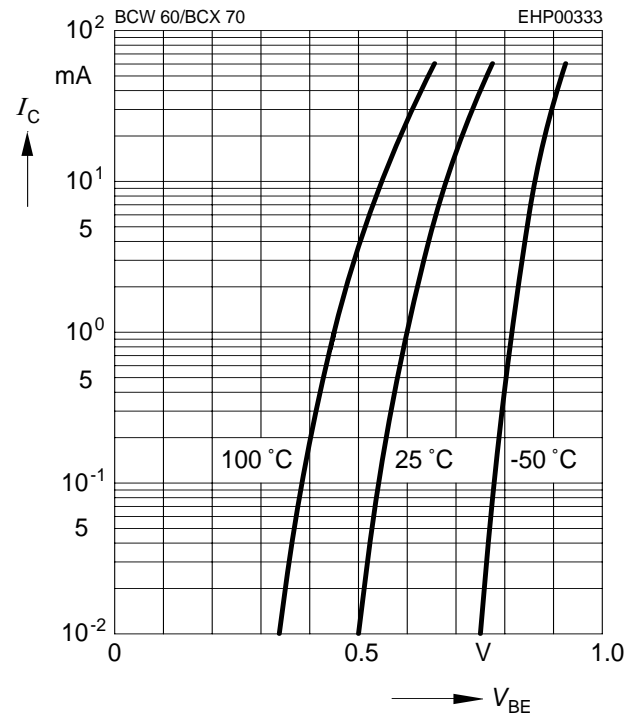
**Base-emitter saturation voltage**

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



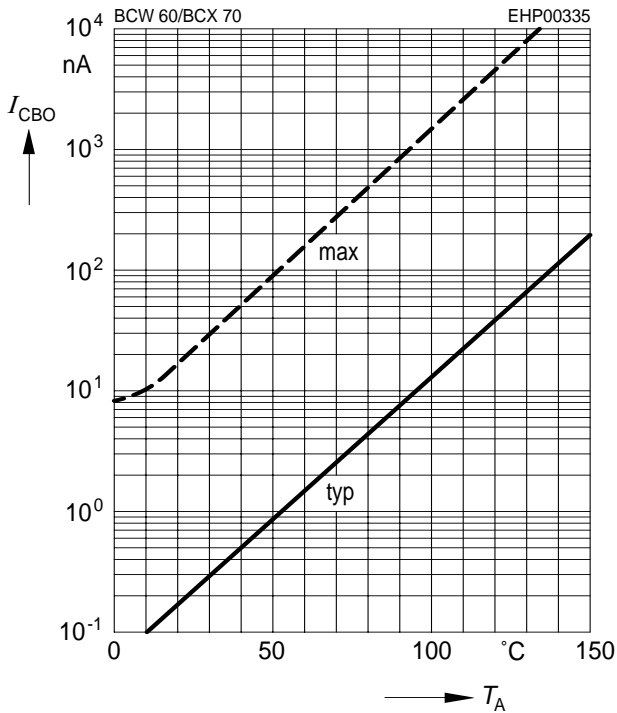
**Collector current  $I_C = f(V_{BE})$**

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



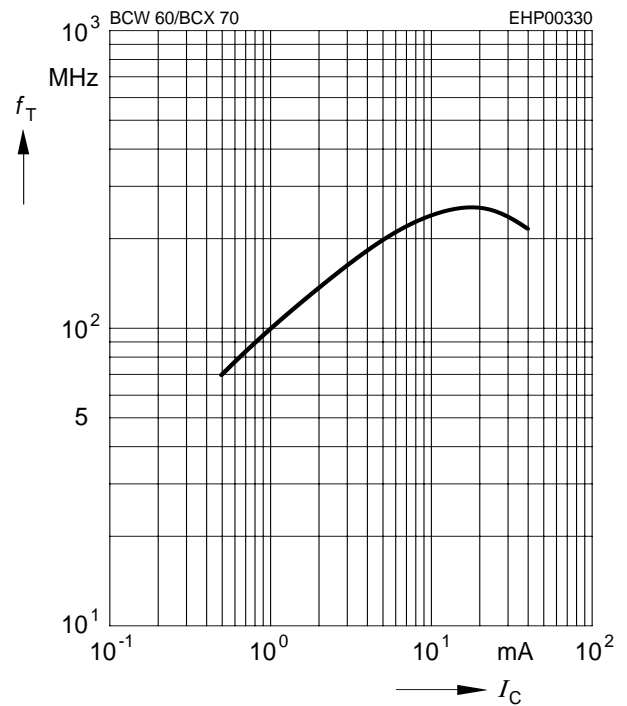
**Collector cutoff current**  $I_{CBO} = f(T_A)$

$V_{CB} = V_{CEmax}$



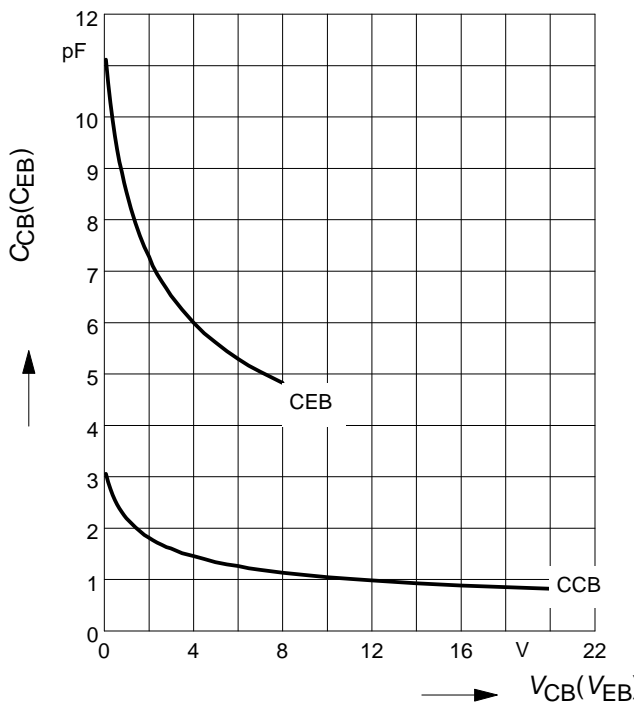
**Transition frequency**  $f_T = f(I_C)$

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

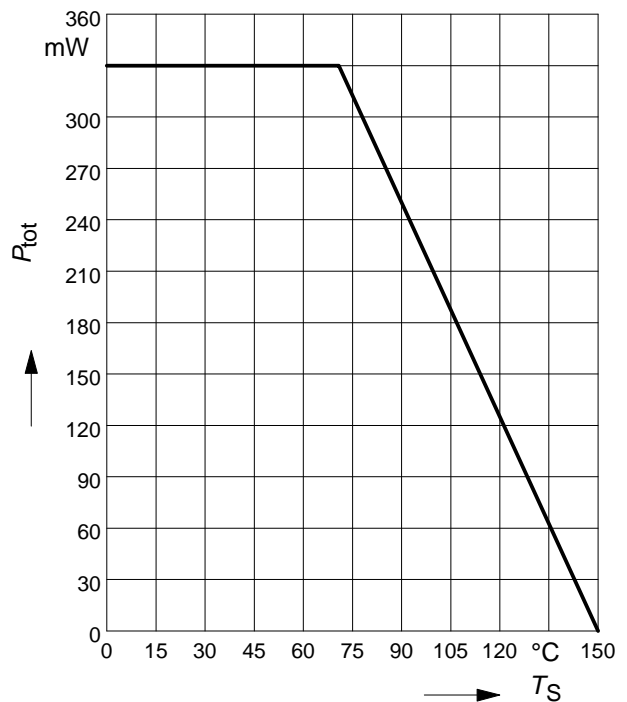


**Collector-base capacitance**  $C_{cb} = f(V_{CB})$

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

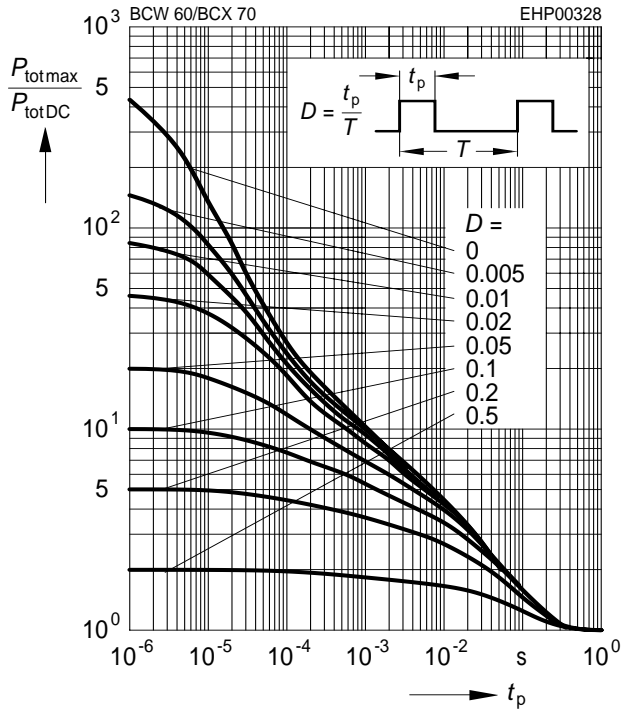


**Total power dissipation**  $P_{tot} = f(T_S)$



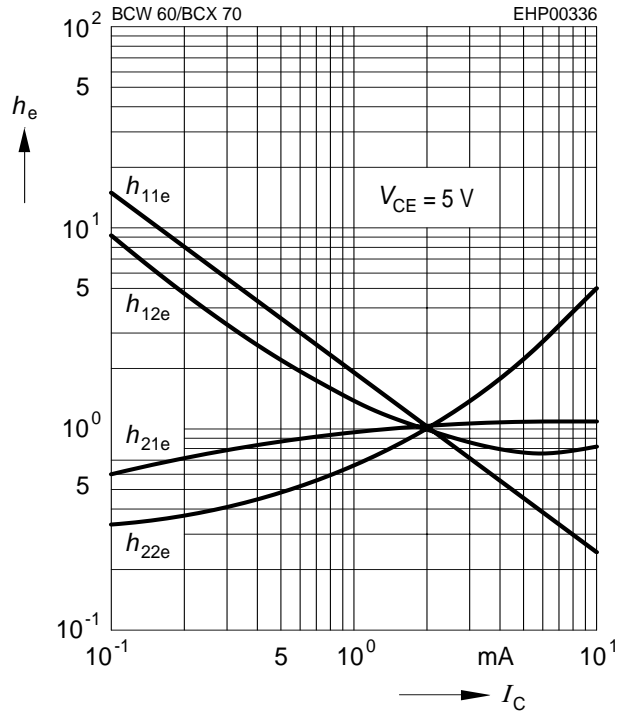
**Permissible Pulse Load**

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



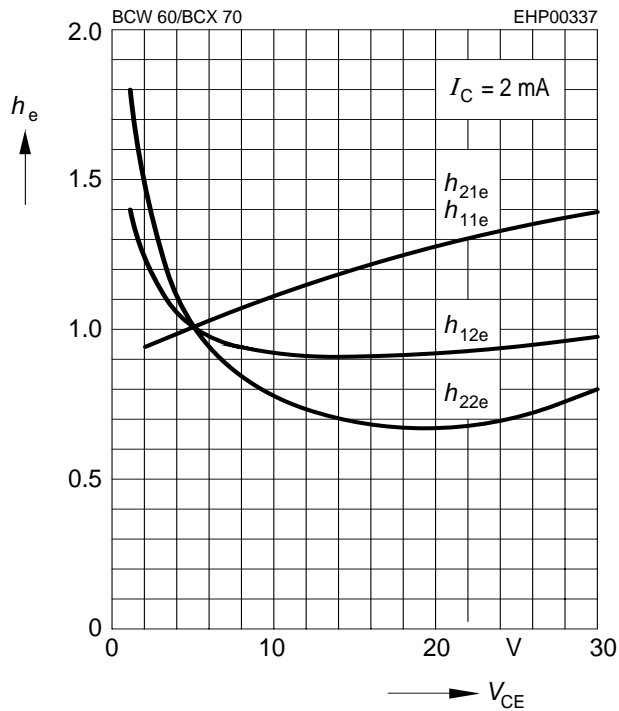
**h parameter  $h_e = f(I_C)$  normalized**

$$V_{CE} = 5V$$



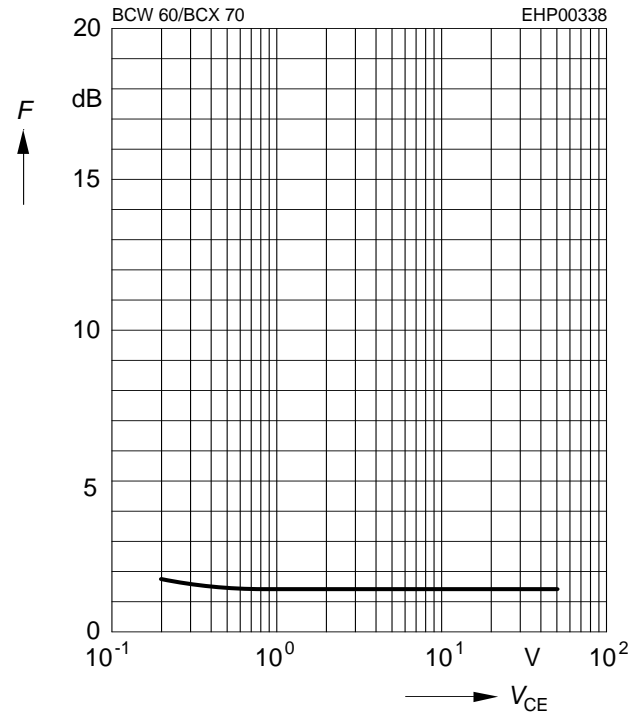
**h parameter  $h_e = f(V_{CE})$  normalized**

$$I_C = 2mA$$



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

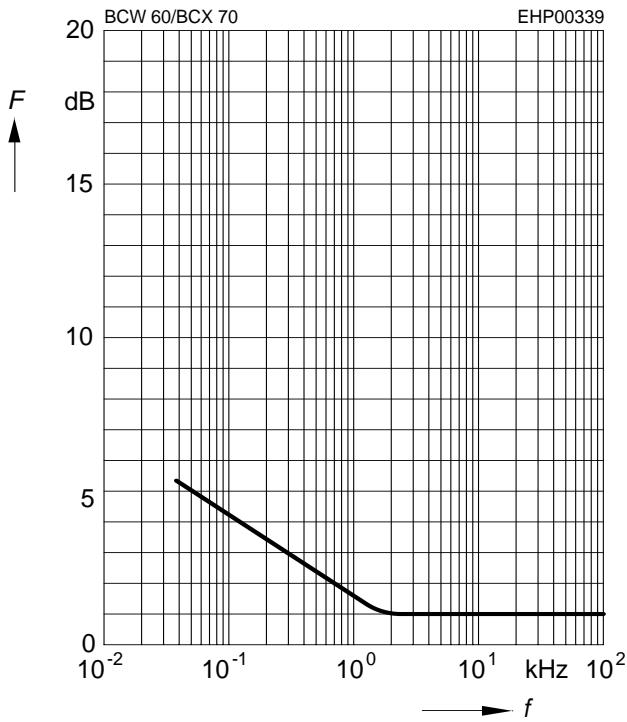
$$I_C = 0.2mA, R_S = 2k\Omega, f = 1kHz$$





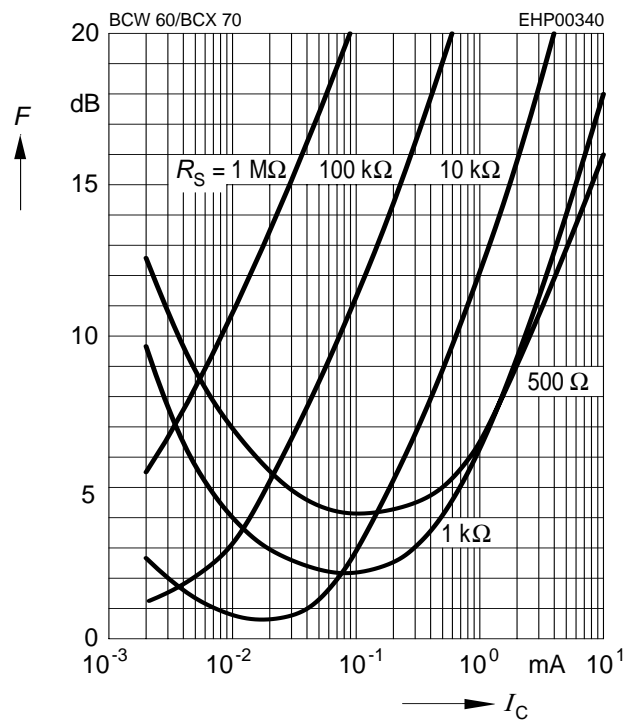
**Noise figure  $F = f(f)$**

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



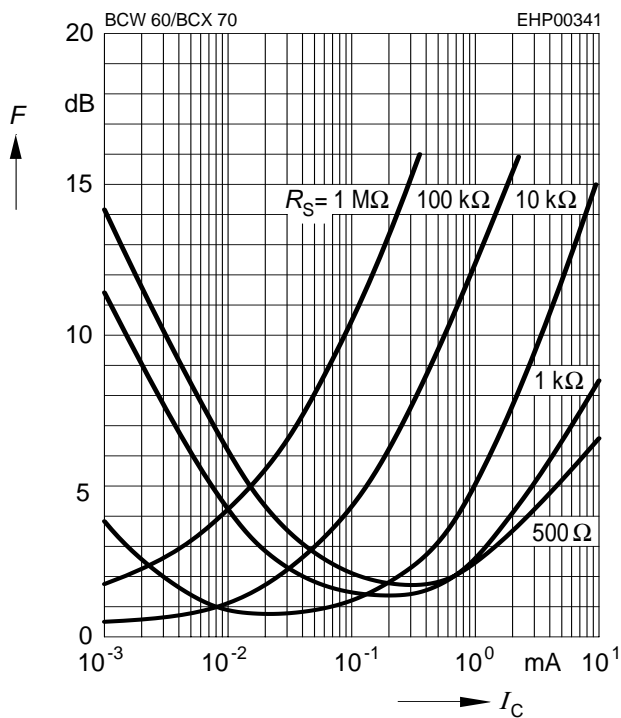
**Noise figure  $F = f(I_C)$**

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



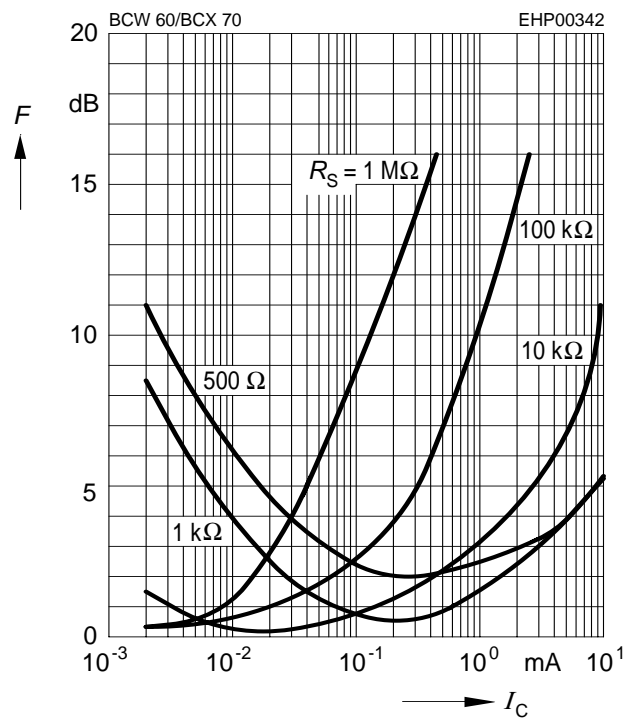
**Noise figure  $F = f(I_C)$**

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



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

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

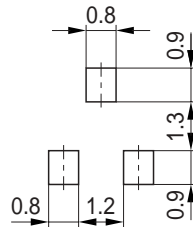


Package Outline

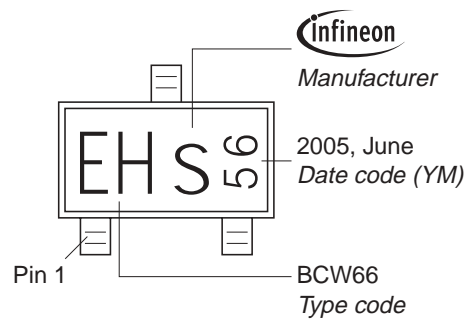


1) Lead width can be 0.6 max. in dambar area

Foot Print

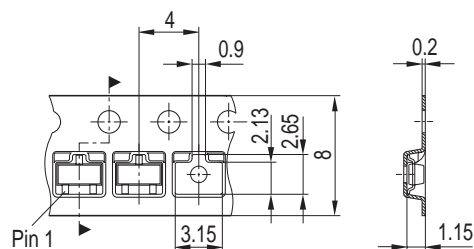


Marking Layout (Example)



Standard Packing

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



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