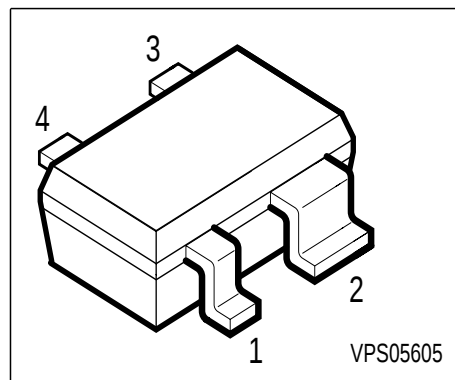


NPN Silicon RF Transistor

- For low current applications
- For oscillators up to 12 GHz
- Noise figure $F = 1.15$ dB at 1.8 GHz
outstanding $G_{ms} = 22$ dB at 1.8 GHz
- Transition frequency $f_T = 25$ GHz
- Gold metalization for high reliability
- **SIEGET[®] 25 - Line**
Siemens Grounded Emitter Transistor
25 GHz f_T - Line



ESD: Electrostatic discharge sensitive device, observe handling precaution!

Type	Marking	Ordering Code	Pin Configuration				Package
BFP 405	ALs	Q62702-F1592	1 = B	2 = E	3 = C	4 = E	SOT-343

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CEO}	4.5	V
Collector-base voltage	V_{CBO}	15	
Emitter-base voltage	V_{EBO}	1.5	
Collector current	I_C	12	mA
Base current	I_B	1	
Total power dissipation, $T_S \leq 120$ °C	P_{tot}	55	mW
Junction temperature	T_j	150	°C
Ambient temperature	T_A	-65 ...+150	
Storage temperature	T_{stg}	-65 ...+150	

Thermal Resistance

Junction - soldering point ¹⁾	R_{thJS}	≤ 530	K/W
--	------------	------------	-----

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.	
DC characteristics					
Collector-emitter breakdown voltage $I_C = 1\text{ mA}, I_B = 0$	$V_{(BR)CEO}$	4.5	5	6.5	V
Collector-base cutoff current $V_{CB} = 5\text{ V}, I_E = 0$	I_{CBO}	-	-	150	nA
Emitter-base cutoff current $V_{EB} = 1.5\text{ V}, I_C = 0$	I_{EBO}	-	-	15	μA
DC current gain $I_C = 5\text{ mA}, V_{CE} = 4\text{ V}$	h_{FE}	50	90	150	-
AC characteristics					
Transition frequency $I_C = 10\text{ mA}, V_{CE} = 3\text{ V}, f = 2\text{ GHz}$	f_T	20	25	-	GHz
Collector-base capacitance $V_{CB} = 2\text{ V}, f = 1\text{ MHz}$	C_{cb}	-	0.05	0.08	pF
Collector-emitter capacitance $V_{CE} = 2\text{ V}, f = 1\text{ MHz}$	C_{ce}	-	0.28	-	
Emitter-base capacitance $V_{EB} = 0.5\text{ V}, f = 1\text{ MHz}$	C_{eb}	-	0.29	-	
Noise figure $I_C = 2\text{ mA}, V_{CE} = 2\text{ V}, Z_S = Z_{Sopt}, f = 900\text{ MHz}$	F	-	1.15	1.4	dB
Power gain ¹⁾ $I_C = 5\text{ mA}, V_{CE} = 2\text{ V}, Z_S = Z_{Sopt}, Z_L = Z_{Lopt}, f = 1.8\text{ GHz}$	G_{ms}	-	22	-	
Insertion power gain $I_C = 5\text{ mA}, V_{CE} = 2\text{ V}, f = 1.8\text{ GHz}, Z_S = Z_L = 50\Omega$	$ S_{21} ^2$	14	17	-	dB
Third order intercept point $I_C = 5\text{ mA}, V_{CE} = 2\text{ V}, Z_S = Z_{Sopt}, Z_L = Z_{Lopt}, f = 1.8\text{ GHz}$	IP_3	-	15	-	dBm
1dB Compression point $I_C = 5\text{ mA}, V_{CE} = 2\text{ V}, f = 1.8\text{ GHz}, Z_S = Z_{Sopt}, Z_L = Z_{Lopt}$	P_{-1dB}	-	5	-	

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

Common Emitter S-Parameters

f	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
$V_{CE} = 2V, I_C = 5mA$								
0.1	0.841	-5.2	13.52	174.9	0.0033	88.9	0.986	-2.5
0.5	0.791	-25.4	12.76	154.6	0.0161	77.5	0.956	-12.6
1	0.682	-48.7	11.25	133.3	0.0290	67.9	0.873	-22.7
2	0.449	-88.6	8.04	100.3	0.0479	55.4	0.709	-36.8
3	0.304	-126.1	5.91	77.4	0.0639	49.2	0.594	-44.7
4	0.239	-171.1	4.63	58.9	0.799	43.2	0.509	-55.5
6	0.303	129.3	3.13	28	0.1104	30.2	0.386	-73.5
8	0.464	91.4	2.22	-1.5	0.118	13.6	0.251	-92.2
9	0.549	77.9	1.93	-15.5	0.129	5.1	0.153	106.6
10	0.631	71	1.65	-27.5	0.136	-2.2	0.069	-166.6
11	0.666	67.6	1.47	-38.2	0.145	-8.5	0.127	137.2
12	0.693	63.4	1.23	-49.5	0.155	-15.3	0.187	75.6

Common Emitter Noise Parameters

f	F_{min} ¹⁾	G_a ¹⁾	Γ_{opt}		R_N	r_n	$F_{50\Omega}$ ²⁾	$ S_{21} ^2$ ²⁾
GHz	dB	dB	MAG	ANG	Ω	-	dB	dB
$V_{CE} = 2V, I_C = 2mA$								
0.9	0.9	21.2	0.54	14	21	0.42	1.8	16.1
1.8	1.15	18.2	0.46	27	19	0.38	1.8	15
2.4	1.35	15.5	0.41	38	18	0.36	1.8	14
3.0	1.46	14.5	0.34	55	17	0.34	1.8	12.9
4	1.62	11.9	0.26	80	12.5	0.25	1.8	11.3
5	1.75	9.3	0.17	117	11	0.22	1.9	9.7
6	2.15	8.1	0.13	180	14	0.28	2.2	8.2

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

2) $Z_S = Z_L = 50\Omega$

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

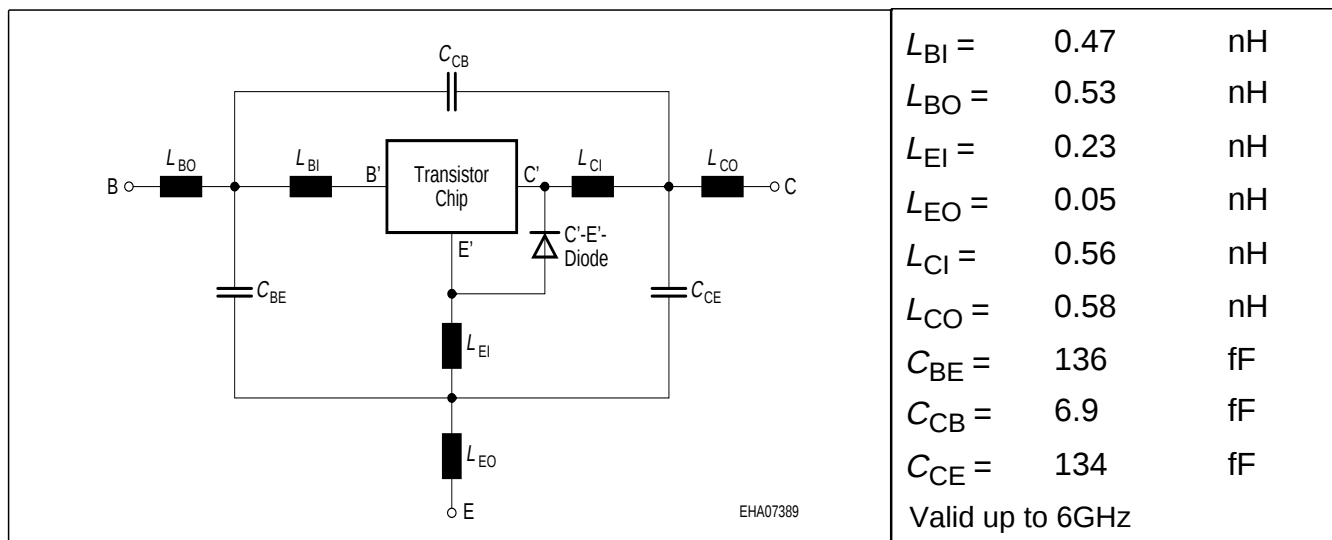
IS =	0.21024	fA	BF =	83.23	-	NF =	1.0405	-
VAF =	39.251	V	IKF =	0.16493	A	ISE =	15.761	fA
NE =	1.7763	-	BR =	10.526	-	NR =	0.96647	-
VAR =	34.368	V	IKR =	0.25052	A	ISC =	0.037223	fA
NC =	1.3152	-	RB =	15	Ω	IRB =	0.21215	mA
RBM =	1.3491	Ω	RE =	1.9289		RC =	0.12691	Ω
CJE =	3.7265	fF	VJE =	0.70367	V	MJE =	0.37747	-
TF =	4.5899	ps	XTF =	0.3641	-	VTF =	0.19762	V
ITF =	1.3364	mA	PTF =	0	deg	CJC =	96.941	fF
VJC =	0.99532	V	MJC =	0.48652	-	XCJC =	0.08161	-
TR =	1.4935	ns	CJS =	0	fF	VJS =	0.75	V
MJS =	0	-	XTB =	0	-	EG =	1.11	eV
XTI =	3	-	FC =	0.99469	-	TNOM	300	K

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

IS =	2	fA	N =	1.02	-	RS =	20	Ω
------	---	----	-----	------	---	------	----	----------

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)
© 1996 SIEMENS AG

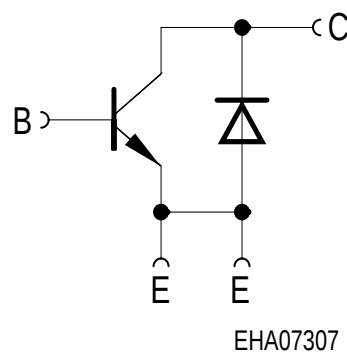
For examples and ready to use parameters please contact your local Siemens distributor or sales office to obtain a Siemens CD-ROM or see Internet: <http://www.siemens.de/Semiconductor/products/35/35.htm>

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 $< 100\text{MHz}$.
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:

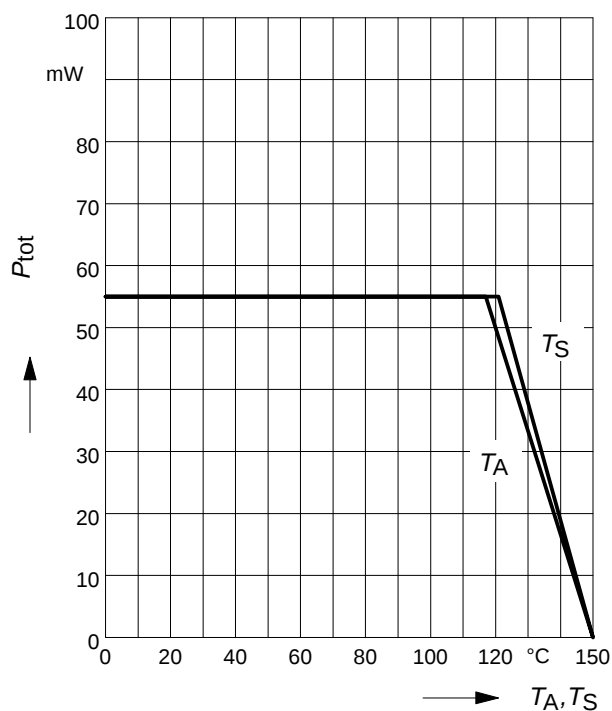
- Higher gain because of lower emitter inductance.
- Power is dissipated via the grounded emitter leads, because the chip is mounted on copper emitter leadframe.

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

The AC characteristics are verified by random sampling.

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

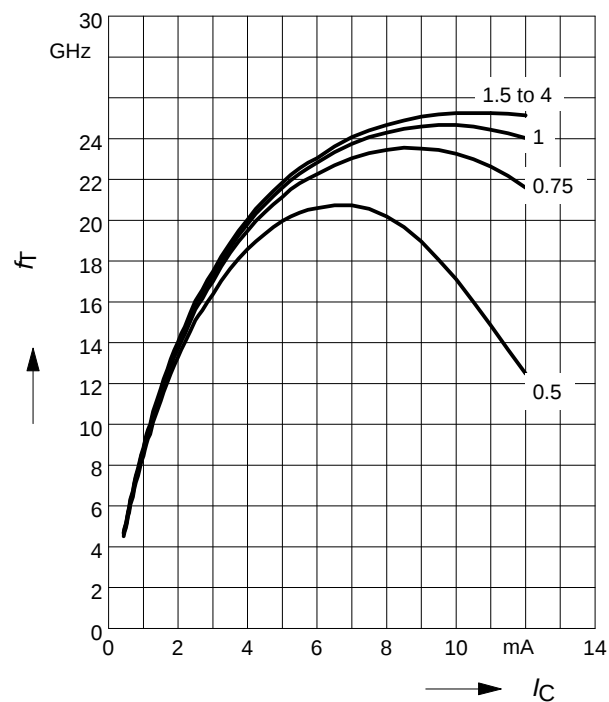
* Package mounted on epoxy



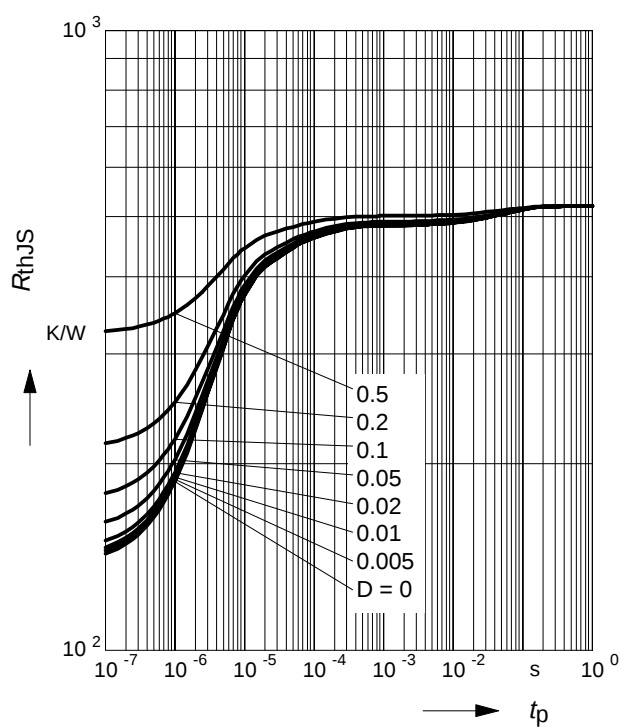
Transition frequency $f_T = f(I_C)$

$f = 2 \text{ GHz}$

$V_{CE} = \text{parameter in V}$

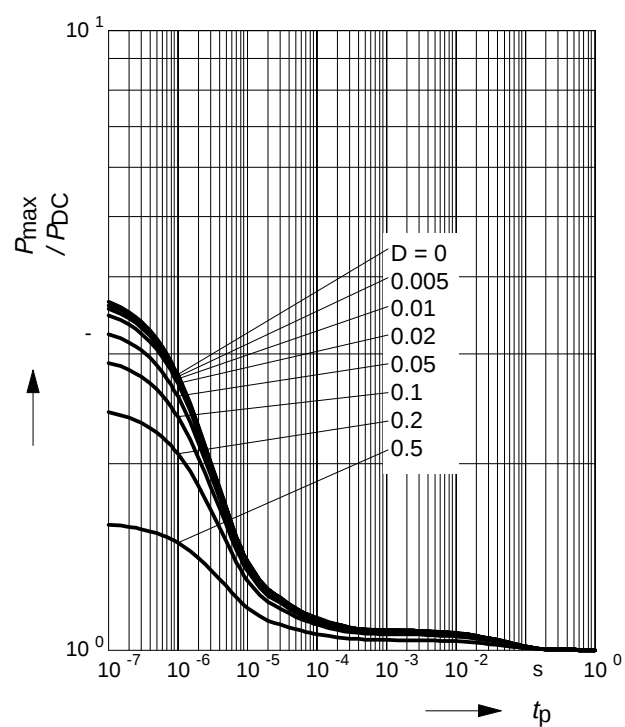


Permissible Pulse Load $R_{\text{thJS}} = f(t_p)$



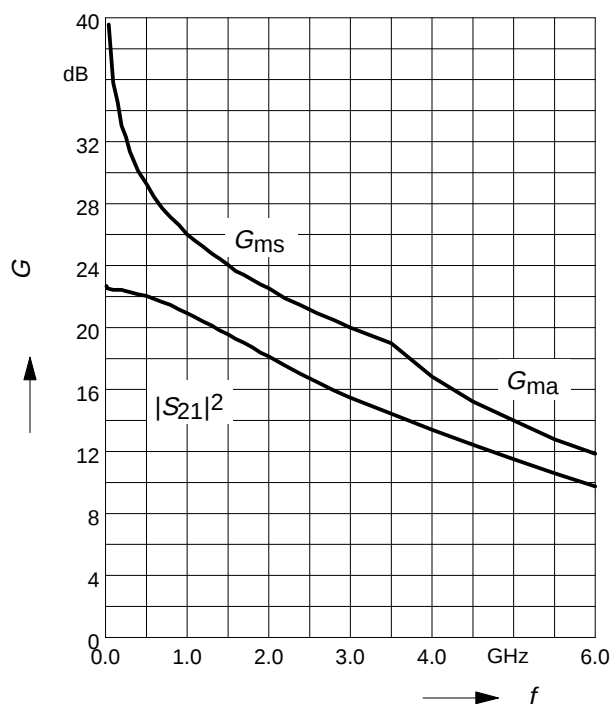
Permissible Pulse Load

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



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

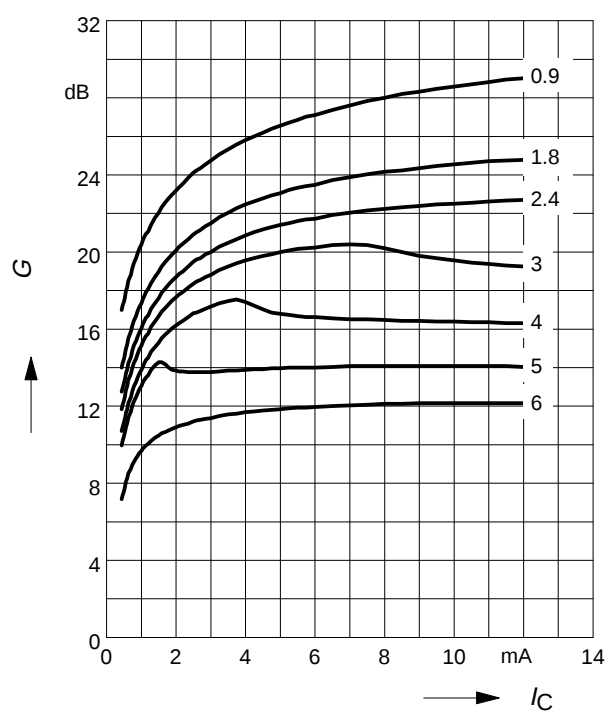
$V_{CE} = 2V$, $I_C = 5mA$



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

$V_{CE} = 2V$

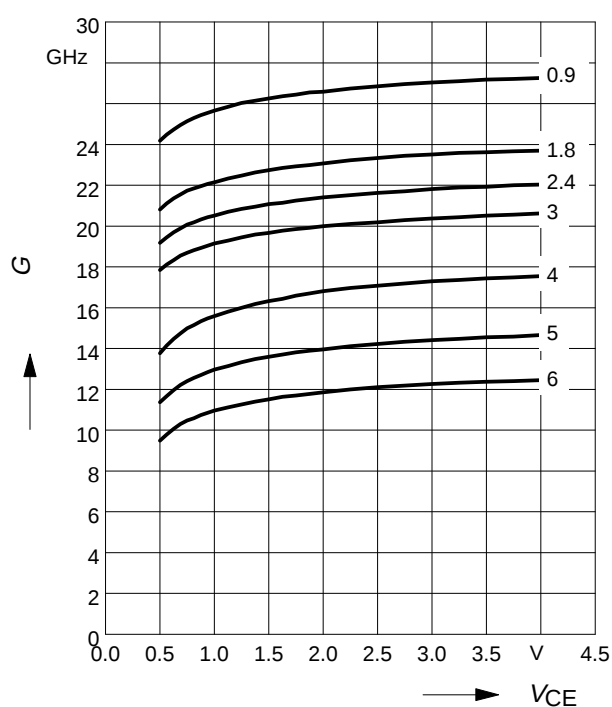
$f = \text{parameter in GHz}$



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

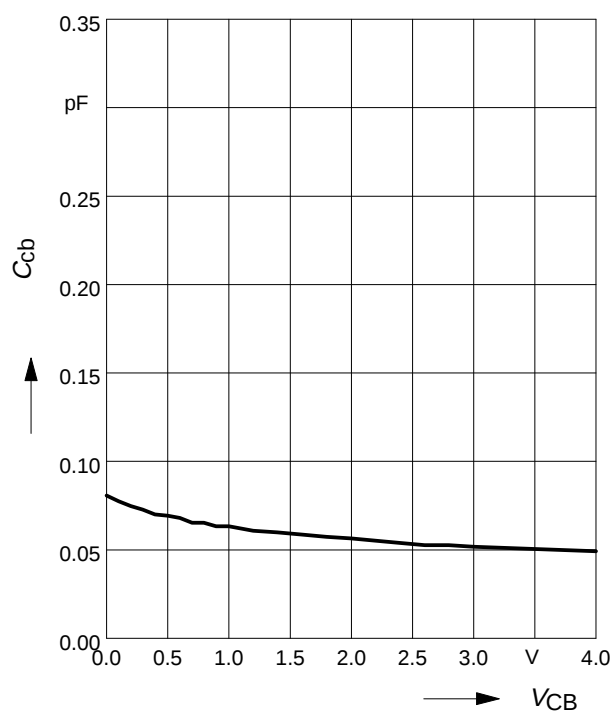
$I_C = 5mA$

$f = \text{parameter in V}$



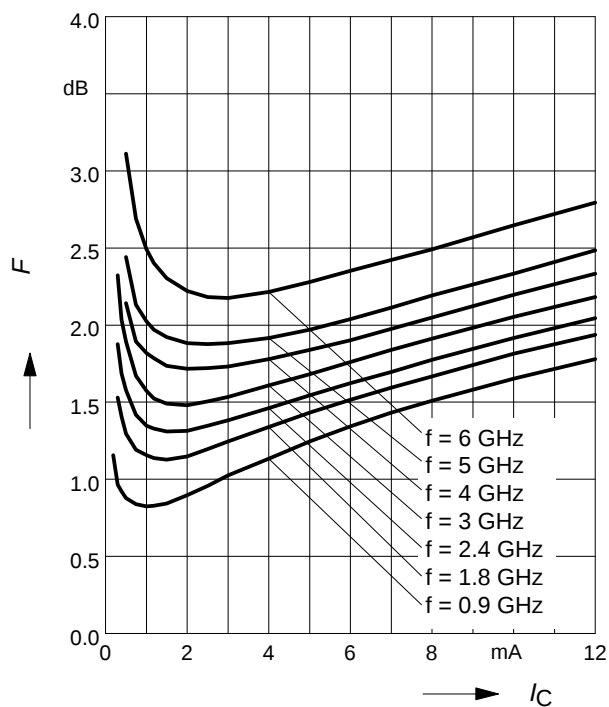
Collector-base capacitance $C_{cb} = f(V_{CB})$

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



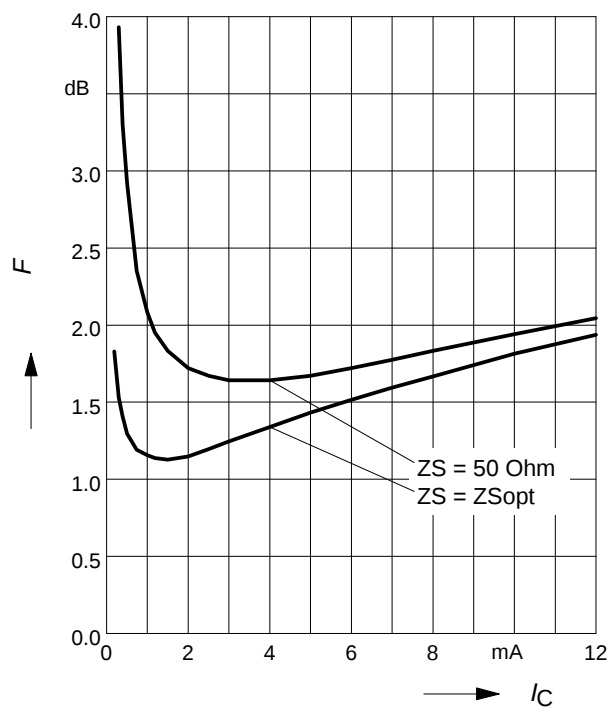
Noise figure $F = f(I_C)$

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



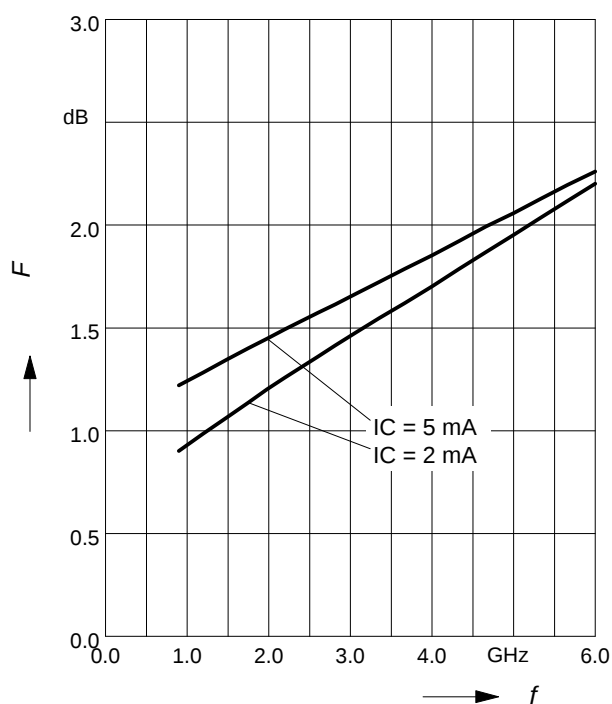
Noise figure $F = f(I_C)$

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



Noise figure $F = f(f)$

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



Source impedance for min.

Noise Figure versus Frequency

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

