

### NPN Silicon RF Transistor

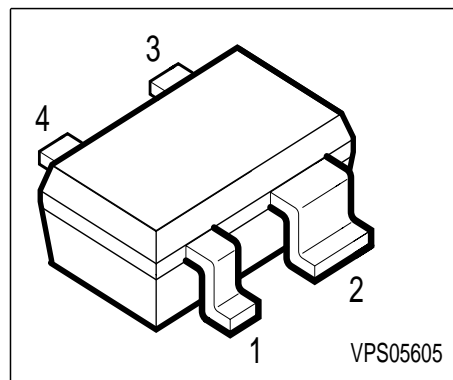
#### Preliminary data

- For highest gain low noise amplifier at 1.8 GHz and 2 mA / 2 V

**Outstanding  $G_a = 20$  dB**

**Noise Figure  $F = 0.95$  dB**

- For oscillators up to 15 GHz
- Transition frequency  $f_T = 45$  GHz
- Gold metalization for high reliability
- **SIEGET® 45 - Line**  
**Siemens Grounded Emitter Transistor**  
**45 GHz  $f_T$  - Line**



**ESD: Electrostatic discharge sensitive device, observe handling precaution!**

Type	Marking	Ordering Code	Pin Configuration				Package
BFP 520	APs	Q62702-F1794	1 = B	2 = E	3 = C	4 = E	SOT-343

#### Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	$V_{CEO}$	2.5	V
Collector-base voltage	$V_{CBO}$	12	V
Emitter-base voltage	$V_{EBO}$	1	V
Collector current	$I_C$	40	mA
Base current	$I_B$	4	mA
Total power dissipation, $T_S \leq 105$ °C	$P_{tot}$	100	mW
Junction temperature	$T_j$	150	°C
Ambient temperature	$T_A$	-65 ...+150	°C
Storage temperature	$T_{stg}$	-65 ...+150	°C

#### Thermal Resistance

Junction - soldering point <sup>1)</sup>	$R_{thJS}$	$\leq 450$	K/W
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1) TS is measured on the collector lead at the soldering point to the pcb

**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 $I_C = 1 \text{ mA}, I_B = 0$	$V_{(BR)CEO}$	2.5	3	3.5	V
Collector-base cutoff current $V_{CB} = 5 \text{ V}, I_E = 0$	$I_{CBO}$	-	-	200	nA
Emitter-base cutoff current $V_{EB} = 1.5 \text{ V}, I_C = 0$	$I_{EBO}$	-	-	35	nA
DC current gain $I_C = 20 \text{ mA}, V_{CE} = 4 \text{ V}$	$h_{FE}$	50	80	150	-
<b>AC characteristics</b>					
Transition frequency $I_C = 30 \text{ mA}, V_{CE} = 2 \text{ V}, f = 2 \text{ GHz}$	$f_T$	-	45	-	GHz
Collector-base capacitance $V_{CB} = 2 \text{ V}, f = 1 \text{ MHz}$	$C_{cb}$	-	0.06	-	pF
Collector-emitter capacitance $V_{CE} = 2 \text{ V}, f = 1 \text{ MHz}$	$C_{ce}$	-	0.3	-	pF
Emitter-base capacitance $V_{EB} = 0.5 \text{ V}, f = 1 \text{ MHz}$	$C_{eb}$	-	0.35	-	pF
Noise figure $I_C = 2 \text{ mA}, V_{CE} = 2 \text{ V}, Z_S = Z_{Sopt}, f = 1.8 \text{ GHz}$	$F$	-	0.95	-	dB
Power gain <sup>1)</sup> $I_C = 20 \text{ mA}, V_{CE} = 2 \text{ V}, Z_S = Z_{Sopt}, Z_L = Z_{Lopt}, f = 1.8 \text{ GHz}$	$G_{ms}$	-	23	-	dB
Insertion power gain $I_C = 20 \text{ mA}, V_{CE} = 2 \text{ V}, f = 1.8 \text{ GHz}, Z_S = Z_L = 50\Omega$	$ S_{21} ^2$	-	21	-	dB
Third order intercept point at output $V_{CE} = 2 \text{ V}, f = 1.8 \text{ GHz}, Z_S = Z_{Sopt}, Z_L = Z_{Lopt}, I_C = 20 \text{ mA}$ $I_C = 7 \text{ mA}$	$IP_3$	-	25	-	dBm
		-	17	-	
1dB compression point $V_{CE} = 2 \text{ V}, f = 1.8 \text{ GHz}, Z_S = Z_{Sopt}, Z_L = Z_{Lopt}, I_C = 20 \text{ mA}$ $I_C = 7 \text{ mA}$	$P_{-1dB}$	-	12	-	dBm
		-	5	-	

1)  $G_{ms} = |S_{21} / S_{12}|$

2)  $G_{ma} = |S_{21} / S_{12}| (k - (k^2 - 1)^{1/2})$

## Common Emitter S-Parameters

f	S <sub>11</sub>		S <sub>21</sub>		S <sub>12</sub>		S <sub>22</sub>	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
V <sub>CE</sub> = 2 V, I <sub>C</sub> = 20 mA								
0.01	0.7244	-0.7	32.273	178.6	0.0007	69.4	0.9052	1.2
0.1	0.7251	-8.4	31.637	171.4	0.0041	92.8	0.9363	-4.4
0.5	0.6368	-40.7	27.293	140.7	0.0194	75.9	0.8523	-26.7
1	0.4768	-73.6	19.6	113.5	0.0351	66.5	0.6496	-46
2	0.2816	-123.8	11.02	84.9	0.00574	56.3	0.3818	-64.6
3	0.225	-166	7.48	67.6	0.0788	49.2	0.2407	-73.6
4	0.2552	156.2	5.636	53	0.0994	41.5	0.1544	-95.3
5	0.3207	133.6	4.488	39.7	0.1177	32.9	0.095	-128.9
6	0.3675	118.7	3.683	27.5	0.1343	24.7	0.0545	177.6

## Common Emitter Noise Parameters

f	F <sub>min</sub> <sup>1)</sup>	G <sub>a</sub> <sup>1)</sup>	Γ <sub>opt</sub>		R <sub>N</sub>	r <sub>n</sub>	F <sub>50Ω</sub> <sup>2)</sup>	S <sub>21</sub>   <sup>2 2)</sup>
	dB	dB	MAG	ANG	Ω	-	dB	dB
V <sub>CE</sub> = 2 V, I <sub>C</sub> = 2 mA								
0.9	0.72	21.5	0.64	14	21.5	0.43	1.75	16.1
1.8	0.95	20	0.49	30	19	0.38	1.55	15.14
2.4	1.07	16	0.45	41	18	0.36	1.6	14.07
3	1.3	14.5	0.4	54	16.5	0.33	1.7	13.13
4	1.35	11.6	0.26	82	12.5	0.25	1.6	11.49
5	1.7	9.5	0.14	128	9	0.18	1.85	9.87
6	1.95	8	0.12	151	8	0.16	1.95	8.28
V <sub>CE</sub> = 2 V, I <sub>C</sub> = 5 mA								
0.9	0.89	22	0.49	12	16	0.32	1.5	21.94
1.8	1.08	20.5	0.38	22	14	0.28	1.38	19.34
2.4	1.12	18	0.34	33	14	0.28	1.4	17.54
3	1.32	16.2	0.29	45	13.5	0.27	1.5	16.01
4	1.35	13.5	0.156	71	11	0.22	1.45	13.82
5	1.6	11.5	0.08	120	10	0.2	1.65	11.93
6	1.8	10.5	0.07	150	8	0.16	1.8	10.23

1) Input matched for minimum noise figure, output for maximum gain

2) Z<sub>S</sub> = Z<sub>L</sub> = 50Ω

For more and detailed S- and Noise-parameters please contact your local Siemens distributor or sales office to obtain a Siemens Application Notes CD-ROM or see Internet: <http://www.siemens.de/Semiconductor/products/35/35.htm>

## SPICE Parameters (Gummel-Poon Model, Berkley-SPICE 2G.6 Syntax) :

### Transistor Chip Data

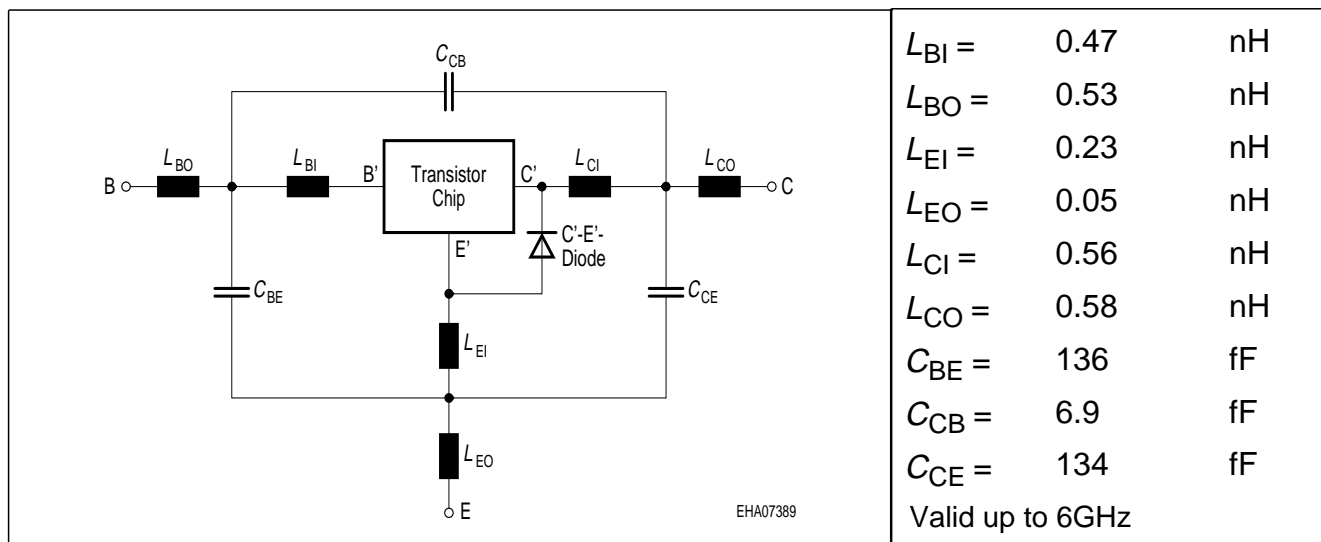
IS =	tbd	aA	BF =	tbd	-	NF =	tbd	-
VAF =	tbd	V	IKF =	tbd	A	ISE =	tbd	fA
NE =	tbd	-	BR =	tbd	-	NR =	tbd	-
VAR =	tbd	V	IKR =	tbd	A	ISC =	tbd	fA
NC =	tbd	-	RB =	tbd	$\Omega$	IRB =	tbd	mA
RBM =	tbd	$\Omega$	RE =	tbd	$\Omega$	RC =	tbd	$\Omega$
CJE =	tbd	fF	VJE =	tbd	V	MJE =	tbd	-
TF =	tbd	ps	XTF =	tbd	-	VTF =	tbd	V
ITF =	tbd	mA	PTF =	tbd	deg	CJC =	tbd	fF
VJC =	tbd	V	MJC =	tbd	-	XCJC =	tbd	-
TR =	tbd	ns	CJS =	tbd	fF	VJS =	tbd	V
MJS =	tbd	-	XTB =	tbd	-	EG =	tbd	eV
XTI =	tbd	-	FC =	tbd	-	TNOM	tbd	K

### C'-E'-Diode Data (Berkley-SPICE 2G.6 Syntax) :

IS =	tbd	fA	N =	tbd	-	RS =	tbd	$\Omega$
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All parameters are ready to use, no scaling is necessary

### Package Equivalent Circuit:



The SOT-343 package has two emitter leads. To avoid high complexity of the package equivalent circuit, both leads are combined in one electrical connection.

Extracted on behalf of SIEMENS Small Signal Semiconductors by:  
 Institut für Mobil-und Satellitentechnik (IMST)  
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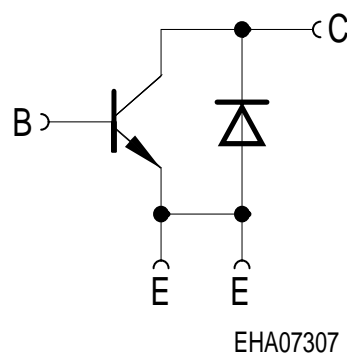
For examples and ready to use parameters please contact your local Siemens distributor or sales office to obtain a Siemens CD-ROM or see Internet: <http://www.siemens.de/Semiconductor/products/35/35.htm>

**For non-linear simulation:**

- Use transistor chip parameters in Berkeley SPICE 2G.6 syntax for all simulators.
- If you need simulation of the reverse characteristics, add the diode with the C'-E'- diode data between collector and emitter.
- Simulation of package is not necessary for frequencies < 100MHz.  
For higher frequencies add the wiring of package equivalent circuit around the non-linear transistor and diode model.

**Note:**

- This transistor is constructed in a common emitter configuration. This feature causes an additional reverse biased diode between emitter and collector, which does not effect normal operation.



**Transistor Schematic Diagram**

The common emitter configuration shows the following advantages:

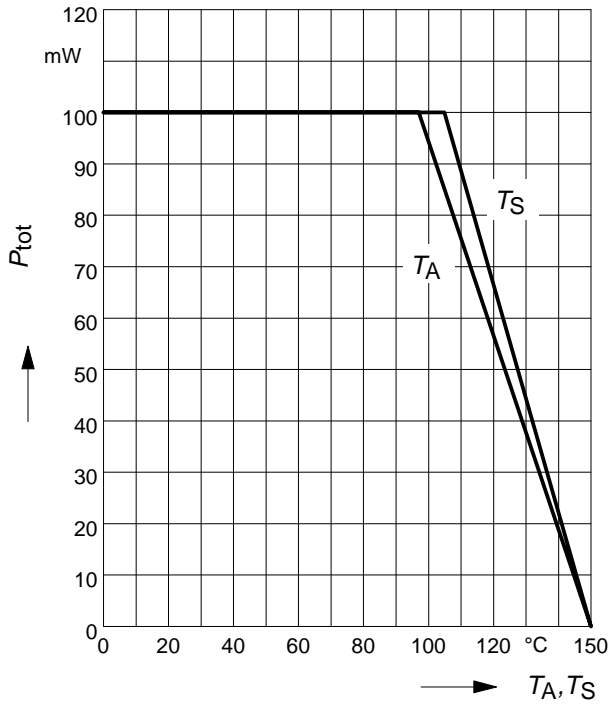
- Higher gain because of lower emitter inductance.
- Power is dissipated via the grounded emitter leads, because the chip is mounted on copper emitter leadframe.

Please note, that the broadest lead is the emitter lead.

The AC characteristics are verified by random sampling.

### Total power dissipation $P_{tot} = f(T_A^*, T_S)$

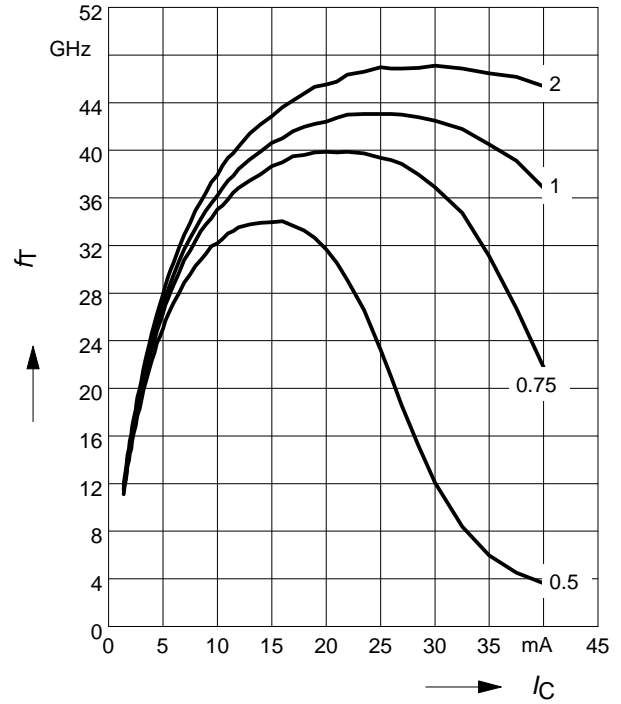
\* Package mounted on epoxy



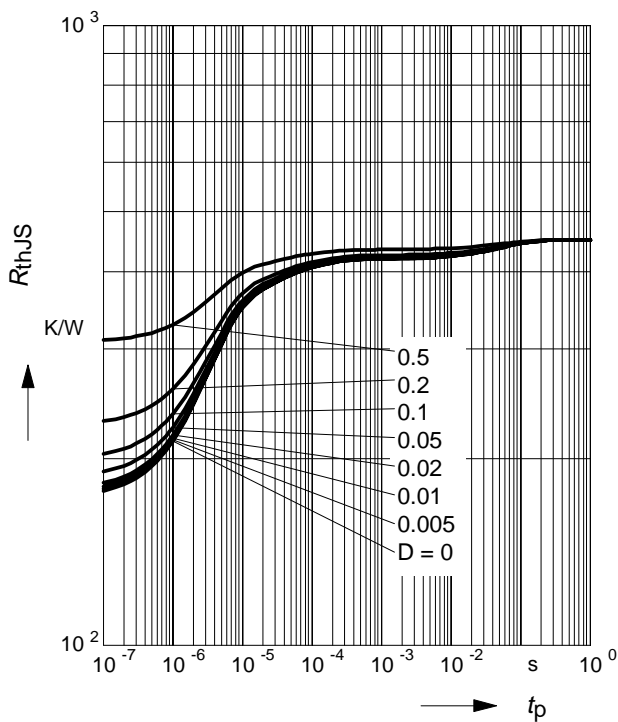
### Transition frequency $f_T = f(I_C)$

$f = 2$  GHz

$V_{CE}$  = parameter in V

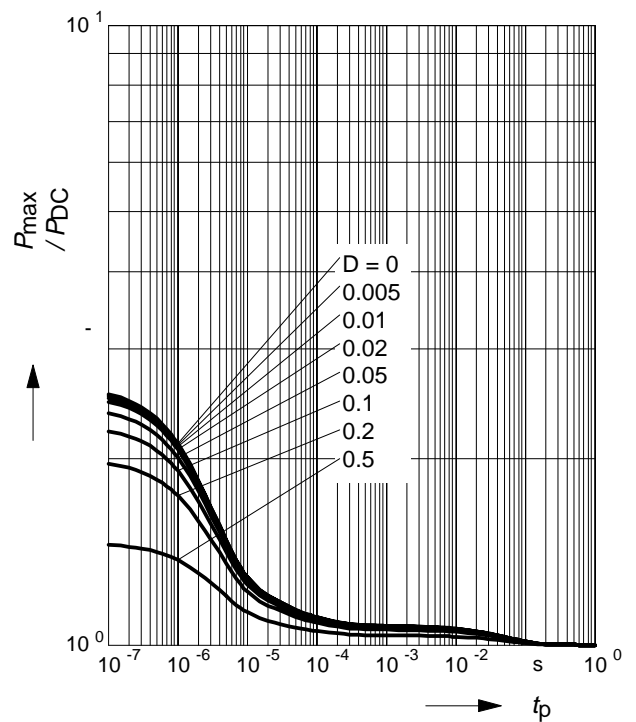


### Permissible Pulse Load $R_{thJS} = f(t_p)$



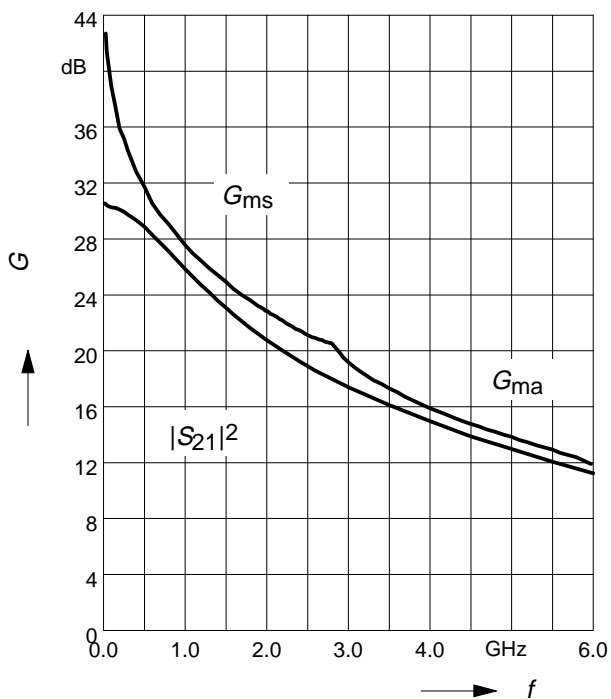
### Permissible Pulse Load

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



**Power gain  $G_{ma}$ ,  $G_{ms}$ ,  $|S_{21}|^2 = f(f)$**

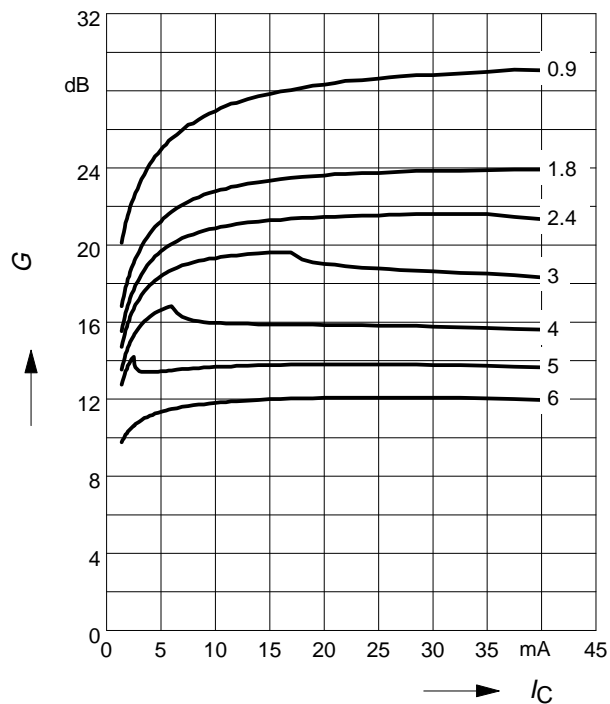
$V_{CE} = 2V$ ,  $I_C = 20\text{ mA}$



**Power gain  $G_{ma}$ ,  $G_{ms} = f(I_C)$**

$V_{CE} = 2V$

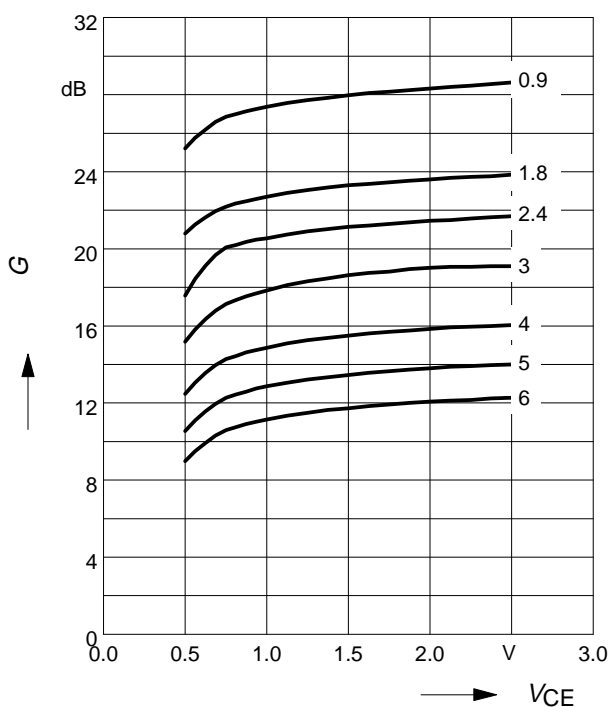
$f = \text{parameter in GHz}$



**Power gain  $G_{ma}$ ,  $G_{ms} = f(V_{CE})$**

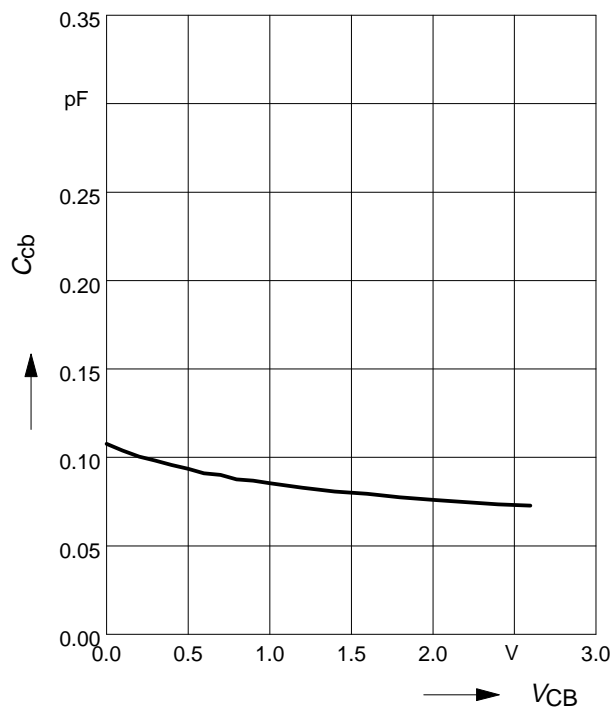
$I_C = 20\text{ mA}$

$f = \text{parameter in GHz}$



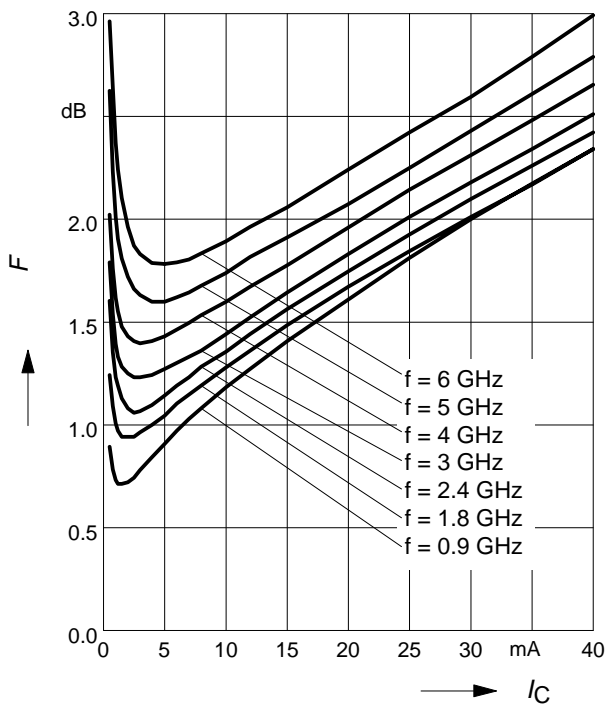
**Collector-base capacitance  $C_{cb} = f(V_{CB})$**

$V_{BE} = 0$ ,  $f = 1\text{ MHz}$



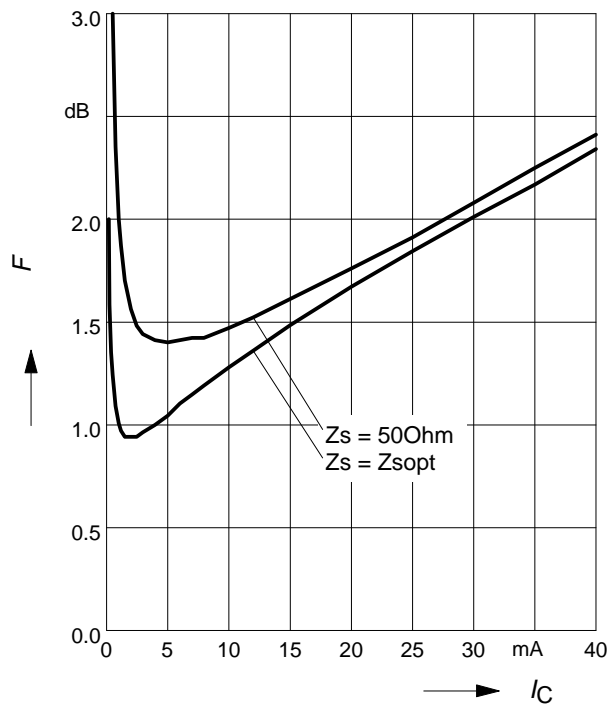
### Noise figure $F = f(I_C)$

$V_{CE} = 2 \text{ V}$ ,  $Z_S = Z_{Sopt}$



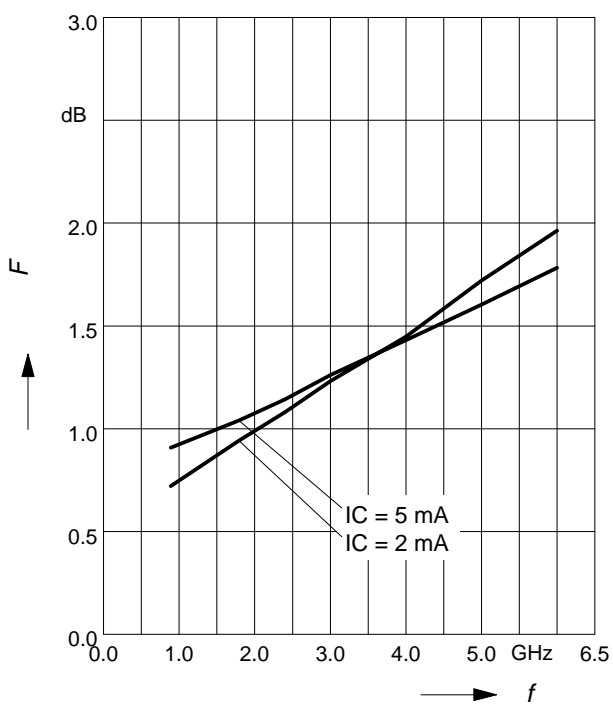
### Noise figure $F = f(I_C)$

$V_{CE} = 2 \text{ V}$ ,  $f = 1.8 \text{ GHz}$



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

$V_{CE} = 2 \text{ V}$ ,  $Z_S = Z_{Sopt}$



### Source impedance for min.

Noise Figure vs. Frequency

$V_{CE} = 2 \text{ V}$ ,  $I_C = 2 \text{ mA} / 5 \text{ mA}$

